

Linux Device Drivers

Linux Device Drivers

This documentation is free software; you can redistribute it and/or modify it under the terms of the GNU General Public License as published by the Free Software Foundation; either version 2 of the License, or (at your option) any later version.

This program is distributed in the hope that it will be useful, but WITHOUT ANY WARRANTY; without even the implied warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the GNU General Public License for more details.

You should have received a copy of the GNU General Public License along with this program; if not, write to the Free Software Foundation, Inc., 59 Temple Place, Suite 330, Boston, MA 02111-1307 USA

For more details see the file COPYING in the source distribution of Linux.

Table of Contents

1. Driver Basics	1
Driver Entry and Exit points	1
Atomic and pointer manipulation	3
Delaying, scheduling, and timer routines	17
Wait queues and Wake events	71
High-resolution timers	103
Workqueues and Kevents	123
Internal Functions	140
Kernel objects manipulation	174
Kernel utility functions	187
Device Resource Management	243
2. Device drivers infrastructure	267
The Basic Device Driver-Model Structures	267
Device Drivers Base	278
Device Drivers DMA Management	380
Device Drivers Power Management	432
Device Drivers ACPI Support	438
Device drivers PnP support	447
Userspace IO devices	459
3. Parallel Port Devices	466
parport_yield	467
parport_yield_blocking	468
parport_wait_event	469
parport_wait_peripheral	470
parport_negotiate	471
parport_write	472
parport_read	473
parport_set_timeout	474
parport_register_driver	475
parport_unregister_driver	476
parport_get_port	477
parport_put_port	478
parport_register_port	479
parport_announce_port	480
parport_remove_port	481
parport_register_device	482
parport_unregister_device	484
parport_find_number	485
parport_find_base	486
parport_claim	487
parport_claim_or_block	488
parport_release	489
parport_open	490
parport_close	491
4. Message-based devices	492
Fusion message devices	492
5. Sound Devices	611
snd_printk	612
snd_printd	613
snd_BUG	614
snd_printd_ratelimit	615

snd_BUG_ON	616
snd_printdd	617
register_sound_special_device	618
register_sound_mixer	619
register_sound_midi	620
register_sound_dsp	621
unregister_sound_special	622
unregister_sound_mixer	623
unregister_sound_midi	624
unregister_sound_dsp	625
snd_pcm_stream_linked	626
snd_pcm_stream_lock_irqsave	627
snd_pcm_group_for_each_entry	628
snd_pcm_running	629
bytes_to_samples	630
bytes_to_frames	631
samples_to_bytes	632
frames_to_bytes	633
frame_aligned	634
snd_pcm_lib_buffer_bytes	635
snd_pcm_lib_period_bytes	636
snd_pcm_playback_avail	637
snd_pcm_capture_avail	638
snd_pcm_playback_hw_avail	639
snd_pcm_capture_hw_avail	640
snd_pcm_playback_ready	641
snd_pcm_capture_ready	642
snd_pcm_playback_data	643
snd_pcm_playback_empty	644
snd_pcm_capture_empty	645
snd_pcm_trigger_done	646
params_channels	647
params_rate	648
params_period_size	649
params_periods	650
params_buffer_size	651
params_buffer_bytes	652
snd_pcm_format_cpu_endian	653
snd_pcm_set_runtime_buffer	654
snd_pcm_gettime	655
snd_pcm_lib_alloc_vmalloc_buffer	656
snd_pcm_lib_alloc_vmalloc_32_buffer	657
snd_pcm_sgbuf_get_addr	658
snd_pcm_sgbuf_get_ptr	659
snd_pcm_sgbuf_get_chunk_size	660
snd_pcm_mmap_data_open	661
snd_pcm_mmap_data_close	662
snd_pcm_limit_isa_dma_size	663
snd_pcm_stream_str	664
snd_pcm_chmap_substream	665
pcm_format_to_bits	666
snd_pcm_format_name	667
snd_pcm_new_stream	668
snd_pcm_new	669

snd_pcm_new_internal	670
snd_pcm_notify	671
snd_device_new	672
snd_device_disconnect	673
snd_device_free	674
snd_device_register	675
snd_iprintf	676
snd_info_get_line	677
snd_info_get_str	678
snd_info_create_module_entry	679
snd_info_create_card_entry	680
snd_card_proc_new	681
snd_info_free_entry	682
snd_info_register	683
snd_rawmidi_receive	684
snd_rawmidi_transmit_empty	685
__snd_rawmidi_transmit_peek	686
snd_rawmidi_transmit_peek	687
__snd_rawmidi_transmit_ack	688
snd_rawmidi_transmit_ack	689
snd_rawmidi_transmit	690
snd_rawmidi_new	691
snd_rawmidi_set_ops	692
snd_request_card	693
snd_lookup_minor_data	694
snd_register_device	695
snd_unregister_device	696
copy_to_user_fromio	697
copy_from_user_toio	698
snd_pcm_lib_preallocate_free_for_all	699
snd_pcm_lib_preallocate_pages	700
snd_pcm_lib_preallocate_pages_for_all	701
snd_pcm_sgbuf_ops_page	702
snd_pcm_lib_malloc_pages	703
snd_pcm_lib_free_pages	704
snd_pcm_lib_free_vmalloc_buffer	705
snd_pcm_lib_get_vmalloc_page	706
snd_device_initialize	707
snd_card_new	708
snd_card_disconnect	709
snd_card_free_when_closed	710
snd_card_free	711
snd_card_set_id	712
snd_card_add_dev_attr	713
snd_card_register	714
snd_component_add	715
snd_card_file_add	716
snd_card_file_remove	717
snd_power_wait	718
snd_dma_program	719
snd_dma_disable	720
snd_dma_pointer	721
snd_ctl_notify	722
snd_ctl_new1	723

snd_ctl_free_one	724
snd_ctl_add	725
snd_ctl_replace	726
snd_ctl_remove	727
snd_ctl_remove_id	728
snd_ctl_activate_id	729
snd_ctl_rename_id	730
snd_ctl_find_numid	731
snd_ctl_find_id	732
snd_ctl_register_ioctl	733
snd_ctl_register_ioctl_compat	734
snd_ctl_unregister_ioctl	735
snd_ctl_unregister_ioctl_compat	736
snd_ctl_boolean_mono_info	737
snd_ctl_boolean_stereo_info	738
snd_ctl_enum_info	739
snd_pcm_set_ops	740
snd_pcm_set_sync	741
snd_interval_refine	742
snd_interval_ratnum	743
snd_interval_list	744
snd_interval_ranges	745
snd_pcm_hw_rule_add	746
snd_pcm_hw_constraint_mask64	747
snd_pcm_hw_constraint_integer	748
snd_pcm_hw_constraint_minmax	749
snd_pcm_hw_constraint_list	750
snd_pcm_hw_constraint_ranges	751
snd_pcm_hw_constraint_ratnums	752
snd_pcm_hw_constraint_ratdens	753
snd_pcm_hw_constraint_msbits	754
snd_pcm_hw_constraint_step	755
snd_pcm_hw_constraint_pow2	756
snd_pcm_hw_rule_noresample	757
snd_pcm_hw_param_value	758
snd_pcm_hw_param_first	759
snd_pcm_hw_param_last	760
snd_pcm_lib_ioctl	761
snd_pcm_period_elapsed	762
snd_pcm_add_chmap_ctls	763
snd_hwdep_new	764
snd_pcm_stream_lock	765
snd_pcm_stream_unlock	766
snd_pcm_stream_lock_irq	767
snd_pcm_stream_unlock_irq	768
snd_pcm_stream_unlock_irqrestore	769
snd_pcm_stop	770
snd_pcm_stop_xrun	771
snd_pcm_suspend	772
snd_pcm_suspend_all	773
snd_pcm_lib_default_mmap	774
snd_pcm_lib_mmap_iomem	775
snd_malloc_pages	776
snd_free_pages	777

snd_dma_alloc_pages	778
snd_dma_alloc_pages_fallback	779
snd_dma_free_pages	780
6. 16x50 UART Driver	781
uart_update_timeout	782
uart_get_baud_rate	783
uart_get_divisor	784
uart_console_write	785
uart_parse_earlycon	786
uart_parse_options	787
uart_set_options	788
uart_register_driver	789
uart_unregister_driver	790
uart_add_one_port	791
uart_remove_one_port	792
uart_handle_dcd_change	793
uart_handle_cts_change	794
uart_insert_char	795
serial8250_get_port	796
serial8250_suspend_port	797
serial8250_resume_port	798
serial8250_register_8250_port	799
serial8250_unregister_port	800
7. Frame Buffer Library	801
Frame Buffer Memory	801
Frame Buffer Colormap	804
Frame Buffer Video Mode Database	809
Frame Buffer Macintosh Video Mode Database	821
Frame Buffer Fonts	824
8. Input Subsystem	825
Input core	825
Multitouch Library	866
Polled input devices	878
Matrix keyboards/keypads	884
Sparse keymap support	887
9. Serial Peripheral Interface (SPI)	895
struct spi_device	896
struct spi_driver	898
spi_unregister_driver	899
module_spi_driver	900
struct spi_master	901
struct spi_transfer	905
struct spi_message	907
spi_message_init_with_transfers	908
spi_write	909
spi_read	910
spi_sync_transfer	911
spi_w8r8	912
spi_w8r16	913
spi_w8r16be	914
struct spi_board_info	915
spi_register_board_info	916
spi_register_driver	917
spi_alloc_device	918

spi_add_device	919
spi_new_device	920
spi_finalize_current_transfer	921
spi_get_next_queued_message	922
spi_finalize_current_message	923
spi_alloc_master	924
spi_register_master	925
devm_spi_register_master	926
spi_unregister_master	927
spi_busnum_to_master	928
spi_setup	929
spi_async	930
spi_async_locked	931
spi_sync	932
spi_sync_locked	933
spi_bus_lock	934
spi_bus_unlock	935
spi_write_then_read	936
10. I ² C and SMBus Subsystem	937
struct i2c_driver	938
struct i2c_client	940
struct i2c_board_info	941
I2C_BOARD_INFO	942
struct i2c_algorithm	943
struct i2c_bus_recovery_info	944
struct i2c_adapter_quirks	945
module_i2c_driver	946
i2c_register_board_info	947
i2c_verify_client	948
i2c_lock_adapter	949
i2c_unlock_adapter	950
i2c_new_device	951
i2c_unregister_device	952
i2c_new_dummy	953
i2c_verify_adapter	954
i2c_add_adapter	955
i2c_add_numbered_adapter	956
i2c_del_adapter	957
i2c_del_driver	958
i2c_use_client	959
i2c_release_client	960
__i2c_transfer	961
i2c_transfer	962
i2c_master_send	963
i2c_master_recv	964
i2c_smbus_read_byte	965
i2c_smbus_write_byte	966
i2c_smbus_read_byte_data	967
i2c_smbus_write_byte_data	968
i2c_smbus_read_word_data	969
i2c_smbus_write_word_data	970
i2c_smbus_read_block_data	971
i2c_smbus_write_block_data	972
i2c_smbus_xfer	973

11. High Speed Synchronous Serial Interface (HSI)	974
struct hsi_channel	975
struct hsi_config	976
struct hsi_board_info	977
struct hsi_client	978
struct hsi_client_driver	979
struct hsi_msg	980
struct hsi_port	981
struct hsi_controller	982
hsi_id	983
hsi_port_id	984
hsi_setup	985
hsi_flush	986
hsi_async_read	987
hsi_async_write	988
hsi_start_tx	989
hsi_stop_tx	990
hsi_port_unregister_clients	991
hsi_unregister_controller	992
hsi_register_controller	993
hsi_register_client_driver	994
hsi_put_controller	995
hsi_alloc_controller	996
hsi_free_msg	997
hsi_alloc_msg	998
hsi_async	999
hsi_claim_port	1000
hsi_release_port	1001
hsi_register_port_event	1002
hsi_unregister_port_event	1003
hsi_event	1004
hsi_get_channel_id_by_name	1005

Chapter 1. Driver Basics

Driver Entry and Exit points

Name

`module_init` — driver initialization entry point

Synopsis

```
module_init ( x );
```

Arguments

`x` function to be run at kernel boot time or module insertion

Description

`module_init` will either be called during `do_initcalls` (if builtin) or at module insertion time (if a module). There can only be one per module.

Name

`module_exit` — driver exit entry point

Synopsis

```
module_exit ( x );
```

Arguments

`x` function to be run when driver is removed

Description

`module_exit` will wrap the driver clean-up code with `cleanup_module` when used with `rmmod` when the driver is a module. If the driver is statically compiled into the kernel, `module_exit` has no effect. There can only be one per module.

Atomic and pointer manipulation

Name

`atomic_read` — read atomic variable

Synopsis

```
int atomic_read (const atomic_t * v);
```

Arguments

`v` pointer of type `atomic_t`

Description

Atomically reads the value of `v`.

Name

`atomic_set` — set atomic variable

Synopsis

```
void atomic_set (atomic_t * v, int i);
```

Arguments

v pointer of type `atomic_t`

i required value

Description

Atomically sets the value of *v* to *i*.

Name

`atomic_add` — add integer to atomic variable

Synopsis

```
void atomic_add (int i, atomic_t * v);
```

Arguments

i integer value to add

v pointer of type `atomic_t`

Description

Atomically adds *i* to *v*.

Name

`atomic_sub` — subtract integer from atomic variable

Synopsis

```
void atomic_sub (int i, atomic_t * v);
```

Arguments

i integer value to subtract

v pointer of type `atomic_t`

Description

Atomically subtracts *i* from *v*.

Name

`atomic_sub_and_test` — subtract value from variable and test result

Synopsis

```
int atomic_sub_and_test (int i, atomic_t * v);
```

Arguments

i integer value to subtract

v pointer of type `atomic_t`

Description

Atomically subtracts *i* from *v* and returns true if the result is zero, or false for all other cases.

Name

`atomic_inc` — increment atomic variable

Synopsis

```
void atomic_inc (atomic_t * v);
```

Arguments

`v` pointer of type `atomic_t`

Description

Atomically increments `v` by 1.

Name

`atomic_dec` — decrement atomic variable

Synopsis

```
void atomic_dec (atomic_t * v);
```

Arguments

`v` pointer of type `atomic_t`

Description

Atomically decrements `v` by 1.

Name

`atomic_dec_and_test` — decrement and test

Synopsis

```
int atomic_dec_and_test (atomic_t * v);
```

Arguments

`v` pointer of type `atomic_t`

Description

Atomically decrements `v` by 1 and returns true if the result is 0, or false for all other cases.

Name

`atomic_inc_and_test` — increment and test

Synopsis

```
int atomic_inc_and_test (atomic_t * v);
```

Arguments

`v` pointer of type `atomic_t`

Description

Atomically increments `v` by 1 and returns true if the result is zero, or false for all other cases.

Name

`atomic_add_negative` — add and test if negative

Synopsis

```
int atomic_add_negative (int i, atomic_t * v);
```

Arguments

i integer value to add

v pointer of type `atomic_t`

Description

Atomically adds *i* to *v* and returns true if the result is negative, or false when result is greater than or equal to zero.

Name

`atomic_add_return` — add integer and return

Synopsis

```
int atomic_add_return (int i, atomic_t * v);
```

Arguments

i integer value to add

v pointer of type `atomic_t`

Description

Atomically adds *i* to *v* and returns *i* + *v*

Name

`atomic_sub_return` — subtract integer and return

Synopsis

```
int atomic_sub_return (int i, atomic_t * v);
```

Arguments

i integer value to subtract

v pointer of type `atomic_t`

Description

Atomically subtracts *i* from *v* and returns *v* - *i*

Name

`__atomic_add_unless` — add unless the number is already a given value

Synopsis

```
int __atomic_add_unless (atomic_t * v, int a, int u);
```

Arguments

v pointer of type `atomic_t`

a the amount to add to *v*...

u ...unless *v* is equal to *u*.

Description

Atomically adds *a* to *v*, so long as *v* was not already *u*. Returns the old value of *v*.

Name

`atomic_inc_short` — increment of a short integer

Synopsis

```
short int atomic_inc_short (short int * v);
```

Arguments

`v` pointer to type `int`

Description

Atomically adds 1 to `v` Returns the new value of `u`

Delaying, scheduling, and timer routines

Name

struct cputime — snaphsot of system and user cputime

Synopsis

```
struct cputime {  
    cputime_t utime;  
    cputime_t stime;  
};
```

Members

utime time spent in user mode

stime time spent in system mode

Description

Gathers a generic snapshot of user and system time.

Name

struct task_cputime — collected CPU time counts

Synopsis

```
struct task_cputime {  
    cputime_t utime;  
    cputime_t stime;  
    unsigned long long sum_exec_runtime;  
};
```

Members

utime	time spent in user mode, in cputime_t units
stime	time spent in kernel mode, in cputime_t units
sum_exec_runtime	total time spent on the CPU, in nanoseconds

Description

This is an extension of struct cputime that includes the total runtime spent by the task from the scheduler point of view.

As a result, this structure groups together three kinds of CPU time that are tracked for threads and thread groups. Most things considering CPU time want to group these counts together and treat all three of them in parallel.

Name

struct thread_group_cputimer — thread group interval timer counts

Synopsis

```
struct thread_group_cputimer {  
    struct task_cputime cputime;  
    int running;  
    raw_spinlock_t lock;  
};
```

Members

<code>cputime</code>	thread group interval timers.
<code>running</code>	non-zero when there are timers running and <i>cputime</i> receives updates.
<code>lock</code>	lock for fields in this struct.

Description

This structure contains the version of `task_cputime`, above, that is used for thread group CPU timer calculations.

Name

`pid_alive` — check that a task structure is not stale

Synopsis

```
int pid_alive (const struct task_struct * p);
```

Arguments

p Task structure to be checked.

Description

Test if a process is not yet dead (at most zombie state) If `pid_alive` fails, then pointers within the task structure can be stale and must not be dereferenced.

Return

1 if the process is alive. 0 otherwise.

Name

`is_global_init` — check if a task structure is init

Synopsis

```
int is_global_init (struct task_struct * tsk);
```

Arguments

tsk Task structure to be checked.

Description

Check if a task structure is the first user space task the kernel created.

Return

1 if the task structure is init. 0 otherwise.

Name

`task_nice` — return the nice value of a given task.

Synopsis

```
int task_nice (const struct task_struct * p);
```

Arguments

p the task in question.

Return

The nice value [-20 ... 0 ... 19].

Name

`is_idle_task` — is the specified task an idle task?

Synopsis

```
bool is_idle_task (const struct task_struct * p);
```

Arguments

p the task in question.

Return

1 if *p* is an idle task. 0 otherwise.

Name

`threadgroup_lock` — lock threadgroup

Synopsis

```
void threadgroup_lock (struct task_struct * tsk);
```

Arguments

tsk member task of the threadgroup to lock

Description

Lock the threadgroup *tsk* belongs to. No new task is allowed to enter and member tasks aren't allowed to exit (as indicated by `PF_EXITING`) or change `->group_leader/pid`. This is useful for cases where the threadgroup needs to stay stable across blockable operations.

fork and exit paths explicitly call `threadgroup_change_{begin|end}()` for synchronization. While held, no new task will be added to threadgroup and no existing live task will have its `PF_EXITING` set.

`de_thread` does `threadgroup_change_{begin|end}()` when a non-leader sub-thread becomes a new leader.

Name

threadgroup_unlock — unlock threadgroup

Synopsis

```
void threadgroup_unlock (struct task_struct * tsk);
```

Arguments

tsk member task of the threadgroup to unlock

Description

Reverse threadgroup_lock.

Name

wake_up_process — Wake up a specific process

Synopsis

```
int wake_up_process (struct task_struct * p);
```

Arguments

p The process to be woken up.

Description

Attempt to wake up the nominated process and move it to the set of runnable processes.

Return

1 if the process was woken up, 0 if it was already running.

It may be assumed that this function implies a write memory barrier before changing the task state if and only if any tasks are woken up.

Name

`preempt_notifier_register` — tell me when current is being preempted & rescheduled

Synopsis

```
void preempt_notifier_register (struct preempt_notifier * notifier);
```

Arguments

notifier notifier struct to register

Name

`preempt_notifier_unregister` — no longer interested in preemption notifications

Synopsis

```
void preempt_notifier_unregister (struct preempt_notifier * notifier);
```

Arguments

notifier notifier struct to unregister

Description

This is safe to call from within a preemption notifier.

Name

`preempt_schedule_context` — `preempt_schedule` called by tracing

Synopsis

```
__visible void __sched notrace preempt_schedule_context ( void );
```

Arguments

void no arguments

Description

The tracing infrastructure uses `preempt_enable_notrace` to prevent recursion and tracing preempt enabling caused by the tracing infrastructure itself. But as tracing can happen in areas coming from userspace or just about to enter userspace, a preempt enable can occur before `user_exit` is called. This will cause the scheduler to be called when the system is still in usermode.

To prevent this, the `preempt_enable_notrace` will use this function instead of `preempt_schedule` to exit user context if needed before calling the scheduler.

Name

`sched_setscheduler` — change the scheduling policy and/or RT priority of a thread.

Synopsis

```
int sched_setscheduler (struct task_struct * p, int policy, const struct  
sched_param * param);
```

Arguments

p the task in question.

policy new policy.

param structure containing the new RT priority.

Return

0 on success. An error code otherwise.

NOTE that the task may be already dead.

Name

`yield` — yield the current processor to other threads.

Synopsis

```
void __sched yield ( void );
```

Arguments

void no arguments

Description

Do not ever use this function, there's a 99% chance you're doing it wrong.

The scheduler is at all times free to pick the calling task as the most eligible task to run, if removing the `yield` call from your code breaks it, its already broken.

Typical broken usage is

```
while (!event) yield;
```

where one assumes that `yield` will let 'the other' process run that will make event true. If the current task is a `SCHED_FIFO` task that will never happen. Never use `yield` as a progress guarantee!!

If you want to use `yield` to wait for something, use `wait_event`. If you want to use `yield` to be 'nice' for others, use `cond_resched`. If you still want to use `yield`, do not!

Name

`yield_to` — yield the current processor to another thread in your thread group, or accelerate that thread toward the processor it's on.

Synopsis

```
int __sched yield_to (struct task_struct * p, bool preempt);
```

Arguments

p target task

preempt whether task preemption is allowed or not

Description

It's the caller's job to ensure that the target task struct can't go away on us before we can do any checks.

Return

true (>0) if we indeed boosted the target task. false (0) if we failed to boost the target. -ESRCH if there's no task to yield to.

Name

`cpupri_find` — find the best (lowest-pri) CPU in the system

Synopsis

```
int cpupri_find (struct cpupri * cp, struct task_struct * p, struct
cpumask * lowest_mask);
```

Arguments

<i>cp</i>	The cpupri context
<i>p</i>	The task
<i>lowest_mask</i>	A mask to fill in with selected CPUs (or NULL)

Note

This function returns the recommended CPUs as calculated during the current invocation. By the time the call returns, the CPUs may have in fact changed priorities any number of times. While not ideal, it is not an issue of correctness since the normal rebalancer logic will correct any discrepancies created by racing against the uncertainty of the current priority configuration.

Return

(int)bool - CPUs were found

Name

`cpupri_set` — update the cpu priority setting

Synopsis

```
void cpupri_set (struct cpupri * cp, int cpu, int newpri);
```

Arguments

<i>cp</i>	The cpupri context
<i>cpu</i>	The target cpu
<i>newpri</i>	The priority (INVALID-RT99) to assign to this CPU

Note

Assumes `cpu_rq(cpu)->lock` is locked

Returns

(void)

Name

`cpupri_init` — initialize the `cpupri` structure

Synopsis

```
int cpupri_init (struct cpupri * cp);
```

Arguments

cp The `cpupri` context

Return

-ENOMEM on memory allocation failure.

Name

`cpupri_cleanup` — clean up the `cpupri` structure

Synopsis

```
void cpupri_cleanup (struct cpupri * cp);
```

Arguments

cp The `cpupri` context

Name

`get_sd_load_idx` — Obtain the load index for a given sched domain.

Synopsis

```
int get_sd_load_idx (struct sched_domain * sd, enum cpu_idle_type idle);
```

Arguments

sd The sched_domain whose load_idx is to be obtained.

idle The idle status of the CPU for whose sd load_idx is obtained.

Return

The load index.

Name

`update_sg_lb_stats` — Update `sched_group`'s statistics for load balancing.

Synopsis

```
void update_sg_lb_stats (struct lb_env * env, struct sched_group *  
group, int load_idx, int local_group, struct sg_lb_stats * sgs, bool  
* overload);
```

Arguments

<i>env</i>	The load balancing environment.
<i>group</i>	<code>sched_group</code> whose statistics are to be updated.
<i>load_idx</i>	Load index of <code>sched_domain</code> of <code>this_cpu</code> for load calc.
<i>local_group</i>	Does group contain <code>this_cpu</code> .
<i>sgs</i>	variable to hold the statistics for this group.
<i>overload</i>	Indicate more than one runnable task for any CPU.

Name

`update_sd_pick_busiest` — return 1 on busiest group

Synopsis

```
bool update_sd_pick_busiest (struct lb_env * env, struct sd_lb_stats *  
sds, struct sched_group * sg, struct sg_lb_stats * sgs);
```

Arguments

env The load balancing environment.

sds sched_domain statistics

sg sched_group candidate to be checked for being the busiest

sgs sched_group statistics

Description

Determine if *sg* is a busier group than the previously selected busiest group.

Return

true if *sg* is a busier group than the previously selected busiest group. false otherwise.

Name

`update_sd_lb_stats` — Update sched_domain's statistics for load balancing.

Synopsis

```
void update_sd_lb_stats (struct lb_env * env, struct sd_lb_stats * sds);
```

Arguments

env The load balancing environment.

sds variable to hold the statistics for this sched_domain.

Name

`check_asym_packing` — Check to see if the group is packed into the sched domain.

Synopsis

```
int check_asym_packing (struct lb_env * env, struct sd_lb_stats * sds);
```

Arguments

env The load balancing environment.

sds Statistics of the sched_domain which is to be packed

Description

This is primarily intended to be used at the sibling level. Some cores like POWER7 prefer to use lower numbered SMT threads. In the case of POWER7, it can move to lower SMT modes only when higher threads are idle. When in lower SMT modes, the threads will perform better since they share less core resources. Hence when we have idle threads, we want them to be the higher ones.

This packing function is run on idle threads. It checks to see if the busiest CPU in this domain (core in the P7 case) has a higher CPU number than the packing function is being run on. Here we are assuming lower CPU number will be equivalent to lower a SMT thread number.

Return

1 when packing is required and a task should be moved to this CPU. The amount of the imbalance is returned in **imbalance*.

Name

`fix_small_imbalance` — Calculate the minor imbalance that exists amongst the groups of a `sched_domain`, during load balancing.

Synopsis

```
void fix_small_imbalance (struct lb_env * env, struct sd_lb_stats *  
sds);
```

Arguments

env The load balancing environment.

sds Statistics of the `sched_domain` whose imbalance is to be calculated.

Name

`calculate_imbalance` — Calculate the amount of imbalance present within the groups of a given `sched_domain` during load balance.

Synopsis

```
void calculate_imbalance (struct lb_env * env, struct sd_lb_stats *  
sds);
```

Arguments

env load balance environment

sds statistics of the `sched_domain` whose imbalance is to be calculated.

Name

`find_busiest_group` — Returns the busiest group within the `sched_domain` if there is an imbalance. If there isn't an imbalance, and the user has opted for power-savings, it returns a group whose CPUs can be put to idle by rebalancing those tasks elsewhere, if such a group exists.

Synopsis

```
struct sched_group * find_busiest_group (struct lb_env * env);
```

Arguments

env The load balancing environment.

Description

Also calculates the amount of weighted load which should be moved to restore balance.

Return

- The busiest group if imbalance exists. - If no imbalance and user has opted for power-savings balance, return the least loaded group whose CPUs can be put to idle by rebalancing its tasks onto our group.

Name

DECLARE_COMPLETION — declare and initialize a completion structure

Synopsis

```
DECLARE_COMPLETION ( work );
```

Arguments

work identifier for the completion structure

Description

This macro declares and initializes a completion structure. Generally used for static declarations. You should use the `_ONSTACK` variant for automatic variables.

Name

`DECLARE_COMPLETION_ONSTACK` — declare and initialize a completion structure

Synopsis

```
DECLARE_COMPLETION_ONSTACK ( work );
```

Arguments

work identifier for the completion structure

Description

This macro declares and initializes a completion structure on the kernel stack.

Name

`init_completion` — Initialize a dynamically allocated completion

Synopsis

```
void init_completion (struct completion * x);
```

Arguments

x pointer to completion structure that is to be initialized

Description

This inline function will initialize a dynamically created completion structure.

Name

`reinit_completion` — reinitialize a completion structure

Synopsis

```
void reinit_completion (struct completion * x);
```

Arguments

x pointer to completion structure that is to be reinitialized

Description

This inline function should be used to reinitialize a completion structure so it can be reused. This is especially important after `complete_all` is used.

Name

`__round_jiffies` — function to round jiffies to a full second

Synopsis

```
unsigned long __round_jiffies (unsigned long j, int cpu);
```

Arguments

j the time in (absolute) jiffies that should be rounded

cpu the processor number on which the timeout will happen

Description

`__round_jiffies` rounds an absolute time in the future (in jiffies) up or down to (approximately) full seconds. This is useful for timers for which the exact time they fire does not matter too much, as long as they fire approximately every X seconds.

By rounding these timers to whole seconds, all such timers will fire at the same time, rather than at various times spread out. The goal of this is to have the CPU wake up less, which saves power.

The exact rounding is skewed for each processor to avoid all processors firing at the exact same time, which could lead to lock contention or spurious cache line bouncing.

The return value is the rounded version of the *j* parameter.

Name

`__round_jiffies_relative` — function to round jiffies to a full second

Synopsis

```
unsigned long __round_jiffies_relative (unsigned long j, int cpu);
```

Arguments

j the time in (relative) jiffies that should be rounded

cpu the processor number on which the timeout will happen

Description

`__round_jiffies_relative` rounds a time delta in the future (in jiffies) up or down to (approximately) full seconds. This is useful for timers for which the exact time they fire does not matter too much, as long as they fire approximately every X seconds.

By rounding these timers to whole seconds, all such timers will fire at the same time, rather than at various times spread out. The goal of this is to have the CPU wake up less, which saves power.

The exact rounding is skewed for each processor to avoid all processors firing at the exact same time, which could lead to lock contention or spurious cache line bouncing.

The return value is the rounded version of the *j* parameter.

Name

`round_jiffies` — function to round jiffies to a full second

Synopsis

```
unsigned long round_jiffies (unsigned long j);
```

Arguments

j the time in (absolute) jiffies that should be rounded

Description

`round_jiffies` rounds an absolute time in the future (in jiffies) up or down to (approximately) full seconds. This is useful for timers for which the exact time they fire does not matter too much, as long as they fire approximately every X seconds.

By rounding these timers to whole seconds, all such timers will fire at the same time, rather than at various times spread out. The goal of this is to have the CPU wake up less, which saves power.

The return value is the rounded version of the *j* parameter.

Name

`round_jiffies_relative` — function to round jiffies to a full second

Synopsis

```
unsigned long round_jiffies_relative (unsigned long j);
```

Arguments

j the time in (relative) jiffies that should be rounded

Description

`round_jiffies_relative` rounds a time delta in the future (in jiffies) up or down to (approximately) full seconds. This is useful for timers for which the exact time they fire does not matter too much, as long as they fire approximately every X seconds.

By rounding these timers to whole seconds, all such timers will fire at the same time, rather than at various times spread out. The goal of this is to have the CPU wake up less, which saves power.

The return value is the rounded version of the *j* parameter.

Name

`__round_jiffies_up` — function to round jiffies up to a full second

Synopsis

```
unsigned long __round_jiffies_up (unsigned long j, int cpu);
```

Arguments

j the time in (absolute) jiffies that should be rounded

cpu the processor number on which the timeout will happen

Description

This is the same as `__round_jiffies` except that it will never round down. This is useful for timeouts for which the exact time of firing does not matter too much, as long as they don't fire too early.

Name

`__round_jiffies_up_relative` — function to round jiffies up to a full second

Synopsis

```
unsigned long __round_jiffies_up_relative (unsigned long j, int cpu);
```

Arguments

j the time in (relative) jiffies that should be rounded

cpu the processor number on which the timeout will happen

Description

This is the same as `__round_jiffies_relative` except that it will never round down. This is useful for timeouts for which the exact time of firing does not matter too much, as long as they don't fire too early.

Name

`round_jiffies_up` — function to round jiffies up to a full second

Synopsis

```
unsigned long round_jiffies_up (unsigned long j);
```

Arguments

j the time in (absolute) jiffies that should be rounded

Description

This is the same as `round_jiffies` except that it will never round down. This is useful for timeouts for which the exact time of firing does not matter too much, as long as they don't fire too early.

Name

`round_jiffies_up_relative` — function to round jiffies up to a full second

Synopsis

```
unsigned long round_jiffies_up_relative (unsigned long j);
```

Arguments

j the time in (relative) jiffies that should be rounded

Description

This is the same as `round_jiffies_relative` except that it will never round down. This is useful for timeouts for which the exact time of firing does not matter too much, as long as they don't fire too early.

Name

`set_timer_slack` — set the allowed slack for a timer

Synopsis

```
void set_timer_slack (struct timer_list * timer, int slack_hz);
```

Arguments

timer the timer to be modified

slack_hz the amount of time (in jiffies) allowed for rounding

Description

Set the amount of time, in jiffies, that a certain timer has in terms of slack. By setting this value, the timer subsystem will schedule the actual timer somewhere between the time `mod_timer` asks for, and that time plus the slack.

By setting the slack to -1, a percentage of the delay is used instead.

Name

`init_timer_key` — initialize a timer

Synopsis

```
void init_timer_key (struct timer_list * timer, unsigned int flags,  
const char * name, struct lock_class_key * key);
```

Arguments

timer the timer to be initialized

flags timer flags

name name of the timer

key lockdep class key of the fake lock used for tracking timer sync lock dependencies

Description

`init_timer_key` must be done to a timer prior calling *any* of the other timer functions.

Name

`mod_timer_pending` — modify a pending timer's timeout

Synopsis

```
int mod_timer_pending (struct timer_list * timer, unsigned long expires);
```

Arguments

timer the pending timer to be modified

expires new timeout in jiffies

Description

`mod_timer_pending` is the same for pending timers as `mod_timer`, but will not re-activate and modify already deleted timers.

It is useful for unserialized use of timers.

Name

`mod_timer` — modify a timer's timeout

Synopsis

```
int mod_timer (struct timer_list * timer, unsigned long expires);
```

Arguments

timer the timer to be modified

expires new timeout in jiffies

Description

`mod_timer` is a more efficient way to update the `expire` field of an active timer (if the timer is inactive it will be activated)

`mod_timer(timer, expires)` is equivalent to:

```
del_timer(timer); timer->expires = expires; add_timer(timer);
```

Note that if there are multiple unserialized concurrent users of the same timer, then `mod_timer` is the only safe way to modify the timeout, since `add_timer` cannot modify an already running timer.

The function returns whether it has modified a pending timer or not. (ie. `mod_timer` of an inactive timer returns 0, `mod_timer` of an active timer returns 1.)

Name

`mod_timer_pinned` — modify a timer's timeout

Synopsis

```
int mod_timer_pinned (struct timer_list * timer, unsigned long expires);
```

Arguments

timer the timer to be modified

expires new timeout in jiffies

Description

`mod_timer_pinned` is a way to update the `expire` field of an active timer (if the timer is inactive it will be activated) and to ensure that the timer is scheduled on the current CPU.

Note that this does not prevent the timer from being migrated when the current CPU goes offline. If this is a problem for you, use CPU-hotplug notifiers to handle it correctly, for example, cancelling the timer when the corresponding CPU goes offline.

`mod_timer_pinned(timer, expires)` is equivalent to:

```
del_timer(timer); timer->expires = expires; add_timer(timer);
```

Name

`add_timer` — start a timer

Synopsis

```
void add_timer (struct timer_list * timer);
```

Arguments

timer the timer to be added

Description

The kernel will do a `->function(->data)` callback from the timer interrupt at the `->expires` point in the future. The current time is 'jiffies'.

The timer's `->expires`, `->function` (and if the handler uses it, `->data`) fields must be set prior calling this function.

Timers with an `->expires` field in the past will be executed in the next timer tick.

Name

`add_timer_on` — start a timer on a particular CPU

Synopsis

```
void add_timer_on (struct timer_list * timer, int cpu);
```

Arguments

timer the timer to be added

cpu the CPU to start it on

Description

This is not very scalable on SMP. Double adds are not possible.

Name

`del_timer` — deactivate a timer.

Synopsis

```
int del_timer (struct timer_list * timer);
```

Arguments

timer the timer to be deactivated

Description

`del_timer` deactivates a timer - this works on both active and inactive timers.

The function returns whether it has deactivated a pending timer or not. (ie. `del_timer` of an inactive timer returns 0, `del_timer` of an active timer returns 1.)

Name

`try_to_del_timer_sync` — Try to deactivate a timer

Synopsis

```
int try_to_del_timer_sync (struct timer_list * timer);
```

Arguments

timer timer to del

Description

This function tries to deactivate a timer. Upon successful (ret \geq 0) exit the timer is not queued and the handler is not running on any CPU.

Name

`del_timer_sync` — deactivate a timer and wait for the handler to finish.

Synopsis

```
int del_timer_sync (struct timer_list * timer);
```

Arguments

timer the timer to be deactivated

Description

This function only differs from `del_timer` on SMP: besides deactivating the timer it also makes sure the handler has finished executing on other CPUs.

Synchronization rules

Callers must prevent restarting of the timer, otherwise this function is meaningless. It must not be called from interrupt contexts unless the timer is an irqsafe one. The caller must not hold locks which would prevent completion of the timer's handler. The timer's handler must not call `add_timer_on`. Upon exit the timer is not queued and the handler is not running on any CPU.

Note

For !irqsafe timers, you must not hold locks that are held in interrupt context while calling this function. Even if the lock has nothing to do with the timer in question. Here's why:

```
CPU0  CPU1  ----  ----  <SOFTIRQ>  call_timer_fn;  base->running_timer = mytimer;
spin_lock_irq(somelock);  <IRQ>  spin_lock(somelock);  del_timer_sync(mytimer);  while (base-
->running_timer == mytimer);
```

Now `del_timer_sync` will never return and never release `somelock`. The interrupt on the other CPU is waiting to grab `somelock` but it has interrupted the softirq that CPU0 is waiting to finish.

The function returns whether it has deactivated a pending timer or not.

Name

`schedule_timeout` — sleep until timeout

Synopsis

```
signed long __sched schedule_timeout (signed long timeout);
```

Arguments

timeout timeout value in jiffies

Description

Make the current task sleep until *timeout* jiffies have elapsed. The routine will return immediately unless the current task state has been set (see `set_current_state`).

You can set the task state as follows -

`TASK_UNINTERRUPTIBLE` - at least *timeout* jiffies are guaranteed to pass before the routine returns. The routine will return 0

`TASK_INTERRUPTIBLE` - the routine may return early if a signal is delivered to the current task. In this case the remaining time in jiffies will be returned, or 0 if the timer expired in time

The current task state is guaranteed to be `TASK_RUNNING` when this routine returns.

Specifying a *timeout* value of `MAX_SCHEDULE_TIMEOUT` will schedule the CPU away without a bound on the timeout. In this case the return value will be `MAX_SCHEDULE_TIMEOUT`.

In all cases the return value is guaranteed to be non-negative.

Name

`msleep` — sleep safely even with waitqueue interruptions

Synopsis

```
void msleep (unsigned int msecs);
```

Arguments

msecs Time in milliseconds to sleep for

Name

`msleep_interruptible` — sleep waiting for signals

Synopsis

```
unsigned long msleep_interruptible (unsigned int msecs);
```

Arguments

msecs Time in milliseconds to sleep for

Name

`usleep_range` — Drop in replacement for `udelay` where wakeup is flexible

Synopsis

```
void usleep_range (unsigned long min, unsigned long max);
```

Arguments

min Minimum time in usecs to sleep

max Maximum time in usecs to sleep

Wait queues and Wake events

Name

`wait_event` — sleep until a condition gets true

Synopsis

```
wait_event ( wq, condition);
```

Arguments

wq the waitqueue to wait on

condition a C expression for the event to wait for

Description

The process is put to sleep (`TASK_UNINTERRUPTIBLE`) until the *condition* evaluates to true. The *condition* is checked each time the waitqueue *wq* is woken up.

`wake_up` has to be called after changing any variable that could change the result of the wait condition.

Name

`wait_event_freezable` — sleep (or freeze) until a condition gets true

Synopsis

```
wait_event_freezable ( wq, condition );
```

Arguments

wq the waitqueue to wait on

condition a C expression for the event to wait for

Description

The process is put to sleep (`TASK_INTERRUPTIBLE` -- so as not to contribute to system load) until the *condition* evaluates to true. The *condition* is checked each time the waitqueue *wq* is woken up.

`wake_up` has to be called after changing any variable that could change the result of the wait condition.

Name

`wait_event_timeout` — sleep until a condition gets true or a timeout elapses

Synopsis

```
wait_event_timeout ( wq, condition, timeout );
```

Arguments

<i>wq</i>	the waitqueue to wait on
<i>condition</i>	a C expression for the event to wait for
<i>timeout</i>	timeout, in jiffies

Description

The process is put to sleep (`TASK_UNINTERRUPTIBLE`) until the *condition* evaluates to true. The *condition* is checked each time the waitqueue *wq* is woken up.

`wake_up` has to be called after changing any variable that could change the result of the wait condition.

Returns

0 if the *condition* evaluated to false after the *timeout* elapsed, 1 if the *condition* evaluated to true after the *timeout* elapsed, or the remaining jiffies (at least 1) if the *condition* evaluated to true before the *timeout* elapsed.

Name

`wait_event_cmd` — sleep until a condition gets true

Synopsis

```
wait_event_cmd ( wq, condition, cmd1, cmd2 );
```

Arguments

<i>wq</i>	the waitqueue to wait on
<i>condition</i>	a C expression for the event to wait for
<i>cmd1</i>	the command will be executed before sleep
<i>cmd2</i>	the command will be executed after sleep

Description

The process is put to sleep (TASK_UNINTERRUPTIBLE) until the *condition* evaluates to true. The *condition* is checked each time the waitqueue *wq* is woken up.

`wake_up` has to be called after changing any variable that could change the result of the wait condition.

Name

`wait_event_interruptible` — sleep until a condition gets true

Synopsis

```
wait_event_interruptible ( wq, condition);
```

Arguments

wq the waitqueue to wait on

condition a C expression for the event to wait for

Description

The process is put to sleep (TASK_INTERRUPTIBLE) until the *condition* evaluates to true or a signal is received. The *condition* is checked each time the waitqueue *wq* is woken up.

`wake_up` has to be called after changing any variable that could change the result of the wait condition.

The function will return `-ERESTARTSYS` if it was interrupted by a signal and 0 if *condition* evaluated to true.

Name

`wait_event_interruptible_timeout` — sleep until a condition gets true or a timeout elapses

Synopsis

```
wait_event_interruptible_timeout ( wq, condition, timeout);
```

Arguments

<i>wq</i>	the waitqueue to wait on
<i>condition</i>	a C expression for the event to wait for
<i>timeout</i>	timeout, in jiffies

Description

The process is put to sleep (`TASK_INTERRUPTIBLE`) until the *condition* evaluates to true or a signal is received. The *condition* is checked each time the waitqueue *wq* is woken up.

`wake_up` has to be called after changing any variable that could change the result of the wait condition.

Returns

0 if the *condition* evaluated to false after the *timeout* elapsed, 1 if the *condition* evaluated to true after the *timeout* elapsed, the remaining jiffies (at least 1) if the *condition* evaluated to true before the *timeout* elapsed, or `-ERESTARTSYS` if it was interrupted by a signal.

Name

`wait_event_hrtimeout` — sleep until a condition gets true or a timeout elapses

Synopsis

```
wait_event_hrtimeout ( wq, condition, timeout);
```

Arguments

<i>wq</i>	the waitqueue to wait on
<i>condition</i>	a C expression for the event to wait for
<i>timeout</i>	timeout, as a <code>ktime_t</code>

Description

The process is put to sleep (`TASK_UNINTERRUPTIBLE`) until the *condition* evaluates to true or a signal is received. The *condition* is checked each time the waitqueue *wq* is woken up.

`wake_up` has to be called after changing any variable that could change the result of the wait condition.

The function returns 0 if *condition* became true, or `-ETIME` if the timeout elapsed.

Name

`wait_event_interruptible_hrtimeout` — sleep until a condition gets true or a timeout elapses

Synopsis

```
wait_event_interruptible_hrtimeout ( wq, condition, timeout);
```

Arguments

<i>wq</i>	the waitqueue to wait on
<i>condition</i>	a C expression for the event to wait for
<i>timeout</i>	timeout, as a <code>ktime_t</code>

Description

The process is put to sleep (`TASK_INTERRUPTIBLE`) until the *condition* evaluates to true or a signal is received. The *condition* is checked each time the waitqueue *wq* is woken up.

`wake_up` has to be called after changing any variable that could change the result of the wait condition.

The function returns 0 if *condition* became true, `-ERESTARTSYS` if it was interrupted by a signal, or `-ETIME` if the timeout elapsed.

Name

`wait_event_interruptible_locked` — sleep until a condition gets true

Synopsis

```
wait_event_interruptible_locked ( wq, condition);
```

Arguments

wq the waitqueue to wait on

condition a C expression for the event to wait for

Description

The process is put to sleep (TASK_INTERRUPTIBLE) until the *condition* evaluates to true or a signal is received. The *condition* is checked each time the waitqueue *wq* is woken up.

It must be called with *wq.lock* being held. This spinlock is unlocked while sleeping but *condition* testing is done while lock is held and when this macro exits the lock is held.

The lock is locked/unlocked using `spin_lock/spin_unlock` functions which must match the way they are locked/unlocked outside of this macro.

`wake_up_locked` has to be called after changing any variable that could change the result of the wait condition.

The function will return `-ERESTARTSYS` if it was interrupted by a signal and 0 if *condition* evaluated to true.

Name

`wait_event_interruptible_locked_irq` — sleep until a condition gets true

Synopsis

```
wait_event_interruptible_locked_irq ( wq, condition);
```

Arguments

wq the waitqueue to wait on

condition a C expression for the event to wait for

Description

The process is put to sleep (TASK_INTERRUPTIBLE) until the *condition* evaluates to true or a signal is received. The *condition* is checked each time the waitqueue *wq* is woken up.

It must be called with *wq.lock* being held. This spinlock is unlocked while sleeping but *condition* testing is done while lock is held and when this macro exits the lock is held.

The lock is locked/unlocked using `spin_lock_irq/spin_unlock_irq` functions which must match the way they are locked/unlocked outside of this macro.

`wake_up_locked` has to be called after changing any variable that could change the result of the wait condition.

The function will return `-ERESTARTSYS` if it was interrupted by a signal and 0 if *condition* evaluated to true.

Name

`wait_event_interruptible_exclusive_locked` — sleep exclusively until a condition gets true

Synopsis

```
wait_event_interruptible_exclusive_locked ( wq, condition);
```

Arguments

wq the waitqueue to wait on

condition a C expression for the event to wait for

Description

The process is put to sleep (TASK_INTERRUPTIBLE) until the *condition* evaluates to true or a signal is received. The *condition* is checked each time the waitqueue *wq* is woken up.

It must be called with *wq.lock* being held. This spinlock is unlocked while sleeping but *condition* testing is done while lock is held and when this macro exits the lock is held.

The lock is locked/unlocked using `spin_lock/spin_unlock` functions which must match the way they are locked/unlocked outside of this macro.

The process is put on the wait queue with an `WQ_FLAG_EXCLUSIVE` flag set thus when other process waits process on the list if this process is awoken further processes are not considered.

`wake_up_locked` has to be called after changing any variable that could change the result of the wait condition.

The function will return `-ERESTARTSYS` if it was interrupted by a signal and 0 if *condition* evaluated to true.

Name

`wait_event_interruptible_exclusive_locked_irq` — sleep until a condition gets true

Synopsis

```
wait_event_interruptible_exclusive_locked_irq ( wq, condition);
```

Arguments

wq the waitqueue to wait on

condition a C expression for the event to wait for

Description

The process is put to sleep (TASK_INTERRUPTIBLE) until the *condition* evaluates to true or a signal is received. The *condition* is checked each time the waitqueue *wq* is woken up.

It must be called with *wq.lock* being held. This spinlock is unlocked while sleeping but *condition* testing is done while lock is held and when this macro exits the lock is held.

The lock is locked/unlocked using `spin_lock_irq/spin_unlock_irq` functions which must match the way they are locked/unlocked outside of this macro.

The process is put on the wait queue with an WQ_FLAG_EXCLUSIVE flag set thus when other process waits process on the list if this process is awoken further processes are not considered.

`wake_up_locked` has to be called after changing any variable that could change the result of the wait condition.

The function will return -ERESTARTSYS if it was interrupted by a signal and 0 if *condition* evaluated to true.

Name

`wait_event_killable` — sleep until a condition gets true

Synopsis

```
wait_event_killable ( wq, condition);
```

Arguments

wq the waitqueue to wait on

condition a C expression for the event to wait for

Description

The process is put to sleep (TASK_KILLABLE) until the *condition* evaluates to true or a signal is received. The *condition* is checked each time the waitqueue *wq* is woken up.

`wake_up` has to be called after changing any variable that could change the result of the wait condition.

The function will return `-ERESTARTSYS` if it was interrupted by a signal and 0 if *condition* evaluated to true.

Name

`wait_event_lock_irq_cmd` — sleep until a condition gets true. The condition is checked under the lock. This is expected to be called with the lock taken.

Synopsis

```
wait_event_lock_irq_cmd ( wq, condition, lock, cmd);
```

Arguments

<i>wq</i>	the waitqueue to wait on
<i>condition</i>	a C expression for the event to wait for
<i>lock</i>	a locked <code>spinlock_t</code> , which will be released before <code>cmd</code> and <code>schedule</code> and reacquired afterwards.
<i>cmd</i>	a command which is invoked outside the critical section before sleep

Description

The process is put to sleep (`TASK_UNINTERRUPTIBLE`) until the *condition* evaluates to true. The *condition* is checked each time the waitqueue *wq* is woken up.

`wake_up` has to be called after changing any variable that could change the result of the wait condition.

This is supposed to be called while holding the lock. The lock is dropped before invoking the `cmd` and going to sleep and is reacquired afterwards.

Name

`wait_event_lock_irq` — sleep until a condition gets true. The condition is checked under the lock. This is expected to be called with the lock taken.

Synopsis

```
wait_event_lock_irq ( wq, condition, lock);
```

Arguments

wq the waitqueue to wait on

condition a C expression for the event to wait for

lock a locked `spinlock_t`, which will be released before `schedule` and reacquired afterwards.

Description

The process is put to sleep (`TASK_UNINTERRUPTIBLE`) until the *condition* evaluates to true. The *condition* is checked each time the waitqueue *wq* is woken up.

`wake_up` has to be called after changing any variable that could change the result of the wait condition.

This is supposed to be called while holding the lock. The lock is dropped before going to sleep and is reacquired afterwards.

Name

`wait_event_interruptible_lock_irq_cmd` — sleep until a condition gets true. The condition is checked under the lock. This is expected to be called with the lock taken.

Synopsis

```
wait_event_interruptible_lock_irq_cmd ( wq, condition, lock, cmd);
```

Arguments

<i>wq</i>	the waitqueue to wait on
<i>condition</i>	a C expression for the event to wait for
<i>lock</i>	a locked <code>spinlock_t</code> , which will be released before <code>cmd</code> and <code>schedule</code> and reacquired afterwards.
<i>cmd</i>	a command which is invoked outside the critical section before sleep

Description

The process is put to sleep (`TASK_INTERRUPTIBLE`) until the *condition* evaluates to true or a signal is received. The *condition* is checked each time the waitqueue *wq* is woken up.

`wake_up` has to be called after changing any variable that could change the result of the wait condition.

This is supposed to be called while holding the lock. The lock is dropped before invoking the `cmd` and going to sleep and is reacquired afterwards.

The macro will return `-ERESTARTSYS` if it was interrupted by a signal and 0 if *condition* evaluated to true.

Name

`wait_event_interruptible_lock_irq` — sleep until a condition gets true. The condition is checked under the lock. This is expected to be called with the lock taken.

Synopsis

```
wait_event_interruptible_lock_irq ( wq, condition, lock);
```

Arguments

wq the waitqueue to wait on

condition a C expression for the event to wait for

lock a locked `spinlock_t`, which will be released before `schedule` and reacquired afterwards.

Description

The process is put to sleep (`TASK_INTERRUPTIBLE`) until the *condition* evaluates to true or signal is received. The *condition* is checked each time the waitqueue *wq* is woken up.

`wake_up` has to be called after changing any variable that could change the result of the wait condition.

This is supposed to be called while holding the lock. The lock is dropped before going to sleep and is reacquired afterwards.

The macro will return `-ERESTARTSYS` if it was interrupted by a signal and 0 if *condition* evaluated to true.

Name

`wait_event_interruptible_lock_irq_timeout` — sleep until a condition gets true or a timeout elapses. The condition is checked under the lock. This is expected to be called with the lock taken.

Synopsis

```
wait_event_interruptible_lock_irq_timeout ( wq, condition, lock, time-  
out );
```

Arguments

<i>wq</i>	the waitqueue to wait on
<i>condition</i>	a C expression for the event to wait for
<i>lock</i>	a locked <code>spinlock_t</code> , which will be released before <code>schedule</code> and reacquired afterwards.
<i>timeout</i>	timeout, in jiffies

Description

The process is put to sleep (`TASK_INTERRUPTIBLE`) until the *condition* evaluates to true or signal is received. The *condition* is checked each time the waitqueue *wq* is woken up.

`wake_up` has to be called after changing any variable that could change the result of the wait condition.

This is supposed to be called while holding the lock. The lock is dropped before going to sleep and is reacquired afterwards.

The function returns 0 if the *timeout* elapsed, `-ERESTARTSYS` if it was interrupted by a signal, and the remaining jiffies otherwise if the condition evaluated to true before the timeout elapsed.

Name

`wait_on_bit` — wait for a bit to be cleared

Synopsis

```
int wait_on_bit (void * word, int bit, unsigned mode);
```

Arguments

word the word being waited on, a kernel virtual address

bit the bit of the word being waited on

mode the task state to sleep in

Description

There is a standard hashed waitqueue table for generic use. This is the part of the hashtable's accessor API that waits on a bit. For instance, if one were to have waiters on a bitflag, one would call `wait_on_bit` in threads waiting for the bit to clear. One uses `wait_on_bit` where one is waiting for the bit to clear, but has no intention of setting it. Returned value will be zero if the bit was cleared, or non-zero if the process received a signal and the mode permitted wakeup on that signal.

Name

`wait_on_bit_io` — wait for a bit to be cleared

Synopsis

```
int wait_on_bit_io (void * word, int bit, unsigned mode);
```

Arguments

word the word being waited on, a kernel virtual address

bit the bit of the word being waited on

mode the task state to sleep in

Description

Use the standard hashed waitqueue table to wait for a bit to be cleared. This is similar to `wait_on_bit`, but calls `io_schedule` instead of `schedule` for the actual waiting.

Returned value will be zero if the bit was cleared, or non-zero if the process received a signal and the mode permitted wakeup on that signal.

Name

`wait_on_bit_timeout` — wait for a bit to be cleared or a timeout elapses

Synopsis

```
int wait_on_bit_timeout (void * word, int bit, unsigned mode, unsigned  
long timeout);
```

Arguments

word the word being waited on, a kernel virtual address

bit the bit of the word being waited on

mode the task state to sleep in

timeout timeout, in jiffies

Description

Use the standard hashed waitqueue table to wait for a bit to be cleared. This is similar to `wait_on_bit`, except also takes a timeout parameter.

Returned value will be zero if the bit was cleared before the *timeout* elapsed, or non-zero if the *timeout* elapsed or process received a signal and the mode permitted wakeup on that signal.

Name

`wait_on_bit_action` — wait for a bit to be cleared

Synopsis

```
int wait_on_bit_action (void * word, int bit, wait_bit_action_f * action,  
unsigned mode);
```

Arguments

word the word being waited on, a kernel virtual address

bit the bit of the word being waited on

action the function used to sleep, which may take special actions

mode the task state to sleep in

Description

Use the standard hashed waitqueue table to wait for a bit to be cleared, and allow the waiting action to be specified. This is like `wait_on_bit` but allows fine control of how the waiting is done.

Returned value will be zero if the bit was cleared, or non-zero if the process received a signal and the mode permitted wakeup on that signal.

Name

`wait_on_bit_lock` — wait for a bit to be cleared, when wanting to set it

Synopsis

```
int wait_on_bit_lock (void * word, int bit, unsigned mode);
```

Arguments

word the word being waited on, a kernel virtual address

bit the bit of the word being waited on

mode the task state to sleep in

Description

There is a standard hashed waitqueue table for generic use. This is the part of the hashtable's accessor API that waits on a bit when one intends to set it, for instance, trying to lock bitflags. For instance, if one were to have waiters trying to set bitflag and waiting for it to clear before setting it, one would call `wait_on_bit` in threads waiting to be able to set the bit. One uses `wait_on_bit_lock` where one is waiting for the bit to clear with the intention of setting it, and when done, clearing it.

Returns zero if the bit was (eventually) found to be clear and was set. Returns non-zero if a signal was delivered to the process and the *mode* allows that signal to wake the process.

Name

`wait_on_bit_lock_io` — wait for a bit to be cleared, when wanting to set it

Synopsis

```
int wait_on_bit_lock_io (void * word, int bit, unsigned mode);
```

Arguments

word the word being waited on, a kernel virtual address

bit the bit of the word being waited on

mode the task state to sleep in

Description

Use the standard hashed waitqueue table to wait for a bit to be cleared and then to atomically set it. This is similar to `wait_on_bit`, but calls `io_schedule` instead of `schedule` for the actual waiting.

Returns zero if the bit was (eventually) found to be clear and was set. Returns non-zero if a signal was delivered to the process and the *mode* allows that signal to wake the process.

Name

`wait_on_bit_lock_action` — wait for a bit to be cleared, when wanting to set it

Synopsis

```
int wait_on_bit_lock_action (void * word, int bit, wait_bit_action_f *  
action, unsigned mode);
```

Arguments

word the word being waited on, a kernel virtual address

bit the bit of the word being waited on

action the function used to sleep, which may take special actions

mode the task state to sleep in

Description

Use the standard hashed waitqueue table to wait for a bit to be cleared and then to set it, and allow the waiting action to be specified. This is like `wait_on_bit` but allows fine control of how the waiting is done.

Returns zero if the bit was (eventually) found to be clear and was set. Returns non-zero if a signal was delivered to the process and the *mode* allows that signal to wake the process.

Name

`wait_on_atomic_t` — Wait for an `atomic_t` to become 0

Synopsis

```
int wait_on_atomic_t (atomic_t * val, int (*action) (atomic_t *), unsigned mode);
```

Arguments

val The atomic value being waited on, a kernel virtual address

action the function used to sleep, which may take special actions

mode the task state to sleep in

Description

Wait for an `atomic_t` to become 0. We abuse the bit-wait waitqueue table for the purpose of getting a waitqueue, but we set the key to a bit number outside of the target 'word'.

Name

`__wake_up` — wake up threads blocked on a waitqueue.

Synopsis

```
void __wake_up (wait_queue_head_t * q, unsigned int mode, int
nr_exclusive, void * key);
```

Arguments

<i>q</i>	the waitqueue
<i>mode</i>	which threads
<i>nr_exclusive</i>	how many wake-one or wake-many threads to wake up
<i>key</i>	is directly passed to the wakeup function

Description

It may be assumed that this function implies a write memory barrier before changing the task state if and only if any tasks are woken up.

Name

`__wake_up_sync_key` — wake up threads blocked on a waitqueue.

Synopsis

```
void __wake_up_sync_key (wait_queue_head_t * q, unsigned int mode, int
nr_exclusive, void * key);
```

Arguments

<i>q</i>	the waitqueue
<i>mode</i>	which threads
<i>nr_exclusive</i>	how many wake-one or wake-many threads to wake up
<i>key</i>	opaque value to be passed to wakeup targets

Description

The sync wakeup differs that the waker knows that it will schedule away soon, so while the target thread will be woken up, it will not be migrated to another CPU - ie. the two threads are 'synchronized' with each other. This can prevent needless bouncing between CPUs.

On UP it can prevent extra preemption.

It may be assumed that this function implies a write memory barrier before changing the task state if and only if any tasks are woken up.

Name

`finish_wait` — clean up after waiting in a queue

Synopsis

```
void finish_wait (wait_queue_head_t * q, wait_queue_t * wait);
```

Arguments

q waitqueue waited on

wait wait descriptor

Description

Sets current thread back to running state and removes the wait descriptor from the given waitqueue if still queued.

Name

`abort_exclusive_wait` — abort exclusive waiting in a queue

Synopsis

```
void abort_exclusive_wait (wait_queue_head_t * q, wait_queue_t * wait,  
unsigned int mode, void * key);
```

Arguments

q waitqueue waited on

wait wait descriptor

mode runstate of the waiter to be woken

key key to identify a wait bit queue or NULL

Description

Sets current thread back to running state and removes the wait descriptor from the given waitqueue if still queued.

Wakes up the next waiter if the caller is concurrently woken up through the queue.

This prevents waiter starvation where an exclusive waiter aborts and is woken up concurrently and no one wakes up the next waiter.

Name

`wake_up_bit` — wake up a waiter on a bit

Synopsis

```
void wake_up_bit (void * word, int bit);
```

Arguments

word the word being waited on, a kernel virtual address

bit the bit of the word being waited on

Description

There is a standard hashed waitqueue table for generic use. This is the part of the hashtable's accessor API that wakes up waiters on a bit. For instance, if one were to have waiters on a bitflag, one would call `wake_up_bit` after clearing the bit.

In order for this to function properly, as it uses `waitqueue_active` internally, some kind of memory barrier must be done prior to calling this. Typically, this will be `smp_mb__after_atomic`, but in some cases where bitflags are manipulated non-atomically under a lock, one may need to use a less regular barrier, such as `fs/inode.c`'s `smp_mb`, because `spin_unlock` does not guarantee a memory barrier.

Name

`wake_up_atomic_t` — Wake up a waiter on a `atomic_t`

Synopsis

```
void wake_up_atomic_t (atomic_t * p);
```

Arguments

p The `atomic_t` being waited on, a kernel virtual address

Description

Wake up anyone waiting for the `atomic_t` to go to zero.

Abuse the bit-waker function and its waitqueue hash table set (the `atomic_t` check is done by the waiter's wake function, not the by the waker itself).

High-resolution timers

Name

`ktime_set` — Set a `ktime_t` variable from a seconds/nanoseconds value

Synopsis

```
ktime_t ktime_set (const s64 secs, const unsigned long nsecs);
```

Arguments

secs seconds to set

nsecs nanoseconds to set

Return

The `ktime_t` representation of the value.

Name

`ktime_equal` — Compares two `ktime_t` variables to see if they are equal

Synopsis

```
int ktime_equal (const ktime_t cmp1, const ktime_t cmp2);
```

Arguments

cmp1 comparable1

cmp2 comparable2

Description

Compare two `ktime_t` variables.

Return

1 if equal.

Name

`ktime_compare` — Compares two `ktime_t` variables for less, greater or equal

Synopsis

```
int ktime_compare (const ktime_t cmp1, const ktime_t cmp2);
```

Arguments

cmp1 comparable1

cmp2 comparable2

Return

... `cmp1 < cmp2`: return `<0` `cmp1 == cmp2`: return `0` `cmp1 > cmp2`: return `>0`

Name

`ktime_after` — Compare if a `ktime_t` value is bigger than another one.

Synopsis

```
bool ktime_after (const ktime_t cmp1, const ktime_t cmp2);
```

Arguments

cmp1 comparable1

cmp2 comparable2

Return

true if *cmp1* happened after *cmp2*.

Name

`ktime_before` — Compare if a `ktime_t` value is smaller than another one.

Synopsis

```
bool ktime_before (const ktime_t cmp1, const ktime_t cmp2);
```

Arguments

cmp1 comparable1

cmp2 comparable2

Return

true if *cmp1* happened before *cmp2*.

Name

`ktime_to_timespec_cond` — convert a `ktime_t` variable to `timespec` format only if the variable contains data

Synopsis

```
bool ktime_to_timespec_cond (const ktime_t kt, struct timespec * ts);
```

Arguments

kt the `ktime_t` variable to convert

ts the `timespec` variable to store the result in

Return

true if there was a successful conversion, false if `kt` was 0.

Name

`ktime_to_timespec64_cond` — convert a `ktime_t` variable to `timespec64` format only if the variable contains data

Synopsis

```
bool ktime_to_timespec64_cond (const ktime_t kt, struct timespec64 *  
ts);
```

Arguments

kt the `ktime_t` variable to convert

ts the `timespec` variable to store the result in

Return

true if there was a successful conversion, false if `kt` was 0.

Name

struct hrtimer — the basic hrtimer structure

Synopsis

```
struct hrtimer {
    struct timerqueue_node node;
    ktime_t _softexpires;
    enum hrtimer_restart (* function) (struct hrtimer *);
    struct hrtimer_clock_base * base;
    unsigned long state;
#ifdef CONFIG_TIMER_STATS
    int start_pid;
    void * start_site;
    char start_comm[16];
#endif
};
```

Members

node	timerqueue node, which also manages node.expires, the absolute expiry time in the hrtimers internal representation. The time is related to the clock on which the timer is based. Is setup by adding slack to the _softexpires value. For non range timers identical to _softexpires.
_softexpires	the absolute earliest expiry time of the hrtimer. The time which was given as expiry time when the timer was armed.
function	timer expiry callback function
base	pointer to the timer base (per cpu and per clock)
state	state information (See bit values above)
start_pid	timer statistics field to store the pid of the task which started the timer
start_site	timer statistics field to store the site where the timer was started
start_comm[16]	timer statistics field to store the name of the process which started the timer

Description

The hrtimer structure must be initialized by `hrtimer_init`

Name

struct hrtimer_sleeper — simple sleeper structure

Synopsis

```
struct hrtimer_sleeper {  
    struct hrtimer timer;  
    struct task_struct * task;  
};
```

Members

timer embedded timer structure

task task to wake up

Description

task is set to NULL, when the timer expires.

Name

struct hrtimer_clock_base — the timer base for a specific clock

Synopsis

```
struct hrtimer_clock_base {
    struct hrtimer_cpu_base * cpu_base;
    int index;
    clockid_t clockid;
    struct timerqueue_head active;
    ktime_t resolution;
    ktime_t (* get_time) (void);
    ktime_t softirq_time;
    ktime_t offset;
};
```

Members

cpu_base	per cpu clock base
index	clock type index for per_cpu support when moving a timer to a base on another cpu.
clockid	clock id for per_cpu support
active	red black tree root node for the active timers
resolution	the resolution of the clock, in nanoseconds
get_time	function to retrieve the current time of the clock
softirq_time	the time when running the hrtimer queue in the softirq
offset	offset of this clock to the monotonic base

Name

`hrtimer_forward` — forward the timer expiry

Synopsis

```
u64 hrtimer_forward (struct hrtimer * timer, ktime_t now, ktime_t interval);
```

Arguments

timer hrtimer to forward

now forward past this time

interval the interval to forward

Description

Forward the timer expiry so it will expire in the future. Returns the number of overruns.

Name

`hrtimer_start_range_ns` — (re)start an hrtimer on the current CPU

Synopsis

```
int hrtimer_start_range_ns (struct hrtimer * timer, ktime_t tim, unsigned long delta_ns, const enum hrtimer_mode mode);
```

Arguments

timer the timer to be added

tim expiry time

delta_ns "slack" range for the timer

mode expiry mode: absolute (HRTIMER_MODE_ABS) or relative (HRTIMER_MODE_REL)

Returns

0 on success 1 when the timer was active

Name

`hrtimer_start` — (re)start an hrtimer on the current CPU

Synopsis

```
int hrtimer_start (struct hrtimer * timer, ktime_t tim, const enum  
hrtimer_mode mode);
```

Arguments

timer the timer to be added

tim expiry time

mode expiry mode: absolute (`HRTIMER_MODE_ABS`) or relative (`HRTIMER_MODE_REL`)

Returns

0 on success 1 when the timer was active

Name

`hrtimer_try_to_cancel` — try to deactivate a timer

Synopsis

```
int hrtimer_try_to_cancel (struct hrtimer * timer);
```

Arguments

timer hrtimer to stop

Returns

0 when the timer was not active 1 when the timer was active -1 when the timer is currently excuting the callback function and cannot be stopped

Name

`hrtimer_cancel` — cancel a timer and wait for the handler to finish.

Synopsis

```
int hrtimer_cancel (struct hrtimer * timer);
```

Arguments

timer the timer to be cancelled

Returns

0 when the timer was not active 1 when the timer was active

Name

`hrtimer_get_remaining` — get remaining time for the timer

Synopsis

```
ktime_t hrtimer_get_remaining (const struct hrtimer * timer);
```

Arguments

timer the timer to read

Name

`hrtimer_init` — initialize a timer to the given clock

Synopsis

```
void hrtimer_init (struct hrtimer * timer, clockid_t clock_id, enum  
hrtimer_mode mode);
```

Arguments

timer the timer to be initialized

clock_id the clock to be used

mode timer mode abs/rel

Name

`hrtimer_get_res` — get the timer resolution for a clock

Synopsis

```
int hrtimer_get_res (const clockid_t which_clock, struct timespec * tp);
```

Arguments

which_clock which clock to query

tp pointer to timespec variable to store the resolution

Description

Store the resolution of the clock selected by *which_clock* in the variable pointed to by *tp*.

Name

`schedule_hrttimeout_range` — sleep until timeout

Synopsis

```
int __sched schedule_hrttimeout_range (ktime_t * expires, unsigned long
delta, const enum hrtimer_mode mode);
```

Arguments

expires timeout value (ktime_t)

delta slack in expires timeout (ktime_t)

mode timer mode, HRTIMER_MODE_ABS or HRTIMER_MODE_REL

Description

Make the current task sleep until the given expiry time has elapsed. The routine will return immediately unless the current task state has been set (see `set_current_state`).

The *delta* argument gives the kernel the freedom to schedule the actual wakeup to a time that is both power and performance friendly. The kernel give the normal best effort behavior for “*expires+delta*”, but may decide to fire the timer earlier, but no earlier than *expires*.

You can set the task state as follows -

`TASK_UNINTERRUPTIBLE` - at least *timeout* time is guaranteed to pass before the routine returns.

`TASK_INTERRUPTIBLE` - the routine may return early if a signal is delivered to the current task.

The current task state is guaranteed to be `TASK_RUNNING` when this routine returns.

Returns 0 when the timer has expired otherwise -EINTR

Name

`schedule_hrtimeout` — sleep until timeout

Synopsis

```
int __sched schedule_hrtimeout (ktime_t * expires, const enum
hrtimer_mode mode);
```

Arguments

expires timeout value (ktime_t)

mode timer mode, HRTIMER_MODE_ABS or HRTIMER_MODE_REL

Description

Make the current task sleep until the given expiry time has elapsed. The routine will return immediately unless the current task state has been set (see `set_current_state`).

You can set the task state as follows -

`TASK_UNINTERRUPTIBLE` - at least *timeout* time is guaranteed to pass before the routine returns.

`TASK_INTERRUPTIBLE` - the routine may return early if a signal is delivered to the current task.

The current task state is guaranteed to be `TASK_RUNNING` when this routine returns.

Returns 0 when the timer has expired otherwise `-EINTR`

Workqueues and Kevents

Name

`queue_work_on` — queue work on specific cpu

Synopsis

```
bool queue_work_on (int cpu, struct workqueue_struct * wq, struct
work_struct * work);
```

Arguments

cpu CPU number to execute work on

wq workqueue to use

work work to queue

Description

We queue the work to a specific CPU, the caller must ensure it can't go away.

Return

false if *work* was already on a queue, true otherwise.

Name

`queue_delayed_work_on` — queue work on specific CPU after delay

Synopsis

```
bool queue_delayed_work_on (int cpu, struct workqueue_struct * wq,
struct delayed_work * dwork, unsigned long delay);
```

Arguments

cpu CPU number to execute work on

wq workqueue to use

dwork work to queue

delay number of jiffies to wait before queueing

Return

false if *work* was already on a queue, true otherwise. If *delay* is zero and *dwork* is idle, it will be scheduled for immediate execution.

Name

`mod_delayed_work_on` — modify delay of or queue a delayed work on specific CPU

Synopsis

```
bool mod_delayed_work_on (int cpu, struct workqueue_struct * wq, struct
delayed_work * dwork, unsigned long delay);
```

Arguments

<i>cpu</i>	CPU number to execute work on
<i>wq</i>	workqueue to use
<i>dwork</i>	work to queue
<i>delay</i>	number of jiffies to wait before queueing

Description

If *dwork* is idle, equivalent to `queue_delayed_work_on`; otherwise, modify *dwork*'s timer so that it expires after *delay*. If *delay* is zero, *work* is guaranteed to be scheduled immediately regardless of its current state.

Return

false if *dwork* was idle and queued, true if *dwork* was pending and its timer was modified.

This function is safe to call from any context including IRQ handler. See `try_to_grab_pending` for details.

Name

`flush_workqueue` — ensure that any scheduled work has run to completion.

Synopsis

```
void flush_workqueue (struct workqueue_struct * wq);
```

Arguments

wq workqueue to flush

Description

This function sleeps until all work items which were queued on entry have finished execution, but it is not livelocked by new incoming ones.

Name

`drain_workqueue` — drain a workqueue

Synopsis

```
void drain_workqueue (struct workqueue_struct * wq);
```

Arguments

wq workqueue to drain

Description

Wait until the workqueue becomes empty. While draining is in progress, only chain queueing is allowed. IOW, only currently pending or running work items on *wq* can queue further work items on it. *wq* is flushed repeatedly until it becomes empty. The number of flushing is determined by the depth of chaining and should be relatively short. Whine if it takes too long.

Name

`flush_work` — wait for a work to finish executing the last queueing instance

Synopsis

```
bool flush_work (struct work_struct * work);
```

Arguments

work the work to flush

Description

Wait until *work* has finished execution. *work* is guaranteed to be idle on return if it hasn't been requeued since flush started.

Return

true if `flush_work` waited for the work to finish execution, false if it was already idle.

Name

`cancel_work_sync` — cancel a work and wait for it to finish

Synopsis

```
bool cancel_work_sync (struct work_struct * work);
```

Arguments

work the work to cancel

Description

Cancel *work* and wait for its execution to finish. This function can be used even if the work re-queues itself or migrates to another workqueue. On return from this function, *work* is guaranteed to be not pending or executing on any CPU.

`cancel_work_sync(delayed_work->work)` must not be used for `delayed_work`'s. Use `cancel_delayed_work_sync` instead.

The caller must ensure that the workqueue on which *work* was last queued can't be destroyed before this function returns.

Return

true if *work* was pending, false otherwise.

Name

`flush_delayed_work` — wait for a `dwork` to finish executing the last queueing

Synopsis

```
bool flush_delayed_work (struct delayed_work * dwork);
```

Arguments

dwork the delayed work to flush

Description

Delayed timer is cancelled and the pending work is queued for immediate execution. Like `flush_work`, this function only considers the last queueing instance of *dwork*.

Return

true if `flush_work` waited for the work to finish execution, false if it was already idle.

Name

`cancel_delayed_work` — cancel a delayed work

Synopsis

```
bool cancel_delayed_work (struct delayed_work * dwork);
```

Arguments

dwork delayed_work to cancel

Description

Kill off a pending `delayed_work`.

Return

`true` if *dwork* was pending and canceled; `false` if it wasn't pending.

Note

The work callback function may still be running on return, unless it returns `true` and the work doesn't re-arm itself. Explicitly flush or use `cancel_delayed_work_sync` to wait on it.

This function is safe to call from any context including IRQ handler.

Name

`cancel_delayed_work_sync` — cancel a delayed work and wait for it to finish

Synopsis

```
bool cancel_delayed_work_sync (struct delayed_work * dwork);
```

Arguments

dwork the delayed work cancel

Description

This is `cancel_work_sync` for delayed works.

Return

true if *dwork* was pending, false otherwise.

Name

`flush_scheduled_work` — ensure that any scheduled work has run to completion.

Synopsis

```
void flush_scheduled_work ( void );
```

Arguments

void no arguments

Description

Forces execution of the kernel-global workqueue and blocks until its completion.

Think twice before calling this function! It's very easy to get into trouble if you don't take great care. Either of the following situations

will lead to deadlock

One of the work items currently on the workqueue needs to acquire a lock held by your code or its caller.

Your code is running in the context of a work routine.

They will be detected by lockdep when they occur, but the first might not occur very often. It depends on what work items are on the workqueue and what locks they need, which you have no control over.

In most situations flushing the entire workqueue is overkill; you merely need to know that a particular work item isn't queued and isn't running. In such cases you should use `cancel_delayed_work_sync` or `cancel_work_sync` instead.

Name

`execute_in_process_context` — reliably execute the routine with user context

Synopsis

```
int execute_in_process_context (work_func_t fn, struct execute_work *  
ew);
```

Arguments

fn the function to execute

ew guaranteed storage for the execute work structure (must be available when the work executes)

Description

Executes the function immediately if process context is available, otherwise schedules the function for delayed execution.

Return

0 - function was executed 1 - function was scheduled for execution

Name

`destroy_workqueue` — safely terminate a workqueue

Synopsis

```
void destroy_workqueue (struct workqueue_struct * wq);
```

Arguments

wq target workqueue

Description

Safely destroy a workqueue. All work currently pending will be done first.

Name

`workqueue_set_max_active` — adjust `max_active` of a workqueue

Synopsis

```
void workqueue_set_max_active (struct workqueue_struct * wq, int  
max_active);
```

Arguments

wq target workqueue

max_active new `max_active` value.

Description

Set `max_active` of *wq* to *max_active*.

CONTEXT

Don't call from IRQ context.

Name

`workqueue_congested` — test whether a workqueue is congested

Synopsis

```
bool workqueue_congested (int cpu, struct workqueue_struct * wq);
```

Arguments

cpu CPU in question

wq target workqueue

Description

Test whether *wq*'s cpu workqueue for *cpu* is congested. There is no synchronization around this function and the test result is unreliable and only useful as advisory hints or for debugging.

If *cpu* is `WORK_CPU_UNBOUND`, the test is performed on the local CPU. Note that both per-cpu and unbound workqueues may be associated with multiple `pool_workqueues` which have separate congested states. A workqueue being congested on one CPU doesn't mean the workqueue is also congested on other CPUs / NUMA nodes.

Return

true if congested, false otherwise.

Name

`work_busy` — test whether a work is currently pending or running

Synopsis

```
unsigned int work_busy (struct work_struct * work);
```

Arguments

work the work to be tested

Description

Test whether *work* is currently pending or running. There is no synchronization around this function and the test result is unreliable and only useful as advisory hints or for debugging.

Return

OR'd bitmask of `WORK_BUSY_*` bits.

Name

`work_on_cpu` — run a function in user context on a particular cpu

Synopsis

```
long work_on_cpu (int cpu, long (*fn) (void *), void * arg);
```

Arguments

cpu the cpu to run on

fn the function to run

arg the function arg

Description

It is up to the caller to ensure that the cpu doesn't go offline. The caller must not hold any locks which would prevent *fn* from completing.

Return

The value *fn* returns.

Internal Functions

Name

`wait_task_stopped` — Wait for `TASK_STOPPED` or `TASK_TRACED`

Synopsis

```
int wait_task_stopped (struct wait_opts * wo, int ptrace, struct
task_struct * p);
```

Arguments

wo wait options

ptrace is the wait for ptrace

p task to wait for

Description

Handle `sys_wait4` work for `p` in state `TASK_STOPPED` or `TASK_TRACED`.

CONTEXT

`read_lock(tasklist_lock)`, which is released if return value is non-zero. Also, grabs and releases `p->sig-hand->siglock`.

RETURNS

0 if wait condition didn't exist and search for other wait conditions should continue. Non-zero return, -`errno` on failure and `p`'s pid on success, implies that `tasklist_lock` is released and wait condition search should terminate.

Name

`task_set_jobctl_pending` — set jobctl pending bits

Synopsis

```
bool task_set_jobctl_pending (struct task_struct * task, unsigned int
mask);
```

Arguments

task target task

mask pending bits to set

Description

Clear *mask* from *task->jobctl*. *mask* must be subset of `JOBCTL_PENDING_MASK | JOBCTL_STOP_CONSUME | JOBCTL_STOP_SIGMASK | JOBCTL_TRAPPING`. If stop signo is being set, the existing signo is cleared. If *task* is already being killed or exiting, this function becomes noop.

CONTEXT

Must be called with *task->sighand->siglock* held.

RETURNS

true if *mask* is set, false if made noop because *task* was dying.

Name

`task_clear_jobctl_trapping` — clear jobctl trapping bit

Synopsis

```
void task_clear_jobctl_trapping (struct task_struct * task);
```

Arguments

task target task

Description

If `JOBCTL_TRAPPING` is set, a ptracer is waiting for us to enter `TRACED`. Clear it and wake up the ptracer. Note that we don't need any further locking. *task*->siglock guarantees that *task*->parent points to the ptracer.

CONTEXT

Must be called with *task*->sigband->siglock held.

Name

`task_clear_jobctl_pending` — clear jobctl pending bits

Synopsis

```
void task_clear_jobctl_pending (struct task_struct * task, unsigned int  
mask);
```

Arguments

task target task

mask pending bits to clear

Description

Clear *mask* from *task->jobctl*. *mask* must be subset of `JOBCTL_PENDING_MASK`. If `JOBCTL_STOP_PENDING` is being cleared, other `STOP` bits are cleared together.

If clearing of *mask* leaves no stop or trap pending, this function calls `task_clear_jobctl_trapping`.

CONTEXT

Must be called with *task->sighand->siglock* held.

Name

`task_participate_group_stop` — participate in a group stop

Synopsis

```
bool task_participate_group_stop (struct task_struct * task);
```

Arguments

task task participating in a group stop

Description

task has `JOBCTL_STOP_PENDING` set and is participating in a group stop. Group stop states are cleared and the group stop count is consumed if `JOBCTL_STOP_CONSUME` was set. If the consumption completes the group stop, the appropriate `SIGNAL_*` flags are set.

CONTEXT

Must be called with *task*->sigband->siglock held.

RETURNS

`true` if group stop completion should be notified to the parent, `false` otherwise.

Name

`ptrace_trap_notify` — schedule trap to notify ptracer

Synopsis

```
void ptrace_trap_notify (struct task_struct * t);
```

Arguments

`t` tracee wanting to notify tracer

Description

This function schedules sticky ptrace trap which is cleared on the next `TRAP_STOP` to notify ptracer of an event. `t` must have been seized by ptracer.

If `t` is running, `STOP` trap will be taken. If trapped for `STOP` and ptracer is listening for events, tracee is woken up so that it can re-trap for the new event. If trapped otherwise, `STOP` trap will be eventually taken without returning to userland after the existing traps are finished by `PTRACE_CONT`.

CONTEXT

Must be called with `task->sigband->siglock` held.

Name

`do_notify_parent_cldstop` — notify parent of stopped/continued state change

Synopsis

```
void do_notify_parent_cldstop (struct task_struct * tsk, bool
for_ptracer, int why);
```

Arguments

<i>tsk</i>	task reporting the state change
<i>for_ptracer</i>	the notification is for ptracer
<i>why</i>	CLD_{CONTINUED STOPPED TRAPPED} to report

Description

Notify *tsk*'s parent that the stopped/continued state has changed. If *for_ptracer* is false, *tsk*'s group leader notifies to its real parent. If true, *tsk* reports to *tsk*->parent which should be the ptracer.

CONTEXT

Must be called with `tasklist_lock` at least read locked.

Name

`do_signal_stop` — handle group stop for SIGSTOP and other stop signals

Synopsis

```
bool do_signal_stop (int signr);
```

Arguments

signr *signr* causing group stop if initiating

Description

If `JOBCTL_STOP_PENDING` is not set yet, initiate group stop with *signr* and participate in it. If already set, participate in the existing group stop. If participated in a group stop (and thus slept), `true` is returned with siglock released.

If ptraced, this function doesn't handle stop itself. Instead, `JOBCTL_TRAP_STOP` is scheduled and `false` is returned with siglock untouched. The caller must ensure that `INTERRUPT` trap handling takes places afterwards.

CONTEXT

Must be called with *current->sigband->siglock* held, which is released on `true` return.

RETURNS

`false` if group stop is already cancelled or ptrace trap is scheduled. `true` if participated in group stop.

Name

`do_jobctl_trap` — take care of ptrace jobctl traps

Synopsis

```
void do_jobctl_trap ( void );
```

Arguments

void no arguments

Description

When `PT_SEIZED`, it's used for both group stop and explicit `SEIZE/INTERRUPT` traps. Both generate `PTRACE_EVENT_STOP` trap with accompanying `siginfo`. If stopped, lower eight bits of `exit_code` contain the stop signal; otherwise, `SIGTRAP`.

When `!PT_SEIZED`, it's used only for group stop trap with stop signal number as `exit_code` and no `siginfo`.

CONTEXT

Must be called with `current->sigband->siglock` held, which may be released and re-acquired before returning with intervening sleep.

Name

`signal_delivered` —

Synopsis

```
void signal_delivered (struct ksignal * ksig, int stepping);
```

Arguments

ksig kernel signal struct

stepping nonzero if debugger single-step or block-step in use

Description

This function should be called when a signal has successfully been delivered. It updates the blocked signals accordingly (*ksig*->ka.sa.sa_mask is always blocked, and the signal itself is blocked unless SA_NODEFER is set in *ksig*->ka.sa.sa_flags. Tracing is notified.

Name

`sys_restart_syscall` — restart a system call

Synopsis

```
long sys_restart_syscall ( void );
```

Arguments

void no arguments

Name

`set_current_blocked` — change `current->blocked` mask

Synopsis

```
void set_current_blocked (sigset_t * newset);
```

Arguments

newset new mask

Description

It is wrong to change `->blocked` directly, this helper should be used to ensure the process can't miss a shared signal we are going to block.

Name

`sys_rt_sigprocmask` — change the list of currently blocked signals

Synopsis

```
long sys_rt_sigprocmask (int how, sigset_t __user * nset, sigset_t  
__user * oset, size_t sigsetsize);
```

Arguments

<i>how</i>	whether to add, remove, or set signals
<i>nset</i>	stores pending signals
<i>oset</i>	previous value of signal mask if non-null
<i>sigsetsize</i>	size of sigset_t type

Name

`sys_rt_sigpending` — examine a pending signal that has been raised while blocked

Synopsis

```
long sys_rt_sigpending (sigset_t __user * uset, size_t sigsetsize);
```

Arguments

uset stores pending signals

sigsetsize size of `sigset_t` type or larger

Name

`do_sigtimedwait` — wait for queued signals specified in *which*

Synopsis

```
int do_sigtimedwait (const sigset_t * which, siginfo_t * info, const
struct timespec * ts);
```

Arguments

which queued signals to wait for

info if non-null, the signal's siginfo is returned here

ts upper bound on process time suspension

Name

`sys_rt_sigtimedwait` — synchronously wait for queued signals specified in *uthese*

Synopsis

```
long sys_rt_sigtimedwait (const sigset_t __user * uthese, siginfo_t  
__user * uinfo, const struct timespec __user * uts, size_t sigsetsize);
```

Arguments

<i>uthese</i>	queued signals to wait for
<i>uinfo</i>	if non-null, the signal's siginfo is returned here
<i>uts</i>	upper bound on process time suspension
<i>sigsetsize</i>	size of sigset_t type

Name

`sys_kill` — send a signal to a process

Synopsis

```
long sys_kill (pid_t pid, int sig);
```

Arguments

pid the PID of the process

sig signal to be sent

Name

`sys_tgkill` — send signal to one specific thread

Synopsis

```
long sys_tgkill (pid_t tgid, pid_t pid, int sig);
```

Arguments

tgid the thread group ID of the thread

pid the PID of the thread

sig signal to be sent

Description

This syscall also checks the *tgid* and returns `-ESRCH` even if the PID exists but it's not belonging to the target process anymore. This method solves the problem of threads exiting and PIDs getting reused.

Name

`sys_kill` — send signal to one specific task

Synopsis

```
long sys_kill (pid_t pid, int sig);
```

Arguments

pid the PID of the task

sig signal to be sent

Description

Send a signal to only one task, even if it's a `CLONE_THREAD` task.

Name

`sys_rt_sigqueueinfo` — send signal information to a signal

Synopsis

```
long sys_rt_sigqueueinfo (pid_t pid, int sig, siginfo_t __user * uinfo);
```

Arguments

pid the PID of the thread

sig signal to be sent

uinfo signal info to be sent

Name

`sys_sigpending` — examine pending signals

Synopsis

```
long sys_sigpending (old_sigset_t __user * set);
```

Arguments

set where mask of pending signal is returned

Name

`sys_sigprocmask` — examine and change blocked signals

Synopsis

```
long sys_sigprocmask (int how, old_sigset_t __user * nset, old_sigset_t  
__user * oset);
```

Arguments

how whether to add, remove, or set signals

nset signals to add or remove (if non-null)

oset previous value of signal mask if non-null

Description

Some platforms have their own version with special arguments; others support only `sys_rt_sigprocmask`.

Name

`sys_rt_sigaction` — alter an action taken by a process

Synopsis

```
long sys_rt_sigaction (int sig, const struct sigaction __user * act,  
struct sigaction __user * oact, size_t sigsetsize);
```

Arguments

<i>sig</i>	signal to be sent
<i>act</i>	new sigaction
<i>oact</i>	used to save the previous sigaction
<i>sigsetsize</i>	size of sigset_t type

Name

`sys_rt_sigsuspend` — replace the signal mask for a value with the *unewset* value until a signal is received

Synopsis

```
long sys_rt_sigsuspend (sigset_t __user * unewset, size_t sigsetsize);
```

Arguments

unewset new signal mask value

sigsetsize size of sigset_t type

Name

`kthread_run` — create and wake a thread.

Synopsis

```
kthread_run ( threadfn, data, namefmt, ... );
```

Arguments

threadfn the function to run until `signal_pending(current)`.

data data ptr for *threadfn*.

namefmt printf-style name for the thread.

... variable arguments

Description

Convenient wrapper for `kthread_create` followed by `wake_up_process`. Returns the `kthread` or `ERR_PTR(-ENOMEM)`.

Name

`kthread_should_stop` — should this kthread return now?

Synopsis

```
bool kthread_should_stop ( void );
```

Arguments

void no arguments

Description

When someone calls `kthread_stop` on your kthread, it will be woken and this will return true. You should then return, and your return value will be passed through to `kthread_stop`.

Name

`kthread_freezable_should_stop` — should this freezable kthread return now?

Synopsis

```
bool kthread_freezable_should_stop (bool * was_frozen);
```

Arguments

was_frozen optional out parameter, indicates whether current was frozen

Description

`kthread_should_stop` for freezable kthreads, which will enter refrigerator if necessary. This function is safe from `kthread_stop` / freezer deadlock and freezable kthreads should use this function instead of calling `try_to_freeze` directly.

Name

`kthread_create_on_node` — create a kthread.

Synopsis

```
struct task_struct * kthread_create_on_node (int (*threadfn) (void *data), void * data, int node, const char namefmt[], ...);
```

Arguments

threadfn the function to run until `signal_pending(current)`.

data data ptr for *threadfn*.

node memory node number.

namefmt[] printf-style name for the thread.

... variable arguments

Description

This helper function creates and names a kernel thread. The thread will be stopped: use `wake_up_process` to start it. See also `kthread_run`.

If thread is going to be bound on a particular cpu, give its node in *node*, to get NUMA affinity for kthread stack, or else give -1. When woken, the thread will run *threadfn*() with *data* as its argument. *threadfn*() can either call `do_exit` directly if it is a standalone thread for which no one will call `kthread_stop`, or return when '`kthread_should_stop`' is true (which means `kthread_stop` has been called). The return value should be zero or a negative error number; it will be passed to `kthread_stop`.

Returns a `task_struct` or `ERR_PTR(-ENOMEM)` or `ERR_PTR(-EINTR)`.

Name

`kthread_bind` — bind a just-created kthread to a cpu.

Synopsis

```
void kthread_bind (struct task_struct * p, unsigned int cpu);
```

Arguments

p thread created by `kthread_create`.

cpu cpu (might not be online, must be possible) for *k* to run on.

Description

This function is equivalent to `set_cpus_allowed`, except that *cpu* doesn't need to be online, and the thread must be stopped (i.e., just returned from `kthread_create`).

Name

`kthread_stop` — stop a thread created by `kthread_create`.

Synopsis

```
int kthread_stop (struct task_struct * k);
```

Arguments

k thread created by `kthread_create`.

Description

Sets `kthread_should_stop` for *k* to return true, wakes it, and waits for it to exit. This can also be called after `kthread_create` instead of calling `wake_up_process`: the thread will exit without calling `threadfn`.

If `threadfn` may call `do_exit` itself, the caller must ensure `task_struct` can't go away.

Returns the result of `threadfn`, or `-EINTR` if `wake_up_process` was never called.

Name

`kthread_worker_fn` — kthread function to process `kthread_worker`

Synopsis

```
int kthread_worker_fn (void * worker_ptr);
```

Arguments

worker_ptr pointer to initialized `kthread_worker`

Description

This function can be used as *threadfn* to `kthread_create` or `kthread_run` with *worker_ptr* argument pointing to an initialized `kthread_worker`. The started kthread will process `work_list` until the it is stopped with `kthread_stop`. A kthread can also call this function directly after extra initialization.

Different kthreads can be used for the same `kthread_worker` as long as there's only one kthread attached to it at any given time. A `kthread_worker` without an attached kthread simply collects queued `kthread_works`.

Name

`queue_kthread_work` — queue a `kthread_work`

Synopsis

```
bool queue_kthread_work (struct kthread_worker * worker, struct
kthread_work * work);
```

Arguments

worker target `kthread_worker`

work `kthread_work` to queue

Description

Queue *work* to work processor *task* for async execution. *task* must have been created with `kthread_worker_create`. Returns `true` if *work* was successfully queued, `false` if it was already pending.

Name

`flush_kthread_work` — flush a `kthread_work`

Synopsis

```
void flush_kthread_work (struct kthread_work * work);
```

Arguments

work work to flush

Description

If *work* is queued or executing, wait for it to finish execution.

Name

`flush_kthread_worker` — flush all current works on a `kthread_worker`

Synopsis

```
void flush_kthread_worker (struct kthread_worker * worker);
```

Arguments

worker worker to flush

Description

Wait until all currently executing or pending works on *worker* are finished.

Kernel objects manipulation

Name

`kobject_get_path` — generate and return the path associated with a given `kobj` and `kset` pair.

Synopsis

```
char * kobject_get_path (struct kobject * kobj, gfp_t gfp_mask);
```

Arguments

kobj `kobject` in question, with which to build the path

gfp_mask the allocation type used to allocate the path

Description

The result must be freed by the caller with `kfree`.

Name

`kobject_set_name` — Set the name of a `kobject`

Synopsis

```
int kobject_set_name (struct kobject * kobj, const char * fmt, ...);
```

Arguments

kobj struct `kobject` to set the name of

fmt format string used to build the name

... variable arguments

Description

This sets the name of the `kobject`. If you have already added the `kobject` to the system, you must call `kobject_rename` in order to change the name of the `kobject`.

Name

`kobject_init` — initialize a kobject structure

Synopsis

```
void kobject_init (struct kobject * kobj, struct kobj_type * ktype);
```

Arguments

kobj pointer to the kobject to initialize

ktype pointer to the ktype for this kobject.

Description

This function will properly initialize a kobject such that it can then be passed to the `kobject_add` call.

After this function is called, the kobject **MUST** be cleaned up by a call to `kobject_put`, not by a call to `kfree` directly to ensure that all of the memory is cleaned up properly.

Name

`kobject_add` — the main kobject add function

Synopsis

```
int kobject_add (struct kobject * kobj, struct kobject * parent, const
char * fmt, ...);
```

Arguments

<i>kobj</i>	the kobject to add
<i>parent</i>	pointer to the parent of the kobject.
<i>fmt</i>	format to name the kobject with.
...	variable arguments

Description

The kobject name is set and added to the kobject hierarchy in this function.

If *parent* is set, then the parent of the *kobj* will be set to it. If *parent* is NULL, then the parent of the *kobj* will be set to the kobject associated with the kset assigned to this kobject. If no kset is assigned to the kobject, then the kobject will be located in the root of the sysfs tree.

If this function returns an error, `kobject_put` must be called to properly clean up the memory associated with the object. Under no instance should the kobject that is passed to this function be directly freed with a call to `kfree`, that can leak memory.

Note, no “add” uevent will be created with this call, the caller should set up all of the necessary sysfs files for the object and then call `kobject_uevent` with the `UEVENT_ADD` parameter to ensure that userspace is properly notified of this kobject's creation.

Name

`kobject_init_and_add` — initialize a kobject structure and add it to the kobject hierarchy

Synopsis

```
int kobject_init_and_add (struct kobject * kobj, struct kobj_type *  
ktype, struct kobject * parent, const char * fmt, ...);
```

Arguments

<i>kobj</i>	pointer to the kobject to initialize
<i>ktype</i>	pointer to the ktype for this kobject.
<i>parent</i>	pointer to the parent of this kobject.
<i>fmt</i>	the name of the kobject.
...	variable arguments

Description

This function combines the call to `kobject_init` and `kobject_add`. The same type of error handling after a call to `kobject_add` and kobject lifetime rules are the same here.

Name

`kobject_rename` — change the name of an object

Synopsis

```
int kobject_rename (struct kobject * kobj, const char * new_name);
```

Arguments

kobj object in question.

new_name object's new name

Description

It is the responsibility of the caller to provide mutual exclusion between two different calls of `kobject_rename` on the same `kobject` and to ensure that `new_name` is valid and won't conflict with other `kobjects`.

Name

`kobject_del` — unlink `kobject` from hierarchy.

Synopsis

```
void kobject_del (struct kobject * kobj);
```

Arguments

kobj object.

Name

`kobject_get` — increment refcount for object.

Synopsis

```
struct kobject * kobject_get (struct kobject * kobj);
```

Arguments

kobj object.

Name

`kobject_put` — decrement refcount for object.

Synopsis

```
void kobject_put (struct kobject * kobj);
```

Arguments

kobj object.

Description

Decrement the refcount, and if 0, call `kobject_cleanup`.

Name

`kobject_create_and_add` — create a struct `kobject` dynamically and register it with `sysfs`

Synopsis

```
struct kobject * kobject_create_and_add (const char * name, struct
kobject * parent);
```

Arguments

name the name for the `kobject`

parent the parent `kobject` of this `kobject`, if any.

Description

This function creates a `kobject` structure dynamically and registers it with `sysfs`. When you are finished with this structure, call `kobject_put` and the structure will be dynamically freed when it is no longer being used.

If the `kobject` was not able to be created, `NULL` will be returned.

Name

`kset_register` — initialize and add a kset.

Synopsis

```
int kset_register (struct kset * k);
```

Arguments

k kset.

Name

`kset_unregister` — remove a kset.

Synopsis

```
void kset_unregister (struct kset * k);
```

Arguments

k kset.

Name

`kset_create_and_add` — create a struct kset dynamically and add it to sysfs

Synopsis

```
struct kset * kset_create_and_add (const char * name, const struct  
kset_uevent_ops * uevent_ops, struct kobject * parent_kobj);
```

Arguments

name the name for the kset

uevent_ops a struct kset_uevent_ops for the kset

parent_kobj the parent kobject of this kset, if any.

Description

This function creates a kset structure dynamically and registers it with sysfs. When you are finished with this structure, call `kset_unregister` and the structure will be dynamically freed when it is no longer being used.

If the kset was not able to be created, NULL will be returned.

Kernel utility functions

Name

`upper_32_bits` — return bits 32-63 of a number

Synopsis

```
upper_32_bits ( n );
```

Arguments

n the number we're accessing

Description

A basic shift-right of a 64- or 32-bit quantity. Use this to suppress the “right shift count \geq width of type” warning when that quantity is 32-bits.

Name

`lower_32_bits` — return bits 0-31 of a number

Synopsis

```
lower_32_bits ( n );
```

Arguments

n the number we're accessing

Name

`might_sleep` — annotation for functions that can sleep

Synopsis

```
might_sleep (void);
```

Arguments

None

Description

this macro will print a stack trace if it is executed in an atomic context (spinlock, irq-handler, ...).

This is a useful debugging help to be able to catch problems early and not be bitten later when the calling function happens to sleep when it is not supposed to.

Name

`reciprocal_scale` — "scale" a value into range $[0, ep_ro)$

Synopsis

```
u32 reciprocal_scale (u32 val, u32 ep_ro);
```

Arguments

val value

ep_ro right open interval endpoint

Description

Perform a “reciprocal multiplication” in order to “scale” a value into range $[0, ep_ro)$, where the upper interval endpoint is right-open. This is useful, e.g. for accessing a index of an array containing `ep_ro` elements, for example. Think of it as sort of modulus, only that the result isn't that of modulo. ;) Note that if initial input is a small value, then result will return 0.

Return

a result based on `val` in interval $[0, ep_ro)$.

Name

kstrtoul — convert a string to an unsigned long

Synopsis

```
int kstrtoul (const char * s, unsigned int base, unsigned long * res);
```

Arguments

- s* The start of the string. The string must be null-terminated, and may also include a single newline before its terminating null. The first character may also be a plus sign, but not a minus sign.
- base* The number base to use. The maximum supported base is 16. If base is given as 0, then the base of the string is automatically detected with the conventional semantics - If it begins with 0x the number will be parsed as a hexadecimal (case insensitive), if it otherwise begins with 0, it will be parsed as an octal number. Otherwise it will be parsed as a decimal.
- res* Where to write the result of the conversion on success.

Description

Returns 0 on success, -ERANGE on overflow and -EINVAL on parsing error. Used as a replacement for the obsolete `simple_strtoul`. Return code must be checked.

Name

kstrtol — convert a string to a long

Synopsis

```
int kstrtol (const char * s, unsigned int base, long * res);
```

Arguments

- | | |
|-------------|---|
| <i>s</i> | The start of the string. The string must be null-terminated, and may also include a single newline before its terminating null. The first character may also be a plus sign or a minus sign. |
| <i>base</i> | The number base to use. The maximum supported base is 16. If base is given as 0, then the base of the string is automatically detected with the conventional semantics - If it begins with 0x the number will be parsed as a hexadecimal (case insensitive), if it otherwise begins with 0, it will be parsed as an octal number. Otherwise it will be parsed as a decimal. |
| <i>res</i> | Where to write the result of the conversion on success. |

Description

Returns 0 on success, -ERANGE on overflow and -EINVAL on parsing error. Used as a replacement for the obsolete `simple_strtoul`. Return code must be checked.

Name

`trace_printk` — printf formatting in the ftrace buffer

Synopsis

```
trace_printk ( fmt, ... );
```

Arguments

fmt the printf format for printing

... variable arguments

Note

`__trace_printk` is an internal function for `trace_printk` and the *ip* is passed in via the `trace_printk` macro.

This function allows a kernel developer to debug fast path sections that `printk` is not appropriate for. By scattering in various `printk` like tracing in the code, a developer can quickly see where problems are occurring.

This is intended as a debugging tool for the developer only. Please refrain from leaving `trace_printks` scattered around in your code. (Extra memory is used for special buffers that are allocated when `trace_printk` is used)

A little optimization trick is done here. If there's only one argument, there's no need to scan the string for printf formats. The `trace_puts` will suffice. But how can we take advantage of using `trace_puts` when `trace_printk` has only one argument? By stringifying the args and checking the size we can tell whether or not there are args. `__stringify((__VA_ARGS__))` will turn into `"()\0"` with a size of 3 when there are no args, anything else will be bigger. All we need to do is define a string to this, and then take its size and compare to 3. If it's bigger, use `do_trace_printk` otherwise, optimize it to `trace_puts`. Then just let gcc optimize the rest.

Name

`trace_puts` — write a string into the ftrace buffer

Synopsis

```
trace_puts ( str );
```

Arguments

str the string to record

Note

`__trace_bputs` is an internal function for `trace_puts` and the *ip* is passed in via the `trace_puts` macro.

This is similar to `trace_printk` but is made for those really fast paths that a developer wants the least amount of “Heisenbug” affects, where the processing of the print format is still too much.

This function allows a kernel developer to debug fast path sections that `printk` is not appropriate for. By scattering in various `printk` like tracing in the code, a developer can quickly see where problems are occurring.

This is intended as a debugging tool for the developer only. Please refrain from leaving `trace_puts` scattered around in your code. (Extra memory is used for special buffers that are allocated when `trace_puts` is used)

Returns

0 if nothing was written, positive # if string was. (1 when `__trace_bputs` is used, `strlen(str)` when `__trace_puts` is used)

Name

`min_not_zero` — return the minimum that is `_not_ zero`, unless both are zero

Synopsis

```
min_not_zero ( x, y );
```

Arguments

x value1

y value2

Name

`clamp` — return a value clamped to a given range with strict typechecking

Synopsis

```
clamp ( val, lo, hi );
```

Arguments

val current value

lo lowest allowable value

hi highest allowable value

Description

This macro does strict typechecking of `lo/hi` to make sure they are of the same type as `val`. See the unnecessary pointer comparisons.

Name

`clamp_t` — return a value clamped to a given range using a given type

Synopsis

```
clamp_t ( type, val, lo, hi );
```

Arguments

type the type of variable to use

val current value

lo minimum allowable value

hi maximum allowable value

Description

This macro does no typechecking and uses temporary variables of type 'type' to make all the comparisons.

Name

`clamp_val` — return a value clamped to a given range using `val`'s type

Synopsis

```
clamp_val ( val, lo, hi );
```

Arguments

val current value

lo minimum allowable value

hi maximum allowable value

Description

This macro does no typechecking and uses temporary variables of whatever type the input argument '`val`' is. This is useful when `val` is an unsigned type and `min` and `max` are literals that will otherwise be assigned a signed integer type.

Name

`container_of` — cast a member of a structure out to the containing structure

Synopsis

```
container_of ( ptr, type, member );
```

Arguments

ptr the pointer to the member.

type the type of the container struct this is embedded in.

member the name of the member within the struct.

Name

`printk` — print a kernel message

Synopsis

```
__visible int printk (const char * fmt, ...);
```

Arguments

fmt format string

... variable arguments

Description

This is `printk`. It can be called from any context. We want it to work.

We try to grab the `console_lock`. If we succeed, it's easy - we log the output and call the console drivers. If we fail to get the semaphore, we place the output into the log buffer and return. The current holder of the `console_sem` will notice the new output in `console_unlock`; and will send it to the consoles before releasing the lock.

One effect of this deferred printing is that code which calls `printk` and then changes `console_loglevel` may break. This is because `console_loglevel` is inspected when the actual printing occurs.

See also

`printf(3)`

See the `vsnprintf` documentation for format string extensions over C99.

Name

`console_lock` — lock the console system for exclusive use.

Synopsis

```
void console_lock ( void );
```

Arguments

void no arguments

Description

Acquires a lock which guarantees that the caller has exclusive access to the console system and the `console_drivers` list.

Can sleep, returns nothing.

Name

`console_trylock` — try to lock the console system for exclusive use.

Synopsis

```
int console_trylock ( void );
```

Arguments

void no arguments

Description

Try to acquire a lock which guarantees that the caller has exclusive access to the console system and the `console_drivers` list.

returns 1 on success, and 0 on failure to acquire the lock.

Name

`console_unlock` — unlock the console system

Synopsis

```
void console_unlock ( void );
```

Arguments

void no arguments

Description

Releases the `console_lock` which the caller holds on the console system and the console driver list.

While the `console_lock` was held, console output may have been buffered by `printk`. If this is the case, `console_unlock`; emits the output prior to releasing the lock.

If there is output waiting, we wake `/dev/kmsg` and `syslog` users.

`console_unlock`; may be called from any context.

Name

`console_conditional_schedule` — yield the CPU if required

Synopsis

```
void __sched console_conditional_schedule ( void );
```

Arguments

void no arguments

Description

If the console code is currently allowed to sleep, and if this CPU should yield the CPU to another task, do so here.

Must be called within `console_lock`;

Name

`printk_timed_ratelimit` — caller-controlled printk ratelimiting

Synopsis

```
bool printk_timed_ratelimit (unsigned long * caller_jiffies, unsigned
int interval_msecs);
```

Arguments

caller_jiffies pointer to caller's state

interval_msecs minimum interval between prints

Description

`printk_timed_ratelimit` returns true if more than *interval_msecs* milliseconds have elapsed since the last time `printk_timed_ratelimit` returned true.

Name

`kmsg_dump_register` — register a kernel log dumper.

Synopsis

```
int kmsg_dump_register (struct kmsg_dumper * dumper);
```

Arguments

dumper pointer to the `kmsg_dumper` structure

Description

Adds a kernel log dumper to the system. The dump callback in the structure will be called when the kernel oopses or panics and must be set. Returns zero on success and `-EINVAL` or `-EBUSY` otherwise.

Name

`kmsg_dump_unregister` — unregister a kmsg dumper.

Synopsis

```
int kmsg_dump_unregister (struct kmsg_dumper * dumper);
```

Arguments

dumper pointer to the kmsg_dumper structure

Description

Removes a dump device from the system. Returns zero on success and `-EINVAL` otherwise.

Name

`kmsg_dump_get_line` — retrieve one kmsg log line

Synopsis

```
bool kmsg_dump_get_line (struct kmsg_dumper * dumper, bool syslog, char  
* line, size_t size, size_t * len);
```

Arguments

dumper registered kmsg dumper

syslog include the “<4>” prefixes

line buffer to copy the line to

size maximum size of the buffer

len length of line placed into buffer

Description

Start at the beginning of the kmsg buffer, with the oldest kmsg record, and copy one record into the provided buffer.

Consecutive calls will return the next available record moving towards the end of the buffer with the youngest messages.

A return value of FALSE indicates that there are no more records to read.

Name

`kmsg_dump_get_buffer` — copy kmsg log lines

Synopsis

```
bool kmsg_dump_get_buffer (struct kmsg_dumper * dumper, bool syslog,  
char * buf, size_t size, size_t * len);
```

Arguments

<i>dumper</i>	registered kmsg dumper
<i>syslog</i>	include the “<4>” prefixes
<i>buf</i>	buffer to copy the line to
<i>size</i>	maximum size of the buffer
<i>len</i>	length of line placed into buffer

Description

Start at the end of the kmsg buffer and fill the provided buffer with as many of the the *youngest* kmsg records that fit into it. If the buffer is large enough, all available kmsg records will be copied with a single call.

Consecutive calls will fill the buffer with the next block of available older records, not including the earlier retrieved ones.

A return value of FALSE indicates that there are no more records to read.

Name

`kmsg_dump_rewind` — reset the iterator

Synopsis

```
void kmsg_dump_rewind (struct kmsg_dumper * dumper);
```

Arguments

dumper registered kmsg dumper

Description

Reset the dumper's iterator so that `kmsg_dump_get_line` and `kmsg_dump_get_buffer` can be called again and used multiple times within the same `dumper.dump` callback.

Name

`printk_hash` — print a kernel message include a hash over the message

Synopsis

```
int printk_hash (const char * prefix, const char * fmt, ...);
```

Arguments

prefix message prefix including the ".06x" for the hash

fmt format string

... variable arguments

Name

`printk_dev_hash` — print a kernel message include a hash over the message

Synopsis

```
int printk_dev_hash (const char * prefix, const char * driver_name,  
const char * fmt, ...);
```

Arguments

<i>prefix</i>	message prefix including the ".06x" for the hash
<i>driver_name</i>	-- undescribed --
<i>fmt</i>	format string
...	variable arguments

Name

panic — halt the system

Synopsis

```
void panic (const char * fmt, ...);
```

Arguments

fmt The text string to print

... variable arguments

Description

Display a message, then perform cleanups.

This function never returns.

Name

`add_taint` —

Synopsis

```
void add_taint (unsigned flag, enum lockdep_ok lockdep_ok);
```

Arguments

flag one of the TAIN*_ constants.

lockdep_ok whether lock debugging is still OK.

Description

If something bad has gone wrong, you'll want *lockdebug_ok* = false, but for some noteworthy-but-not-corrupting cases, it can be set to true.

Name

/usr/src/linux-4.1.38-50//kernel/sys.c — Document generation inconsistency

Oops

Warning

The template for this document tried to insert the structured comment from the file `/usr/src/linux-4.1.38-50//kernel/sys.c` at this point, but none was found. This dummy section is inserted to allow generation to continue.

Name

`init_srcu_struct` — initialize a sleep-RCU structure

Synopsis

```
int init_srcu_struct (struct srcu_struct * sp);
```

Arguments

sp structure to initialize.

Description

Must invoke this on a given `srcu_struct` before passing that `srcu_struct` to any other function. Each `srcu_struct` represents a separate domain of SRCU protection.

Name

`cleanup_srcu_struct` — deconstruct a sleep-RCU structure

Synopsis

```
void cleanup_srcu_struct (struct srcu_struct * sp);
```

Arguments

sp structure to clean up.

Description

Must invoke this after you are finished using a given `srcu_struct` that was initialized via `init_srcu_struct`, else you leak memory.

Name

`synchronize_srcu` — wait for prior SRCU read-side critical-section completion

Synopsis

```
void synchronize_srcu (struct srcu_struct * sp);
```

Arguments

sp srcu_struct with which to synchronize.

Description

Wait for the count to drain to zero of both indexes. To avoid the possible starvation of `synchronize_srcu`, it waits for the count of the index= $((\rightarrow\text{completed} \& 1) \wedge 1)$ to drain to zero at first, and then flip the completed and wait for the count of the other index.

Can block; must be called from process context.

Note that it is illegal to call `synchronize_srcu` from the corresponding SRCU read-side critical section; doing so will result in deadlock. However, it is perfectly legal to call `synchronize_srcu` on one `srcu_struct` from some other `srcu_struct`'s read-side critical section, as long as the resulting graph of `srcu_structs` is acyclic.

There are memory-ordering constraints implied by `synchronize_srcu`. On systems with more than one CPU, when `synchronize_srcu` returns, each CPU is guaranteed to have executed a full memory barrier since the end of its last corresponding SRCU-sched read-side critical section whose beginning preceded the call to `synchronize_srcu`. In addition, each CPU having an SRCU read-side critical section that extends beyond the return from `synchronize_srcu` is guaranteed to have executed a full memory barrier after the beginning of `synchronize_srcu` and before the beginning of that SRCU read-side critical section. Note that these guarantees include CPUs that are offline, idle, or executing in user mode, as well as CPUs that are executing in the kernel.

Furthermore, if CPU A invoked `synchronize_srcu`, which returned to its caller on CPU B, then both CPU A and CPU B are guaranteed to have executed a full memory barrier during the execution of `synchronize_srcu`. This guarantee applies even if CPU A and CPU B are the same CPU, but again only if the system has more than one CPU.

Of course, these memory-ordering guarantees apply only when `synchronize_srcu`, `srcu_read_lock`, and `srcu_read_unlock` are passed the same `srcu_struct` structure.

Name

synchronize_srcu_expedited — Brute-force SRCU grace period

Synopsis

```
void synchronize_srcu_expedited (struct srcu_struct * sp);
```

Arguments

sp srcu_struct with which to synchronize.

Description

Wait for an SRCU grace period to elapse, but be more aggressive about spinning rather than blocking when waiting.

Note that `synchronize_srcu_expedited` has the same deadlock and memory-ordering properties as does `synchronize_srcu`.

Name

`srcu_barrier` — Wait until all in-flight `call_srcu` callbacks complete.

Synopsis

```
void srcu_barrier (struct srcu_struct * sp);
```

Arguments

sp `srcu_struct` on which to wait for in-flight callbacks.

Name

`srcu_batches_completed` — return batches completed.

Synopsis

```
unsigned long srcu_batches_completed (struct srcu_struct * sp);
```

Arguments

sp `srcu_struct` on which to report batch completion.

Description

Report the number of batches, correlated with, but not necessarily precisely the same as, the number of grace periods that have elapsed.

Name

`rcu_idle_enter` — inform RCU that current CPU is entering idle

Synopsis

```
void rcu_idle_enter ( void );
```

Arguments

void no arguments

Description

Enter idle mode, in other words, -leave- the mode in which RCU read-side critical sections can occur. (Though RCU read-side critical sections can occur in irq handlers in idle, a possibility handled by `irq_enter` and `irq_exit`.)

We crowbar the `->dynticks_nesting` field to zero to allow for the possibility of usermode upcalls having messed up our count of interrupt nesting level during the prior busy period.

Name

`rcu_idle_exit` — inform RCU that current CPU is leaving idle

Synopsis

```
void rcu_idle_exit ( void );
```

Arguments

void no arguments

Description

Exit idle mode, in other words, -enter- the mode in which RCU read-side critical sections can occur.

We crowbar the `->dynticks_nesting` field to `DYNTICK_TASK_NEST` to allow for the possibility of user-mode upcalls messing up our count of interrupt nesting level during the busy period that is just now starting.

Name

`rcu_is_watching` — see if RCU thinks that the current CPU is idle

Synopsis

```
bool notrace rcu_is_watching ( void );
```

Arguments

void no arguments

Description

If the current CPU is in its idle loop and is neither in an interrupt or NMI handler, return true.

Name

`synchronize_sched` — wait until an rcu-sched grace period has elapsed.

Synopsis

```
void synchronize_sched ( void );
```

Arguments

void no arguments

Description

Control will return to the caller some time after a full rcu-sched grace period has elapsed, in other words after all currently executing rcu-sched read-side critical sections have completed. These read-side critical sections are delimited by `rcu_read_lock_sched` and `rcu_read_unlock_sched`, and may be nested. Note that `preempt_disable`, `local_irq_disable`, and so on may be used in place of `rcu_read_lock_sched`.

This means that all `preempt_disable` code sequences, including NMI and non-threaded hardware-interrupt handlers, in progress on entry will have completed before this primitive returns. However, this does not guarantee that softirq handlers will have completed, since in some kernels, these handlers can run in process context, and can block.

Note that this guarantee implies further memory-ordering guarantees. On systems with more than one CPU, when `synchronize_sched` returns, each CPU is guaranteed to have executed a full memory barrier since the end of its last RCU-sched read-side critical section whose beginning preceded the call to `synchronize_sched`. In addition, each CPU having an RCU read-side critical section that extends beyond the return from `synchronize_sched` is guaranteed to have executed a full memory barrier after the beginning of `synchronize_sched` and before the beginning of that RCU read-side critical section. Note that these guarantees include CPUs that are offline, idle, or executing in user mode, as well as CPUs that are executing in the kernel.

Furthermore, if CPU A invoked `synchronize_sched`, which returned to its caller on CPU B, then both CPU A and CPU B are guaranteed to have executed a full memory barrier during the execution of `synchronize_sched` -- even if CPU A and CPU B are the same CPU (but again only if the system has more than one CPU).

This primitive provides the guarantees made by the (now removed) `synchronize_kernel` API. In contrast, `synchronize_rcu` only guarantees that `rcu_read_lock` sections will have completed. In “classic RCU”, these two guarantees happen to be one and the same, but can differ in realtime RCU implementations.

Name

`synchronize_rcu_bh` — wait until an `rcu_bh` grace period has elapsed.

Synopsis

```
void synchronize_rcu_bh ( void );
```

Arguments

void no arguments

Description

Control will return to the caller some time after a full `rcu_bh` grace period has elapsed, in other words after all currently executing `rcu_bh` read-side critical sections have completed. RCU read-side critical sections are delimited by `rcu_read_lock_bh` and `rcu_read_unlock_bh`, and may be nested.

See the description of `synchronize_sched` for more detailed information on memory ordering guarantees.

Name

`get_state_synchronize_rcu` — Snapshot current RCU state

Synopsis

```
unsigned long get_state_synchronize_rcu ( void );
```

Arguments

void no arguments

Description

Returns a cookie that is used by a later call to `cond_synchronize_rcu` to determine whether or not a full grace period has elapsed in the meantime.

Name

`cond_synchronize_rcu` — Conditionally wait for an RCU grace period

Synopsis

```
void cond_synchronize_rcu (unsigned long oldstate);
```

Arguments

oldstate return value from earlier call to `get_state_synchronize_rcu`

Description

If a full RCU grace period has elapsed since the earlier call to `get_state_synchronize_rcu`, just return. Otherwise, invoke `synchronize_rcu` to wait for a full grace period.

Yes, this function does not take counter wrap into account. But counter wrap is harmless. If the counter wraps, we have waited for more than 2 billion grace periods (and way more on a 64-bit system!), so waiting for one additional grace period should be just fine.

Name

`synchronize_sched_expedited` — Brute-force RCU-sched grace period

Synopsis

```
void synchronize_sched_expedited ( void );
```

Arguments

void no arguments

Description

Wait for an RCU-sched grace period to elapse, but use a “big hammer” approach to force the grace period to end quickly. This consumes significant time on all CPUs and is unfriendly to real-time workloads, so is thus not recommended for any sort of common-case code. In fact, if you are using `synchronize_sched_expedited` in a loop, please restructure your code to batch your updates, and then use a single `synchronize_sched` instead.

This implementation can be thought of as an application of ticket locking to RCU, with `sync_sched_expedited_started` and `sync_sched_expedited_done` taking on the roles of the halves of the ticket-lock word. Each task atomically increments `sync_sched_expedited_started` upon entry, snapshotting the old value, then attempts to stop all the CPUs. If this succeeds, then each CPU will have executed a context switch, resulting in an RCU-sched grace period. We are then done, so we use `atomic_cmpxchg` to update `sync_sched_expedited_done` to match our snapshot -- but only if someone else has not already advanced past our snapshot.

On the other hand, if `try_stop_cpus` fails, we check the value of `sync_sched_expedited_done`. If it has advanced past our initial snapshot, then someone else must have forced a grace period some time after we took our snapshot. In this case, our work is done for us, and we can simply return. Otherwise, we try again, but keep our initial snapshot for purposes of checking for someone doing our work for us.

If we fail too many times in a row, we fall back to `synchronize_sched`.

Name

`rcu_barrier_bh` — Wait until all in-flight `call_rcu_bh` callbacks complete.

Synopsis

```
void rcu_barrier_bh ( void );
```

Arguments

void no arguments

Name

`rcu_barrier_sched` — Wait for in-flight `call_rcu_sched` callbacks.

Synopsis

```
void rcu_barrier_sched ( void );
```

Arguments

void no arguments

Name

`synchronize_rcu` — wait until a grace period has elapsed.

Synopsis

```
void synchronize_rcu ( void );
```

Arguments

void no arguments

Description

Control will return to the caller some time after a full grace period has elapsed, in other words after all currently executing RCU read-side critical sections have completed. Note, however, that upon return from `synchronize_rcu`, the caller might well be executing concurrently with new RCU read-side critical sections that began while `synchronize_rcu` was waiting. RCU read-side critical sections are delimited by `rcu_read_lock` and `rcu_read_unlock`, and may be nested.

See the description of `synchronize_sched` for more detailed information on memory ordering guarantees.

Name

synchronize_rcu_expedited — Brute-force RCU grace period

Synopsis

```
void synchronize_rcu_expedited ( void );
```

Arguments

void no arguments

Description

Wait for an RCU-preempt grace period, but expedite it. The basic idea is to invoke `synchronize_sched_expedited` to push all the tasks to the `->blkd_tasks` lists and wait for this list to drain. This consumes significant time on all CPUs and is unfriendly to real-time workloads, so is thus not recommended for any sort of common-case code. In fact, if you are using `synchronize_rcu_expedited` in a loop, please restructure your code to batch your updates, and then Use a single `synchronize_rcu` instead.

Name

`rcu_barrier` — Wait until all in-flight `call_rcu` callbacks complete.

Synopsis

```
void rcu_barrier ( void );
```

Arguments

void no arguments

Description

Note that this primitive does not necessarily wait for an RCU grace period to complete. For example, if there are no RCU callbacks queued anywhere in the system, then `rcu_barrier` is within its rights to return immediately, without waiting for anything, much less an RCU grace period.

Name

`rcu_expedite_gp` — Expedite future RCU grace periods

Synopsis

```
void rcu_expedite_gp ( void );
```

Arguments

void no arguments

Description

After a call to this function, future calls to `synchronize_rcu` and friends act as the corresponding `synchronize_rcu_expedited` function had instead been called.

Name

`rcu_unexpedite_gp` — Cancel prior `rcu_expedite_gp` invocation

Synopsis

```
void rcu_unexpedite_gp ( void );
```

Arguments

void no arguments

Description

Undo a prior call to `rcu_expedite_gp`. If all prior calls to `rcu_expedite_gp` are undone by a subsequent call to `rcu_unexpedite_gp`, and if the `rcu_expedited` sysfs/boot parameter is not set, then all subsequent calls to `synchronize_rcu` and friends will return to their normal non-expedited behavior.

Name

`rcu_read_lock_held` — might we be in RCU read-side critical section?

Synopsis

```
int rcu_read_lock_held ( void );
```

Arguments

void no arguments

Description

If `CONFIG_DEBUG_LOCK_ALLOC` is selected, returns nonzero iff in an RCU read-side critical section. In absence of `CONFIG_DEBUG_LOCK_ALLOC`, this assumes we are in an RCU read-side critical section unless it can prove otherwise. This is useful for debug checks in functions that require that they be called within an RCU read-side critical section.

Checks `debug_lockdep_rcu_enabled` to prevent false positives during boot and while lockdep is disabled.

Note that `rcu_read_lock` and the matching `rcu_read_unlock` must occur in the same context, for example, it is illegal to invoke `rcu_read_unlock` in process context if the matching `rcu_read_lock` was invoked from within an irq handler.

Note that `rcu_read_lock` is disallowed if the CPU is either idle or offline from an RCU perspective, so check for those as well.

Name

`rcu_read_lock_bh_held` — might we be in RCU-bh read-side critical section?

Synopsis

```
int rcu_read_lock_bh_held ( void );
```

Arguments

void no arguments

Description

Check for bottom half being disabled, which covers both the `CONFIG_PROVE_RCU` and not cases. Note that if someone uses `rcu_read_lock_bh`, but then later enables BH, lockdep (if enabled) will show the situation. This is useful for debug checks in functions that require that they be called within an RCU read-side critical section.

Check `debug_lockdep_rcu_enabled` to prevent false positives during boot.

Note that `rcu_read_lock` is disallowed if the CPU is either idle or offline from an RCU perspective, so check for those as well.

Name

`init_rcu_head_on_stack` — initialize on-stack `rcu_head` for debugobjects

Synopsis

```
void init_rcu_head_on_stack (struct rcu_head * head);
```

Arguments

head pointer to `rcu_head` structure to be initialized

Description

This function informs debugobjects of a new `rcu_head` structure that has been allocated as an auto variable on the stack. This function is not required for `rcu_head` structures that are statically defined or that are dynamically allocated on the heap. This function has no effect for !`CONFIG_DEBUG_OBJECTS_RCU_HEAD` kernel builds.

Name

`destroy_rcu_head_on_stack` — destroy on-stack `rcu_head` for debugobjects

Synopsis

```
void destroy_rcu_head_on_stack (struct rcu_head * head);
```

Arguments

head pointer to `rcu_head` structure to be initialized

Description

This function informs debugobjects that an on-stack `rcu_head` structure is about to go out of scope. As with `init_rcu_head_on_stack`, this function is not required for `rcu_head` structures that are statically defined or that are dynamically allocated on the heap. Also as with `init_rcu_head_on_stack`, this function has no effect for `!CONFIG_DEBUG_OBJECTS_RCU_HEAD` kernel builds.

Name

`synchronize_rcu_tasks` — wait until an rcu-tasks grace period has elapsed.

Synopsis

```
void synchronize_rcu_tasks ( void );
```

Arguments

void no arguments

Description

Control will return to the caller some time after a full rcu-tasks grace period has elapsed, in other words after all currently executing rcu-tasks read-side critical sections have elapsed. These read-side critical sections are delimited by calls to `schedule`, `cond_resched_rcu_qs`, idle execution, userspace execution, calls to `synchronize_rcu_tasks`, and (in theory, anyway) `cond_resched`.

This is a very specialized primitive, intended only for a few uses in tracing and other situations requiring manipulation of function preambles and profiling hooks. The `synchronize_rcu_tasks` function is not (yet) intended for heavy use from multiple CPUs.

Note that this guarantee implies further memory-ordering guarantees. On systems with more than one CPU, when `synchronize_rcu_tasks` returns, each CPU is guaranteed to have executed a full memory barrier since the end of its last RCU-tasks read-side critical section whose beginning preceded the call to `synchronize_rcu_tasks`. In addition, each CPU having an RCU-tasks read-side critical section that extends beyond the return from `synchronize_rcu_tasks` is guaranteed to have executed a full memory barrier after the beginning of `synchronize_rcu_tasks` and before the beginning of that RCU-tasks read-side critical section. Note that these guarantees include CPUs that are offline, idle, or executing in user mode, as well as CPUs that are executing in the kernel.

Furthermore, if CPU A invoked `synchronize_rcu_tasks`, which returned to its caller on CPU B, then both CPU A and CPU B are guaranteed to have executed a full memory barrier during the execution of `synchronize_rcu_tasks` -- even if CPU A and CPU B are the same CPU (but again only if the system has more than one CPU).

Name

`rcu_barrier_tasks` — Wait for in-flight `call_rcu_tasks` callbacks.

Synopsis

```
void rcu_barrier_tasks ( void );
```

Arguments

void no arguments

Description

Although the current implementation is guaranteed to wait, it is not obligated to, for example, if there are no pending callbacks.

Device Resource Management

Name

`devres_alloc` — Allocate device resource data

Synopsis

```
void * devres_alloc (dr_release_t release, size_t size, gfp_t gfp);
```

Arguments

release Release function devres will be associated with

size Allocation size

gfp Allocation flags

Description

Allocate devres of *size* bytes. The allocated area is zeroed, then associated with *release*. The returned pointer can be passed to other `devres_*`() functions.

RETURNS

Pointer to allocated devres on success, NULL on failure.

Name

`devres_for_each_res` — Resource iterator

Synopsis

```
void devres_for_each_res (struct device * dev, dr_release_t release,  
dr_match_t match, void * match_data, void (*fn) (struct device *, void  
*, void *), void * data);
```

Arguments

<i>dev</i>	Device to iterate resource from
<i>release</i>	Look for resources associated with this release function
<i>match</i>	Match function (optional)
<i>match_data</i>	Data for the match function
<i>fn</i>	Function to be called for each matched resource.
<i>data</i>	Data for <i>fn</i> , the 3rd parameter of <i>fn</i>

Description

Call *fn* for each devres of *dev* which is associated with *release* and for which *match* returns 1.

RETURNS

void

Name

`devres_free` — Free device resource data

Synopsis

```
void devres_free (void * res);
```

Arguments

res Pointer to devres data to free

Description

Free devres created with `devres_alloc`.

Name

`devres_add` — Register device resource

Synopsis

```
void devres_add (struct device * dev, void * res);
```

Arguments

dev Device to add resource to

res Resource to register

Description

Register devres *res* to *dev*. *res* should have been allocated using `devres_alloc`. On driver detach, the associated release function will be invoked and devres will be freed automatically.

Name

`devres_find` — Find device resource

Synopsis

```
void * devres_find (struct device * dev, dr_release_t release, dr_match_t  
match, void * match_data);
```

Arguments

<i>dev</i>	Device to lookup resource from
<i>release</i>	Look for resources associated with this release function
<i>match</i>	Match function (optional)
<i>match_data</i>	Data for the match function

Description

Find the latest devres of *dev* which is associated with *release* and for which *match* returns 1. If *match* is NULL, it's considered to match all.

RETURNS

Pointer to found devres, NULL if not found.

Name

`devres_get` — Find devres, if non-existent, add one atomically

Synopsis

```
void * devres_get (struct device * dev, void * new_res, dr_match_t  
match, void * match_data);
```

Arguments

<i>dev</i>	Device to lookup or add devres for
<i>new_res</i>	Pointer to new initialized devres to add if not found
<i>match</i>	Match function (optional)
<i>match_data</i>	Data for the match function

Description

Find the latest devres of *dev* which has the same release function as *new_res* and for which *match* return 1. If found, *new_res* is freed; otherwise, *new_res* is added atomically.

RETURNS

Pointer to found or added devres.

Name

`devres_remove` — Find a device resource and remove it

Synopsis

```
void * devres_remove (struct device * dev, dr_release_t release,  
dr_match_t match, void * match_data);
```

Arguments

<i>dev</i>	Device to find resource from
<i>release</i>	Look for resources associated with this release function
<i>match</i>	Match function (optional)
<i>match_data</i>	Data for the match function

Description

Find the latest devres of *dev* associated with *release* and for which *match* returns 1. If *match* is NULL, it's considered to match all. If found, the resource is removed atomically and returned.

RETURNS

Pointer to removed devres on success, NULL if not found.

Name

`devres_destroy` — Find a device resource and destroy it

Synopsis

```
int devres_destroy (struct device * dev, dr_release_t release,
dr_match_t match, void * match_data);
```

Arguments

<i>dev</i>	Device to find resource from
<i>release</i>	Look for resources associated with this release function
<i>match</i>	Match function (optional)
<i>match_data</i>	Data for the match function

Description

Find the latest devres of *dev* associated with *release* and for which *match* returns 1. If *match* is NULL, it's considered to match all. If found, the resource is removed atomically and freed.

Note that the release function for the resource will not be called, only the devres-allocated data will be freed. The caller becomes responsible for freeing any other data.

RETURNS

0 if devres is found and freed, -ENOENT if not found.

Name

`devres_release` — Find a device resource and destroy it, calling `release`

Synopsis

```
int devres_release (struct device * dev, dr_release_t release,
dr_match_t match, void * match_data);
```

Arguments

<i>dev</i>	Device to find resource from
<i>release</i>	Look for resources associated with this release function
<i>match</i>	Match function (optional)
<i>match_data</i>	Data for the match function

Description

Find the latest devres of *dev* associated with *release* and for which *match* returns 1. If *match* is NULL, it's considered to match all. If found, the resource is removed atomically, the release function called and the resource freed.

RETURNS

0 if devres is found and freed, -ENOENT if not found.

Name

`devres_open_group` — Open a new devres group

Synopsis

```
void * devres_open_group (struct device * dev, void * id, gfp_t gfp);
```

Arguments

dev Device to open devres group for

id Separator ID

gfp Allocation flags

Description

Open a new devres group for *dev* with *id*. For *id*, using a pointer to an object which won't be used for another group is recommended. If *id* is NULL, address-wise unique ID is created.

RETURNS

ID of the new group, NULL on failure.

Name

`devres_close_group` — Close a devres group

Synopsis

```
void devres_close_group (struct device * dev, void * id);
```

Arguments

dev Device to close devres group for

id ID of target group, can be NULL

Description

Close the group identified by *id*. If *id* is NULL, the latest open group is selected.

Name

`devres_remove_group` — Remove a devres group

Synopsis

```
void devres_remove_group (struct device * dev, void * id);
```

Arguments

dev Device to remove group for

id ID of target group, can be NULL

Description

Remove the group identified by *id*. If *id* is NULL, the latest open group is selected. Note that removing a group doesn't affect any other resources.

Name

`devres_release_group` — Release resources in a devres group

Synopsis

```
int devres_release_group (struct device * dev, void * id);
```

Arguments

dev Device to release group for

id ID of target group, can be NULL

Description

Release all resources in the group identified by *id*. If *id* is NULL, the latest open group is selected. The selected group and groups properly nested inside the selected group are removed.

RETURNS

The number of released non-group resources.

Name

`devm_add_action` — add a custom action to list of managed resources

Synopsis

```
int devm_add_action (struct device * dev, void (*action) (void *), void  
* data);
```

Arguments

dev Device that owns the action

action Function that should be called

data Pointer to data passed to *action* implementation

Description

This adds a custom action to the list of managed resources so that it gets executed as part of standard resource unwinding.

Name

`devm_remove_action` — removes previously added custom action

Synopsis

```
void devm_remove_action (struct device * dev, void (*action) (void *),  
void * data);
```

Arguments

dev Device that owns the action

action Function implementing the action

data Pointer to data passed to *action* implementation

Description

Removes instance of *action* previously added by `devm_add_action`. Both action and data should match one of the existing entries.

Name

`devm_kmalloc` — Resource-managed `kmalloc`

Synopsis

```
void * devm_kmalloc (struct device * dev, size_t size, gfp_t gfp);
```

Arguments

dev Device to allocate memory for

size Allocation size

gfp Allocation gfp flags

Description

Managed `kmalloc`. Memory allocated with this function is automatically freed on driver detach. Like all other devres resources, guaranteed alignment is unsigned long long.

RETURNS

Pointer to allocated memory on success, NULL on failure.

Name

`devm_kstrdup` — Allocate resource managed space and copy an existing string into that.

Synopsis

```
char * devm_kstrdup (struct device * dev, const char * s, gfp_t gfp);
```

Arguments

dev Device to allocate memory for

s the string to duplicate

gfp the GFP mask used in the `devm_kmalloc` call when allocating memory

RETURNS

Pointer to allocated string on success, NULL on failure.

Name

`devm_kvasprintf` — Allocate resource managed space and format a string into that.

Synopsis

```
char * devm_kvasprintf (struct device * dev, gfp_t gfp, const char *  
fmt, va_list ap);
```

Arguments

dev Device to allocate memory for

gfp the GFP mask used in the `devm_kmalloc` call when allocating memory

fmt The `printf`-style format string

ap Arguments for the format string

RETURNS

Pointer to allocated string on success, NULL on failure.

Name

`devm_kasprintf` — Allocate resource managed space and format a string into that.

Synopsis

```
char * devm_kasprintf (struct device * dev, gfp_t gfp, const char *  
fmt, ...);
```

Arguments

dev Device to allocate memory for

gfp the GFP mask used in the `devm_kmalloc` call when allocating memory

fmt The `printf`-style format string @...: Arguments for the format string

... variable arguments

RETURNS

Pointer to allocated string on success, NULL on failure.

Name

devm_kfree — Resource-managed kfree

Synopsis

```
void devm_kfree (struct device * dev, void * p);
```

Arguments

dev Device this memory belongs to

p Memory to free

Description

Free memory allocated with `devm_kmalloc`.

Name

`devm_kmemdup` — Resource-managed `kmemdup`

Synopsis

```
void * devm_kmemdup (struct device * dev, const void * src, size_t len,  
gfp_t gfp);
```

Arguments

dev Device this memory belongs to

src Memory region to duplicate

len Memory region length

gfp GFP mask to use

Description

Duplicate region of a memory using resource managed `kmalloc`

Name

`devm_get_free_pages` — Resource-managed `__get_free_pages`

Synopsis

```
unsigned long devm_get_free_pages (struct device * dev, gfp_t gfp_mask,  
unsigned int order);
```

Arguments

<i>dev</i>	Device to allocate memory for
<i>gfp_mask</i>	Allocation gfp flags
<i>order</i>	Allocation size is $(1 \ll \text{order})$ pages

Description

Managed `get_free_pages`. Memory allocated with this function is automatically freed on driver detach.

RETURNS

Address of allocated memory on success, 0 on failure.

Name

`devm_free_pages` — Resource-managed `free_pages`

Synopsis

```
void devm_free_pages (struct device * dev, unsigned long addr);
```

Arguments

dev Device this memory belongs to

addr Memory to free

Description

Free memory allocated with `devm_get_free_pages`. Unlike `free_pages`, there is no need to supply the *order*.

Chapter 2. Device drivers infrastructure

The Basic Device Driver-Model Structures

Name

struct bus_type — The bus type of the device

Synopsis

```
struct bus_type {
    const char * name;
    const char * dev_name;
    struct device * dev_root;
    struct device_attribute * dev_attrs;
    const struct attribute_group ** bus_groups;
    const struct attribute_group ** dev_groups;
    const struct attribute_group ** drv_groups;
    int (* match) (struct device *dev, struct device_driver *drv);
    int (* uevent) (struct device *dev, struct kobj_uevent_env *env);
    int (* probe) (struct device *dev);
    int (* remove) (struct device *dev);
    void (* shutdown) (struct device *dev);
    int (* online) (struct device *dev);
    int (* offline) (struct device *dev);
    int (* suspend) (struct device *dev, pm_message_t state);
    int (* resume) (struct device *dev);
    const struct dev_pm_ops * pm;
    const struct iommu_ops * iommu_ops;
    struct subsys_private * p;
    struct lock_class_key lock_key;
};
```

Members

name	The name of the bus.
dev_name	Used for subsystems to enumerate devices like (“foou”, dev->id).
dev_root	Default device to use as the parent.
dev_attrs	Default attributes of the devices on the bus.
bus_groups	Default attributes of the bus.
dev_groups	Default attributes of the devices on the bus.
drv_groups	Default attributes of the device drivers on the bus.
match	Called, perhaps multiple times, whenever a new device or driver is added for this bus. It should return a nonzero value if the given device can be handled by the given driver.
uevent	Called when a device is added, removed, or a few other things that generate uevents to add the environment variables.
probe	Called when a new device or driver add to this bus, and callback the specific driver's probe to initial the matched device.
remove	Called when a device removed from this bus.

shutdown	Called at shut-down time to quiesce the device.
online	Called to put the device back online (after offlining it).
offline	Called to put the device offline for hot-removal. May fail.
suspend	Called when a device on this bus wants to go to sleep mode.
resume	Called to bring a device on this bus out of sleep mode.
pm	Power management operations of this bus, callback the specific device driver's pm-ops.
iommu_ops	IOMMU specific operations for this bus, used to attach IOMMU driver implementations to a bus and allow the driver to do bus-specific setup
p	The private data of the driver core, only the driver core can touch this.
lock_key	Lock class key for use by the lock validator

Description

A bus is a channel between the processor and one or more devices. For the purposes of the device model, all devices are connected via a bus, even if it is an internal, virtual, “platform” bus. Buses can plug into each other. A USB controller is usually a PCI device, for example. The device model represents the actual connections between buses and the devices they control. A bus is represented by the `bus_type` structure. It contains the name, the default attributes, the bus' methods, PM operations, and the driver core's private data.

Name

struct device_driver — The basic device driver structure

Synopsis

```
struct device_driver {
    const char * name;
    struct bus_type * bus;
    struct module * owner;
    const char * mod_name;
    bool suppress_bind_attrs;
    const struct of_device_id * of_match_table;
    const struct acpi_device_id * acpi_match_table;
    int (* probe) (struct device *dev);
    int (* remove) (struct device *dev);
    void (* shutdown) (struct device *dev);
    int (* suspend) (struct device *dev, pm_message_t state);
    int (* resume) (struct device *dev);
    const struct attribute_group ** groups;
    const struct dev_pm_ops * pm;
    struct driver_private * p;
};
```

Members

name	Name of the device driver.
bus	The bus which the device of this driver belongs to.
owner	The module owner.
mod_name	Used for built-in modules.
suppress_bind_attrs	Disables bind/unbind via sysfs.
of_match_table	The open firmware table.
acpi_match_table	The ACPI match table.
probe	Called to query the existence of a specific device, whether this driver can work with it, and bind the driver to a specific device.
remove	Called when the device is removed from the system to unbind a device from this driver.
shutdown	Called at shut-down time to quiesce the device.
suspend	Called to put the device to sleep mode. Usually to a low power state.
resume	Called to bring a device from sleep mode.
groups	Default attributes that get created by the driver core automatically.
pm	Power management operations of the device which matched this driver.

p

Driver core's private data, no one other than the driver core can touch this.

Description

The device driver-model tracks all of the drivers known to the system. The main reason for this tracking is to enable the driver core to match up drivers with new devices. Once drivers are known objects within the system, however, a number of other things become possible. Device drivers can export information and configuration variables that are independent of any specific device.

Name

struct subsys_interface — interfaces to device functions

Synopsis

```
struct subsys_interface {
    const char * name;
    struct bus_type * subsys;
    struct list_head node;
    int (* add_dev) (struct device *dev, struct subsys_interface *sif);
    int (* remove_dev) (struct device *dev, struct subsys_interface *sif);
};
```

Members

name	name of the device function
subsys	subsystem of the devices to attach to
node	the list of functions registered at the subsystem
add_dev	device hookup to device function handler
remove_dev	device hookup to device function handler

Description

Simple interfaces attached to a subsystem. Multiple interfaces can attach to a subsystem and its devices. Unlike drivers, they do not exclusively claim or control devices. Interfaces usually represent a specific functionality of a subsystem/class of devices.

Name

struct class — device classes

Synopsis

```
struct class {
    const char * name;
    struct module * owner;
    struct class_attribute * class_attrs;
    const struct attribute_group ** dev_groups;
    struct kobject * dev_kobj;
    int (* dev_uevent) (struct device *dev, struct kobj_uevent_env *env);
    char *(* devnode) (struct device *dev, umode_t *mode);
    void (* class_release) (struct class *class);
    void (* dev_release) (struct device *dev);
    int (* suspend) (struct device *dev, pm_message_t state);
    int (* resume) (struct device *dev);
    const struct kobj_ns_type_operations * ns_type;
    const void *(* namespace) (struct device *dev);
    const struct dev_pm_ops * pm;
    struct subsys_private * p;
};
```

Members

name	Name of the class.
owner	The module owner.
class_attrs	Default attributes of this class.
dev_groups	Default attributes of the devices that belong to the class.
dev_kobj	The kobject that represents this class and links it into the hierarchy.
dev_uevent	Called when a device is added, removed from this class, or a few other things that generate uevents to add the environment variables.
devnode	Callback to provide the devtmpfs.
class_release	Called to release this class.
dev_release	Called to release the device.
suspend	Used to put the device to sleep mode, usually to a low power state.
resume	Used to bring the device from the sleep mode.
ns_type	Callbacks so sysfs can determine namespaces.
namespace	Namespace of the device belongs to this class.
pm	The default device power management operations of this class.
p	The private data of the driver core, no one other than the driver core can touch this.

Description

A class is a higher-level view of a device that abstracts out low-level implementation details. Drivers may see a SCSI disk or an ATA disk, but, at the class level, they are all simply disks. Classes allow user space to work with devices based on what they do, rather than how they are connected or how they work.

Name

struct device — The basic device structure

Synopsis

```
struct device {
    struct device * parent;
    struct device_private * p;
    struct kobject kobj;
    const char * init_name;
    const struct device_type * type;
    struct mutex mutex;
    struct bus_type * bus;
    struct device_driver * driver;
    void * platform_data;
    void * driver_data;
    struct dev_pm_info power;
    struct dev_pm_domain * pm_domain;
#ifdef CONFIG_PINCTRL
    struct dev_pin_info * pins;
#endif
#ifdef CONFIG_NUMA
    int numa_node;
#endif
    u64 * dma_mask;
    u64 coherent_dma_mask;
    unsigned long dma_pfn_offset;
    struct device_dma_parameters * dma_parms;
    struct list_head dma_pools;
    struct dma_coherent_mem * dma_mem;
#ifdef CONFIG_DMA_CMA
    struct cma * cma_area;
#endif
    struct dev_archdata archdata;
    struct device_node * of_node;
    struct fwnode_handle * fwnode;
    dev_t devt;
    u32 id;
    spinlock_t devres_lock;
    struct list_head devres_head;
    struct klist_node knode_class;
    struct class * class;
    const struct attribute_group ** groups;
    void (* release) (struct device *dev);
    struct iommu_group * iommu_group;
    bool offline_disabled:1;
    bool offline:1;
};
```

Members

parent	The device's “parent” device, the device to which it is attached. In most cases, a parent device is some sort of bus or host controller. If parent is NULL, the device, is a top-level device, which is not usually what you want.
p	Holds the private data of the driver core portions of the device. See the comment of the struct device_private for detail.
kobj	A top-level, abstract class from which other classes are derived.
init_name	Initial name of the device.
type	The type of device. This identifies the device type and carries type-specific information.
mutex	Mutex to synchronize calls to its driver.
bus	Type of bus device is on.
driver	Which driver has allocated this
platform_data	Platform data specific to the device.
driver_data	Private pointer for driver specific info.
power	For device power management. See Documentation/power/devices.txt for details.
pm_domain	Provide callbacks that are executed during system suspend, hibernation, system resume and during runtime PM transitions along with subsystem-level and driver-level callbacks.
pins	For device pin management. See Documentation/pinctrl.txt for details.
numa_node	NUMA node this device is close to.
dma_mask	Dma mask (if dma'ble device).
coherent_dma_mask	Like dma_mask, but for alloc_coherent mapping as not all hardware supports 64-bit addresses for consistent allocations such descriptors.
dma_pfn_offset	offset of DMA memory range relatively of RAM
dma_parms	A low level driver may set these to teach IOMMU code about segment limitations.
dma_pools	Dma pools (if dma'ble device).
dma_mem	Internal for coherent mem override.
cma_area	Contiguous memory area for dma allocations
archdata	For arch-specific additions.
of_node	Associated device tree node.
fwnode	Associated device node supplied by platform firmware.

devt	For creating the sysfs “dev”.
id	device instance
devres_lock	Spinlock to protect the resource of the device.
devres_head	The resources list of the device.
knode_class	The node used to add the device to the class list.
class	The class of the device.
groups	Optional attribute groups.
release	Callback to free the device after all references have gone away. This should be set by the allocator of the device (i.e. the bus driver that discovered the device).
iommu_group	IOMMU group the device belongs to.
offline_disabled	If set, the device is permanently online.
offline	Set after successful invocation of bus type's .offline.

Example

```
For devices on custom boards, as typical of embedded
and SOC based hardware, Linux often uses platform_data to point
to board-specific structures describing devices and how they
are wired. That can include what ports are available, chip
variants, which GPIO pins act in what additional roles, and so
on. This shrinks the “Board Support Packages” (BSPs) and
minimizes board-specific #ifdefs in drivers.
```

Description

At the lowest level, every device in a Linux system is represented by an instance of struct device. The device structure contains the information that the device model core needs to model the system. Most subsystems, however, track additional information about the devices they host. As a result, it is rare for devices to be represented by bare device structures; instead, that structure, like kobject structures, is usually embedded within a higher-level representation of the device.

Name

`module_driver` — Helper macro for drivers that don't do anything special in module init/exit. This eliminates a lot of boilerplate. Each module may only use this macro once, and calling it replaces `module_init` and `module_exit`.

Synopsis

```
module_driver ( __driver, __register, __unregister, ... );
```

Arguments

<i>__driver</i>	driver name
<i>__register</i>	register function for this driver type
<i>__unregister</i>	unregister function for this driver type @...: Additional arguments to be passed to <i>__register</i> and <i>__unregister</i> .
...	variable arguments

Description

Use this macro to construct bus specific macros for registering drivers, and do not use it on its own.

Device Drivers Base

Name

`driver_init` — initialize driver model.

Synopsis

```
void driver_init ( void );
```

Arguments

void no arguments

Description

Call the driver model init functions to initialize their subsystems. Called early from `init/main.c`.

Name

`driver_for_each_device` — Iterator for devices bound to a driver.

Synopsis

```
int driver_for_each_device (struct device_driver * drv, struct device  
* start, void * data, int (*fn) (struct device *, void *));
```

Arguments

drv Driver we're iterating.

start Device to begin with

data Data to pass to the callback.

fn Function to call for each device.

Description

Iterate over the *drv*'s list of devices calling *fn* for each one.

Name

`driver_find_device` — device iterator for locating a particular device.

Synopsis

```
struct device * driver_find_device (struct device_driver * drv, struct
device * start, void * data, int (*match) (struct device *dev, void
*data));
```

Arguments

drv The device's driver

start Device to begin with

data Data to pass to match function

match Callback function to check device

Description

This is similar to the `driver_for_each_device` function above, but it returns a reference to a device that is 'found' for later use, as determined by the *match* callback.

The callback should return 0 if the device doesn't match and non-zero if it does. If the callback returns non-zero, this function will return to the caller and not iterate over any more devices.

Name

`driver_create_file` — create sysfs file for driver.

Synopsis

```
int driver_create_file (struct device_driver * drv, const struct
driver_attribute * attr);
```

Arguments

drv driver.

attr driver attribute descriptor.

Name

`driver_remove_file` — remove sysfs file for driver.

Synopsis

```
void driver_remove_file (struct device_driver * drv, const struct  
driver_attribute * attr);
```

Arguments

drv driver.

attr driver attribute descriptor.

Name

`driver_register` — register driver with bus

Synopsis

```
int driver_register (struct device_driver * drv);
```

Arguments

drv driver to register

Description

We pass off most of the work to the `bus_add_driver` call, since most of the things we have to do deal with the bus structures.

Name

`driver_unregister` — remove driver from system.

Synopsis

```
void driver_unregister (struct device_driver * drv);
```

Arguments

drv driver.

Description

Again, we pass off most of the work to the bus-level call.

Name

`driver_find` — locate driver on a bus by its name.

Synopsis

```
struct device_driver * driver_find (const char * name, struct bus_type  
* bus);
```

Arguments

name name of the driver.

bus bus to scan for the driver.

Description

Call `kset_find_obj` to iterate over list of drivers on a bus to find driver by name. Return driver if found.

This routine provides no locking to prevent the driver it returns from being unregistered or unloaded while the caller is using it. The caller is responsible for preventing this.

Name

`dev_driver_string` — Return a device's driver name, if at all possible

Synopsis

```
const char * dev_driver_string (const struct device * dev);
```

Arguments

dev struct device to get the name of

Description

Will return the device's driver's name if it is bound to a device. If the device is not bound to a driver, it will return the name of the bus it is attached to. If it is not attached to a bus either, an empty string will be returned.

Name

`device_create_file` — create sysfs attribute file for device.

Synopsis

```
int  device_create_file (struct device * dev, const struct
device_attribute * attr);
```

Arguments

dev device.

attr device attribute descriptor.

Name

`device_remove_file` — remove sysfs attribute file.

Synopsis

```
void device_remove_file (struct device * dev, const struct  
device_attribute * attr);
```

Arguments

dev device.

attr device attribute descriptor.

Name

`device_remove_file_self` — remove sysfs attribute file from its own method.

Synopsis

```
bool device_remove_file_self (struct device * dev, const struct
device_attribute * attr);
```

Arguments

dev device.

attr device attribute descriptor.

Description

See `kernfs_remove_self` for details.

Name

`device_create_bin_file` — create sysfs binary attribute file for device.

Synopsis

```
int  device_create_bin_file (struct device * dev, const struct
bin_attribute * attr);
```

Arguments

dev device.

attr device binary attribute descriptor.

Name

`device_remove_bin_file` — remove sysfs binary attribute file

Synopsis

```
void device_remove_bin_file (struct device * dev, const struct  
bin_attribute * attr);
```

Arguments

dev device.

attr device binary attribute descriptor.

Name

`device_initialize` — init device structure.

Synopsis

```
void device_initialize (struct device * dev);
```

Arguments

dev device.

Description

This prepares the device for use by other layers by initializing its fields. It is the first half of `device_register`, if called by that function, though it can also be called separately, so one may use *dev*'s fields. In particular, `get_device`/`put_device` may be used for reference counting of *dev* after calling this function.

All fields in *dev* must be initialized by the caller to 0, except for those explicitly set to some other value. The simplest approach is to use `kzalloc` to allocate the structure containing *dev*.

NOTE

Use `put_device` to give up your reference instead of freeing *dev* directly once you have called this function.

Name

`dev_set_name` — set a device name

Synopsis

```
int dev_set_name (struct device * dev, const char * fmt, ...);
```

Arguments

dev device

fmt format string for the device's name

... variable arguments

Name

`device_add` — add device to device hierarchy.

Synopsis

```
int device_add (struct device * dev);
```

Arguments

dev device.

Description

This is part 2 of `device_register`, though may be called separately if `_device_initialize` has been called separately.

This adds *dev* to the kobject hierarchy via `kobject_add`, adds it to the global and sibling lists for the device, then adds it to the other relevant subsystems of the driver model.

Do not call this routine or `device_register` more than once for any device structure. The driver model core is not designed to work with devices that get unregistered and then spring back to life. (Among other things, it's very hard to guarantee that all references to the previous incarnation of *dev* have been dropped.) Allocate and register a fresh new struct device instead.

NOTE

Never directly free *dev* after calling this function, even if it returned an error! Always use `put_device` to give up your reference instead.

Name

`device_register` — register a device with the system.

Synopsis

```
int device_register (struct device * dev);
```

Arguments

dev pointer to the device structure

Description

This happens in two clean steps - initialize the device and add it to the system. The two steps can be called separately, but this is the easiest and most common. I.e. you should only call the two helpers separately if have a clearly defined need to use and refcount the device before it is added to the hierarchy.

For more information, see the kerneldoc for `device_initialize` and `device_add`.

NOTE

Never directly free *dev* after calling this function, even if it returned an error! Always use `put_device` to give up the reference initialized in this function instead.

Name

`get_device` — increment reference count for device.

Synopsis

```
struct device * get_device (struct device * dev);
```

Arguments

dev device.

Description

This simply forwards the call to `kobject_get`, though we do take care to provide for the case that we get a NULL pointer passed in.

Name

`put_device` — decrement reference count.

Synopsis

```
void put_device (struct device * dev);
```

Arguments

dev device in question.

Name

`device_del` — delete device from system.

Synopsis

```
void device_del (struct device * dev);
```

Arguments

dev device.

Description

This is the first part of the device unregistration sequence. This removes the device from the lists we control from here, has it removed from the other driver model subsystems it was added to in `device_add`, and removes it from the kobject hierarchy.

NOTE

this should be called manually `_iff_ device_add` was also called manually.

Name

`device_unregister` — unregister device from system.

Synopsis

```
void device_unregister (struct device * dev);
```

Arguments

dev device going away.

Description

We do this in two parts, like we do `device_register`. First, we remove it from all the subsystems with `device_del`, then we decrement the reference count via `put_device`. If that is the final reference count, the device will be cleaned up via `device_release` above. Otherwise, the structure will stick around until the final reference to the device is dropped.

Name

`device_for_each_child` — device child iterator.

Synopsis

```
int device_for_each_child (struct device * parent, void * data, int
(*fn) (struct device *dev, void *data));
```

Arguments

parent parent struct device.

data data for the callback.

fn function to be called for each device.

Description

Iterate over *parent*'s child devices, and call *fn* for each, passing it *data*.

We check the return of *fn* each time. If it returns anything other than 0, we break out and return that value.

Name

`device_find_child` — device iterator for locating a particular device.

Synopsis

```
struct device * device_find_child (struct device * parent, void * data,  
int (*match) (struct device *dev, void *data));
```

Arguments

parent parent struct device

data Data to pass to match function

match Callback function to check device

Description

This is similar to the `device_for_each_child` function above, but it returns a reference to a device that is 'found' for later use, as determined by the *match* callback.

The callback should return 0 if the device doesn't match and non-zero if it does. If the callback returns non-zero and a reference to the current device can be obtained, this function will return to the caller and not iterate over any more devices.

NOTE

you will need to drop the reference with `put_device` after use.

Name

`__root_device_register` — allocate and register a root device

Synopsis

```
struct device * __root_device_register (const char * name, struct module  
* owner);
```

Arguments

name root device name

owner owner module of the root device, usually `THIS_MODULE`

Description

This function allocates a root device and registers it using `device_register`. In order to free the returned device, use `root_device_unregister`.

Root devices are dummy devices which allow other devices to be grouped under `/sys/devices`. Use this function to allocate a root device and then use it as the parent of any device which should appear under `/sys/devices/{name}`

The `/sys/devices/{name}` directory will also contain a 'module' symlink which points to the *owner* directory in `sysfs`.

Returns struct device pointer on success, or `ERR_PTR` on error.

Note

You probably want to use `root_device_register`.

Name

`root_device_unregister` — unregister and free a root device

Synopsis

```
void root_device_unregister (struct device * dev);
```

Arguments

dev device going away

Description

This function unregisters and cleans up a device that was created by `root_device_register`.

Name

`device_create_vargs` — creates a device and registers it with sysfs

Synopsis

```
struct device * device_create_vargs (struct class * class, struct device  
* parent, dev_t devt, void * drvdata, const char * fmt, va_list args);
```

Arguments

<i>class</i>	pointer to the struct class that this device should be registered to
<i>parent</i>	pointer to the parent struct device of this new device, if any
<i>devt</i>	the dev_t for the char device to be added
<i>drvdata</i>	the data to be added to the device for callbacks
<i>fmt</i>	string for the device's name
<i>args</i>	va_list for the device's name

Description

This function can be used by char device classes. A struct device will be created in sysfs, registered to the specified class.

A “dev” file will be created, showing the dev_t for the device, if the dev_t is not 0,0. If a pointer to a parent struct device is passed in, the newly created struct device will be a child of that device in sysfs. The pointer to the struct device will be returned from the call. Any further sysfs files that might be required can be created using this pointer.

Returns struct device pointer on success, or ERR_PTR on error.

Note

the struct class passed to this function must have previously been created with a call to `class_create`.

Name

`device_create` — creates a device and registers it with sysfs

Synopsis

```
struct device * device_create (struct class * class, struct device *  
parent, dev_t devt, void * drvdata, const char * fmt, ...);
```

Arguments

<i>class</i>	pointer to the struct class that this device should be registered to
<i>parent</i>	pointer to the parent struct device of this new device, if any
<i>devt</i>	the dev_t for the char device to be added
<i>drvdata</i>	the data to be added to the device for callbacks
<i>fmt</i>	string for the device's name
...	variable arguments

Description

This function can be used by char device classes. A struct device will be created in sysfs, registered to the specified class.

A “dev” file will be created, showing the dev_t for the device, if the dev_t is not 0,0. If a pointer to a parent struct device is passed in, the newly created struct device will be a child of that device in sysfs. The pointer to the struct device will be returned from the call. Any further sysfs files that might be required can be created using this pointer.

Returns struct device pointer on success, or ERR_PTR on error.

Note

the struct class passed to this function must have previously been created with a call to `class_create`.

Name

`device_create_with_groups` — creates a device and registers it with sysfs

Synopsis

```
struct device * device_create_with_groups (struct class * class, struct
device * parent, dev_t devt, void * drvdata, const struct attribute_group
** groups, const char * fmt, ...);
```

Arguments

<i>class</i>	pointer to the struct class that this device should be registered to
<i>parent</i>	pointer to the parent struct device of this new device, if any
<i>devt</i>	the dev_t for the char device to be added
<i>drvdata</i>	the data to be added to the device for callbacks
<i>groups</i>	NULL-terminated list of attribute groups to be created
<i>fmt</i>	string for the device's name
...	variable arguments

Description

This function can be used by char device classes. A struct device will be created in sysfs, registered to the specified class. Additional attributes specified in the `groups` parameter will also be created automatically.

A “dev” file will be created, showing the `dev_t` for the device, if the `dev_t` is not 0,0. If a pointer to a parent struct device is passed in, the newly created struct device will be a child of that device in sysfs. The pointer to the struct device will be returned from the call. Any further sysfs files that might be required can be created using this pointer.

Returns struct device pointer on success, or `ERR_PTR` on error.

Note

the struct class passed to this function must have previously been created with a call to `class_create`.

Name

`device_destroy` — removes a device that was created with `device_create`

Synopsis

```
void device_destroy (struct class * class, dev_t devt);
```

Arguments

class pointer to the struct class that this device was registered with

devt the dev_t of the device that was previously registered

Description

This call unregisters and cleans up a device that was created with a call to `device_create`.

Name

`device_rename` — renames a device

Synopsis

```
int device_rename (struct device * dev, const char * new_name);
```

Arguments

dev the pointer to the struct device to be renamed

new_name the new name of the device

Description

It is the responsibility of the caller to provide mutual exclusion between two different calls of `device_rename` on the same device to ensure that `new_name` is valid and won't conflict with other devices.

Note

Don't call this function. Currently, the networking layer calls this function, but that will change. The following text from Kay Sievers offers

some insight

Renaming devices is racy at many levels, symlinks and other stuff are not replaced atomically, and you get a “move” uevent, but it's not easy to connect the event to the old and new device. Device nodes are not renamed at all, there isn't even support for that in the kernel now.

In the meantime, during renaming, your target name might be taken by another driver, creating conflicts. Or the old name is taken directly after you renamed it -- then you get events for the same DEVPATH, before you even see the “move” event. It's just a mess, and nothing new should ever rely on kernel device renaming. Besides that, it's not even implemented now for other things than (driver-core wise very simple) network devices.

We are currently about to change network renaming in udev to completely disallow renaming of devices in the same namespace as the kernel uses, because we can't solve the problems properly, that arise with swapping names of multiple interfaces without races. Means, renaming of `eth[0-9]*` will only be allowed to some other name than `eth[0-9]*`, for the aforementioned reasons.

Make up a “real” name in the driver before you register anything, or add some other attributes for userspace to find the device, or use udev to add symlinks -- but never rename kernel devices later, it's a complete mess. We don't even want to get into that and try to implement the missing pieces in the core. We really have other pieces to fix in the driver core mess. :)

Name

`device_move` — moves a device to a new parent

Synopsis

```
int device_move (struct device * dev, struct device * new_parent, enum  
dpm_order dpm_order);
```

Arguments

<i>dev</i>	the pointer to the struct device to be moved
<i>new_parent</i>	the new parent of the device (can be NULL)
<i>dpm_order</i>	how to reorder the <code>dpm_list</code>

Name

`set_primary_fwnode` — Change the primary firmware node of a given device.

Synopsis

```
void set_primary_fwnode (struct device * dev, struct fwnode_handle *  
fwnode);
```

Arguments

dev Device to handle.

fwnode New primary firmware node of the device.

Description

Set the device's firmware node pointer to *fwnode*, but if a secondary firmware node of the device is present, preserve it.

Name

`register_syscore_ops` — Register a set of system core operations.

Synopsis

```
void register_syscore_ops (struct syscore_ops * ops);
```

Arguments

ops System core operations to register.

Name

`unregister_syscore_ops` — Unregister a set of system core operations.

Synopsis

```
void unregister_syscore_ops (struct syscore_ops * ops);
```

Arguments

ops System core operations to unregister.

Name

`syscore_suspend` — Execute all the registered system core suspend callbacks.

Synopsis

```
int syscore_suspend ( void );
```

Arguments

void no arguments

Description

This function is executed with one CPU on-line and disabled interrupts.

Name

`syscore_resume` — Execute all the registered system core resume callbacks.

Synopsis

```
void syscore_resume ( void );
```

Arguments

void no arguments

Description

This function is executed with one CPU on-line and disabled interrupts.

Name

`__class_create` — create a struct class structure

Synopsis

```
struct class * __class_create (struct module * owner, const char * name,  
struct lock_class_key * key);
```

Arguments

owner pointer to the module that is to “own” this struct class

name pointer to a string for the name of this class.

key the lock_class_key for this class; used by mutex lock debugging

Description

This is used to create a struct class pointer that can then be used in calls to `device_create`.

Returns struct class pointer on success, or `ERR_PTR` on error.

Note, the pointer created here is to be destroyed when finished by making a call to `class_destroy`.

Name

`class_destroy` — destroys a struct class structure

Synopsis

```
void class_destroy (struct class * cls);
```

Arguments

cls pointer to the struct class that is to be destroyed

Description

Note, the pointer to be destroyed must have been created with a call to `class_create`.

Name

`class_dev_iter_init` — initialize class device iterator

Synopsis

```
void class_dev_iter_init (struct class_dev_iter * iter, struct class *  
class, struct device * start, const struct device_type * type);
```

Arguments

iter class iterator to initialize

class the class we wanna iterate over

start the device to start iterating from, if any

type device_type of the devices to iterate over, NULL for all

Description

Initialize class iterator *iter* such that it iterates over devices of *class*. If *start* is set, the list iteration will start there, otherwise if it is NULL, the iteration starts at the beginning of the list.

Name

`class_dev_iter_next` — iterate to the next device

Synopsis

```
struct device * class_dev_iter_next (struct class_dev_iter * iter);
```

Arguments

iter class iterator to proceed

Description

Proceed *iter* to the next device and return it. Returns NULL if iteration is complete.

The returned device is referenced and won't be released till iterator is proceed to the next device or exited. The caller is free to do whatever it wants to do with the device including calling back into class code.

Name

`class_dev_iter_exit` — finish iteration

Synopsis

```
void class_dev_iter_exit (struct class_dev_iter * iter);
```

Arguments

iter class iterator to finish

Description

Finish an iteration. Always call this function after iteration is complete whether the iteration ran till the end or not.

Name

`class_for_each_device` — device iterator

Synopsis

```
int class_for_each_device (struct class * class, struct device * start,  
void * data, int (*fn) (struct device *, void *));
```

Arguments

class the class we're iterating

start the device to start with in the list, if any.

data data for the callback

fn function to be called for each device

Description

Iterate over *class*'s list of devices, and call *fn* for each, passing it *data*. If *start* is set, the list iteration will start there, otherwise if it is NULL, the iteration starts at the beginning of the list.

We check the return of *fn* each time. If it returns anything other than 0, we break out and return that value.

fn is allowed to do anything including calling back into class code. There's no locking restriction.

Name

`class_find_device` — device iterator for locating a particular device

Synopsis

```
struct device * class_find_device (struct class * class, struct device *  
start, const void * data, int (*match) (struct device *, const void *));
```

Arguments

class the class we're iterating

start Device to begin with

data data for the match function

match function to check device

Description

This is similar to the `class_for_each_dev` function above, but it returns a reference to a device that is 'found' for later use, as determined by the *match* callback.

The callback should return 0 if the device doesn't match and non-zero if it does. If the callback returns non-zero, this function will return to the caller and not iterate over any more devices.

Note, you will need to drop the reference with `put_device` after use.

fn is allowed to do anything including calling back into class code. There's no locking restriction.

Name

`class_compat_register` — register a compatibility class

Synopsis

```
struct class_compat * class_compat_register (const char * name);
```

Arguments

name the name of the class

Description

Compatibility class are meant as a temporary user-space compatibility workaround when converting a family of class devices to a bus devices.

Name

`class_compat_unregister` — unregister a compatibility class

Synopsis

```
void class_compat_unregister (struct class_compat * cls);
```

Arguments

cls the class to unregister

Name

`class_compat_create_link` — create a compatibility class device link to a bus device

Synopsis

```
int class_compat_create_link (struct class_compat * cls, struct device  
* dev, struct device * device_link);
```

Arguments

cls the compatibility class

dev the target bus device

device_link an optional device to which a “device” link should be created

Name

`class_compat_remove_link` — remove a compatibility class device link to a bus device

Synopsis

```
void class_compat_remove_link (struct class_compat * cls, struct device  
* dev, struct device * device_link);
```

Arguments

cls the compatibility class

dev the target bus device

device_link an optional device to which a “device” link was previously created

Name

`unregister_node` — unregister a node device

Synopsis

```
void unregister_node (struct node * node);
```

Arguments

node node going away

Description

Unregisters a node device *node*. All the devices on the node must be unregistered before calling this function.

Name

`request_firmware` — send firmware request and wait for it

Synopsis

```
int request_firmware (const struct firmware ** firmware_p, const char
* name, struct device * device);
```

Arguments

firmware_p pointer to firmware image

name name of firmware file

device device for which firmware is being loaded

Description

firmware_p will be used to return a firmware image by the name of *name* for device *device*.

Should be called from user context where sleeping is allowed.

name will be used as `$FIRMWARE` in the uevent environment and should be distinctive enough not to be confused with any other firmware image for this or any other device.

Caller must hold the reference count of *device*.

The function can be called safely inside device's suspend and resume callback.

Name

`request_firmware_direct` — load firmware directly without usermode helper

Synopsis

```
int request_firmware_direct (const struct firmware ** firmware_p, const
char * name, struct device * device);
```

Arguments

<i>firmware_p</i>	pointer to firmware image
<i>name</i>	name of firmware file
<i>device</i>	device for which firmware is being loaded

Description

This function works pretty much like `request_firmware`, but this doesn't fall back to usermode helper even if the firmware couldn't be loaded directly from fs. Hence it's useful for loading optional firmwares, which aren't always present, without extra long timeouts of udev.

Name

`release_firmware` — release the resource associated with a firmware image

Synopsis

```
void release_firmware (const struct firmware * fw);
```

Arguments

fw firmware resource to release

Name

`request_firmware_nowait` — asynchronous version of `request_firmware`

Synopsis

```
int request_firmware_nowait (struct module * module, bool uevent, const
char * name, struct device * device, gfp_t gfp, void * context, void
(*cont) (const struct firmware *fw, void *context));
```

Arguments

<i>module</i>	module requesting the firmware
<i>uevent</i>	sends uevent to copy the firmware image if this flag is non-zero else the firmware copy must be done manually.
<i>name</i>	name of firmware file
<i>device</i>	device for which firmware is being loaded
<i>gfp</i>	allocation flags
<i>context</i>	will be passed over to <i>cont</i> , and <i>fw</i> may be NULL if firmware request fails.
<i>cont</i>	function will be called asynchronously when the firmware request is over.

Description

Caller must hold the reference count of *device*.

Asynchronous variant of `request_firmware` for user contexts: - sleep for as small periods as possible since it may increase kernel boot time of built-in device drivers requesting firmware in their `->probe` methods, if *gfp* is `GFP_KERNEL`.

- can't sleep at all if *gfp* is `GFP_ATOMIC`.

Name

`transport_class_register` — register an initial transport class

Synopsis

```
int transport_class_register (struct transport_class * tclass);
```

Arguments

tclass a pointer to the transport class structure to be initialised

Description

The transport class contains an embedded class which is used to identify it. The caller should initialise this structure with zeros and then generic class must have been initialised with the actual transport class unique name. There's a macro `DECLARE_TRANSPORT_CLASS` to do this (declared classes still must be registered).

Returns 0 on success or error on failure.

Name

`transport_class_unregister` — unregister a previously registered class

Synopsis

```
void transport_class_unregister (struct transport_class * tclass);
```

Arguments

tclass The transport class to unregister

Description

Must be called prior to deallocating the memory for the transport class.

Name

`anon_transport_class_register` — register an anonymous class

Synopsis

```
int anon_transport_class_register (struct anon_transport_class * atc);
```

Arguments

atc The anon transport class to register

Description

The anonymous transport class contains both a transport class and a container. The idea of an anonymous class is that it never actually has any device attributes associated with it (and thus saves on container storage). So it can only be used for triggering events. Use `prezero` and then use `DECLARE_ANON_TRANSPORT_CLASS` to initialise the anon transport class storage.

Name

`anon_transport_class_unregister` — unregister an anon class

Synopsis

```
void anon_transport_class_unregister (struct anon_transport_class *  
    atc);
```

Arguments

atc Pointer to the anon transport class to unregister

Description

Must be called prior to deallocating the memory for the anon transport class.

Name

`transport_setup_device` — declare a new dev for transport class association but don't make it visible yet.

Synopsis

```
void transport_setup_device (struct device * dev);
```

Arguments

dev the generic device representing the entity being added

Description

Usually, *dev* represents some component in the HBA system (either the HBA itself or a device remote across the HBA bus). This routine is simply a trigger point to see if any set of transport classes wishes to associate with the added device. This allocates storage for the class device and initialises it, but does not yet add it to the system or add attributes to it (you do this with `transport_add_device`). If you have no need for a separate setup and add operations, use `transport_register_device` (see `transport_class.h`).

Name

`transport_add_device` — declare a new dev for transport class association

Synopsis

```
void transport_add_device (struct device * dev);
```

Arguments

dev the generic device representing the entity being added

Description

Usually, *dev* represents some component in the HBA system (either the HBA itself or a device remote across the HBA bus). This routine is simply a trigger point used to add the device to the system and register attributes for it.

Name

`transport_configure_device` — configure an already set up device

Synopsis

```
void transport_configure_device (struct device * dev);
```

Arguments

dev generic device representing device to be configured

Description

The idea of `configure` is simply to provide a point within the setup process to allow the transport class to extract information from a device after it has been setup. This is used in SCSI because we have to have a setup device to begin using the HBA, but after we send the initial inquiry, we use `configure` to extract the device parameters. The device need not have been added to be configured.

Name

`transport_remove_device` — remove the visibility of a device

Synopsis

```
void transport_remove_device (struct device * dev);
```

Arguments

dev generic device to remove

Description

This call removes the visibility of the device (to the user from sysfs), but does not destroy it. To eliminate a device entirely you must also call `transport_destroy_device`. If you don't need to do remove and destroy as separate operations, use `transport_unregister_device` (see `transport_class.h`) which will perform both calls for you.

Name

`transport_destroy_device` — destroy a removed device

Synopsis

```
void transport_destroy_device (struct device * dev);
```

Arguments

dev device to eliminate from the transport class.

Description

This call triggers the elimination of storage associated with the transport classdev. Note: all it really does is relinquish a reference to the classdev. The memory will not be freed until the last reference goes to zero. Note also that the classdev retains a reference count on dev, so dev too will remain for as long as the transport class device remains around.

Name

`device_bind_driver` — bind a driver to one device.

Synopsis

```
int device_bind_driver (struct device * dev);
```

Arguments

dev device.

Description

Allow manual attachment of a driver to a device. Caller must have already set *dev->driver*.

Note that this does not modify the bus reference count nor take the bus's `rwsem`. Please verify those are accounted for before calling this. (It is ok to call with no other effort from a driver's `probe` method.)

This function must be called with the device lock held.

Name

`wait_for_device_probe` —

Synopsis

```
void wait_for_device_probe ( void );
```

Arguments

void no arguments

Description

Wait for device probing to be completed.

Name

`device_attach` — try to attach device to a driver.

Synopsis

```
int device_attach (struct device * dev);
```

Arguments

dev device.

Description

Walk the list of drivers that the bus has and call `driver_probe_device` for each pair. If a compatible pair is found, break out and return.

Returns 1 if the device was bound to a driver; 0 if no matching driver was found; `-ENODEV` if the device is not registered.

When called for a USB interface, `dev->parent` lock must be held.

Name

`driver_attach` — try to bind driver to devices.

Synopsis

```
int driver_attach (struct device_driver * drv);
```

Arguments

drv driver.

Description

Walk the list of devices that the bus has on it and try to match the driver with each one. If `driver_probe_device` returns 0 and the `dev->driver` is set, we've found a compatible pair.

Name

`device_release_driver` — manually detach device from driver.

Synopsis

```
void device_release_driver (struct device * dev);
```

Arguments

dev device.

Description

Manually detach device from driver. When called for a USB interface, *dev*->parent lock must be held.

Name

`platform_device_register_resndata` — add a platform-level device with resources and platform-specific data

Synopsis

```
struct platform_device * platform_device_register_resndata (struct de-  
vice * parent, const char * name, int id, const struct resource * res,  
unsigned int num, const void * data, size_t size);
```

Arguments

<i>parent</i>	parent device for the device we're adding
<i>name</i>	base name of the device we're adding
<i>id</i>	instance id
<i>res</i>	set of resources that needs to be allocated for the device
<i>num</i>	number of resources
<i>data</i>	platform specific data for this platform device
<i>size</i>	size of platform specific data

Description

Returns struct `platform_device` pointer on success, or `ERR_PTR` on error.

Name

`platform_device_register_simple` — add a platform-level device and its resources

Synopsis

```
struct platform_device * platform_device_register_simple (const char *  
name, int id, const struct resource * res, unsigned int num);
```

Arguments

name base name of the device we're adding

id instance id

res set of resources that needs to be allocated for the device

num number of resources

Description

This function creates a simple platform device that requires minimal resource and memory management. Canned release function freeing memory allocated for the device allows drivers using such devices to be unloaded without waiting for the last reference to the device to be dropped.

This interface is primarily intended for use with legacy drivers which probe hardware directly. Because such drivers create sysfs device nodes themselves, rather than letting system infrastructure handle such device enumeration tasks, they don't fully conform to the Linux driver model. In particular, when such drivers are built as modules, they can't be “hotplugged”.

Returns struct `platform_device` pointer on success, or `ERR_PTR` on error.

Name

`platform_device_register_data` — add a platform-level device with platform-specific data

Synopsis

```
struct platform_device * platform_device_register_data (struct device
* parent, const char * name, int id, const void * data, size_t size);
```

Arguments

<i>parent</i>	parent device for the device we're adding
<i>name</i>	base name of the device we're adding
<i>id</i>	instance id
<i>data</i>	platform specific data for this platform device
<i>size</i>	size of platform specific data

Description

This function creates a simple platform device that requires minimal resource and memory management. Canned release function freeing memory allocated for the device allows drivers using such devices to be unloaded without waiting for the last reference to the device to be dropped.

Returns struct `platform_device` pointer on success, or `ERR_PTR` on error.

Name

`platform_get_resource` — get a resource for a device

Synopsis

```
struct resource * platform_get_resource (struct platform_device * dev,  
unsigned int type, unsigned int num);
```

Arguments

dev platform device

type resource type

num resource index

Name

`platform_get_irq` — get an IRQ for a device

Synopsis

```
int platform_get_irq (struct platform_device * dev, unsigned int num);
```

Arguments

dev platform device

num IRQ number index

Name

platform_get_resource_byname — get a resource for a device by name

Synopsis

```
struct resource * platform_get_resource_byname (struct platform_device  
* dev, unsigned int type, const char * name);
```

Arguments

dev platform device

type resource type

name resource name

Name

`platform_get_irq_byname` — get an IRQ for a device by name

Synopsis

```
int platform_get_irq_byname (struct platform_device * dev, const char  
* name);
```

Arguments

dev platform device

name IRQ name

Name

`platform_add_devices` — add a numbers of platform devices

Synopsis

```
int platform_add_devices (struct platform_device ** devs, int num);
```

Arguments

devs array of platform devices to add

num number of platform devices in array

Name

`platform_device_put` — destroy a platform device

Synopsis

```
void platform_device_put (struct platform_device * pdev);
```

Arguments

pdev platform device to free

Description

Free all memory associated with a platform device. This function must only be externally called in error cases. All other usage is a bug.

Name

`platform_device_alloc` — create a platform device

Synopsis

```
struct platform_device * platform_device_alloc (const char * name, int
id);
```

Arguments

name base name of the device we're adding

id instance id

Description

Create a platform device object which can have other objects attached to it, and which will have attached objects freed when it is released.

Name

`platform_device_add_resources` — add resources to a platform device

Synopsis

```
int platform_device_add_resources (struct platform_device * pdev, const  
struct resource * res, unsigned int num);
```

Arguments

pdev platform device allocated by `platform_device_alloc` to add resources to

res set of resources that needs to be allocated for the device

num number of resources

Description

Add a copy of the resources to the platform device. The memory associated with the resources will be freed when the platform device is released.

Name

`platform_device_add_data` — add platform-specific data to a platform device

Synopsis

```
int platform_device_add_data (struct platform_device * pdev, const void  
* data, size_t size);
```

Arguments

pdev platform device allocated by `platform_device_alloc` to add resources to

data platform specific data for this platform device

size size of platform specific data

Description

Add a copy of platform specific data to the platform device's `platform_data` pointer. The memory associated with the platform data will be freed when the platform device is released.

Name

`platform_device_add` — add a platform device to device hierarchy

Synopsis

```
int platform_device_add (struct platform_device * pdev);
```

Arguments

pdev platform device we're adding

Description

This is part 2 of `platform_device_register`, though may be called separately _iff_ `pdev` was allocated by `platform_device_alloc`.

Name

`platform_device_del` — remove a platform-level device

Synopsis

```
void platform_device_del (struct platform_device * pdev);
```

Arguments

pdev platform device we're removing

Description

Note that this function will also release all memory- and port-based resources owned by the device (*dev->resource*). This function must `_only_` be externally called in error cases. All other usage is a bug.

Name

`platform_device_register` — add a platform-level device

Synopsis

```
int platform_device_register (struct platform_device * pdev);
```

Arguments

pdev platform device we're adding

Name

`platform_device_unregister` — unregister a platform-level device

Synopsis

```
void platform_device_unregister (struct platform_device * pdev);
```

Arguments

pdev platform device we're unregistering

Description

Unregistration is done in 2 steps. First we release all resources and remove it from the subsystem, then we drop reference count by calling `platform_device_put`.

Name

`platform_device_register_full` — add a platform-level device with resources and platform-specific data

Synopsis

```
struct platform_device * platform_device_register_full (const struct
platform_device_info * pdevinfo);
```

Arguments

pdevinfo data used to create device

Description

Returns struct `platform_device` pointer on success, or `ERR_PTR` on error.

Name

`__platform_driver_register` — register a driver for platform-level devices

Synopsis

```
int __platform_driver_register (struct platform_driver * drv, struct  
module * owner);
```

Arguments

drv platform driver structure

owner owning module/driver

Name

`platform_driver_unregister` — unregister a driver for platform-level devices

Synopsis

```
void platform_driver_unregister (struct platform_driver * drv);
```

Arguments

drv platform driver structure

Name

`__platform_driver_probe` — register driver for non-hotpluggable device

Synopsis

```
int __platform_driver_probe (struct platform_driver * drv, int (*probe)
                             (struct platform_device *), struct module * module);
```

Arguments

drv platform driver structure

probe the driver probe routine, probably from an `__init` section

module module which will be the owner of the driver

Description

Use this instead of `platform_driver_register` when you know the device is not hotpluggable and has already been registered, and you want to remove its run-once `probe` infrastructure from memory after the driver has bound to the device.

One typical use for this would be with drivers for controllers integrated into system-on-chip processors, where the controller devices have been configured as part of board setup.

Note that this is incompatible with deferred probing.

Returns zero if the driver registered and bound to a device, else returns a negative error code and with the driver not registered.

Name

`__platform_create_bundle` — register driver and create corresponding device

Synopsis

```
struct    platform_device    *    __platform_create_bundle    (struct
platform_driver * driver, int (*probe) (struct platform_device *),
struct resource * res, unsigned int n_res, const void * data, size_t
size, struct module * module);
```

Arguments

<i>driver</i>	platform driver structure
<i>probe</i>	the driver probe routine, probably from an <code>__init</code> section
<i>res</i>	set of resources that needs to be allocated for the device
<i>n_res</i>	number of resources
<i>data</i>	platform specific data for this platform device
<i>size</i>	size of platform specific data
<i>module</i>	module which will be the owner of the driver

Description

Use this in legacy-style modules that probe hardware directly and register a single platform device and corresponding platform driver.

Returns struct platform_device pointer on success, or ERR_PTR on error.

Name

`bus_for_each_dev` — device iterator.

Synopsis

```
int bus_for_each_dev (struct bus_type * bus, struct device * start, void  
* data, int (*fn) (struct device *, void *));
```

Arguments

bus bus type.

start device to start iterating from.

data data for the callback.

fn function to be called for each device.

Description

Iterate over *bus*'s list of devices, and call *fn* for each, passing it *data*. If *start* is not NULL, we use that device to begin iterating from.

We check the return of *fn* each time. If it returns anything other than 0, we break out and return that value.

NOTE

The device that returns a non-zero value is not retained in any way, nor is its refcount incremented. If the caller needs to retain this data, it should do so, and increment the reference count in the supplied callback.

Name

`bus_find_device` — device iterator for locating a particular device.

Synopsis

```
struct device * bus_find_device (struct bus_type * bus, struct device  
* start, void * data, int (*match) (struct device *dev, void *data));
```

Arguments

bus bus type

start Device to begin with

data Data to pass to match function

match Callback function to check device

Description

This is similar to the `bus_for_each_dev` function above, but it returns a reference to a device that is 'found' for later use, as determined by the *match* callback.

The callback should return 0 if the device doesn't match and non-zero if it does. If the callback returns non-zero, this function will return to the caller and not iterate over any more devices.

Name

`bus_find_device_by_name` — device iterator for locating a particular device of a specific name

Synopsis

```
struct device * bus_find_device_by_name (struct bus_type * bus, struct
device * start, const char * name);
```

Arguments

bus bus type

start Device to begin with

name name of the device to match

Description

This is similar to the `bus_find_device` function above, but it handles searching by a name automatically, no need to write another `strcmp` matching function.

Name

`subsys_find_device_by_id` — find a device with a specific enumeration number

Synopsis

```
struct device * subsys_find_device_by_id (struct bus_type * subsys,  
unsigned int id, struct device * hint);
```

Arguments

subsys subsystem

id index 'id' in struct device

hint device to check first

Description

Check the hint's next object and if it is a match return it directly, otherwise, fall back to a full list search. Either way a reference for the returned object is taken.

Name

`bus_for_each_drv` — driver iterator

Synopsis

```
int bus_for_each_drv (struct bus_type * bus, struct device_driver *  
start, void * data, int (*fn) (struct device_driver *, void *));
```

Arguments

bus bus we're dealing with.

start driver to start iterating on.

data data to pass to the callback.

fn function to call for each driver.

Description

This is nearly identical to the device iterator above. We iterate over each driver that belongs to *bus*, and call *fn* for each. If *fn* returns anything but 0, we break out and return it. If *start* is not NULL, we use it as the head of the list.

NOTE

we don't return the driver that returns a non-zero value, nor do we leave the reference count incremented for that driver. If the caller needs to know that info, it must set it in the callback. It must also be sure to increment the refcount so it doesn't disappear before returning to the caller.

Name

`bus_rescan_devices` — rescan devices on the bus for possible drivers

Synopsis

```
int bus_rescan_devices (struct bus_type * bus);
```

Arguments

bus the bus to scan.

Description

This function will look for devices on the bus with no driver attached and rescan it against existing drivers to see if it matches any by calling `device_attach` for the unbound devices.

Name

`device_reprobe` — remove driver for a device and probe for a new driver

Synopsis

```
int device_reprobe (struct device * dev);
```

Arguments

dev the device to reprobe

Description

This function detaches the attached driver (if any) for the given device and restarts the driver probing process. It is intended to use if probing criteria changed during a devices lifetime and driver attachment should change accordingly.

Name

`bus_register` — register a driver-core subsystem

Synopsis

```
int bus_register (struct bus_type * bus);
```

Arguments

bus bus to register

Description

Once we have that, we register the bus with the kobject infrastructure, then register the children subsystems it has: the devices and drivers that belong to the subsystem.

Name

`bus_unregister` — remove a bus from the system

Synopsis

```
void bus_unregister (struct bus_type * bus);
```

Arguments

bus bus.

Description

Unregister the child subsystems and the bus itself. Finally, we call `bus_put` to release the refcount

Name

`subsys_dev_iter_init` — initialize subsys device iterator

Synopsis

```
void subsys_dev_iter_init (struct subsys_dev_iter * iter, struct  
bus_type * subsys, struct device * start, const struct device_type *  
type);
```

Arguments

iter subsys iterator to initialize

subsys the subsys we wanna iterate over

start the device to start iterating from, if any

type device_type of the devices to iterate over, NULL for all

Description

Initialize subsys iterator *iter* such that it iterates over devices of *subsys*. If *start* is set, the list iteration will start there, otherwise if it is NULL, the iteration starts at the beginning of the list.

Name

`subsys_dev_iter_next` — iterate to the next device

Synopsis

```
struct device * subsys_dev_iter_next (struct subsys_dev_iter * iter);
```

Arguments

iter subsys iterator to proceed

Description

Proceed *iter* to the next device and return it. Returns NULL if iteration is complete.

The returned device is referenced and won't be released till iterator is proceed to the next device or exited. The caller is free to do whatever it wants to do with the device including calling back into subsys code.

Name

`subsys_dev_iter_exit` — finish iteration

Synopsis

```
void subsys_dev_iter_exit (struct subsys_dev_iter * iter);
```

Arguments

iter subsys iterator to finish

Description

Finish an iteration. Always call this function after iteration is complete whether the iteration ran till the end or not.

Name

`subsys_system_register` — register a subsystem at `/sys/devices/system/`

Synopsis

```
int subsys_system_register (struct bus_type * subsys, const struct  
attribute_group ** groups);
```

Arguments

subsys system subsystem

groups default attributes for the root device

Description

All 'system' subsystems have a `/sys/devices/system/<name>` root device with the name of the subsystem. The root device can carry subsystem- wide attributes. All registered devices are below this single root device and are named after the subsystem with a simple enumeration number appended. The registered devices are not explicitly named; only 'id' in the device needs to be set.

Do not use this interface for anything new, it exists for compatibility with bad ideas only. New subsystems should use plain subsystems; and add the subsystem-wide attributes should be added to the subsystem directory itself and not some create fake root-device placed in `/sys/devices/system/<name>`.

Name

`subsys_virtual_register` — register a subsystem at `/sys/devices/virtual/`

Synopsis

```
int subsys_virtual_register (struct bus_type * subsys, const struct
attribute_group ** groups);
```

Arguments

subsys virtual subsystem

groups default attributes for the root device

Description

All 'virtual' subsystems have a `/sys/devices/system/<name>` root device with the name of the subsystem. The root device can carry subsystem-wide attributes. All registered devices are below this single root device. There's no restriction on device naming. This is for kernel software constructs which need sysfs interface.

Device Drivers DMA Management

Name

`dma_buf_export` — Creates a new `dma_buf`, and associates an anon file with this buffer, so it can be exported. Also connect the allocator specific data and ops to the buffer. Additionally, provide a name string for exporter; useful in debugging.

Synopsis

```
struct dma_buf * dma_buf_export (const struct dma_buf_export_info *  
exp_info);
```

Arguments

exp_info [in] holds all the export related information provided by the exporter. see struct `dma_buf_export_info` for further details.

Description

Returns, on success, a newly created `dma_buf` object, which wraps the supplied private data and operations for `dma_buf_ops`. On either missing ops, or error in allocating struct `dma_buf`, will return negative error.

Name

`dma_buf_fd` — returns a file descriptor for the given `dma_buf`

Synopsis

```
int dma_buf_fd (struct dma_buf * dmabuf, int flags);
```

Arguments

dmabuf [in] pointer to `dma_buf` for which fd is required.

flags [in] flags to give to fd

Description

On success, returns an associated 'fd'. Else, returns error.

Name

`dma_buf_get` — returns the `dma_buf` structure related to an `fd`

Synopsis

```
struct dma_buf * dma_buf_get (int fd);
```

Arguments

fd [in] `fd` associated with the `dma_buf` to be returned

Description

On success, returns the `dma_buf` structure associated with an `fd`; uses file's refcounting done by `fget` to increase refcount. returns `ERR_PTR` otherwise.

Name

`dma_buf_put` — decreases refcount of the buffer

Synopsis

```
void dma_buf_put (struct dma_buf * dmabuf);
```

Arguments

dmabuf [in] buffer to reduce refcount of

Description

Uses file's refcounting done implicitly by `fput`

Name

`dma_buf_attach` — Add the device to `dma_buf`'s attachments list; optionally, calls `attach` of `dma_buf_ops` to allow device-specific attach functionality

Synopsis

```
struct dma_buf_attachment * dma_buf_attach (struct dma_buf * dmabuf,  
struct device * dev);
```

Arguments

dmabuf [in] buffer to attach device to.

dev [in] device to be attached.

Description

Returns `struct dma_buf_attachment *` for this attachment; returns `ERR_PTR` on error.

Name

`dma_buf_detach` — Remove the given attachment from `dmabuf`'s attachments list; optionally calls `detach` of `dma_buf_ops` for device-specific detach

Synopsis

```
void dma_buf_detach (struct dma_buf * dmabuf, struct dma_buf_attachment  
* attach);
```

Arguments

dmabuf [in] buffer to detach from.

attach [in] attachment to be detached; is free'd after this call.

Name

`dma_buf_map_attachment` — Returns the scatterlist table of the attachment; mapped into `_device_` address space. Is a wrapper for `map_dma_buf` of the `dma_buf_ops`.

Synopsis

```
struct sg_table * dma_buf_map_attachment (struct dma_buf_attachment *  
attach, enum dma_data_direction direction);
```

Arguments

attach [in] attachment whose scatterlist is to be returned

direction [in] direction of DMA transfer

Description

Returns `sg_table` containing the scatterlist to be returned; returns `ERR_PTR` on error.

Name

`dma_buf_unmap_attachment` — unmaps and decreases usecount of the buffer; might deallocate the scatterlist associated. Is a wrapper for `unmap_dma_buf` of `dma_buf_ops`.

Synopsis

```
void dma_buf_unmap_attachment (struct dma_buf_attachment * attach,  
struct sg_table * sg_table, enum dma_data_direction direction);
```

Arguments

attach [in] attachment to unmap buffer from

sg_table [in] scatterlist info of the buffer to unmap

direction [in] direction of DMA transfer

Name

`dma_buf_begin_cpu_access` — Must be called before accessing a `dma_buf` from the cpu in the kernel context. Calls `begin_cpu_access` to allow exporter-specific preparations. Coherency is only guaranteed in the specified range for the specified access direction.

Synopsis

```
int dma_buf_begin_cpu_access (struct dma_buf * dmabuf, size_t start,
size_t len, enum dma_data_direction direction);
```

Arguments

<i>dmabuf</i>	[in] buffer to prepare cpu access for.
<i>start</i>	[in] start of range for cpu access.
<i>len</i>	[in] length of range for cpu access.
<i>direction</i>	[in] length of range for cpu access.

Description

Can return negative error values, returns 0 on success.

Name

`dma_buf_end_cpu_access` — Must be called after accessing a `dma_buf` from the cpu in the kernel context. Calls `end_cpu_access` to allow exporter-specific actions. Coherency is only guaranteed in the specified range for the specified access direction.

Synopsis

```
void dma_buf_end_cpu_access (struct dma_buf * dmabuf, size_t start,  
size_t len, enum dma_data_direction direction);
```

Arguments

<i>dmabuf</i>	[in] buffer to complete cpu access for.
<i>start</i>	[in] start of range for cpu access.
<i>len</i>	[in] length of range for cpu access.
<i>direction</i>	[in] length of range for cpu access.

Description

This call must always succeed.

Name

`dma_buf_kmap_atomic` — Map a page of the buffer object into kernel address space. The same restrictions as for `kmap_atomic` and friends apply.

Synopsis

```
void * dma_buf_kmap_atomic (struct dma_buf * dmabuf, unsigned long
                             page_num);
```

Arguments

dmabuf [in] buffer to map page from.

page_num [in] page in PAGE_SIZE units to map.

Description

This call must always succeed, any necessary preparations that might fail need to be done in `begin_cpu_access`.

Name

`dma_buf_kunmap_atomic` — Unmap a page obtained by `dma_buf_kmap_atomic`.

Synopsis

```
void dma_buf_kunmap_atomic (struct dma_buf * dmabuf, unsigned long  
  page_num, void * vaddr);
```

Arguments

dmabuf [in] buffer to unmap page from.

page_num [in] page in PAGE_SIZE units to unmap.

vaddr [in] kernel space pointer obtained from `dma_buf_kmap_atomic`.

Description

This call must always succeed.

Name

`dma_buf_kmap` — Map a page of the buffer object into kernel address space. The same restrictions as for `kmap` and friends apply.

Synopsis

```
void * dma_buf_kmap (struct dma_buf * dmabuf, unsigned long page_num);
```

Arguments

dmabuf [in] buffer to map page from.

page_num [in] page in PAGE_SIZE units to map.

Description

This call must always succeed, any necessary preparations that might fail need to be done in `begin_cpu_access`.

Name

`dma_buf_kunmap` — Unmap a page obtained by `dma_buf_kmap`.

Synopsis

```
void dma_buf_kunmap (struct dma_buf * dmabuf, unsigned long page_num,  
void * vaddr);
```

Arguments

dmabuf [in] buffer to unmap page from.

page_num [in] page in PAGE_SIZE units to unmap.

vaddr [in] kernel space pointer obtained from `dma_buf_kmap`.

Description

This call must always succeed.

Name

`dma_buf_mmap` — Setup up a userspace mmap with the given vma

Synopsis

```
int dma_buf_mmap (struct dma_buf * dmabuf, struct vm_area_struct * vma,  
unsigned long pgoff);
```

Arguments

dmabuf [in] buffer that should back the vma

vma [in] vma for the mmap

pgoff [in] offset in pages where this mmap should start within the dma-buf buffer.

Description

This function adjusts the passed in vma so that it points at the file of the dma_buf operation. It also adjusts the starting pgoff and does bounds checking on the size of the vma. Then it calls the exporters mmap function to set up the mapping.

Can return negative error values, returns 0 on success.

Name

`dma_buf_vmap` — Create virtual mapping for the buffer object into kernel address space. Same restrictions as for `vmap` and friends apply.

Synopsis

```
void * dma_buf_vmap (struct dma_buf * dmabuf);
```

Arguments

dmabuf [in] buffer to vmap

Description

This call may fail due to lack of virtual mapping address space. These calls are optional in drivers. The intended use for them is for mapping objects linear in kernel space for high use objects. Please attempt to use `kmap/kunmap` before thinking about these interfaces.

Returns `NULL` on error.

Name

`dma_buf_vunmap` — Unmap a vmmap obtained by `dma_buf_vmap`.

Synopsis

```
void dma_buf_vunmap (struct dma_buf * dmabuf, void * vaddr);
```

Arguments

dmabuf [in] buffer to vunmap

vaddr [in] vmmap to vunmap

Name

`fence_context_alloc` — allocate an array of fence contexts

Synopsis

```
unsigned fence_context_alloc (unsigned num);
```

Arguments

num [in] amount of contexts to allocate

Description

This function will return the first index of the number of fences allocated. The fence context is used for setting fence->context to a unique number.

Name

`fence_signal_locked` — signal completion of a fence

Synopsis

```
int fence_signal_locked (struct fence * fence);
```

Arguments

fence the fence to signal

Description

Signal completion for software callbacks on a fence, this will unblock `fence_wait` calls and run all the callbacks added with `fence_add_callback`. Can be called multiple times, but since a fence can only go from unsignaled to signaled state, it will only be effective the first time.

Unlike `fence_signal`, this function must be called with `fence->lock` held.

Name

`fence_signal` — signal completion of a fence

Synopsis

```
int fence_signal (struct fence * fence);
```

Arguments

fence the fence to signal

Description

Signal completion for software callbacks on a fence, this will unblock `fence_wait` calls and run all the callbacks added with `fence_add_callback`. Can be called multiple times, but since a fence can only go from unsignaled to signaled state, it will only be effective the first time.

Name

`fence_wait_timeout` — sleep until the fence gets signaled or until timeout elapses

Synopsis

```
signed long fence_wait_timeout (struct fence * fence, bool intr, signed  
long timeout);
```

Arguments

fence [in] the fence to wait on

intr [in] if true, do an interruptible wait

timeout [in] timeout value in jiffies, or MAX_SCHEDULE_TIMEOUT

Description

Returns `-ERESTARTSYS` if interrupted, 0 if the wait timed out, or the remaining timeout in jiffies on success. Other error values may be returned on custom implementations.

Performs a synchronous wait on this fence. It is assumed the caller directly or indirectly (buf-mgr between reservation and committing) holds a reference to the fence, otherwise the fence might be freed before return, resulting in undefined behavior.

Name

`fence_enable_sw_signaling` — enable signaling on fence

Synopsis

```
void fence_enable_sw_signaling (struct fence * fence);
```

Arguments

fence [in] the fence to enable

Description

this will request for sw signaling to be enabled, to make the fence complete as soon as possible

Name

`fence_add_callback` — add a callback to be called when the fence is signaled

Synopsis

```
int fence_add_callback (struct fence * fence, struct fence_cb * cb,  
fence_func_t func);
```

Arguments

fence [in] the fence to wait on

cb [in] the callback to register

func [in] the function to call

Description

`cb` will be initialized by `fence_add_callback`, no initialization by the caller is required. Any number of callbacks can be registered to a fence, but a callback can only be registered to one fence at a time.

Note that the callback can be called from an atomic context. If fence is already signaled, this function will return `-ENOENT` (and *not* call the callback)

Add a software callback to the fence. Same restrictions apply to refcount as it does to `fence_wait`, however the caller doesn't need to

keep a refcount to fence afterwards

when software access is enabled, the creator of the fence is required to keep the fence alive until after it signals with `fence_signal`. The callback itself can be called from irq context.

Name

`fence_remove_callback` — remove a callback from the signaling list

Synopsis

```
bool fence_remove_callback (struct fence * fence, struct fence_cb * cb);
```

Arguments

fence [in] the fence to wait on

cb [in] the callback to remove

Description

Remove a previously queued callback from the fence. This function returns true if the callback is successfully removed, or false if the fence has already been signaled.

WARNING: Cancelling a callback should only be done if you really know what you're doing, since deadlocks and race conditions could occur all too easily. For this reason, it should only ever be done on hardware lockup recovery, with a reference held to the fence.

Name

`fence_default_wait` — default sleep until the fence gets signaled or until timeout elapses

Synopsis

```
signed long fence_default_wait (struct fence * fence, bool intr, signed  
long timeout);
```

Arguments

fence [in] the fence to wait on

intr [in] if true, do an interruptible wait

timeout [in] timeout value in jiffies, or MAX_SCHEDULE_TIMEOUT

Description

Returns `-ERESTARTSYS` if interrupted, 0 if the wait timed out, or the remaining timeout in jiffies on success.

Name

`fence_init` — Initialize a custom fence.

Synopsis

```
void fence_init (struct fence * fence, const struct fence_ops * ops,  
spinlock_t * lock, unsigned context, unsigned seqno);
```

Arguments

<i>fence</i>	[in] the fence to initialize
<i>ops</i>	[in] the fence_ops for operations on this fence
<i>lock</i>	[in] the irqsafe spinlock to use for locking this fence
<i>context</i>	[in] the execution context this fence is run on
<i>seqno</i>	[in] a linear increasing sequence number for this context

Description

Initializes an allocated fence, the caller doesn't have to keep its refcount after committing with this fence, but it will need to hold a refcount again if `fence_ops.enable_signaling` gets called. This can be used for other implementing other types of fence.

`context` and `seqno` are used for easy comparison between fences, allowing to check which fence is later by simply using `fence_later`.

Name

/usr/src/linux-4.1.38-50//drivers/dma-buf/seqno-fence.c — Document generation inconsistency

Oops

Warning

The template for this document tried to insert the structured comment from the file `/usr/src/linux-4.1.38-50//drivers/dma-buf/seqno-fence.c` at this point, but none was found. This dummy section is inserted to allow generation to continue.

Name

struct fence — software synchronization primitive

Synopsis

```
struct fence {
    struct kref refcount;
    const struct fence_ops * ops;
    struct rcu_head rcu;
    struct list_head cb_list;
    spinlock_t * lock;
    unsigned context;
    unsigned seqno;
    unsigned long flags;
    ktime_t timestamp;
    int status;
};
```

Members

refcount	refcount for this fence
ops	fence_ops associated with this fence
rcu	used for releasing fence with kfree_rcu
cb_list	list of all callbacks to call
lock	spin_lock_irqsave used for locking
context	execution context this fence belongs to, returned by fence_context_alloc
seqno	the sequence number of this fence inside the execution context, can be compared to decide which fence would be signaled later.
flags	A mask of FENCE_FLAG_* defined below
timestamp	Timestamp when the fence was signaled.
status	Optional, only valid if < 0, must be set before calling fence_signal, indicates that the fence has completed with an error.

Description

the flags member must be manipulated and read using the appropriate atomic ops (bit_*), so taking the spinlock will not be needed most of the time.

FENCE_FLAG_SIGNALED_BIT - fence is already signaled
FENCE_FLAG_ENABLE_SIGNAL_BIT - enable_signaling might have been called
FENCE_FLAG_USER_BITS - start of the unused bits, can be used by the implementer of the fence for its own purposes. Can be used in different ways by different fence implementers, so do not rely on this.

*) Since atomic bitops are used, this is not guaranteed to be the case. Particularly, if the bit was set, but fence_signal was called right before this bit was set, it would have been able to

set the `FENCE_FLAG_SIGNALED_BIT`, before `enable_signaling` was called. Adding a check for `FENCE_FLAG_SIGNALED_BIT` after setting `FENCE_FLAG_ENABLE_SIGNAL_BIT` closes this race, and makes sure that after `fence_signal` was called, any `enable_signaling` call will have either been completed, or never called at all.

Name

struct fence_cb — callback for fence_add_callback

Synopsis

```
struct fence_cb {  
    struct list_head node;  
    fence_func_t func;  
};
```

Members

node used by fence_add_callback to append this struct to fence::cb_list

func fence_func_t to call

Description

This struct will be initialized by fence_add_callback, additional data can be passed along by embedding fence_cb in another struct.

Name

struct fence_ops — operations implemented for fence

Synopsis

```
struct fence_ops {
    const char * (* get_driver_name) (struct fence *fence);
    const char * (* get_timeline_name) (struct fence *fence);
    bool (* enable_signaling) (struct fence *fence);
    bool (* signaled) (struct fence *fence);
    signed long (* wait) (struct fence *fence, bool intr, signed long timeout);
    void (* release) (struct fence *fence);
    int (* fill_driver_data) (struct fence *fence, void *data, int size);
    void (* fence_value_str) (struct fence *fence, char *str, int size);
    void (* timeline_value_str) (struct fence *fence, char *str, int size);
};
```

Members

get_driver_name	returns the driver name.
get_timeline_name	return the name of the context this fence belongs to.
enable_signaling	enable software signaling of fence.
signaled	[optional] peek whether the fence is signaled, can be null.
wait	custom wait implementation, or fence_default_wait.
release	[optional] called on destruction of fence, can be null
fill_driver_data	[optional] callback to fill in free-form debug info Returns amount of bytes filled, or -errno.
fence_value_str	[optional] fills in the value of the fence as a string
timeline_value_str	[optional] fills in the current value of the timeline as a string

Notes on enable_signaling

For fence implementations that have the capability for hw->hw signaling, they can implement this op to enable the necessary irqs, or insert commands into cmdstream, etc. This is called in the first wait or add_callback path to let the fence implementation know that there is another driver waiting on the signal (ie. hw->sw case).

This function can be called called from atomic context, but not from irq context, so normal spinlocks can be used.

A return value of false indicates the fence already passed, or some failure occurred that made it impossible to enable signaling. True indicates successful enabling.

fence->status may be set in enable_signaling, but only when false is returned.

Calling fence_signal before enable_signaling is called allows for a tiny race window in which enable_signaling is called during, before, or after fence_signal. To fight this, it is recommended that before

`enable_signaling` returns true an extra reference is taken on the fence, to be released when the fence is signaled. This will mean `fence_signal` will still be called twice, but the second time will be a noop since it was already signaled.

Notes on signaled

May set `fence->status` if returning true.

Notes on wait

Must not be NULL, set to `fence_default_wait` for default implementation. the `fence_default_wait` implementation should work for any fence, as long as `enable_signaling` works correctly.

Must return `-ERESTARTSYS` if the wait is `intr = true` and the wait was interrupted, and remaining jiffies if fence has signaled, or 0 if wait timed out. Can also return other error values on custom implementations, which should be treated as if the fence is signaled. For example a hardware lockup could be reported like that.

Notes on release

Can be NULL, this function allows additional commands to run on destruction of the fence. Can be called from irq context. If pointer is set to NULL, `kfree` will get called instead.

Name

`fence_get` — increases refcount of the fence

Synopsis

```
struct fence * fence_get (struct fence * fence);
```

Arguments

fence [in] fence to increase refcount of

Description

Returns the same fence, with refcount increased by 1.

Name

`fence_get_rcu` — get a fence from a `reservation_object_list` with rcu read lock

Synopsis

```
struct fence * fence_get_rcu (struct fence * fence);
```

Arguments

fence [in] fence to increase refcount of

Description

Function returns NULL if no refcount could be obtained, or the fence.

Name

`fence_put` — decreases refcount of the fence

Synopsis

```
void fence_put (struct fence * fence);
```

Arguments

fence [in] fence to reduce refcount of

Name

`fence_is_signaled_locked` — Return an indication if the fence is signaled yet.

Synopsis

```
bool fence_is_signaled_locked (struct fence * fence);
```

Arguments

fence [in] the fence to check

Description

Returns true if the fence was already signaled, false if not. Since this function doesn't enable signaling, it is not guaranteed to ever return true if `fence_add_callback`, `fence_wait` or `fence_enable_sw_signaling` haven't been called before.

This function requires `fence->lock` to be held.

Name

`fence_is_signaled` — Return an indication if the fence is signaled yet.

Synopsis

```
bool fence_is_signaled (struct fence * fence);
```

Arguments

fence [in] the fence to check

Description

Returns true if the fence was already signaled, false if not. Since this function doesn't enable signaling, it is not guaranteed to ever return true if `fence_add_callback`, `fence_wait` or `fence_enable_sw_signaling` haven't been called before.

It's recommended for seqno fences to call `fence_signal` when the operation is complete, it makes it possible to prevent issues from wraparound between time of issue and time of use by checking the return value of this function before calling hardware-specific wait instructions.

Name

`fence_later` — return the chronologically later fence

Synopsis

```
struct fence * fence_later (struct fence * f1, struct fence * f2);
```

Arguments

f1 [in] the first fence from the same context

f2 [in] the second fence from the same context

Description

Returns NULL if both fences are signaled, otherwise the fence that would be signaled last. Both fences must be from the same context, since a seqno is not re-used across contexts.

Name

`fence_wait` — sleep until the fence gets signaled

Synopsis

```
signed long fence_wait (struct fence * fence, bool intr);
```

Arguments

fence [in] the fence to wait on

intr [in] if true, do an interruptible wait

Description

This function will return `-ERESTARTSYS` if interrupted by a signal, or 0 if the fence was signaled. Other error values may be returned on custom implementations.

Performs a synchronous wait on this fence. It is assumed the caller directly or indirectly holds a reference to the fence, otherwise the fence might be freed before return, resulting in undefined behavior.

Name

`to_seqno_fence` — cast a fence to a `seqno_fence`

Synopsis

```
struct seqno_fence * to_seqno_fence (struct fence * fence);
```

Arguments

fence fence to cast to a `seqno_fence`

Description

Returns NULL if the fence is not a `seqno_fence`, or the `seqno_fence` otherwise.

Name

`seqno_fence_init` — initialize a seqno fence

Synopsis

```
void seqno_fence_init (struct seqno_fence * fence, spinlock_t * lock,
struct dma_buf * sync_buf, uint32_t context, uint32_t seqno_ofs,
uint32_t seqno, enum seqno_fence_condition cond, const struct fence_ops
* ops);
```

Arguments

<i>fence</i>	seqno_fence to initialize
<i>lock</i>	pointer to spinlock to use for fence
<i>sync_buf</i>	buffer containing the memory location to signal on
<i>context</i>	the execution context this fence is a part of
<i>seqno_ofs</i>	the offset within <i>sync_buf</i>
<i>seqno</i>	the sequence # to signal on
<i>cond</i>	fence wait condition
<i>ops</i>	the fence_ops for operations on this seqno fence

Description

This function initializes a struct `seqno_fence` with passed parameters, and takes a reference on `sync_buf` which is released on fence destruction.

A `seqno_fence` is a `dma_fence` which can complete in software when `enable_signaling` is called, but it also completes when `(s32)((sync_buf)[seqno_ofs] - seqno) >= 0` is true

The `seqno_fence` will take a refcount on the `sync_buf` until it's destroyed, but actual lifetime of `sync_buf` may be longer if one of the callers take a reference to it.

Certain hardware have instructions to insert this type of wait condition in the command stream, so no intervention from software would be needed. This type of fence can be destroyed before completed, however a reference on the `sync_buf` dma-buf can be taken. It is encouraged to re-use the same dma-buf for `sync_buf`, since mapping or unmapping the `sync_buf` to the device's vm can be expensive.

It is recommended for creators of `seqno_fence` to call `fence_signal` before destruction. This will prevent possible issues from wraparound at time of issue vs time of check, since users can check `fence_is_signaled` before submitting instructions for the hardware to wait on the fence. However, when `ops.enable_signaling` is not called, it doesn't have to be done as soon as possible, just before there's any real danger of `seqno` wraparound.

Name

/usr/src/linux-4.1.38-50//drivers/dma-buf/reservation.c — Document generation inconsistency

Oops

Warning

The template for this document tried to insert the structured comment from the file `/usr/src/linux-4.1.38-50//drivers/dma-buf/reservation.c` at this point, but none was found. This dummy section is inserted to allow generation to continue.

Name

/usr/src/linux-4.1.38-50//include/linux/reservation.h — Document generation inconsistency

Oops

Warning

The template for this document tried to insert the structured comment from the file `/usr/src/linux-4.1.38-50//include/linux/reservation.h` at this point, but none was found. This dummy section is inserted to allow generation to continue.

Name

`dma_alloc_from_coherent` — try to allocate memory from the per-device coherent area

Synopsis

```
int dma_alloc_from_coherent (struct device * dev, ssize_t size,
dma_addr_t * dma_handle, void ** ret);
```

Arguments

<i>dev</i>	device from which we allocate memory
<i>size</i>	size of requested memory area
<i>dma_handle</i>	This will be filled with the correct dma handle
<i>ret</i>	This pointer will be filled with the virtual address to allocated area.

Description

This function should be only called from per-arch `dma_alloc_coherent` to support allocation from per-device coherent memory pools.

Returns 0 if `dma_alloc_coherent` should continue with allocating from generic memory areas, or !0 if `dma_alloc_coherent` should return *ret*.

Name

`dma_release_from_coherent` — try to free the memory allocated from per-device coherent memory pool

Synopsis

```
int dma_release_from_coherent (struct device * dev, int order, void *  
vaddr);
```

Arguments

dev device from which the memory was allocated

order the order of pages allocated

vaddr virtual address of allocated pages

Description

This checks whether the memory was allocated from the per-device coherent memory pool and if so, releases that memory.

Returns 1 if we correctly released the memory, or 0 if `dma_release_coherent` should proceed with releasing memory from generic pools.

Name

`dma_mmap_from_coherent` — try to mmap the memory allocated from per-device coherent memory pool to userspace

Synopsis

```
int dma_mmap_from_coherent (struct device * dev, struct vm_area_struct  
* vma, void * vaddr, size_t size, int * ret);
```

Arguments

<i>dev</i>	device from which the memory was allocated
<i>vma</i>	vm_area for the userspace memory
<i>vaddr</i>	cpu address returned by <code>dma_alloc_from_coherent</code>
<i>size</i>	size of the memory buffer allocated by <code>dma_alloc_from_coherent</code>
<i>ret</i>	result from <code>remap_pfn_range</code>

Description

This checks whether the memory was allocated from the per-device coherent memory pool and if so, maps that memory to the provided `vma`.

Returns 1 if we correctly mapped the memory, or 0 if the caller should proceed with mapping memory from generic pools.

Name

`dmam_alloc_coherent` — Managed `dma_alloc_coherent`

Synopsis

```
void * dmam_alloc_coherent (struct device * dev, size_t size, dma_addr_t  
* dma_handle, gfp_t gfp);
```

Arguments

<i>dev</i>	Device to allocate coherent memory for
<i>size</i>	Size of allocation
<i>dma_handle</i>	Out argument for allocated DMA handle
<i>gfp</i>	Allocation flags

Description

Managed `dma_alloc_coherent`. Memory allocated using this function will be automatically released on driver detach.

RETURNS

Pointer to allocated memory on success, NULL on failure.

Name

`dmam_free_coherent` — Managed `dma_free_coherent`

Synopsis

```
void dmam_free_coherent (struct device * dev, size_t size, void * vaddr,  
dma_addr_t dma_handle);
```

Arguments

<i>dev</i>	Device to free coherent memory for
<i>size</i>	Size of allocation
<i>vaddr</i>	Virtual address of the memory to free
<i>dma_handle</i>	DMA handle of the memory to free

Description

Managed `dma_free_coherent`.

Name

`dmam_alloc_noncoherent` — Managed `dma_alloc_non_coherent`

Synopsis

```
void * dmam_alloc_noncoherent (struct device * dev, size_t size,  
dma_addr_t * dma_handle, gfp_t gfp);
```

Arguments

<i>dev</i>	Device to allocate <code>non_coherent</code> memory for
<i>size</i>	Size of allocation
<i>dma_handle</i>	Out argument for allocated DMA handle
<i>gfp</i>	Allocation flags

Description

Managed `dma_alloc_non_coherent`. Memory allocated using this function will be automatically released on driver detach.

RETURNS

Pointer to allocated memory on success, NULL on failure.

Name

`dmam_free_noncoherent` — Managed `dma_free_noncoherent`

Synopsis

```
void dmam_free_noncoherent (struct device * dev, size_t size, void *  
vaddr, dma_addr_t dma_handle);
```

Arguments

<i>dev</i>	Device to free noncoherent memory for
<i>size</i>	Size of allocation
<i>vaddr</i>	Virtual address of the memory to free
<i>dma_handle</i>	DMA handle of the memory to free

Description

Managed `dma_free_noncoherent`.

Name

`dmam_declare_coherent_memory` — Managed `dma_declare_coherent_memory`

Synopsis

```
int dmam_declare_coherent_memory (struct device * dev, phys_addr_t
phys_addr, dma_addr_t device_addr, size_t size, int flags);
```

Arguments

<i>dev</i>	Device to declare coherent memory for
<i>phys_addr</i>	Physical address of coherent memory to be declared
<i>device_addr</i>	Device address of coherent memory to be declared
<i>size</i>	Size of coherent memory to be declared
<i>flags</i>	Flags

Description

Managed `dma_declare_coherent_memory`.

RETURNS

0 on success, -errno on failure.

Name

`dmam_release_declared_memory` — Managed `dma_release_declared_memory`.

Synopsis

```
void dmam_release_declared_memory (struct device * dev);
```

Arguments

dev Device to release declared coherent memory for

Description

Managed `dmam_release_declared_memory`.

Device Drivers Power Management

Name

`dpm_resume_start` — Execute “noirq” and “early” device callbacks.

Synopsis

```
void dpm_resume_start (pm_message_t state);
```

Arguments

state PM transition of the system being carried out.

Name

`dpm_resume_end` — Execute “resume” callbacks and complete system transition.

Synopsis

```
void dpm_resume_end (pm_message_t state);
```

Arguments

state PM transition of the system being carried out.

Description

Execute “resume” callbacks for all devices and complete the PM transition of the system.

Name

`dpm_suspend_end` — Execute “late” and “noirq” device suspend callbacks.

Synopsis

```
int dpm_suspend_end (pm_message_t state);
```

Arguments

state PM transition of the system being carried out.

Name

`dpm_suspend_start` — Prepare devices for PM transition and suspend them.

Synopsis

```
int dpm_suspend_start (pm_message_t state);
```

Arguments

state PM transition of the system being carried out.

Description

Prepare all non-sysdev devices for system PM transition and execute “suspend” callbacks for them.

Name

`device_pm_wait_for_dev` — Wait for suspend/resume of a device to complete.

Synopsis

```
int device_pm_wait_for_dev (struct device * subordinate, struct device  
* dev);
```

Arguments

subordinate Device that needs to wait for *dev*.

dev Device to wait for.

Name

`dpm_for_each_dev` — device iterator.

Synopsis

```
void dpm_for_each_dev (void * data, void (*fn) (struct device *, void  
*));
```

Arguments

data data for the callback.

fn function to be called for each device.

Description

Iterate over devices in `dpm_list`, and call *fn* for each device, passing it *data*.

Device Drivers ACPI Support

Name

`acpi_match_device` — Match a struct device against a given list of ACPI IDs

Synopsis

```
const struct acpi_device_id * acpi_match_device (const struct
acpi_device_id * ids, const struct device * dev);
```

Arguments

ids Array of struct `acpi_device_id` object to match against.

dev The device structure to match.

Description

Check if *dev* has a valid ACPI handle and if there is a struct `acpi_device` object for that handle and use that object to match against a given list of device IDs.

Return a pointer to the first matching ID on success or `NULL` on failure.

Name

`acpi_bus_register_driver` — register a driver with the ACPI bus

Synopsis

```
int acpi_bus_register_driver (struct acpi_driver * driver);
```

Arguments

driver driver being registered

Description

Registers a driver with the ACPI bus. Searches the namespace for all devices that match the driver's criteria and binds. Returns zero for success or a negative error status for failure.

Name

`acpi_bus_unregister_driver` — unregisters a driver with the ACPI bus

Synopsis

```
void acpi_bus_unregister_driver (struct acpi_driver * driver);
```

Arguments

driver driver to unregister

Description

Unregisters a driver with the ACPI bus. Searches the namespace for all devices that match the driver's criteria and unbinds.

Name

`acpi_bus_scan` — Add ACPI device node objects in a given namespace scope.

Synopsis

```
int acpi_bus_scan (acpi_handle handle);
```

Arguments

handle Root of the namespace scope to scan.

Description

Scan a given ACPI tree (probably recently hot-plugged) and create and add found devices.

If no devices were found, `-ENODEV` is returned, but it does not mean that there has been a real error. There just have been no suitable ACPI objects in the table trunk from which the kernel could create a device and add an appropriate driver.

Must be called under `acpi_scan_lock`.

Name

`acpi_bus_trim` — Detach scan handlers and drivers from ACPI device objects.

Synopsis

```
void acpi_bus_trim (struct acpi_device * adev);
```

Arguments

adev Root of the ACPI namespace scope to walk.

Description

Must be called under `acpi_scan_lock`.

Name

`create_pnp_modalias` — Create hid/cid(s) string for modalias and uevent

Synopsis

```
int create_pnp_modalias (struct acpi_device * acpi_dev, char * modalias,  
int size);
```

Arguments

acpi_dev ACPI device object.

modalias Buffer to print into.

size Size of the buffer.

Description

Creates hid/cid(s) string needed for modalias and uevent e.g. on a device with hid:IBM0001 and cid:ACPI0001 you get:

modalias

"acpi:IBM0001:ACPI0001"

Return

0: no `_HID` and no `_CID` -EINVAL: output error -ENOMEM: output is truncated

Name

`create_of_modalias` — Creates DT compatible string for modalias and uevent

Synopsis

```
int create_of_modalias (struct acpi_device * acpi_dev, char * modalias,  
int size);
```

Arguments

acpi_dev ACPI device object.

modalias Buffer to print into.

size Size of the buffer.

Expose DT compatible modalias as of

NnameTCcompatible. This function should only be called for devices having PRP0001 in their list of ACPI/PNP IDs.

Name

`acpi_of_match_device` — Match device object using the “compatible” property.

Synopsis

```
bool acpi_of_match_device (struct acpi_device * adev, const struct  
of_device_id * of_match_table);
```

Arguments

adev ACPI device object to match.

of_match_table List of device IDs to match against.

Description

If *dev* has an ACPI companion which has the special PRP0001 device ID in its list of identifiers and a `_DSD` object with the “compatible” property, use that property to match against the given list of identifiers.

Name

`acpi_scan_drop_device` — Drop an ACPI device object.

Synopsis

```
void acpi_scan_drop_device (acpi_handle handle, void * context);
```

Arguments

handle Handle of an ACPI namespace node, not used.

context Address of the ACPI device object to drop.

Description

This is invoked by `acpi_ns_delete_node` during the removal of the ACPI namespace node the device object pointed to by *context* is attached to.

The unregistration is carried out asynchronously to avoid running `acpi_device_del` under the ACPICA's namespace mutex and the list is used to ensure the correct ordering (the device objects must be unregistered in the same order in which the corresponding namespace nodes are deleted).

Device drivers PnP support

Name

`pnp_register_protocol` — adds a pnp protocol to the pnp layer

Synopsis

```
int pnp_register_protocol (struct pnp_protocol * protocol);
```

Arguments

protocol pointer to the corresponding `pnp_protocol` structure

Ex protocols

ISAPNP, PNPBIOS, etc

Name

`pnp_unregister_protocol` — removes a pnp protocol from the pnp layer

Synopsis

```
void pnp_unregister_protocol (struct pnp_protocol * protocol);
```

Arguments

protocol pointer to the corresponding pnp_protocol structure

Name

`pnp_request_card_device` — Searches for a PnP device under the specified card

Synopsis

```
struct pnp_dev * pnp_request_card_device (struct pnp_card_link * clink,  
const char * id, struct pnp_dev * from);
```

Arguments

clink pointer to the card link, cannot be NULL

id pointer to a PnP ID structure that explains the rules for finding the device

from Starting place to search from. If NULL it will start from the beginning.

Name

`pnp_release_card_device` — call this when the driver no longer needs the device

Synopsis

```
void pnp_release_card_device (struct pnp_dev * dev);
```

Arguments

dev pointer to the PnP device structure

Name

`pnp_register_card_driver` — registers a PnP card driver with the PnP Layer

Synopsis

```
int pnp_register_card_driver (struct pnp_card_driver * drv);
```

Arguments

drv pointer to the driver to register

Name

`pnp_unregister_card_driver` — unregisters a PnP card driver from the PnP Layer

Synopsis

```
void pnp_unregister_card_driver (struct pnp_card_driver * drv);
```

Arguments

drv pointer to the driver to unregister

Name

`pnp_add_id` — adds an EISA id to the specified device

Synopsis

```
struct pnp_id * pnp_add_id (struct pnp_dev * dev, const char * id);
```

Arguments

dev pointer to the desired device

id pointer to an EISA id string

Name

`pnp_start_dev` — low-level start of the PnP device

Synopsis

```
int pnp_start_dev (struct pnp_dev * dev);
```

Arguments

dev pointer to the desired device

Description

assumes that resources have already been allocated

Name

`pnp_stop_dev` — low-level disable of the PnP device

Synopsis

```
int pnp_stop_dev (struct pnp_dev * dev);
```

Arguments

dev pointer to the desired device

Description

does not free resources

Name

`pnp_activate_dev` — activates a PnP device for use

Synopsis

```
int pnp_activate_dev (struct pnp_dev * dev);
```

Arguments

dev pointer to the desired device

Description

does not validate or set resources so be careful.

Name

`pnp_disable_dev` — disables device

Synopsis

```
int pnp_disable_dev (struct pnp_dev * dev);
```

Arguments

dev pointer to the desired device

Description

inform the correct pnp protocol so that resources can be used by other devices

Name

`pnp_is_active` — Determines if a device is active based on its current resources

Synopsis

```
int pnp_is_active (struct pnp_dev * dev);
```

Arguments

dev pointer to the desired PnP device

Userspace IO devices

Name

`uio_event_notify` — trigger an interrupt event

Synopsis

```
void uio_event_notify (struct uio_info * info);
```

Arguments

info UIO device capabilities

Name

`__uio_register_device` — register a new userspace IO device

Synopsis

```
int __uio_register_device (struct module * owner, struct device * parent,  
struct uio_info * info);
```

Arguments

owner module that creates the new device

parent parent device

info UIO device capabilities

Description

returns zero on success or a negative error code.

Name

`uio_unregister_device` — unregister a industrial IO device

Synopsis

```
void uio_unregister_device (struct uio_info * info);
```

Arguments

info UIO device capabilities

Name

struct uio_mem — description of a UIO memory region

Synopsis

```
struct uio_mem {
    const char * name;
    phys_addr_t addr;
    resource_size_t size;
    int memtype;
    void __iomem * internal_addr;
    struct uio_map * map;
};
```

Members

name	name of the memory region for identification
addr	address of the device's memory (phys_addr is used since addr can be logical, virtual, or physical & phys_addr_t should always be large enough to handle any of the address types)
size	size of IO
memtype	type of memory addr points to
internal_addr	ioremap-ped version of addr, for driver internal use
map	for use by the UIO core only.

Name

struct uio_port — description of a UIO port region

Synopsis

```
struct uio_port {  
    const char * name;  
    unsigned long start;  
    unsigned long size;  
    int porttype;  
    struct uio_portio * portio;  
};
```

Members

name	name of the port region for identification
start	start of port region
size	size of port region
porttype	type of port (see UIO_PORT_* below)
portio	for use by the UIO core only.

Name

struct uio_info — UIO device capabilities

Synopsis

```
struct uio_info {
    struct uio_device * uio_dev;
    const char * name;
    const char * version;
    struct uio_mem mem[MAX_UIO_MAPS];
    struct uio_port port[MAX_UIO_PORT_REGIONS];
    long irq;
    unsigned long irq_flags;
    void * priv;
    irqreturn_t (* handler) (int irq, struct uio_info *dev_info);
    int (* mmap) (struct uio_info *info, struct vm_area_struct *vma);
    int (* open) (struct uio_info *info, struct inode *inode);
    int (* release) (struct uio_info *info, struct inode *inode);
    int (* irqcontrol) (struct uio_info *info, s32 irq_on);
};
```

Members

uio_dev	the UIO device this info belongs to
name	device name
version	device driver version
mem[MAX_UIO_MAPS]	list of mappable memory regions, size==0 for end of list
port[MAX_UIO_PORT_REGIONS]	list of port regions, size==0 for end of list
irq	interrupt number or UIO_IRQ_CUSTOM
irq_flags	flags for request_irq
priv	optional private data
handler	the device's irq handler
mmap	mmap operation for this uio device
open	open operation for this uio device
release	release operation for this uio device
irqcontrol	disable/enable irqs when 0/1 is written to /dev/uioX

Chapter 3. Parallel Port Devices

Name

`parport_yield` — relinquish a parallel port temporarily

Synopsis

```
int parport_yield (struct pardevice * dev);
```

Arguments

dev a device on the parallel port

Description

This function relinquishes the port if it would be helpful to other drivers to do so. Afterwards it tries to reclaim the port using `parport_claim`, and the return value is the same as for `parport_claim`. If it fails, the port is left unclaimed and it is the driver's responsibility to reclaim the port.

The `parport_yield` and `parport_yield_blocking` functions are for marking points in the driver at which other drivers may claim the port and use their devices. Yielding the port is similar to releasing it and reclaiming it, but is more efficient because no action is taken if there are no other devices needing the port. In fact, nothing is done even if there are other devices waiting but the current device is still within its “timeslice”. The default timeslice is half a second, but it can be adjusted via the `/proc` interface.

Name

`parport_yield_blocking` — relinquish a parallel port temporarily

Synopsis

```
int parport_yield_blocking (struct pardevice * dev);
```

Arguments

dev a device on the parallel port

Description

This function relinquishes the port if it would be helpful to other drivers to do so. Afterwards it tries to reclaim the port using `parport_claim_or_block`, and the return value is the same as for `parport_claim_or_block`.

Name

`parport_wait_event` — wait for an event on a parallel port

Synopsis

```
int parport_wait_event (struct parport * port, signed long timeout);
```

Arguments

port port to wait on

timeout time to wait (in jiffies)

Description

This function waits for up to *timeout* jiffies for an interrupt to occur on a parallel port. If the port timeout is set to zero, it returns immediately.

If an interrupt occurs before the timeout period elapses, this function returns zero immediately. If it times out, it returns one. An error code less than zero indicates an error (most likely a pending signal), and the calling code should finish what it's doing as soon as it can.

Name

`parport_wait_peripheral` — wait for status lines to change in 35ms

Synopsis

```
int parport_wait_peripheral (struct parport * port, unsigned char mask,  
unsigned char result);
```

Arguments

port port to watch

mask status lines to watch

result desired values of chosen status lines

Description

This function waits until the masked status lines have the desired values, or until 35ms have elapsed (see IEEE 1284-1994 page 24 to 25 for why this value in particular is hardcoded). The *mask* and *result* parameters are bitmasks, with the bits defined by the constants in `parport.h`: `PARPORT_STATUS_BUSY`, and so on.

The port is polled quickly to start off with, in anticipation of a fast response from the peripheral. This fast polling time is configurable (using `/proc`), and defaults to 500usec. If the timeout for this port (see `parport_set_timeout`) is zero, the fast polling time is 35ms, and this function does not call `schedule`.

If the timeout for this port is non-zero, after the fast polling fails it uses `parport_wait_event` to wait for up to 10ms, waking up if an interrupt occurs.

Name

`parport_negotiate` — negotiate an IEEE 1284 mode

Synopsis

```
int parport_negotiate (struct parport * port, int mode);
```

Arguments

port port to use

mode mode to negotiate to

Description

Use this to negotiate to a particular IEEE 1284 transfer mode. The *mode* parameter should be one of the constants in `parport.h` starting `IEEE1284_MODE_`xxx.

The return value is 0 if the peripheral has accepted the negotiation to the mode specified, -1 if the peripheral is not IEEE 1284 compliant (or not present), or 1 if the peripheral has rejected the negotiation.

Name

`parport_write` — write a block of data to a parallel port

Synopsis

```
ssize_t parport_write (struct parport * port, const void * buffer,
size_t len);
```

Arguments

port port to write to

buffer data buffer (in kernel space)

len number of bytes of data to transfer

Description

This will write up to *len* bytes of *buffer* to the port specified, using the IEEE 1284 transfer mode most recently negotiated to (using `parport_negotiate`), as long as that mode supports forward transfers (host to peripheral).

It is the caller's responsibility to ensure that the first *len* bytes of *buffer* are valid.

This function returns the number of bytes transferred (if zero or positive), or else an error code.

Name

`parport_read` — read a block of data from a parallel port

Synopsis

```
ssize_t parport_read (struct parport * port, void * buffer, size_t len);
```

Arguments

port port to read from

buffer data buffer (in kernel space)

len number of bytes of data to transfer

Description

This will read up to *len* bytes of *buffer* to the port specified, using the IEEE 1284 transfer mode most recently negotiated to (using `parport_negotiate`), as long as that mode supports reverse transfers (peripheral to host).

It is the caller's responsibility to ensure that the first *len* bytes of *buffer* are available to write to.

This function returns the number of bytes transferred (if zero or positive), or else an error code.

Name

`parport_set_timeout` — set the inactivity timeout for a device

Synopsis

```
long parport_set_timeout (struct pardevice * dev, long inactivity);
```

Arguments

dev device on a port

inactivity inactivity timeout (in jiffies)

Description

This sets the inactivity timeout for a particular device on a port. This affects functions like `parport_wait_peripheral`. The special value 0 means not to call `schedule` while dealing with this device.

The return value is the previous inactivity timeout.

Any callers of `parport_wait_event` for this device are woken up.

Name

`parport_register_driver` — register a parallel port device driver

Synopsis

```
int parport_register_driver (struct parport_driver * drv);
```

Arguments

drv structure describing the driver

Description

This can be called by a parallel port device driver in order to receive notifications about ports being found in the system, as well as ports no longer available.

The *drv* structure is allocated by the caller and must not be deallocated until after calling `parport_unregister_driver`.

The driver's `attach` function may block. The port that `attach` is given will be valid for the duration of the callback, but if the driver wants to take a copy of the pointer it must call `parport_get_port` to do so. Calling `parport_register_device` on that port will do this for you.

The driver's `detach` function may block. The port that `detach` is given will be valid for the duration of the callback, but if the driver wants to take a copy of the pointer it must call `parport_get_port` to do so.

Returns 0 on success. Currently it always succeeds.

Name

`parport_unregister_driver` — deregister a parallel port device driver

Synopsis

```
void parport_unregister_driver (struct parport_driver * drv);
```

Arguments

drv structure describing the driver that was given to `parport_register_driver`

Description

This should be called by a parallel port device driver that has registered itself using `parport_register_driver` when it is about to be unloaded.

When it returns, the driver's `attach` routine will no longer be called, and for each port that `attach` was called for, the `detach` routine will have been called.

All the driver's `attach` and `detach` calls are guaranteed to have finished by the time this function returns.

Name

`parport_get_port` — increment a port's reference count

Synopsis

```
struct parport * parport_get_port (struct parport * port);
```

Arguments

port the port

Description

This ensures that a struct parport pointer remains valid until the matching `parport_put_port` call.

Name

`parport_put_port` — decrement a port's reference count

Synopsis

```
void parport_put_port (struct parport * port);
```

Arguments

port the port

Description

This should be called once for each call to `parport_get_port`, once the port is no longer needed.

Name

`parport_register_port` — register a parallel port

Synopsis

```
struct parport * parport_register_port (unsigned long base, int irq,  
int dma, struct parport_operations * ops);
```

Arguments

base base I/O address

irq IRQ line

dma DMA channel

ops pointer to the port driver's port operations structure

Description

When a parallel port (lowlevel) driver finds a port that should be made available to parallel port device drivers, it should call `parport_register_port`. The *base*, *irq*, and *dma* parameters are for the convenience of port drivers, and for ports where they aren't meaningful needn't be set to anything special. They can be altered afterwards by adjusting the relevant members of the `parport` structure that is returned and represents the port. They should not be tampered with after calling `parport_announce_port`, however.

If there are parallel port device drivers in the system that have registered themselves using `parport_register_driver`, they are not told about the port at this time; that is done by `parport_announce_port`.

The *ops* structure is allocated by the caller, and must not be deallocated before calling `parport_remove_port`.

If there is no memory to allocate a new `parport` structure, this function will return `NULL`.

Name

`parport_announce_port` — tell device drivers about a parallel port

Synopsis

```
void parport_announce_port (struct parport * port);
```

Arguments

port parallel port to announce

Description

After a port driver has registered a parallel port with `parport_register_port`, and performed any necessary initialisation or adjustments, it should call `parport_announce_port` in order to notify all device drivers that have called `parport_register_driver`. Their attach functions will be called, with *port* as the parameter.

Name

`parport_remove_port` — deregister a parallel port

Synopsis

```
void parport_remove_port (struct parport * port);
```

Arguments

port parallel port to deregister

Description

When a parallel port driver is forcibly unloaded, or a parallel port becomes inaccessible, the port driver must call this function in order to deal with device drivers that still want to use it.

The `parport` structure associated with the port has its operations structure replaced with one containing 'null' operations that return errors or just don't do anything.

Any drivers that have registered themselves using `parport_register_driver` are notified that the port is no longer accessible by having their `detach` routines called with *port* as the parameter.

Name

`parport_register_device` — register a device on a parallel port

Synopsis

```
struct pardevice * parport_register_device (struct parport * port, const
char * name, int (*pf) (void *), void (*kf) (void *), void (*irq_func)
(void *), int flags, void * handle);
```

Arguments

<i>port</i>	port to which the device is attached
<i>name</i>	a name to refer to the device
<i>pf</i>	preemption callback
<i>kf</i>	kick callback (wake-up)
<i>irq_func</i>	interrupt handler
<i>flags</i>	registration flags
<i>handle</i>	data for callback functions

Description

This function, called by parallel port device drivers, declares that a device is connected to a port, and tells the system all it needs to know.

The *name* is allocated by the caller and must not be deallocated until the caller calls `parport_unregister_device` for that device.

The preemption callback function, *pf*, is called when this device driver has claimed access to the port but another device driver wants to use it. It is given *handle* as its parameter, and should return zero if it is willing for the system to release the port to another driver on its behalf. If it wants to keep control of the port it should return non-zero, and no action will be taken. It is good manners for the driver to try to release the port at the earliest opportunity after its preemption callback rejects a preemption attempt. Note that if a preemption callback is happy for preemption to go ahead, there is no need to release the port; it is done automatically. This function may not block, as it may be called from interrupt context. If the device driver does not support preemption, *pf* can be NULL.

The wake-up (“kick”) callback function, *kf*, is called when the port is available to be claimed for exclusive access; that is, `parport_claim` is guaranteed to succeed when called from inside the wake-up callback function. If the driver wants to claim the port it should do so; otherwise, it need not take any action. This function may not block, as it may be called from interrupt context. If the device driver does not want to be explicitly invited to claim the port in this way, *kf* can be NULL.

The interrupt handler, *irq_func*, is called when an interrupt arrives from the parallel port. Note that if a device driver wants to use interrupts it should use `parport_enable_irq`, and can also check the `irq` member of the `parport` structure representing the port.

The parallel port (lowlevel) driver is the one that has called `request_irq` and whose interrupt handler is called first. This handler does whatever needs to be done to the hardware to acknowledge the interrupt

(for PC-style ports there is nothing special to be done). It then tells the IEEE 1284 code about the interrupt, which may involve reacting to an IEEE 1284 event depending on the current IEEE 1284 phase. After this, it calls *irq_func*. Needless to say, *irq_func* will be called from interrupt context, and may not block.

The `PARPORT_DEV_EXCL` flag is for preventing port sharing, and so should only be used when sharing the port with other device drivers is impossible and would lead to incorrect behaviour. Use it sparingly! Normally, *flags* will be zero.

This function returns a pointer to a structure that represents the device on the port, or `NULL` if there is not enough memory to allocate space for that structure.

Name

`parport_unregister_device` — deregister a device on a parallel port

Synopsis

```
void parport_unregister_device (struct pardevice * dev);
```

Arguments

dev pointer to structure representing device

Description

This undoes the effect of `parport_register_device`.

Name

`parport_find_number` — find a parallel port by number

Synopsis

```
struct parport * parport_find_number (int number);
```

Arguments

number parallel port number

Description

This returns the parallel port with the specified number, or `NULL` if there is none.

There is an implicit `parport_get_port` done already; to throw away the reference to the port that `parport_find_number` gives you, use `parport_put_port`.

Name

`parport_find_base` — find a parallel port by base address

Synopsis

```
struct parport * parport_find_base (unsigned long base);
```

Arguments

base base I/O address

Description

This returns the parallel port with the specified base address, or NULL if there is none.

There is an implicit `parport_get_port` done already; to throw away the reference to the port that `parport_find_base` gives you, use `parport_put_port`.

Name

`parport_claim` — claim access to a parallel port device

Synopsis

```
int parport_claim (struct pardevice * dev);
```

Arguments

dev pointer to structure representing a device on the port

Description

This function will not block and so can be used from interrupt context. If `parport_claim` succeeds in claiming access to the port it returns zero and the port is available to use. It may fail (returning non-zero) if the port is in use by another driver and that driver is not willing to relinquish control of the port.

Name

`parport_claim_or_block` — claim access to a parallel port device

Synopsis

```
int parport_claim_or_block (struct pardevice * dev);
```

Arguments

dev pointer to structure representing a device on the port

Description

This behaves like `parport_claim`, but will block if necessary to wait for the port to be free. A return value of 1 indicates that it slept; 0 means that it succeeded without needing to sleep. A negative error code indicates failure.

Name

`parport_release` — give up access to a parallel port device

Synopsis

```
void parport_release (struct pardevice * dev);
```

Arguments

dev pointer to structure representing parallel port device

Description

This function cannot fail, but it should not be called without the port claimed. Similarly, if the port is already claimed you should not try claiming it again.

Name

`parport_open` — find a device by canonical device number

Synopsis

```
struct pardevice * parport_open (int devnum, const char * name);
```

Arguments

devnum canonical device number

name name to associate with the device

Description

This function is similar to `parport_register_device`, except that it locates a device by its number rather than by the port it is attached to.

All parameters except for *devnum* are the same as for `parport_register_device`. The return value is the same as for `parport_register_device`.

Name

`parport_close` — close a device opened with `parport_open`

Synopsis

```
void parport_close (struct pardevice * dev);
```

Arguments

dev device to close

Description

This is to `parport_open` as `parport_unregister_device` is to `parport_register_device`.

Chapter 4. Message-based devices

Fusion message devices

Name

`mpt_register` — Register protocol-specific main callback handler.

Synopsis

```
u8 mpt_register (MPT_CALLBACK cbfunc, MPT_DRIVER_CLASS dclass, char *  
func_name);
```

Arguments

<i>cbfunc</i>	callback function pointer
<i>dclass</i>	Protocol driver's class (MPT_DRIVER_CLASS enum value)
<i>func_name</i>	call function's name

Description

This routine is called by a protocol-specific driver (SCSI host, LAN, SCSI target) to register its reply callback routine. Each protocol-specific driver must do this before it will be able to use any IOC resources, such as obtaining request frames.

NOTES

The SCSI protocol driver currently calls this routine thrice in order to register separate callbacks; one for “normal” SCSI IO; one for `MptScsiTaskMgmt` requests; one for Scan/DV requests.

Returns u8 valued “handle” in the range (and S.O.D. order) {N,...,7,6,5,...,1} if successful. A return value of `MPT_MAX_PROTOCOL_DRIVERS` (including zero!) should be considered an error by the caller.

Name

`mpt_deregister` — Deregister a protocol drivers resources.

Synopsis

```
void mpt_deregister (u8 cb_idx);
```

Arguments

cb_idx previously registered callback handle

Description

Each protocol-specific driver should call this routine when its module is unloaded.

Name

`mpt_event_register` — Register protocol-specific event callback handler.

Synopsis

```
int mpt_event_register (u8 cb_idx, MPT_EVHANDLER ev_cbfunc);
```

Arguments

cb_idx previously registered (via `mpt_register`) callback handle

ev_cbfunc callback function

Description

This routine can be called by one or more protocol-specific drivers if/when they choose to be notified of MPT events.

Returns 0 for success.

Name

`mpt_event_deregister` — Deregister protocol-specific event callback handler

Synopsis

```
void mpt_event_deregister (u8 cb_idx);
```

Arguments

cb_idx previously registered callback handle

Description

Each protocol-specific driver should call this routine when it does not (or can no longer) handle events, or when its module is unloaded.

Name

`mpt_reset_register` — Register protocol-specific IOC reset handler.

Synopsis

```
int mpt_reset_register (u8 cb_idx, MPT_RESETHANDLER reset_func);
```

Arguments

cb_idx previously registered (via `mpt_register`) callback handle

reset_func reset function

Description

This routine can be called by one or more protocol-specific drivers if/when they choose to be notified of IOC resets.

Returns 0 for success.

Name

`mpt_reset_deregister` — Deregister protocol-specific IOC reset handler.

Synopsis

```
void mpt_reset_deregister (u8 cb_idx);
```

Arguments

cb_idx previously registered callback handle

Description

Each protocol-specific driver should call this routine when it does not (or can no longer) handle IOC reset handling, or when its module is unloaded.

Name

`mpt_device_driver_register` — Register device driver hooks

Synopsis

```
int mpt_device_driver_register (struct mpt_pci_driver * dd_cbfunc, u8
cb_idx);
```

Arguments

dd_cbfunc driver callbacks struct

cb_idx MPT protocol driver index

Name

mpt_device_driver_deregister — DeRegister device driver hooks

Synopsis

```
void mpt_device_driver_deregister (u8 cb_idx);
```

Arguments

cb_idx MPT protocol driver index

Name

`mpt_get_msg_frame` — Obtain an MPT request frame from the pool

Synopsis

```
MPT_FRAME_HDR* mpt_get_msg_frame (u8 cb_idx, MPT_ADAPTER * ioc);
```

Arguments

cb_idx Handle of registered MPT protocol driver

ioc Pointer to MPT adapter structure

Description

Obtain an MPT request frame from the pool (of 1024) that are allocated per MPT adapter.

Returns pointer to a MPT request frame or NULL if none are available or IOC is not active.

Name

`mpt_put_msg_frame` — Send a protocol-specific MPT request frame to an IOC

Synopsis

```
void mpt_put_msg_frame (u8 cb_idx, MPT_ADAPTER * ioc, MPT_FRAME_HDR *  
mf);
```

Arguments

cb_idx Handle of registered MPT protocol driver

ioc Pointer to MPT adapter structure

mf Pointer to MPT request frame

Description

This routine posts an MPT request frame to the request post FIFO of a specific MPT adapter.

Name

`mpt_put_msg_frame_hi_pri` — Send a hi-pri protocol-specific MPT request frame

Synopsis

```
void    mpt_put_msg_frame_hi_pri    (u8    cb_idx,    MPT_ADAPTER    *    ioc,  
MPT_FRAME_HDR    *    mf);
```

Arguments

cb_idx Handle of registered MPT protocol driver

ioc Pointer to MPT adapter structure

mf Pointer to MPT request frame

Description

Send a protocol-specific MPT request frame to an IOC using hi-priority request queue.

This routine posts an MPT request frame to the request post FIFO of a specific MPT adapter.

Name

`mpt_free_msg_frame` — Place MPT request frame back on FreeQ.

Synopsis

```
void mpt_free_msg_frame (MPT_ADAPTER * ioc, MPT_FRAME_HDR * mf);
```

Arguments

ioc Pointer to MPT adapter structure

mf Pointer to MPT request frame

Description

This routine places a MPT request frame back on the MPT adapter's FreeQ.

Name

`mpt_send_handshake_request` — Send MPT request via doorbell handshake method.

Synopsis

```
int mpt_send_handshake_request (u8 cb_idx, MPT_ADAPTER * ioc, int reqBytes, u32 * req, int sleepFlag);
```

Arguments

<i>cb_idx</i>	Handle of registered MPT protocol driver
<i>ioc</i>	Pointer to MPT adapter structure
<i>reqBytes</i>	Size of the request in bytes
<i>req</i>	Pointer to MPT request frame
<i>sleepFlag</i>	Use schedule if CAN_SLEEP else use udelay.

Description

This routine is used exclusively to send `MptScsiTaskMgmt` requests since they are required to be sent via doorbell handshake.

NOTE

It is the callers responsibility to byte-swap fields in the request which are greater than 1 byte in size.

Returns 0 for success, non-zero for failure.

Name

`mpt_verify_adapter` — Given IOC identifier, set pointer to its adapter structure.

Synopsis

```
int mpt_verify_adapter (int iocid, MPT_ADAPTER ** iocpp);
```

Arguments

iocid IOC unique identifier (integer)

iocpp Pointer to pointer to IOC adapter

Description

Given a unique IOC identifier, set pointer to the associated MPT adapter structure.

Returns `iocid` and sets `iocpp` if `iocid` is found. Returns -1 if `iocid` is not found.

Name

`mpt_attach` — Install a PCI intelligent MPT adapter.

Synopsis

```
int mpt_attach (struct pci_dev * pdev, const struct pci_device_id * id);
```

Arguments

pdev Pointer to `pci_dev` structure

id PCI device ID information

Description

This routine performs all the steps necessary to bring the IOC of a MPT adapter to a OPERATIONAL state. This includes registering memory regions, registering the interrupt, and allocating request and reply memory pools.

This routine also pre-fetches the LAN MAC address of a Fibre Channel MPT adapter.

Returns 0 for success, non-zero for failure.

TODO

Add support for polled controllers

Name

`mpt_detach` — Remove a PCI intelligent MPT adapter.

Synopsis

```
void mpt_detach (struct pci_dev * pdev);
```

Arguments

pdev Pointer to `pci_dev` structure

Name

`mpt_suspend` — Fusion MPT base driver suspend routine.

Synopsis

```
int mpt_suspend (struct pci_dev * pdev, pm_message_t state);
```

Arguments

pdev Pointer to `pci_dev` structure

state new state to enter

Name

`mpt_resume` — Fusion MPT base driver resume routine.

Synopsis

```
int mpt_resume (struct pci_dev * pdev);
```

Arguments

pdev Pointer to `pci_dev` structure

Name

`mpt_GetIocState` — Get the current state of a MPT adapter.

Synopsis

```
u32 mpt_GetIocState (MPT_ADAPTER * ioc, int cooked);
```

Arguments

ioc Pointer to MPT_ADAPTER structure

cooked Request raw or cooked IOC state

Description

Returns all IOC Doorbell register bits if `cooked==0`, else just the Doorbell bits in `MPI_IOC_STATE_MASK`.

Name

`mpt_alloc_fw_memory` — allocate firmware memory

Synopsis

```
int mpt_alloc_fw_memory (MPT_ADAPTER * ioc, int size);
```

Arguments

ioc Pointer to MPT_ADAPTER structure

size total FW bytes

Description

If memory has already been allocated, the same (cached) value is returned.

Return 0 if successful, or non-zero for failure

Name

`mpt_free_fw_memory` — free firmware memory

Synopsis

```
void mpt_free_fw_memory (MPT_ADAPTER * ioc);
```

Arguments

ioc Pointer to MPT_ADAPTER structure

Description

If `alt_img` is NULL, delete from `ioc` structure. Else, delete a secondary image in same format.

Name

`mptbase_sas_persist_operation` — Perform operation on SAS Persistent Table

Synopsis

```
int    mptbase_sas_persist_operation    (MPT_ADAPTER    *    ioc,    u8
persist_opcode);
```

Arguments

ioc Pointer to MPT_ADAPTER structure

persist_opcode see below

Description

MPI_SAS_OP_CLEAR_NOT_PRESENT - Free all persist TargetID mappings for devices not currently present. MPI_SAS_OP_CLEAR_ALL_PERSISTENT - Clear al persist TargetID mappings

NOTE

Don't use not this function during interrupt time.

Returns 0 for success, non-zero error

Name

`mpt_raid_phys_disk_pg0` — returns phys disk page zero

Synopsis

```
int mpt_raid_phys_disk_pg0 (MPT_ADAPTER * ioc, u8 phys_disk_num,
    RaidPhysDiskPage0_t * phys_disk);
```

Arguments

<i>ioc</i>	Pointer to a Adapter Structure
<i>phys_disk_num</i>	io unit unique phys disk num generated by the ioc
<i>phys_disk</i>	requested payload data returned

Return

0 on success -EFAULT if read of config page header fails or data pointer not NULL -ENOMEM if pci_alloc failed

Name

`mpt_raid_phys_disk_get_num_paths` — returns number paths associated to this `phys_num`

Synopsis

```
int    mpt_raid_phys_disk_get_num_paths    (MPT_ADAPTER    *    ioc,    u8
phys_disk_num);
```

Arguments

ioc Pointer to a Adapter Structure

phys_disk_num io unit unique phys disk num generated by the ioc

Return

returns number paths

Name

`mpt_raid_phys_disk_pg1` — returns phys disk page 1

Synopsis

```
int mpt_raid_phys_disk_pg1 (MPT_ADAPTER * ioc, u8 phys_disk_num,
    RaidPhysDiskPage1_t * phys_disk);
```

Arguments

<i>ioc</i>	Pointer to a Adapter Structure
<i>phys_disk_num</i>	io unit unique phys disk num generated by the ioc
<i>phys_disk</i>	requested payload data returned

Return

0 on success -EFAULT if read of config page header fails or data pointer not NULL -ENOMEM if pci_alloc failed

Name

`mpt_findImVolumes` — Identify IDs of hidden disks and RAID Volumes

Synopsis

```
int mpt_findImVolumes (MPT_ADAPTER * ioc);
```

Arguments

ioc Pointer to a Adapter Strucutre

Return

0 on success -EFAULT if read of config page header fails or data pointer not NULL -ENOMEM if pci_alloc failed

Name

`mpt_config` — Generic function to issue config message

Synopsis

```
int mpt_config (MPT_ADAPTER * ioc, CONFIGPARMS * pCfg);
```

Arguments

ioc Pointer to an adapter structure

pCfg Pointer to a configuration structure. Struct contains action, page address, direction, physical address and pointer to a configuration page header Page header is updated.

Description

Returns 0 for success -EPERM if not allowed due to ISR context -EAGAIN if no msg frames currently available -EFAULT for non-successful reply or no reply (timeout)

Name

`mpt_print_ioc_summary` — Write ASCII summary of IOC to a buffer.

Synopsis

```
void mpt_print_ioc_summary (MPT_ADAPTER * ioc, char * buffer, int *
size, int len, int showlan);
```

Arguments

<i>ioc</i>	Pointer to MPT_ADAPTER structure
<i>buffer</i>	Pointer to buffer where IOC summary info should be written
<i>size</i>	Pointer to number of bytes we wrote (set by this routine)
<i>len</i>	Offset at which to start writing in buffer
<i>showlan</i>	Display LAN stuff?

Description

This routine writes (english readable) ASCII text, which represents a summary of IOC information, to a buffer.

Name

`mpt_set_taskmgmt_in_progress_flag` — set flags associated with task management

Synopsis

```
int mpt_set_taskmgmt_in_progress_flag (MPT_ADAPTER * ioc);
```

Arguments

ioc Pointer to MPT_ADAPTER structure

Description

Returns 0 for SUCCESS or -1 if FAILED.

If -1 is return, then it was not possible to set the flags

Name

`mpt_clear_taskmgmt_in_progress_flag` — clear flags associated with task management

Synopsis

```
void mpt_clear_taskmgmt_in_progress_flag (MPT_ADAPTER * ioc);
```

Arguments

ioc Pointer to MPT_ADAPTER structure

Name

`mpt_halt_firmware` — Halts the firmware if it is operational and panic the kernel

Synopsis

```
void mpt_halt_firmware (MPT_ADAPTER * ioc);
```

Arguments

ioc Pointer to MPT_ADAPTER structure

Name

`mpt_Soft_Hard_ResetHandler` — Try less expensive reset

Synopsis

```
int mpt_Soft_Hard_ResetHandler (MPT_ADAPTER * ioc, int sleepFlag);
```

Arguments

ioc Pointer to MPT_ADAPTER structure

sleepFlag Indicates if sleep or schedule must be called.

Description

Returns 0 for SUCCESS or -1 if FAILED. Try for softreset first, only if it fails go for expensive HardReset.

Name

`mpt_HardResetHandler` — Generic reset handler

Synopsis

```
int mpt_HardResetHandler (MPT_ADAPTER * ioc, int sleepFlag);
```

Arguments

ioc Pointer to MPT_ADAPTER structure

sleepFlag Indicates if sleep or schedule must be called.

Description

Issues SCSI Task Management call based on input arg values. If TaskMgmt fails, returns associated SCSI request.

Remark

`_HardResetHandler` can be invoked from an interrupt thread (timer) or a non-interrupt thread. In the former, must not call `schedule`.

Note

A return of -1 is a FATAL error case, as it means a FW reload/initialization failed.

Returns 0 for SUCCESS or -1 if FAILED.

Name

mpt_get_cb_idx — obtain cb_idx for registered driver

Synopsis

```
u8 mpt_get_cb_idx (MPT_DRIVER_CLASS dclass);
```

Arguments

dclass class driver enum

Description

Returns cb_idx, or zero means it wasn't found

Name

`mpt_is_discovery_complete` — determine if discovery has completed

Synopsis

```
int mpt_is_discovery_complete (MPT_ADAPTER * ioc);
```

Arguments

ioc per adapter instance

Description

Returns 1 when discovery completed, else zero.

Name

`mpt_remove_dead_ioc_func` — kthread context to remove dead ioc

Synopsis

```
int mpt_remove_dead_ioc_func (void * arg);
```

Arguments

arg input argument, used to derive ioc

Description

Return 0 if controller is removed from pci subsystem. Return -1 for other case.

Name

`mpt_fault_reset_work` — work performed on workq after ioc fault

Synopsis

```
void mpt_fault_reset_work (struct work_struct * work);
```

Arguments

work input argument, used to derive ioc

Name

`mpt_interrupt` — MPT adapter (IOC) specific interrupt handler.

Synopsis

```
irqreturn_t mpt_interrupt (int irq, void * bus_id);
```

Arguments

irq irq number (not used)

bus_id bus identifier cookie == pointer to MPT_ADAPTER structure

Description

This routine is registered via the `request_irq` kernel API call, and handles all interrupts generated from a specific MPT adapter (also referred to as a IO Controller or IOC). This routine must clear the interrupt from the adapter and does so by reading the reply FIFO. Multiple replies may be processed per single call to this routine.

This routine handles register-level access of the adapter but dispatches (calls) a protocol-specific callback routine to handle the protocol-specific details of the MPT request completion.

Name

mptbase_reply — MPT base driver's callback routine

Synopsis

```
int mptbase_reply (MPT_ADAPTER * ioc, MPT_FRAME_HDR * req, MPT_FRAME_HDR  
* reply);
```

Arguments

ioc Pointer to MPT_ADAPTER structure

req Pointer to original MPT request frame

reply Pointer to MPT reply frame (NULL if TurboReply)

Description

MPT base driver's callback routine; all base driver “internal” request/reply processing is routed here. Currently used for EventNotification and EventAck handling.

Returns 1 indicating original alloc'd request frame ptr should be freed, or 0 if it shouldn't.

Name

`mpt_add_sge` — Place a simple 32 bit SGE at address `pAddr`.

Synopsis

```
void mpt_add_sge (void * pAddr, u32 flagslength, dma_addr_t dma_addr);
```

Arguments

<i>pAddr</i>	virtual address for SGE
<i>flagslength</i>	SGE flags and data transfer length
<i>dma_addr</i>	Physical address

Description

This routine places a MPT request frame back on the MPT adapter's FreeQ.

Name

`mpt_add_sge_64bit` — Place a simple 64 bit SGE at address `pAddr`.

Synopsis

```
void mpt_add_sge_64bit (void * pAddr, u32 flagslength, dma_addr_t
dma_addr);
```

Arguments

<i>pAddr</i>	virtual address for SGE
<i>flagslength</i>	SGE flags and data transfer length
<i>dma_addr</i>	Physical address

Description

This routine places a MPT request frame back on the MPT adapter's FreeQ.

Name

`mpt_add_sge_64bit_1078` — Place a simple 64 bit SGE at address `pAddr` (1078 workaround).

Synopsis

```
void mpt_add_sge_64bit_1078 (void * pAddr, u32 flagslength, dma_addr_t
dma_addr);
```

Arguments

<i>pAddr</i>	virtual address for SGE
<i>flagslength</i>	SGE flags and data transfer length
<i>dma_addr</i>	Physical address

Description

This routine places a MPT request frame back on the MPT adapter's FreeQ.

Name

`mpt_add_chain` — Place a 32 bit chain SGE at address `pAddr`.

Synopsis

```
void mpt_add_chain (void * pAddr, u8 next, u16 length, dma_addr_t  
  dma_addr);
```

Arguments

<i>pAddr</i>	virtual address for SGE
<i>next</i>	nextChainOffset value (u32's)
<i>length</i>	length of next SGL segment
<i>dma_addr</i>	Physical address

Name

`mpt_add_chain_64bit` — Place a 64 bit chain SGE at address `pAddr`.

Synopsis

```
void mpt_add_chain_64bit (void * pAddr, u8 next, u16 length, dma_addr_t  
dma_addr);
```

Arguments

<i>pAddr</i>	virtual address for SGE
<i>next</i>	nextChainOffset value (u32's)
<i>length</i>	length of next SGL segment
<i>dma_addr</i>	Physical address

Name

`mpt_host_page_access_control` — control the IOC's Host Page Buffer access

Synopsis

```
int    mpt_host_page_access_control (MPT_ADAPTER * ioc, u8
access_control_value, int sleepFlag);
```

Arguments

<i>ioc</i>	Pointer to MPT adapter structure
<i>access_control_value</i>	define bits below
<i>sleepFlag</i>	Specifies whether the process can sleep

Description

Provides mechanism for the host driver to control the IOC's Host Page Buffer access.

Access	Control	Value	-	bits[15:12]	0h	Reserved	1h	En-
able	Access	{	MPI_DB_HPBACK_ENABLE_ACCESS	}	2h	Disable	Access	
		{	MPI_DB_HPBACK_DISABLE_ACCESS	}	3h	Free Buffer	{	MPI_DB_HPBACK_FREE_BUFFER

Returns 0 for success, non-zero for failure.

Name

`mpt_host_page_alloc` — allocate system memory for the fw

Synopsis

```
int mpt_host_page_alloc (MPT_ADAPTER * ioc, pIOCInit_t ioc_init);
```

Arguments

ioc Pointer to pointer to IOC adapter

ioc_init Pointer to ioc init config page

Description

If we already allocated memory in past, then resend the same pointer. Returns 0 for success, non-zero for failure.

Name

`mpt_get_product_name` — returns product string

Synopsis

```
const char* mpt_get_product_name (u16 vendor, u16 device, u8 revision);
```

Arguments

<i>vendor</i>	pci vendor id
<i>device</i>	pci device id
<i>revision</i>	pci revision id

Description

Returns product string displayed when driver loads, in `/proc/mpt/summary` and `/sysfs/class/scsi_host/host<X>/version_product`

Name

mpt_mapresources — map in memory mapped io

Synopsis

```
int mpt_mapresources (MPT_ADAPTER * ioc);
```

Arguments

ioc Pointer to pointer to IOC adapter

Name

`mpt_do_ioc_recovery` — Initialize or recover MPT adapter.

Synopsis

```
int mpt_do_ioc_recovery (MPT_ADAPTER * ioc, u32 reason, int sleepFlag);
```

Arguments

<i>ioc</i>	Pointer to MPT adapter structure
<i>reason</i>	Event word / reason
<i>sleepFlag</i>	Use schedule if CAN_SLEEP else use udelay.

Description

This routine performs all the steps necessary to bring the IOC to a OPERATIONAL state.

This routine also pre-fetches the LAN MAC address of a Fibre Channel MPT adapter.

Returns

0 for success -1 if failed to get board READY -2 if READY but IOCFacts Failed -3 if READY but PrimeIOCFifos Failed -4 if READY but IOCInit Failed -5 if failed to enable_device and/or request_selected_regions -6 if failed to upload firmware

Name

`mpt_detect_bound_ports` — Search for matching PCI bus/dev_function

Synopsis

```
void mpt_detect_bound_ports (MPT_ADAPTER * ioc, struct pci_dev * pdev);
```

Arguments

ioc Pointer to MPT adapter structure

pdev Pointer to (struct pci_dev) structure

Description

Search for PCI bus/dev_function which matches PCI bus/dev_function (+/-1) for newly discovered 929, 929X, 1030 or 1035.

If match on PCI dev_function +/-1 is found, bind the two MPT adapters using alt_ioc pointer fields in their MPT_ADAPTER structures.

Name

`mpt_adapter_disable` — Disable misbehaving MPT adapter.

Synopsis

```
void mpt_adapter_disable (MPT_ADAPTER * ioc);
```

Arguments

ioc Pointer to MPT adapter structure

Name

`mpt_adapter_dispose` — Free all resources associated with an MPT adapter

Synopsis

```
void mpt_adapter_dispose (MPT_ADAPTER * ioc);
```

Arguments

ioc Pointer to MPT adapter structure

Description

This routine unregisters h/w resources and frees all alloc'd memory associated with a MPT adapter structure.

Name

MptDisplayIocCapabilities — Display IOC's capabilities.

Synopsis

```
void MptDisplayIocCapabilities (MPT_ADAPTER * ioc);
```

Arguments

ioc Pointer to MPT adapter structure

Name

MakeIocReady — Get IOC to a READY state, using KickStart if needed.

Synopsis

```
int MakeIocReady (MPT_ADAPTER * ioc, int force, int sleepFlag);
```

Arguments

ioc Pointer to MPT_ADAPTER structure

force Force hard KickStart of IOC

sleepFlag Specifies whether the process can sleep

Returns

1 - DIAG reset and READY 0 - READY initially OR soft reset and READY -1 - Any failure on KickStart
 -2 - Msg Unit Reset Failed -3 - IO Unit Reset Failed -4 - IOC owned by a PEER

Name

GetIocFacts — Send IOCFacts request to MPT adapter.

Synopsis

```
int GetIocFacts (MPT_ADAPTER * ioc, int sleepFlag, int reason);
```

Arguments

<i>ioc</i>	Pointer to MPT_ADAPTER structure
<i>sleepFlag</i>	Specifies whether the process can sleep
<i>reason</i>	If recovery, only update facts.

Description

Returns 0 for success, non-zero for failure.

Name

GetPortFacts — Send PortFacts request to MPT adapter.

Synopsis

```
int GetPortFacts (MPT_ADAPTER * ioc, int portnum, int sleepFlag);
```

Arguments

<i>ioc</i>	Pointer to MPT_ADAPTER structure
<i>portnum</i>	Port number
<i>sleepFlag</i>	Specifies whether the process can sleep

Description

Returns 0 for success, non-zero for failure.

Name

SendIocInit — Send IOInit request to MPT adapter.

Synopsis

```
int SendIocInit (MPT_ADAPTER * ioc, int sleepFlag);
```

Arguments

ioc Pointer to MPT_ADAPTER structure

sleepFlag Specifies whether the process can sleep

Description

Send IOInit followed by PortEnable to bring IOC to OPERATIONAL state.

Returns 0 for success, non-zero for failure.

Name

SendPortEnable — Send PortEnable request to MPT adapter port.

Synopsis

```
int SendPortEnable (MPT_ADAPTER * ioc, int portnum, int sleepFlag);
```

Arguments

<i>ioc</i>	Pointer to MPT_ADAPTER structure
<i>portnum</i>	Port number to enable
<i>sleepFlag</i>	Specifies whether the process can sleep

Description

Send PortEnable to bring IOC to OPERATIONAL state.

Returns 0 for success, non-zero for failure.

Name

`mpt_do_upload` — Construct and Send FWUpload request to MPT adapter port.

Synopsis

```
int mpt_do_upload (MPT_ADAPTER * ioc, int sleepFlag);
```

Arguments

ioc Pointer to MPT_ADAPTER structure

sleepFlag Specifies whether the process can sleep

Description

Returns 0 for success, >0 for handshake failure <0 for fw upload failure.

Remark

If bound IOC and a successful FWUpload was performed on the bound IOC, the second image is discarded and memory is free'd. Both channels must upload to prevent IOC from running in degraded mode.

Name

mpt_downloadboot — DownloadBoot code

Synopsis

```
int mpt_downloadboot (MPT_ADAPTER * ioc, MpiFwHeader_t * pFwHeader, int
sleepFlag);
```

Arguments

ioc Pointer to MPT_ADAPTER structure

pFwHeader Pointer to firmware header info

sleepFlag Specifies whether the process can sleep

Description

FwDownloadBoot requires Programmed IO access.

Returns 0 for success -1 FW Image size is 0 -2 No valid cached_fw Pointer <0 for fw upload failure.

Name

KickStart — Perform hard reset of MPT adapter.

Synopsis

```
int KickStart (MPT_ADAPTER * ioc, int force, int sleepFlag);
```

Arguments

<i>ioc</i>	Pointer to MPT_ADAPTER structure
<i>force</i>	Force hard reset
<i>sleepFlag</i>	Specifies whether the process can sleep

Description

This routine places MPT adapter in diagnostic mode via the WriteSequence register, and then performs a hard reset of adapter via the Diagnostic register.

Inputs

sleepflag - CAN_SLEEP (non-interrupt thread) or NO_SLEEP (interrupt thread, use mdelay) force - 1 if doorbell active, board fault state board operational, IOC_RECOVERY or IOC_BRINGUP and there is an alt_ioc. 0 else

Returns

1 - hard reset, READY 0 - no reset due to History bit, READY -1 - no reset due to History bit but not READY OR reset but failed to come READY -2 - no reset, could not enter DIAG mode -3 - reset but bad FW bit

Name

`mpt_diag_reset` — Perform hard reset of the adapter.

Synopsis

```
int mpt_diag_reset (MPT_ADAPTER * ioc, int ignore, int sleepFlag);
```

Arguments

<i>ioc</i>	Pointer to MPT_ADAPTER structure
<i>ignore</i>	Set if to honor and clear to ignore the reset history bit
<i>sleepFlag</i>	CAN_SLEEP if called in a non-interrupt thread, else set to NO_SLEEP (use mdelay instead)

Description

This routine places the adapter in diagnostic mode via the WriteSequence register and then performs a hard reset of adapter via the Diagnostic register. Adapter should be in ready state upon successful completion.

Returns

1 hard reset successful 0 no reset performed because reset history bit set -2 enabling diagnostic mode failed
-3 diagnostic reset failed

Name

SendIocReset — Send IOCRreset request to MPT adapter.

Synopsis

```
int SendIocReset (MPT_ADAPTER * ioc, u8 reset_type, int sleepFlag);
```

Arguments

<i>ioc</i>	Pointer to MPT_ADAPTER structure
<i>reset_type</i>	reset type, expected values are MPI_FUNCTION_IOC_MESSAGE_UNIT_RESET or MPI_FUNCTION_IO_UNIT_RESET
<i>sleepFlag</i>	Specifies whether the process can sleep

Description

Send IOCRreset request to the MPT adapter.

Returns 0 for success, non-zero for failure.

Name

`initChainBuffers` — Allocate memory for and initialize chain buffers

Synopsis

```
int initChainBuffers (MPT_ADAPTER * ioc);
```

Arguments

ioc Pointer to MPT_ADAPTER structure

Description

Allocates memory for and initializes chain buffers, chain buffer control arrays and spinlock.

Name

PrimeIocFifos — Initialize IOC request and reply FIFOs.

Synopsis

```
int PrimeIocFifos (MPT_ADAPTER * ioc);
```

Arguments

ioc Pointer to MPT_ADAPTER structure

Description

This routine allocates memory for the MPT reply and request frame pools (if necessary), and primes the IOC reply FIFO with reply frames.

Returns 0 for success, non-zero for failure.

Name

`mpt_handshake_req_reply_wait` — Send MPT request to and receive reply from IOC via doorbell handshake method.

Synopsis

```
int mpt_handshake_req_reply_wait (MPT_ADAPTER * ioc, int reqBytes, u32
* req, int replyBytes, ul6 * u16reply, int maxwait, int sleepFlag);
```

Arguments

<i>ioc</i>	Pointer to MPT_ADAPTER structure
<i>reqBytes</i>	Size of the request in bytes
<i>req</i>	Pointer to MPT request frame
<i>replyBytes</i>	Expected size of the reply in bytes
<i>u16reply</i>	Pointer to area where reply should be written
<i>maxwait</i>	Max wait time for a reply (in seconds)
<i>sleepFlag</i>	Specifies whether the process can sleep

NOTES

It is the callers responsibility to byte-swap fields in the request which are greater than 1 byte in size. It is also the callers responsibility to byte-swap response fields which are greater than 1 byte in size.

Returns 0 for success, non-zero for failure.

Name

WaitForDoorbellAck — Wait for IOC doorbell handshake acknowledge

Synopsis

```
int WaitForDoorbellAck (MPT_ADAPTER * ioc, int howlong, int sleepFlag);
```

Arguments

<i>ioc</i>	Pointer to MPT_ADAPTER structure
<i>howlong</i>	How long to wait (in seconds)
<i>sleepFlag</i>	Specifies whether the process can sleep

Description

This routine waits (up to ~2 seconds max) for IOC doorbell handshake ACKnowledge, indicated by the IOP_DOORBELL_STATUS bit in its IntStatus register being clear.

Returns a negative value on failure, else wait loop count.

Name

WaitForDoorbellInt — Wait for IOC to set its doorbell interrupt bit

Synopsis

```
int WaitForDoorbellInt (MPT_ADAPTER * ioc, int howlong, int sleepFlag);
```

Arguments

ioc Pointer to MPT_ADAPTER structure

howlong How long to wait (in seconds)

sleepFlag Specifies whether the process can sleep

Description

This routine waits (up to ~2 seconds max) for IOC doorbell interrupt (MPI_HIS_DOORBELL_INTERRUPT) to be set in the IntStatus register.

Returns a negative value on failure, else wait loop count.

Name

WaitForDoorbellReply — Wait for and capture an IOC handshake reply.

Synopsis

```
int WaitForDoorbellReply (MPT_ADAPTER * ioc, int howlong, int sleep-  
Flag);
```

Arguments

<i>ioc</i>	Pointer to MPT_ADAPTER structure
<i>howlong</i>	How long to wait (in seconds)
<i>sleepFlag</i>	Specifies whether the process can sleep

Description

This routine polls the IOC for a handshake reply, 16 bits at a time. Reply is cached to IOC private area large enough to hold a maximum of 128 bytes of reply data.

Returns a negative value on failure, else size of reply in WORDS.

Name

GetLanConfigPages — Fetch LANConfig pages.

Synopsis

```
int GetLanConfigPages (MPT_ADAPTER * ioc);
```

Arguments

ioc Pointer to MPT_ADAPTER structure

Return

0 for success -ENOMEM if no memory available -EPERM if not allowed due to ISR context -EAGAIN if no msg frames currently available -EFAULT for non-successful reply or no reply (timeout)

Name

GetIoUnitPage2 — Retrieve BIOS version and boot order information.

Synopsis

```
int GetIoUnitPage2 (MPT_ADAPTER * ioc);
```

Arguments

ioc Pointer to MPT_ADAPTER structure

Returns

0 for success -ENOMEM if no memory available -EPERM if not allowed due to ISR context -EAGAIN if no msg frames currently available -EFAULT for non-successful reply or no reply (timeout)

Name

`mpt_GetScsiPortSettings` — read SCSI Port Page 0 and 2

Synopsis

```
int mpt_GetScsiPortSettings (MPT_ADAPTER * ioc, int portnum);
```

Arguments

ioc Pointer to a Adapter Strucutre

portnum IOC port number

Return

-EFAULT if read of config page header fails or if no nvram If read of SCSI Port Page 0 fails, NVRAM = MPT_HOST_NVRAM_INVALID (0xFFFFFFFF)

Adapter settings

async, narrow Return 1 If read of SCSI Port Page 2 fails, Adapter settings valid NVRAM = MPT_HOST_NVRAM_INVALID (0xFFFFFFFF) Return 1 Else Both valid Return 0 CHECK - what type of locking mechanisms should be used???

Name

`mpt_readScsiDevicePageHeaders` — save version and length of SDP1

Synopsis

```
int mpt_readScsiDevicePageHeaders (MPT_ADAPTER * ioc, int portnum);
```

Arguments

ioc Pointer to a Adapter Strucutre

portnum IOC port number

Return

-EFAULT if read of config page header fails or 0 if success.

Name

`mpt_inactive_raid_list_free` — This clears this link list.

Synopsis

```
void mpt_inactive_raid_list_free (MPT_ADAPTER * ioc);
```

Arguments

ioc pointer to per adapter structure

Name

`mpt_inactive_raid_volumes` — sets up link list of `phy_disk_nums` for devices belonging in an inactive volume

Synopsis

```
void mpt_inactive_raid_volumes (MPT_ADAPTER * ioc, u8 channel, u8 id);
```

Arguments

ioc pointer to per adapter structure

channel volume channel

id volume target id

Name

SendEventNotification — Send EventNotification (on or off) request to adapter

Synopsis

```
int SendEventNotification (MPT_ADAPTER * ioc, u8 EvSwitch, int sleep-Flag);
```

Arguments

<i>ioc</i>	Pointer to MPT_ADAPTER structure
<i>EvSwitch</i>	Event switch flags
<i>sleepFlag</i>	Specifies whether the process can sleep

Name

SendEventAck — Send EventAck request to MPT adapter.

Synopsis

```
int SendEventAck (MPT_ADAPTER * ioc, EventNotificationReply_t * evnp);
```

Arguments

ioc Pointer to MPT_ADAPTER structure

evnp Pointer to original EventNotification request

Name

`mpt_ioc_reset` — Base cleanup for hard reset

Synopsis

```
int mpt_ioc_reset (MPT_ADAPTER * ioc, int reset_phase);
```

Arguments

ioc Pointer to the adapter structure

reset_phase Indicates pre- or post-reset functionality

Remark

Frees resources with internally generated commands.

Name

procmt_create — Create MPT_PROCFS_MPTBASEDIR entries.

Synopsis

```
int procmt_create ( void );
```

Arguments

void no arguments

Description

Returns 0 for success, non-zero for failure.

Name

procmpt_destroy — Tear down MPT_PROCFS_MPTBASEDIR entries.

Synopsis

```
void procmpt_destroy ( void );
```

Arguments

void no arguments

Description

Returns 0 for success, non-zero for failure.

Name

`mpt_SoftResetHandler` — Issues a less expensive reset

Synopsis

```
int mpt_SoftResetHandler (MPT_ADAPTER * ioc, int sleepFlag);
```

Arguments

ioc Pointer to MPT_ADAPTER structure

sleepFlag Indicates if sleep or schedule must be called.

Description

Returns 0 for SUCCESS or -1 if FAILED.

Message Unit Reset - instructs the IOC to reset the Reply Post and Free FIFO's. All the Message Frames on Reply Free FIFO are discarded. All posted buffers are freed, and event notification is turned off. IOC doesn't reply to any outstanding request. This will transfer IOC to READY state.

Name

ProcessEventNotification — Route EventNotificationReply to all event handlers

Synopsis

```
int      ProcessEventNotification      (MPT_ADAPTER      *      ioc,
EventNotificationReply_t * pEventReply, int * evHandlers);
```

Arguments

ioc Pointer to MPT_ADAPTER structure

pEventReply Pointer to EventNotification reply frame

evHandlers Pointer to integer, number of event handlers

Description

Routes a received EventNotificationReply to all currently registered event handlers. Returns sum of event handlers return values.

Name

`mpt_fc_log_info` — Log information returned from Fibre Channel IOC.

Synopsis

```
void mpt_fc_log_info (MPT_ADAPTER * ioc, u32 log_info);
```

Arguments

ioc Pointer to MPT_ADAPTER structure

log_info U32 LogInfo reply word from the IOC

Description

Refer to `lsi/mpi_log_fc.h`.

Name

`mpt_spi_log_info` — Log information returned from SCSI Parallel IOC.

Synopsis

```
void mpt_spi_log_info (MPT_ADAPTER * ioc, u32 log_info);
```

Arguments

ioc Pointer to MPT_ADAPTER structure

log_info U32 LogInfo word from the IOC

Description

Refer to `lsi/sp_log.h`.

Name

`mpt_sas_log_info` — Log information returned from SAS IOC.

Synopsis

```
void mpt_sas_log_info (MPT_ADAPTER * ioc, u32 log_info, u8 cb_idx);
```

Arguments

<i>ioc</i>	Pointer to MPT_ADAPTER structure
<i>log_info</i>	U32 LogInfo reply word from the IOC
<i>cb_idx</i>	callback function's handle

Description

Refer to `lsi/mpi_log_sas.h`.

Name

`mpt_iocstatus_info_config` — IOCSTATUS information for config pages

Synopsis

```
void mpt_iocstatus_info_config (MPT_ADAPTER * ioc, u32 ioc_status,
MPT_FRAME_HDR * mf);
```

Arguments

<i>ioc</i>	Pointer to MPT_ADAPTER structure
<i>ioc_status</i>	U32 IOCStatus word from IOC
<i>mf</i>	Pointer to MPT request frame

Description

Refer to `lsi/mpi.h`.

Name

`mpt_iocstatus_info` — IOCSTATUS information returned from IOC.

Synopsis

```
void mpt_iocstatus_info (MPT_ADAPTER * ioc, u32 ioc_status,
MPT_FRAME_HDR * mf);
```

Arguments

<i>ioc</i>	Pointer to MPT_ADAPTER structure
<i>ioc_status</i>	U32 IOCStatus word from IOC
<i>mf</i>	Pointer to MPT request frame

Description

Refer to `lsi/mpi.h`.

Name

`fusion_init` — Fusion MPT base driver initialization routine.

Synopsis

```
int fusion_init ( void );
```

Arguments

void no arguments

Description

Returns 0 for success, non-zero for failure.

Name

`fusion_exit` — Perform driver unload cleanup.

Synopsis

```
void __exit fusion_exit ( void );
```

Arguments

void no arguments

Description

This routine frees all resources associated with each MPT adapter and removes all `MPT_PROCFS_MPTBASEDIR` entries.

Name

mptscsih_info — Return information about MPT adapter

Synopsis

```
const char * mptscsih_info (struct Scsi_Host * SHost);
```

Arguments

SHost Pointer to Scsi_Host structure

Description

(linux scsi_host_template.info routine)

Returns pointer to buffer where information was written.

Name

mptscsih_qcmd — Primary Fusion MPT SCSI initiator IO start routine.

Synopsis

```
int mptscsih_qcmd (struct scsi_cmnd * SCpnt);
```

Arguments

SCpnt Pointer to scsi_cmnd structure

Description

(linux scsi_host_template.queuecommand routine) This is the primary SCSI IO start routine. Create a MPI SCSIIORequest from a linux scsi_cmnd request and send it to the IOC.

Returns 0. (rtn value discarded by linux scsi mid-layer)

Name

`mptscsih_IssueTaskMgmt` — Generic send Task Management function.

Synopsis

```
int mptscsih_IssueTaskMgmt (MPT SCSI_HOST * hd, u8 type, u8 channel, u8  
id, u64 lun, int ctx2abort, ulong timeout);
```

Arguments

<i>hd</i>	Pointer to MPT SCSI_HOST structure
<i>type</i>	Task Management type
<i>channel</i>	channel number for task management
<i>id</i>	Logical Target ID for reset (if appropriate)
<i>lun</i>	Logical Unit for reset (if appropriate)
<i>ctx2abort</i>	Context for the task to be aborted (if appropriate)
<i>timeout</i>	timeout for task management control

Remark

`_HardResetHandler` can be invoked from an interrupt thread (timer) or a non-interrupt thread. In the former, must not call `schedule`.

Not all fields are meaningfull for all task types.

Returns 0 for SUCCESS, or FAILED.

Name

mptscsih_abort — Abort linux scsi_cmnd routine, new_eh variant

Synopsis

```
int mptscsih_abort (struct scsi_cmnd * SCpnt);
```

Arguments

SCpnt Pointer to scsi_cmnd structure, IO to be aborted

Description

(linux scsi_host_template.eh_abort_handler routine)

Returns SUCCESS or FAILED.

Name

mptscsih_dev_reset — Perform a SCSI TARGET_RESET! new_eh variant

Synopsis

```
int mptscsih_dev_reset (struct scsi_cmnd * SCpnt);
```

Arguments

SCpnt Pointer to scsi_cmnd structure, IO which reset is due to

Description

(linux scsi_host_template.eh_dev_reset_handler routine)

Returns SUCCESS or FAILED.

Name

mptscsih_bus_reset — Perform a SCSI BUS_RESET! new_eh variant

Synopsis

```
int mptscsih_bus_reset (struct scsi_cmnd * SCpnt);
```

Arguments

SCpnt Pointer to scsi_cmnd structure, IO which reset is due to

Description

(linux scsi_host_template.eh_bus_reset_handler routine)

Returns SUCCESS or FAILED.

Name

mptscsih_host_reset — Perform a SCSI host adapter RESET (new_eh variant)

Synopsis

```
int mptscsih_host_reset (struct scsi_cmnd * SCpnt);
```

Arguments

SCpnt Pointer to scsi_cmnd structure, IO which reset is due to

Description

(linux scsi_host_template.eh_host_reset_handler routine)

Returns SUCCESS or FAILED.

Name

`mptscsih_taskmgmt_complete` — Registered with Fusion MPT base driver

Synopsis

```
int mptscsih_taskmgmt_complete (MPT_ADAPTER * ioc, MPT_FRAME_HDR * mf,
MPT_FRAME_HDR * mr);
```

Arguments

ioc Pointer to MPT_ADAPTER structure

mf Pointer to SCSI task mgmt request frame

mr Pointer to SCSI task mgmt reply frame

Description

This routine is called from `mptbase.c::mpt_interrupt` at the completion of any SCSI task management request. This routine is registered with the MPT (base) driver at driver load/init time via the `mpt_register` API call.

Returns 1 indicating alloc'd request frame ptr should be freed.

Name

`mptscsih_get_scsi_lookup` — retrieves scmd entry

Synopsis

```
struct scsi_cmnd * mptscsih_get_scsi_lookup (MPT_ADAPTER * ioc, int i);
```

Arguments

ioc Pointer to MPT_ADAPTER structure

i index into the array

Description

Returns the `scsi_cmd` pointer

Name

mptscsih_info_scsiio — debug print info on reply frame

Synopsis

```
void mptscsih_info_scsiio (MPT_ADAPTER * ioc, struct scsi_cmnd * sc,
SCSIIOReply_t * pScsiReply);
```

Arguments

ioc Pointer to MPT_ADAPTER structure

sc original scsi cmnd pointer

pScsiReply Pointer to MPT reply frame

Description

MPT_DEBUG_REPLY needs to be enabled to obtain this info

Refer to lsi/mpi.h.

Name

`mptscsih_getclear_scsi_lookup` — retrieves and clears `scmd` entry from `ScsiLookup[]` array list

Synopsis

```
struct scsi_cmd * mptscsih_getclear_scsi_lookup (MPT_ADAPTER * ioc,
int i);
```

Arguments

ioc Pointer to MPT_ADAPTER structure

i index into the array

Description

Returns the `scsi_cmd` pointer

Name

mptscsih_set_scsi_lookup — write a scmd entry into the ScsiLookup[] array list

Synopsis

```
void mptscsih_set_scsi_lookup (MPT_ADAPTER * ioc, int i, struct  
scsi_cmnd * scmd);
```

Arguments

ioc Pointer to MPT_ADAPTER structure

i index into the array

scmd scsi_cmnd pointer

Name

SCPNT_TO_LOOKUP_IDX — searches for a given scmd in the ScsiLookup[] array list

Synopsis

```
int SCPNT_TO_LOOKUP_IDX (MPT_ADAPTER * ioc, struct scsi_cmnd * sc);
```

Arguments

ioc Pointer to MPT_ADAPTER structure

sc scsi_cmnd pointer

Name

`mptscsih_get_completion_code` — get completion code from MPT request

Synopsis

```
int mptscsih_get_completion_code (MPT_ADAPTER * ioc, MPT_FRAME_HDR *  
req, MPT_FRAME_HDR * reply);
```

Arguments

ioc Pointer to MPT_ADAPTER structure

req Pointer to original MPT request frame

reply Pointer to MPT reply frame (NULL if TurboReply)

Name

`mptscsih_do_cmd` — Do internal command.

Synopsis

```
int mptscsih_do_cmd (MPT SCSI_HOST * hd, INTERNAL_CMD * io);
```

Arguments

hd MPT SCSI_HOST pointer

io INTERNAL_CMD pointer.

Description

Issue the specified internally generated command and do command specific cleanup. For bus scan / DV only.

NOTES

If command is Inquiry and status is good, initialize a target structure, save the data

Remark

Single threaded access only.

Return

< 0 if an illegal command or no resources

0 if good

> 0 if command complete but some type of completion error.

Name

`mptscsih_synchronize_cache` — Send SYNCHRONIZE_CACHE to all disks.

Synopsis

```
void mptscsih_synchronize_cache (MPT SCSI_HOST * hd, VirtDevice * vdevice);
```

Arguments

hd Pointer to a SCSI HOST structure

vdevice virtual target device

Description

Uses the ISR, but with special processing. MUST be single-threaded.

Name

`mptctl_syscall_down` — Down the MPT adapter syscall semaphore.

Synopsis

```
int mptctl_syscall_down (MPT_ADAPTER * ioc, int nonblock);
```

Arguments

ioc Pointer to MPT adapter

nonblock boolean, non-zero if O_NONBLOCK is set

Description

All of the `ioctl` commands can potentially sleep, which is illegal with a spinlock held, thus we perform mutual exclusion here.

Returns negative `errno` on error, or zero for success.

Name

mptspi_setTargetNegoParms — Update the target negotiation parameters

Synopsis

```
void mptspi_setTargetNegoParms (MPT SCSI_HOST * hd, VirtTarget * target,
struct scsi_device * sdev);
```

Arguments

hd Pointer to a SCSI Host Structure

target per target private data

sdev SCSI device

Description

Update the target negotiation parameters based on the the Inquiry data, adapter capabilities, and NVRAM settings.

Name

mptspi_writeIOCPage4 — write IOC Page 4

Synopsis

```
int mptspi_writeIOCPage4 (MPT_SCSI_HOST * hd, u8 channel, u8 id);
```

Arguments

<i>hd</i>	Pointer to a SCSI Host Structure
<i>channel</i>	channel number
<i>id</i>	write IOC Page4 for this ID & Bus

Return

-EAGAIN if unable to obtain a Message Frame or 0 if success.

Remark

We do not wait for a return, write pages sequentially.

Name

mptspi_initTarget — Target, LUN alloc/free functionality.

Synopsis

```
void mptspi_initTarget (MPT SCSI_HOST * hd, VirtTarget * vtarget, struct
scsi_device * sdev);
```

Arguments

hd Pointer to MPT SCSI_HOST structure

vtarget per target private data

sdev SCSI device

NOTE

It's only SAFE to call this routine if data points to sane & valid STANDARD INQUIRY data!

Allocate and initialize memory for this target. Save inquiry data.

Name

`mptspi_is_raid` — Determines whether target is belonging to volume

Synopsis

```
int mptspi_is_raid (struct _MPT_SCSI_HOST * hd, u32 id);
```

Arguments

hd Pointer to a SCSI HOST structure

id target device id

Return

non-zero = true zero = false

Name

mptspi_print_write_nego — negotiation parameters debug info that is being sent

Synopsis

```
void mptspi_print_write_nego (struct _MPT_SCSI_HOST * hd, struct  
scsi_target * starget, u32 ii);
```

Arguments

hd Pointer to a SCSI HOST structure

starget SCSI target

ii negotiation parameters

Name

mptspi_print_read_nego — negotiation parameters debug info that is being read

Synopsis

```
void mptspi_print_read_nego (struct _MPT_SCSI_HOST * hd, struct  
scsi_target * starget, u32 ii);
```

Arguments

hd Pointer to a SCSI HOST structure

starget SCSI target

ii negotiation parameters

Name

mptspi_init — Register MPT adapter(s) as SCSI host(s) with SCSI mid-layer.

Synopsis

```
int mptspi_init ( void );
```

Arguments

void no arguments

Description

Returns 0 for success, non-zero for failure.

Name

mptspi_exit — Unregisters MPT adapter(s)

Synopsis

```
void __exit mptspi_exit ( void );
```

Arguments

void no arguments

Name

`mptfc_init` — Register MPT adapter(s) as SCSI host(s) with SCSI mid-layer.

Synopsis

```
int mptfc_init ( void );
```

Arguments

void no arguments

Description

Returns 0 for success, non-zero for failure.

Name

mptfc_remove — Remove fc infrastructure for devices

Synopsis

```
void mptfc_remove (struct pci_dev * pdev);
```

Arguments

pdev Pointer to pci_dev structure

Name

`mptfc_exit` — Unregisters MPT adapter(s)

Synopsis

```
void __exit mptfc_exit ( void );
```

Arguments

void no arguments

Name

`lan_reply` — Handle all data sent from the hardware.

Synopsis

```
int lan_reply (MPT_ADAPTER * ioc, MPT_FRAME_HDR * mf, MPT_FRAME_HDR *  
reply);
```

Arguments

ioc Pointer to MPT_ADAPTER structure

mf Pointer to original MPT request frame (NULL if TurboReply)

reply Pointer to MPT reply frame

Description

Returns 1 indicating original alloc'd request frame ptr should be freed, or 0 if it shouldn't.

Chapter 5. Sound Devices

Name

`snd_printk` — printk wrapper

Synopsis

```
snd_printk ( fmt, args... );
```

Arguments

fmt format string

args... variable arguments

Description

Works like `printk` but prints the file and the line of the caller when configured with `CONFIG_SND_VERBOSE_PRINTK`.

Name

`snd_printd` — debug printk

Synopsis

```
snd_printd ( fmt, args... );
```

Arguments

fmt format string

args... variable arguments

Description

Works like `snd_printk` for debugging purposes. Ignored when `CONFIG_SND_DEBUG` is not set.

Name

`snd_DEBUG` — give a BUG warning message and stack trace

Synopsis

```
snd_DEBUG (void);
```

Arguments

None

Description

Calls `WARN` if `CONFIG_SND_DEBUG` is set. Ignored when `CONFIG_SND_DEBUG` is not set.

Name

`snd_printd_ratelimit` —

Synopsis

```
snd_printd_ratelimit (void);
```

Arguments

None

Name

`snd_DEBUG_ON` — debugging check macro

Synopsis

```
snd_DEBUG_ON ( cond );
```

Arguments

cond condition to evaluate

Description

Has the same behavior as `WARN_ON` when `CONFIG_SND_DEBUG` is set, otherwise just evaluates the conditional and returns the value.

Name

`snd_printdd` — debug printk

Synopsis

```
snd_printdd ( format, args... );
```

Arguments

format format string

args... variable arguments

Description

Works like `snd_printk` for debugging purposes. Ignored when `CONFIG_SND_DEBUG_VERBOSE` is not set.

Name

`register_sound_special_device` — register a special sound node

Synopsis

```
int register_sound_special_device (const struct file_operations * fops,
int unit, struct device * dev);
```

Arguments

fops File operations for the driver

unit Unit number to allocate

dev device pointer

Description

Allocate a special sound device by minor number from the sound subsystem.

Return

The allocated number is returned on success. On failure, a negative error code is returned.

Name

`register_sound_mixer` — register a mixer device

Synopsis

```
int register_sound_mixer (const struct file_operations * fops, int dev);
```

Arguments

fops File operations for the driver

dev Unit number to allocate

Description

Allocate a mixer device. Unit is the number of the mixer requested. Pass -1 to request the next free mixer unit.

Return

On success, the allocated number is returned. On failure, a negative error code is returned.

Name

`register_sound_midi` — register a midi device

Synopsis

```
int register_sound_midi (const struct file_operations * fops, int dev);
```

Arguments

fops File operations for the driver

dev Unit number to allocate

Description

Allocate a midi device. Unit is the number of the midi device requested. Pass -1 to request the next free midi unit.

Return

On success, the allocated number is returned. On failure, a negative error code is returned.

Name

`register_sound_dsp` — register a DSP device

Synopsis

```
int register_sound_dsp (const struct file_operations * fops, int dev);
```

Arguments

fops File operations for the driver

dev Unit number to allocate

Description

Allocate a DSP device. Unit is the number of the DSP requested. Pass -1 to request the next free DSP unit.

This function allocates both the audio and dsp device entries together and will always allocate them as a matching pair - eg dsp3/audio3

Return

On success, the allocated number is returned. On failure, a negative error code is returned.

Name

`unregister_sound_special` — unregister a special sound device

Synopsis

```
void unregister_sound_special (int unit);
```

Arguments

unit unit number to allocate

Description

Release a sound device that was allocated with `register_sound_special`. The unit passed is the return value from the register function.

Name

`unregister_sound_mixer` — unregister a mixer

Synopsis

```
void unregister_sound_mixer (int unit);
```

Arguments

unit unit number to allocate

Description

Release a sound device that was allocated with `register_sound_mixer`. The unit passed is the return value from the register function.

Name

`unregister_sound_midi` — unregister a midi device

Synopsis

```
void unregister_sound_midi (int unit);
```

Arguments

unit unit number to allocate

Description

Release a sound device that was allocated with `register_sound_midi`. The unit passed is the return value from the register function.

Name

`unregister_sound_dsp` — unregister a DSP device

Synopsis

```
void unregister_sound_dsp (int unit);
```

Arguments

unit unit number to allocate

Description

Release a sound device that was allocated with `register_sound_dsp`. The unit passed is the return value from the register function.

Both of the allocated units are released together automatically.

Name

`snd_pcm_stream_linked` — Check whether the substream is linked with others

Synopsis

```
int snd_pcm_stream_linked (struct snd_pcm_substream * substream);
```

Arguments

substream substream to check

Description

Returns true if the given substream is being linked with others.

Name

`snd_pcm_stream_lock_irqsave` — Lock the PCM stream

Synopsis

```
snd_pcm_stream_lock_irqsave ( substream, flags );
```

Arguments

substream PCM substream

flags irq flags

Description

This locks the PCM stream like `snd_pcm_stream_lock` but with the local IRQ (only when `nonatomic` is false). In nonatomic case, this is identical as `snd_pcm_stream_lock`.

Name

`snd_pcm_group_for_each_entry` — iterate over the linked substreams

Synopsis

```
snd_pcm_group_for_each_entry ( s, substream );
```

Arguments

s the iterator

substream the substream

Description

Iterate over the all linked substreams to the given *substream*. When *substream* isn't linked with any others, this gives returns *substream* itself once.

Name

`snd_pcm_running` — Check whether the substream is in a running state

Synopsis

```
int snd_pcm_running (struct snd_pcm_substream * substream);
```

Arguments

substream substream to check

Description

Returns true if the given substream is in the state `RUNNING`, or in the state `DRAINING` for playback.

Name

`bytes_to_samples` — Unit conversion of the size from bytes to samples

Synopsis

```
ssize_t bytes_to_samples (struct snd_pcm_runtime * runtime, ssize_t
size);
```

Arguments

runtime PCM runtime instance

size size in bytes

Name

`bytes_to_frames` — Unit conversion of the size from bytes to frames

Synopsis

```
snd_pcm_sframes_t bytes_to_frames (struct snd_pcm_runtime * runtime,  
ssize_t size);
```

Arguments

runtime PCM runtime instance

size size in bytes

Name

`samples_to_bytes` — Unit conversion of the size from samples to bytes

Synopsis

```
ssize_t samples_to_bytes (struct snd_pcm_runtime * runtime, ssize_t
size);
```

Arguments

runtime PCM runtime instance

size size in samples

Name

`frames_to_bytes` — Unit conversion of the size from frames to bytes

Synopsis

```
ssize_t frames_to_bytes (struct snd_pcm_runtime * runtime,  
snd_pcm_sframes_t size);
```

Arguments

runtime PCM runtime instance

size size in frames

Name

`frame_aligned` — Check whether the byte size is aligned to frames

Synopsis

```
int frame_aligned (struct snd_pcm_runtime * runtime, ssize_t bytes);
```

Arguments

runtime PCM runtime instance

bytes size in bytes

Name

`snd_pcm_lib_buffer_bytes` — Get the buffer size of the current PCM in bytes

Synopsis

```
size_t snd_pcm_lib_buffer_bytes (struct snd_pcm_substream * substream);
```

Arguments

substream PCM substream

Name

`snd_pcm_lib_period_bytes` — Get the period size of the current PCM in bytes

Synopsis

```
size_t snd_pcm_lib_period_bytes (struct snd_pcm_substream * substream);
```

Arguments

substream PCM substream

Name

`snd_pcm_playback_avail` — Get the available (writable) space for playback

Synopsis

```
snd_pcm_uframes_t snd_pcm_playback_avail (struct snd_pcm_runtime * runtime);
```

Arguments

runtime PCM runtime instance

Description

Result is between 0 ... (boundary - 1)

Name

`snd_pcm_capture_avail` — Get the available (readable) space for capture

Synopsis

```
snd_pcm_uframes_t snd_pcm_capture_avail (struct snd_pcm_runtime * runtime);
```

Arguments

runtime PCM runtime instance

Description

Result is between 0 ... (boundary - 1)

Name

`snd_pcm_playback_hw_avail` — Get the queued space for playback

Synopsis

```
snd_pcm_sframes_t snd_pcm_playback_hw_avail (struct snd_pcm_runtime *  
runtime);
```

Arguments

runtime PCM runtime instance

Name

`snd_pcm_capture_hw_avail` — Get the free space for capture

Synopsis

```
snd_pcm_sframes_t snd_pcm_capture_hw_avail (struct snd_pcm_runtime *  
runtime);
```

Arguments

runtime PCM runtime instance

Name

`snd_pcm_playback_ready` — check whether the playback buffer is available

Synopsis

```
int snd_pcm_playback_ready (struct snd_pcm_substream * substream);
```

Arguments

substream the pcm substream instance

Description

Checks whether enough free space is available on the playback buffer.

Return

Non-zero if available, or zero if not.

Name

`snd_pcm_capture_ready` — check whether the capture buffer is available

Synopsis

```
int snd_pcm_capture_ready (struct snd_pcm_substream * substream);
```

Arguments

substream the pcm substream instance

Description

Checks whether enough capture data is available on the capture buffer.

Return

Non-zero if available, or zero if not.

Name

`snd_pcm_playback_data` — check whether any data exists on the playback buffer

Synopsis

```
int snd_pcm_playback_data (struct snd_pcm_substream * substream);
```

Arguments

substream the pcm substream instance

Description

Checks whether any data exists on the playback buffer.

Return

Non-zero if any data exists, or zero if not. If `stop_threshold` is bigger or equal to boundary, then this function returns always non-zero.

Name

`snd_pcm_playback_empty` — check whether the playback buffer is empty

Synopsis

```
int snd_pcm_playback_empty (struct snd_pcm_substream * substream);
```

Arguments

substream the pcm substream instance

Description

Checks whether the playback buffer is empty.

Return

Non-zero if empty, or zero if not.

Name

`snd_pcm_capture_empty` — check whether the capture buffer is empty

Synopsis

```
int snd_pcm_capture_empty (struct snd_pcm_substream * substream);
```

Arguments

substream the pcm substream instance

Description

Checks whether the capture buffer is empty.

Return

Non-zero if empty, or zero if not.

Name

`snd_pcm_trigger_done` — Mark the master substream

Synopsis

```
void snd_pcm_trigger_done (struct snd_pcm_substream * substream, struct  
snd_pcm_substream * master);
```

Arguments

substream the pcm substream instance

master the linked master substream

Description

When multiple substreams of the same card are linked and the hardware supports the single-shot operation, the driver calls this in the loop in `snd_pcm_group_for_each_entry` for marking the substream as “done”. Then most of trigger operations are performed only to the given master substream.

The `trigger_master` mark is cleared at timestamp updates at the end of trigger operations.

Name

`params_channels` — Get the number of channels from the hw params

Synopsis

```
unsigned int params_channels (const struct snd_pcm_hw_params * p);
```

Arguments

p hw params

Name

`params_rate` — Get the sample rate from the hw params

Synopsis

```
unsigned int params_rate (const struct snd_pcm_hw_params * p);
```

Arguments

p hw params

Name

`params_period_size` — Get the period size (in frames) from the hw params

Synopsis

```
unsigned int params_period_size (const struct snd_pcm_hw_params * p);
```

Arguments

p hw params

Name

`params_periods` — Get the number of periods from the hw params

Synopsis

```
unsigned int params_periods (const struct snd_pcm_hw_params * p);
```

Arguments

p hw params

Name

`params_buffer_size` — Get the buffer size (in frames) from the hw params

Synopsis

```
unsigned int params_buffer_size (const struct snd_pcm_hw_params * p);
```

Arguments

p hw params

Name

`params_buffer_bytes` — Get the buffer size (in bytes) from the hw params

Synopsis

```
unsigned int params_buffer_bytes (const struct snd_pcm_hw_params * p);
```

Arguments

p hw params

Name

`snd_pcm_format_cpu_endian` — Check the PCM format is CPU-endian

Synopsis

```
int snd_pcm_format_cpu_endian (snd_pcm_format_t format);
```

Arguments

format the format to check

Return

1 if the given PCM format is CPU-endian, 0 if opposite, or a negative error code if endian not specified.

Name

`snd_pcm_set_runtime_buffer` — Set the PCM runtime buffer

Synopsis

```
void snd_pcm_set_runtime_buffer (struct snd_pcm_substream * substream,  
struct snd_dma_buffer * bufp);
```

Arguments

substream PCM substream to set

bufp the buffer information, NULL to clear

Description

Copy the buffer information to `runtime->dma_buffer` when *bufp* is non-NULL. Otherwise it clears the current buffer information.

Name

`snd_pcm_gettime` — Fill the timespec depending on the timestamp mode

Synopsis

```
void snd_pcm_gettime (struct snd_pcm_runtime * runtime, struct timespec  
* tv);
```

Arguments

runtime PCM runtime instance

tv timespec to fill

Name

`snd_pcm_lib_alloc_vmalloc_buffer` — allocate virtual DMA buffer

Synopsis

```
int snd_pcm_lib_alloc_vmalloc_buffer (struct snd_pcm_substream * sub-  
stream, size_t size);
```

Arguments

substream the substream to allocate the buffer to

size the requested buffer size, in bytes

Description

Allocates the PCM substream buffer using `vmalloc`, i.e., the memory is contiguous in kernel virtual space, but not in physical memory. Use this if the buffer is accessed by kernel code but not by device DMA.

Return

1 if the buffer was changed, 0 if not changed, or a negative error code.

Name

`snd_pcm_lib_alloc_vmalloc_32_buffer` — allocate 32-bit-addressable buffer

Synopsis

```
int snd_pcm_lib_alloc_vmalloc_32_buffer (struct snd_pcm_substream *  
    substream, size_t size);
```

Arguments

substream the substream to allocate the buffer to

size the requested buffer size, in bytes

Description

This function works like `snd_pcm_lib_alloc_vmalloc_buffer`, but uses `vmalloc_32`, i.e., the pages are allocated from 32-bit-addressable memory.

Return

1 if the buffer was changed, 0 if not changed, or a negative error code.

Name

`snd_pcm_sgbuf_get_addr` — Get the DMA address at the corresponding offset

Synopsis

```
dma_addr_t snd_pcm_sgbuf_get_addr (struct snd_pcm_substream * sub-  
stream, unsigned int ofs);
```

Arguments

substream PCM substream

ofs byte offset

Name

`snd_pcm_sgbuf_get_ptr` — Get the virtual address at the corresponding offset

Synopsis

```
void * snd_pcm_sgbuf_get_ptr (struct snd_pcm_substream * substream,  
unsigned int ofs);
```

Arguments

substream PCM substream

ofs byte offset

Name

`snd_pcm_sgbuf_get_chunk_size` — Compute the max size that fits within the contig. page from the given size

Synopsis

```
unsigned int snd_pcm_sgbuf_get_chunk_size (struct snd_pcm_substream *  
substream, unsigned int ofs, unsigned int size);
```

Arguments

<i>substream</i>	PCM substream
<i>ofs</i>	byte offset
<i>size</i>	byte size to examine

Name

`snd_pcm_mmap_data_open` — increase the mmap counter

Synopsis

```
void snd_pcm_mmap_data_open (struct vm_area_struct * area);
```

Arguments

area VMA

Description

PCM mmap callback should handle this counter properly

Name

`snd_pcm_mmap_data_close` — decrease the mmap counter

Synopsis

```
void snd_pcm_mmap_data_close (struct vm_area_struct * area);
```

Arguments

area VMA

Description

PCM mmap callback should handle this counter properly

Name

`snd_pcm_limit_isa_dma_size` — Get the max size fitting with ISA DMA transfer

Synopsis

```
void snd_pcm_limit_isa_dma_size (int dma, size_t * max);
```

Arguments

dma DMA number

max pointer to store the max size

Name

`snd_pcm_stream_str` — Get a string naming the direction of a stream

Synopsis

```
const char * snd_pcm_stream_str (struct snd_pcm_substream * substream);
```

Arguments

substream the pcm substream instance

Return

A string naming the direction of the stream.

Name

`snd_pcm_chmap_substream` — get the PCM substream assigned to the given chmap info

Synopsis

```
struct    snd_pcm_substream    *    snd_pcm_chmap_substream    (struct  
snd_pcm_chmap * info, unsigned int idx);
```

Arguments

info chmap information

idx the substream number index

Name

`pcm_format_to_bits` — Strong-typed conversion of `pcm_format` to bitwise

Synopsis

```
u64 pcm_format_to_bits (snd_pcm_format_t pcm_format);
```

Arguments

pcm_format PCM format

Name

`snd_pcm_format_name` — Return a name string for the given PCM format

Synopsis

```
const char * snd_pcm_format_name (snd_pcm_format_t format);
```

Arguments

format PCM format

Name

`snd_pcm_new_stream` — create a new PCM stream

Synopsis

```
int snd_pcm_new_stream (struct snd_pcm * pcm, int stream, int
substream_count);
```

Arguments

<i>pcm</i>	the pcm instance
<i>stream</i>	the stream direction, <code>SNDRV_PCM_STREAM_XXX</code>
<i>substream_count</i>	the number of substreams

Description

Creates a new stream for the pcm. The corresponding stream on the pcm must have been empty before calling this, i.e. zero must be given to the argument of `snd_pcm_new`.

Return

Zero if successful, or a negative error code on failure.

Name

`snd_pcm_new` — create a new PCM instance

Synopsis

```
int snd_pcm_new (struct snd_card * card, const char * id, int device,  
int playback_count, int capture_count, struct snd_pcm ** rpcm);
```

Arguments

<i>card</i>	the card instance
<i>id</i>	the id string
<i>device</i>	the device index (zero based)
<i>playback_count</i>	the number of substreams for playback
<i>capture_count</i>	the number of substreams for capture
<i>rpcm</i>	the pointer to store the new pcm instance

Description

Creates a new PCM instance.

The pcm operators have to be set afterwards to the new instance via `snd_pcm_set_ops`.

Return

Zero if successful, or a negative error code on failure.

Name

`snd_pcm_new_internal` — create a new internal PCM instance

Synopsis

```
int snd_pcm_new_internal (struct snd_card * card, const char * id, int
device, int playback_count, int capture_count, struct snd_pcm ** rpcm);
```

Arguments

<i>card</i>	the card instance
<i>id</i>	the id string
<i>device</i>	the device index (zero based - shared with normal PCM's)
<i>playback_count</i>	the number of substreams for playback
<i>capture_count</i>	the number of substreams for capture
<i>rpcm</i>	the pointer to store the new pcm instance

Description

Creates a new internal PCM instance with no userspace device or procfs entries. This is used by ASoC Back End PCM's in order to create a PCM that will only be used internally by kernel drivers. i.e. it cannot be opened by userspace. It provides existing ASoC components drivers with a substream and access to any private data.

The pcm operators have to be set afterwards to the new instance via `snd_pcm_set_ops`.

Return

Zero if successful, or a negative error code on failure.

Name

`snd_pcm_notify` — Add/remove the notify list

Synopsis

```
int snd_pcm_notify (struct snd_pcm_notify * notify, int nfree);
```

Arguments

notify PCM notify list

nfree 0 = register, 1 = unregister

Description

This adds the given notifier to the global list so that the callback is called for each registered PCM devices. This exists only for PCM OSS emulation, so far.

Name

`snd_device_new` — create an ALSA device component

Synopsis

```
int snd_device_new (struct snd_card * card, enum snd_device_type type,  
void * device_data, struct snd_device_ops * ops);
```

Arguments

<i>card</i>	the card instance
<i>type</i>	the device type, <code>SNDRV_DEV_XXX</code>
<i>device_data</i>	the data pointer of this device
<i>ops</i>	the operator table

Description

Creates a new device component for the given data pointer. The device will be assigned to the card and managed together by the card.

The data pointer plays a role as the identifier, too, so the pointer address must be unique and unchanged.

Return

Zero if successful, or a negative error code on failure.

Name

`snd_device_disconnect` — disconnect the device

Synopsis

```
void snd_device_disconnect (struct snd_card * card, void * device_data);
```

Arguments

card the card instance

device_data the data pointer to disconnect

Description

Turns the device into the disconnection state, invoking `dev_disconnect` callback, if the device was already registered.

Usually called from `snd_card_disconnect`.

Return

Zero if successful, or a negative error code on failure or if the device not found.

Name

`snd_device_free` — release the device from the card

Synopsis

```
void snd_device_free (struct snd_card * card, void * device_data);
```

Arguments

card the card instance

device_data the data pointer to release

Description

Removes the device from the list on the card and invokes the callbacks, `dev_disconnect` and `dev_free`, corresponding to the state. Then release the device.

Name

`snd_device_register` — register the device

Synopsis

```
int snd_device_register (struct snd_card * card, void * device_data);
```

Arguments

card the card instance

device_data the data pointer to register

Description

Registers the device which was already created via `snd_device_new`. Usually this is called from `snd_card_register`, but it can be called later if any new devices are created after invocation of `snd_card_register`.

Return

Zero if successful, or a negative error code on failure or if the device not found.

Name

`snd_iprintf` — printf on the procfs buffer

Synopsis

```
int snd_iprintf (struct snd_info_buffer * buffer, const char * fmt, ...);
```

Arguments

buffer the procfs buffer

fmt the printf format

... variable arguments

Description

Outputs the string on the procfs buffer just like `printf`.

Return

The size of output string, or a negative error code.

Name

`snd_info_get_line` — read one line from the procfs buffer

Synopsis

```
int snd_info_get_line (struct snd_info_buffer * buffer, char * line,
int len);
```

Arguments

buffer the procfs buffer

line the buffer to store

len the max. buffer size

Description

Reads one line from the buffer and stores the string.

Return

Zero if successful, or 1 if error or EOF.

Name

`snd_info_get_str` — parse a string token

Synopsis

```
const char * snd_info_get_str (char * dest, const char * src, int len);
```

Arguments

dest the buffer to store the string token

src the original string

len the max. length of token - 1

Description

Parses the original string and copy a token to the given string buffer.

Return

The updated pointer of the original string so that it can be used for the next call.

Name

`snd_info_create_module_entry` — create an info entry for the given module

Synopsis

```
struct snd_info_entry * snd_info_create_module_entry (struct module *  
module, const char * name, struct snd_info_entry * parent);
```

Arguments

module the module pointer

name the file name

parent the parent directory

Description

Creates a new info entry and assigns it to the given module.

Return

The pointer of the new instance, or NULL on failure.

Name

`snd_info_create_card_entry` — create an info entry for the given card

Synopsis

```
struct snd_info_entry * snd_info_create_card_entry (struct snd_card *  
card, const char * name, struct snd_info_entry * parent);
```

Arguments

card the card instance

name the file name

parent the parent directory

Description

Creates a new info entry and assigns it to the given card.

Return

The pointer of the new instance, or NULL on failure.

Name

`snd_card_proc_new` — create an info entry for the given card

Synopsis

```
int snd_card_proc_new (struct snd_card * card, const char * name, struct
snd_info_entry ** entryp);
```

Arguments

card the card instance

name the file name

entryp the pointer to store the new info entry

Description

Creates a new info entry and assigns it to the given card. Unlike `snd_info_create_card_entry`, this function registers the info entry as an ALSA device component, so that it can be unregistered/released without explicit call. Also, you don't have to register this entry via `snd_info_register`, since this will be registered by `snd_card_register` automatically.

The parent is assumed as `card->proc_root`.

For releasing this entry, use `snd_device_free` instead of `snd_info_free_entry`.

Return

Zero if successful, or a negative error code on failure.

Name

`snd_info_free_entry` — release the info entry

Synopsis

```
void snd_info_free_entry (struct snd_info_entry * entry);
```

Arguments

entry the info entry

Description

Releases the info entry. Don't call this after registered.

Name

`snd_info_register` — register the info entry

Synopsis

```
int snd_info_register (struct snd_info_entry * entry);
```

Arguments

entry the info entry

Description

Registers the proc info entry.

Return

Zero if successful, or a negative error code on failure.

Name

`snd_rawmidi_receive` — receive the input data from the device

Synopsis

```
int snd_rawmidi_receive (struct snd_rawmidi_substream * substream, const
unsigned char * buffer, int count);
```

Arguments

substream the rawmidi substream

buffer the buffer pointer

count the data size to read

Description

Reads the data from the internal buffer.

Return

The size of read data, or a negative error code on failure.

Name

`snd_rawmidi_transmit_empty` — check whether the output buffer is empty

Synopsis

```
int snd_rawmidi_transmit_empty (struct snd_rawmidi_substream * sub-  
stream);
```

Arguments

substream the rawmidi substream

Return

1 if the internal output buffer is empty, 0 if not.

Name

`__snd_rawmidi_transmit_peek` — copy data from the internal buffer

Synopsis

```
int __snd_rawmidi_transmit_peek (struct snd_rawmidi_substream * sub-  
stream, unsigned char * buffer, int count);
```

Arguments

substream the rawmidi substream

buffer the buffer pointer

count data size to transfer

Description

This is a variant of `snd_rawmidi_transmit_peek` without spinlock.

Name

`snd_rawmidi_transmit_peek` — copy data from the internal buffer

Synopsis

```
int snd_rawmidi_transmit_peek (struct snd_rawmidi_substream * sub-  
stream, unsigned char * buffer, int count);
```

Arguments

substream the rawmidi substream

buffer the buffer pointer

count data size to transfer

Description

Copies data from the internal output buffer to the given buffer.

Call this in the interrupt handler when the midi output is ready, and call `snd_rawmidi_transmit_ack` after the transmission is finished.

Return

The size of copied data, or a negative error code on failure.

Name

`__snd_rawmidi_transmit_ack` — acknowledge the transmission

Synopsis

```
int __snd_rawmidi_transmit_ack (struct snd_rawmidi_substream * sub-
stream, int count);
```

Arguments

substream the rawmidi substream

count the transferred count

Description

This is a variant of `__snd_rawmidi_transmit_ack` without spinlock.

Name

`snd_rawmidi_transmit_ack` — acknowledge the transmission

Synopsis

```
int snd_rawmidi_transmit_ack (struct snd_rawmidi_substream * substream,
int count);
```

Arguments

substream the rawmidi substream

count the transferred count

Description

Advances the hardware pointer for the internal output buffer with the given size and updates the condition. Call after the transmission is finished.

Return

The advanced size if successful, or a negative error code on failure.

Name

`snd_rawmidi_transmit` — copy from the buffer to the device

Synopsis

```
int snd_rawmidi_transmit (struct snd_rawmidi_substream * substream, unsigned char * buffer, int count);
```

Arguments

substream the rawmidi substream

buffer the buffer pointer

count the data size to transfer

Description

Copies data from the buffer to the device and advances the pointer.

Return

The copied size if successful, or a negative error code on failure.

Name

`snd_rawmidi_new` — create a rawmidi instance

Synopsis

```
int snd_rawmidi_new (struct snd_card * card, char * id, int device, int
output_count, int input_count, struct snd_rawmidi ** rrawmidi);
```

Arguments

<i>card</i>	the card instance
<i>id</i>	the id string
<i>device</i>	the device index
<i>output_count</i>	the number of output streams
<i>input_count</i>	the number of input streams
<i>rrawmidi</i>	the pointer to store the new rawmidi instance

Description

Creates a new rawmidi instance. Use `snd_rawmidi_set_ops` to set the operators to the new instance.

Return

Zero if successful, or a negative error code on failure.

Name

`snd_rawmidi_set_ops` — set the rawmidi operators

Synopsis

```
void snd_rawmidi_set_ops (struct snd_rawmidi * rmidi, int stream, struct  
snd_rawmidi_ops * ops);
```

Arguments

rmidi the rawmidi instance

stream the stream direction, `SNDRV_RAWMIDI_STREAM_XXX`

ops the operator table

Description

Sets the rawmidi operators for the given stream direction.

Name

`snd_request_card` — try to load the card module

Synopsis

```
void snd_request_card (int card);
```

Arguments

card the card number

Description

Tries to load the module “snd-card-X” for the given card number via `request_module`. Returns immediately if already loaded.

Name

`snd_lookup_minor_data` — get user data of a registered device

Synopsis

```
void * snd_lookup_minor_data (unsigned int minor, int type);
```

Arguments

minor the minor number

type device type (SNDRV_DEVICE_TYPE_XXX)

Description

Checks that a minor device with the specified type is registered, and returns its user data pointer.

This function increments the reference counter of the card instance if an associated instance with the given minor number and type is found. The caller must call `snd_card_unref` appropriately later.

Return

The user data pointer if the specified device is found. NULL otherwise.

Name

`snd_register_device` — Register the ALSA device file for the card

Synopsis

```
int snd_register_device (int type, struct snd_card * card, int dev,  
const struct file_operations * f_ops, void * private_data, struct device  
* device);
```

Arguments

<i>type</i>	the device type, SNDRV_DEVICE_TYPE_XXX
<i>card</i>	the card instance
<i>dev</i>	the device index
<i>f_ops</i>	the file operations
<i>private_data</i>	user pointer for <i>f_ops</i> ->open
<i>device</i>	the device to register

Description

Registers an ALSA device file for the given card. The operators have to be set in *reg* parameter.

Return

Zero if successful, or a negative error code on failure.

Name

`snd_unregister_device` — unregister the device on the given card

Synopsis

```
int snd_unregister_device (struct device * dev);
```

Arguments

dev the device instance

Description

Unregisters the device file already registered via `snd_register_device`.

Return

Zero if successful, or a negative error code on failure.

Name

`copy_to_user_fromio` — copy data from mmio-space to user-space

Synopsis

```
int copy_to_user_fromio (void __user * dst, const volatile void __iomem
* src, size_t count);
```

Arguments

dst the destination pointer on user-space

src the source pointer on mmio

count the data size to copy in bytes

Description

Copies the data from mmio-space to user-space.

Return

Zero if successful, or non-zero on failure.

Name

`copy_from_user_toio` — copy data from user-space to mmio-space

Synopsis

```
int copy_from_user_toio (volatile void __iomem * dst, const void __user  
* src, size_t count);
```

Arguments

dst the destination pointer on mmio-space

src the source pointer on user-space

count the data size to copy in bytes

Description

Copies the data from user-space to mmio-space.

Return

Zero if successful, or non-zero on failure.

Name

`snd_pcm_lib_preallocate_free_for_all` — release all pre-allocated buffers on the pcm

Synopsis

```
int snd_pcm_lib_preallocate_free_for_all (struct snd_pcm * pcm);
```

Arguments

pcm the pcm instance

Description

Releases all the pre-allocated buffers on the given pcm.

Return

Zero if successful, or a negative error code on failure.

Name

`snd_pcm_lib_preallocate_pages` — pre-allocation for the given DMA type

Synopsis

```
int snd_pcm_lib_preallocate_pages (struct snd_pcm_substream * sub-  
stream, int type, struct device * data, size_t size, size_t max);
```

Arguments

<i>substream</i>	the pcm substream instance
<i>type</i>	DMA type (SNDRV_DMA_TYPE_*)
<i>data</i>	DMA type dependent data
<i>size</i>	the requested pre-allocation size in bytes
<i>max</i>	the max. allowed pre-allocation size

Description

Do pre-allocation for the given DMA buffer type.

Return

Zero if successful, or a negative error code on failure.

Name

`snd_pcm_lib_preallocate_pages_for_all` — pre-allocation for continuous memory type (all substreams)

Synopsis

```
int snd_pcm_lib_preallocate_pages_for_all (struct snd_pcm * pcm, int
type, void * data, size_t size, size_t max);
```

Arguments

pcm the pcm instance

type DMA type (SNDRV_DMA_TYPE_*)

data DMA type dependent data

size the requested pre-allocation size in bytes

max the max. allowed pre-allocation size

Description

Do pre-allocation to all substreams of the given pcm for the specified DMA type.

Return

Zero if successful, or a negative error code on failure.

Name

`snd_pcm_sgbuf_ops_page` — get the page struct at the given offset

Synopsis

```
struct page * snd_pcm_sgbuf_ops_page (struct snd_pcm_substream * sub-  
stream, unsigned long offset);
```

Arguments

substream the pcm substream instance

offset the buffer offset

Description

Used as the page callback of PCM ops.

Return

The page struct at the given buffer offset. NULL on failure.

Name

`snd_pcm_lib_malloc_pages` — allocate the DMA buffer

Synopsis

```
int snd_pcm_lib_malloc_pages (struct snd_pcm_substream * substream,
size_t size);
```

Arguments

substream the substream to allocate the DMA buffer to

size the requested buffer size in bytes

Description

Allocates the DMA buffer on the BUS type given earlier to `snd_pcm_lib_preallocate_XXX_pages`.

Return

1 if the buffer is changed, 0 if not changed, or a negative code on failure.

Name

`snd_pcm_lib_free_pages` — release the allocated DMA buffer.

Synopsis

```
int snd_pcm_lib_free_pages (struct snd_pcm_substream * substream);
```

Arguments

substream the substream to release the DMA buffer

Description

Releases the DMA buffer allocated via `snd_pcm_lib_malloc_pages`.

Return

Zero if successful, or a negative error code on failure.

Name

`snd_pcm_lib_free_vmalloc_buffer` — free vmalloc buffer

Synopsis

```
int snd_pcm_lib_free_vmalloc_buffer (struct snd_pcm_substream * sub-  
stream);
```

Arguments

substream the substream with a buffer allocated by `snd_pcm_lib_alloc_vmalloc_buffer`

Return

Zero if successful, or a negative error code on failure.

Name

`snd_pcm_lib_get_vmalloc_page` — map vmalloc buffer offset to page struct

Synopsis

```
struct page * snd_pcm_lib_get_vmalloc_page (struct snd_pcm_substream *  
substream, unsigned long offset);
```

Arguments

substream the substream with a buffer allocated by `snd_pcm_lib_alloc_vmalloc_buffer`

offset offset in the buffer

Description

This function is to be used as the page callback in the PCM ops.

Return

The page struct, or NULL on failure.

Name

`snd_device_initialize` — Initialize struct device for sound devices

Synopsis

```
void snd_device_initialize (struct device * dev, struct snd_card * card);
```

Arguments

dev device to initialize

card card to assign, optional

Name

`snd_card_new` — create and initialize a soundcard structure

Synopsis

```
int snd_card_new (struct device * parent, int idx, const char * xid,  
struct module * module, int extra_size, struct snd_card ** card_ret);
```

Arguments

<i>parent</i>	the parent device object
<i>idx</i>	card index (address) [0 ... (SNDRV_CARDS-1)]
<i>xid</i>	card identification (ASCII string)
<i>module</i>	top level module for locking
<i>extra_size</i>	allocate this extra size after the main soundcard structure
<i>card_ret</i>	the pointer to store the created card instance

Description

Creates and initializes a soundcard structure.

The function allocates `snd_card` instance via `kzalloc` with the given space for the driver to use freely. The allocated struct is stored in the given `card_ret` pointer.

Return

Zero if successful or a negative error code.

Name

`snd_card_disconnect` — disconnect all APIs from the file-operations (user space)

Synopsis

```
int snd_card_disconnect (struct snd_card * card);
```

Arguments

card soundcard structure

Description

Disconnects all APIs from the file-operations (user space).

Return

Zero, otherwise a negative error code.

Note

The current implementation replaces all active `file->f_op` with special dummy file operations (they do nothing except release).

Name

`snd_card_free_when_closed` — Disconnect the card, free it later eventually

Synopsis

```
int snd_card_free_when_closed (struct snd_card * card);
```

Arguments

card soundcard structure

Description

Unlike `snd_card_free`, this function doesn't try to release the card resource immediately, but tries to disconnect at first. When the card is still in use, the function returns before freeing the resources. The card resources will be freed when the refcount gets to zero.

Name

`snd_card_free` — frees given soundcard structure

Synopsis

```
int snd_card_free (struct snd_card * card);
```

Arguments

card soundcard structure

Description

This function releases the soundcard structure and the all assigned devices automatically. That is, you don't have to release the devices by yourself.

This function waits until the all resources are properly released.

Return

Zero. Frees all associated devices and frees the control interface associated to given soundcard.

Name

`snd_card_set_id` — set card identification name

Synopsis

```
void snd_card_set_id (struct snd_card * card, const char * nid);
```

Arguments

card soundcard structure

nid new identification string

Description

This function sets the card identification and checks for name collisions.

Name

`snd_card_add_dev_attr` — Append a new sysfs attribute group to card

Synopsis

```
int snd_card_add_dev_attr (struct snd_card * card, const struct
attribute_group * group);
```

Arguments

card card instance

group attribute group to append

Name

`snd_card_register` — register the soundcard

Synopsis

```
int snd_card_register (struct snd_card * card);
```

Arguments

card soundcard structure

Description

This function registers all the devices assigned to the soundcard. Until calling this, the ALSA control interface is blocked from the external accesses. Thus, you should call this function at the end of the initialization of the card.

Return

Zero otherwise a negative error code if the registration failed.

Name

`snd_component_add` — add a component string

Synopsis

```
int snd_component_add (struct snd_card * card, const char * component);
```

Arguments

card soundcard structure

component the component id string

Description

This function adds the component id string to the supported list. The component can be referred from the `alsa-lib`.

Return

Zero otherwise a negative error code.

Name

`snd_card_file_add` — add the file to the file list of the card

Synopsis

```
int snd_card_file_add (struct snd_card * card, struct file * file);
```

Arguments

card soundcard structure

file file pointer

Description

This function adds the file to the file linked-list of the card. This linked-list is used to keep tracking the connection state, and to avoid the release of busy resources by hotplug.

Return

zero or a negative error code.

Name

`snd_card_file_remove` — remove the file from the file list

Synopsis

```
int snd_card_file_remove (struct snd_card * card, struct file * file);
```

Arguments

card soundcard structure

file file pointer

Description

This function removes the file formerly added to the card via `snd_card_file_add` function. If all files are removed and `snd_card_free_when_closed` was called beforehand, it processes the pending release of resources.

Return

Zero or a negative error code.

Name

`snd_power_wait` — wait until the power-state is changed.

Synopsis

```
int snd_power_wait (struct snd_card * card, unsigned int power_state);
```

Arguments

card soundcard structure

power_state expected power state

Description

Waits until the power-state is changed.

Return

Zero if successful, or a negative error code.

Note

the power lock must be active before call.

Name

`snd_dma_program` — program an ISA DMA transfer

Synopsis

```
void snd_dma_program (unsigned long dma, unsigned long addr, unsigned  
int size, unsigned short mode);
```

Arguments

dma the dma number

addr the physical address of the buffer

size the DMA transfer size

mode the DMA transfer mode, `DMA_MODE_XXX`

Description

Programs an ISA DMA transfer for the given buffer.

Name

`snd_dma_disable` — stop the ISA DMA transfer

Synopsis

```
void snd_dma_disable (unsigned long dma);
```

Arguments

dma the dma number

Description

Stops the ISA DMA transfer.

Name

`snd_dma_pointer` — return the current pointer to DMA transfer buffer in bytes

Synopsis

```
unsigned int snd_dma_pointer (unsigned long dma, unsigned int size);
```

Arguments

dma the dma number

size the dma transfer size

Return

The current pointer in DMA transfer buffer in bytes.

Name

`snd_ctl_notify` — Send notification to user-space for a control change

Synopsis

```
void snd_ctl_notify (struct snd_card * card, unsigned int mask, struct
snd_ctl_elem_id * id);
```

Arguments

card the card to send notification

mask the event mask, `SNDRV_CTL_EVENT_*`

id the ctl element id to send notification

Description

This function adds an event record with the given id and mask, appends to the list and wakes up the user-space for notification. This can be called in the atomic context.

Name

`snd_ctl_new1` — create a control instance from the template

Synopsis

```
struct snd_kcontrol * snd_ctl_new1 (const struct snd_kcontrol_new *  
ncontrol, void * private_data);
```

Arguments

ncontrol the initialization record

private_data the private data to set

Description

Allocates a new struct `snd_kcontrol` instance and initialize from the given template. When the access field of `ncontrol` is 0, it's assumed as `READWRITE` access. When the count field is 0, it's assumes as one.

Return

The pointer of the newly generated instance, or `NULL` on failure.

Name

`snd_ctl_free_one` — release the control instance

Synopsis

```
void snd_ctl_free_one (struct snd_kcontrol * kcontrol);
```

Arguments

kcontrol the control instance

Description

Releases the control instance created via `snd_ctl_new` or `snd_ctl_new1`. Don't call this after the control was added to the card.

Name

`snd_ctl_add` — add the control instance to the card

Synopsis

```
int snd_ctl_add (struct snd_card * card, struct snd_kcontrol * kcontrol);
```

Arguments

card the card instance

kcontrol the control instance to add

Description

Adds the control instance created via `snd_ctl_new` or `snd_ctl_new1` to the given card. Assigns also an unique numid used for fast search.

It frees automatically the control which cannot be added.

Return

Zero if successful, or a negative error code on failure.

Name

`snd_ctl_replace` — replace the control instance of the card

Synopsis

```
int snd_ctl_replace (struct snd_card * card, struct snd_kcontrol *  
kcontrol, bool add_on_replace);
```

Arguments

<i>card</i>	the card instance
<i>kcontrol</i>	the control instance to replace
<i>add_on_replace</i>	add the control if not already added

Description

Replaces the given control. If the given control does not exist and the `add_on_replace` flag is set, the control is added. If the control exists, it is destroyed first.

It frees automatically the control which cannot be added or replaced.

Return

Zero if successful, or a negative error code on failure.

Name

`snd_ctl_remove` — remove the control from the card and release it

Synopsis

```
int snd_ctl_remove (struct snd_card * card, struct snd_kcontrol * kcontrol);
```

Arguments

card the card instance

kcontrol the control instance to remove

Description

Removes the control from the card and then releases the instance. You don't need to call `snd_ctl_free_one`. You must be in the write lock - `down_write(card->controls_rwsem)`.

Return

0 if successful, or a negative error code on failure.

Name

`snd_ctl_remove_id` — remove the control of the given id and release it

Synopsis

```
int snd_ctl_remove_id (struct snd_card * card, struct snd_ctl_elem_id
* id);
```

Arguments

card the card instance

id the control id to remove

Description

Finds the control instance with the given id, removes it from the card list and releases it.

Return

0 if successful, or a negative error code on failure.

Name

`snd_ctl_activate_id` — activate/inactivate the control of the given id

Synopsis

```
int snd_ctl_activate_id (struct snd_card * card, struct snd_ctl_elem_id
* id, int active);
```

Arguments

card the card instance

id the control id to activate/inactivate

active non-zero to activate

Description

Finds the control instance with the given id, and activate or inactivate the control together with notification, if changed. The given ID data is filled with full information.

Return

0 if unchanged, 1 if changed, or a negative error code on failure.

Name

`snd_ctl_rename_id` — replace the id of a control on the card

Synopsis

```
int snd_ctl_rename_id (struct snd_card * card, struct snd_ctl_elem_id
* src_id, struct snd_ctl_elem_id * dst_id);
```

Arguments

card the card instance

src_id the old id

dst_id the new id

Description

Finds the control with the old id from the card, and replaces the id with the new one.

Return

Zero if successful, or a negative error code on failure.

Name

`snd_ctl_find_numid` — find the control instance with the given number-id

Synopsis

```
struct snd_kcontrol * snd_ctl_find_numid (struct snd_card * card, unsigned int numid);
```

Arguments

card the card instance

numid the number-id to search

Description

Finds the control instance with the given number-id from the card.

The caller must down `card->controls_rwsem` before calling this function (if the race condition can happen).

Return

The pointer of the instance if found, or `NULL` if not.

Name

`snd_ctl_find_id` — find the control instance with the given id

Synopsis

```
struct snd_kcontrol * snd_ctl_find_id (struct snd_card * card, struct
snd_ctl_elem_id * id);
```

Arguments

card the card instance

id the id to search

Description

Finds the control instance with the given id from the card.

The caller must down `card->controls_rwsem` before calling this function (if the race condition can happen).

Return

The pointer of the instance if found, or `NULL` if not.

Name

`snd_ctl_register_ioctl` — register the device-specific control-ioctl

Synopsis

```
int snd_ctl_register_ioctl (snd_kctl_ioctl_func_t fcn);
```

Arguments

fcn ioctl callback function

Description

called from each device manager like `pcm.c`, `hwdep.c`, etc.

Name

`snd_ctl_register_ioctl_compat` — register the device-specific 32bit compat control-ioctls

Synopsis

```
int snd_ctl_register_ioctl_compat (snd_kctl_ioctl_func_t fcn);
```

Arguments

fcn ioctl callback function

Name

`snd_ctl_unregister_ioctl` — de-register the device-specific control-ioctl

Synopsis

```
int snd_ctl_unregister_ioctl (snd_kctl_ioctl_func_t fcn);
```

Arguments

fcn ioctl callback function to unregister

Name

`snd_ctl_unregister_ioctl_compat` — de-register the device-specific compat 32bit control-iocls

Synopsis

```
int snd_ctl_unregister_ioctl_compat (snd_kctl_ioctl_func_t fcn);
```

Arguments

fcn ioctl callback function to unregister

Name

`snd_ctl_boolean_mono_info` — Helper function for a standard boolean info callback with a mono channel

Synopsis

```
int snd_ctl_boolean_mono_info (struct snd_kcontrol * kcontrol, struct
snd_ctl_elem_info * uinfo);
```

Arguments

kcontrol the kcontrol instance

uinfo info to store

Description

This is a function that can be used as info callback for a standard boolean control with a single mono channel.

Name

`snd_ctl_boolean_stereo_info` — Helper function for a standard boolean info callback with stereo two channels

Synopsis

```
int snd_ctl_boolean_stereo_info (struct snd_kcontrol * kcontrol, struct
snd_ctl_elem_info * uinfo);
```

Arguments

kcontrol the kcontrol instance

uinfo info to store

Description

This is a function that can be used as info callback for a standard boolean control with stereo two channels.

Name

`snd_ctl_enum_info` — fills the info structure for an enumerated control

Synopsis

```
int snd_ctl_enum_info (struct snd_ctl_elem_info * info, unsigned int
channels, unsigned int items, const char *const names[]);
```

Arguments

<i>info</i>	the structure to be filled
<i>channels</i>	the number of the control's channels; often one
<i>items</i>	the number of control values; also the size of <i>names</i>
<i>names</i> []	an array containing the names of all control values

Description

Sets all required fields in *info* to their appropriate values. If the control's accessibility is not the default (readable and writable), the caller has to fill *info->access*.

Return

Zero.

Name

`snd_pcm_set_ops` — set the PCM operators

Synopsis

```
void snd_pcm_set_ops (struct snd_pcm * pcm, int direction, const struct  
snd_pcm_ops * ops);
```

Arguments

<i>pcm</i>	the pcm instance
<i>direction</i>	stream direction, <code>SNDRV_PCM_STREAM_XXX</code>
<i>ops</i>	the operator table

Description

Sets the given PCM operators to the pcm instance.

Name

`snd_pcm_set_sync` — set the PCM sync id

Synopsis

```
void snd_pcm_set_sync (struct snd_pcm_substream * substream);
```

Arguments

substream the pcm substream

Description

Sets the PCM sync identifier for the card.

Name

`snd_interval_refine` — refine the interval value of configurator

Synopsis

```
int snd_interval_refine (struct snd_interval * i, const struct
snd_interval * v);
```

Arguments

i the interval value to refine

v the interval value to refer to

Description

Refines the interval value with the reference value. The interval is changed to the range satisfying both intervals. The interval status (min, max, integer, etc.) are evaluated.

Return

Positive if the value is changed, zero if it's not changed, or a negative error code.

Name

`snd_interval_ratnum` — refine the interval value

Synopsis

```
int snd_interval_ratnum (struct snd_interval * i, unsigned int
rats_count, struct snd_ratnum * rats, unsigned int * nump, unsigned
int * denp);
```

Arguments

<i>i</i>	interval to refine
<i>rats_count</i>	number of <code>ratnum_t</code>
<i>rats</i>	<code>ratnum_t</code> array
<i>nump</i>	pointer to store the resultant numerator
<i>denp</i>	pointer to store the resultant denominator

Return

Positive if the value is changed, zero if it's not changed, or a negative error code.

Name

`snd_interval_list` — refine the interval value from the list

Synopsis

```
int snd_interval_list (struct snd_interval * i, unsigned int count,  
const unsigned int * list, unsigned int mask);
```

Arguments

i the interval value to refine

count the number of elements in the list

list the value list

mask the bit-mask to evaluate

Description

Refines the interval value from the list. When mask is non-zero, only the elements corresponding to bit 1 are evaluated.

Return

Positive if the value is changed, zero if it's not changed, or a negative error code.

Name

`snd_interval_ranges` — refine the interval value from the list of ranges

Synopsis

```
int snd_interval_ranges (struct snd_interval * i, unsigned int count,  
const struct snd_interval * ranges, unsigned int mask);
```

Arguments

<i>i</i>	the interval value to refine
<i>count</i>	the number of elements in the list of ranges
<i>ranges</i>	the ranges list
<i>mask</i>	the bit-mask to evaluate

Description

Refines the interval value from the list of ranges. When mask is non-zero, only the elements corresponding to bit 1 are evaluated.

Return

Positive if the value is changed, zero if it's not changed, or a negative error code.

Name

`snd_pcm_hw_rule_add` — add the hw-constraint rule

Synopsis

```
int snd_pcm_hw_rule_add (struct snd_pcm_runtime * runtime, unsigned int
cond, int var, snd_pcm_hw_rule_func_t func, void * private, int dep,
...);
```

Arguments

<i>runtime</i>	the pcm runtime instance
<i>cond</i>	condition bits
<i>var</i>	the variable to evaluate
<i>func</i>	the evaluation function
<i>private</i>	the private data pointer passed to function
<i>dep</i>	the dependent variables
...	variable arguments

Return

Zero if successful, or a negative error code on failure.

Name

`snd_pcm_hw_constraint_mask64` — apply the given bitmap mask constraint

Synopsis

```
int snd_pcm_hw_constraint_mask64 (struct snd_pcm_runtime * runtime,
snd_pcm_hw_param_t var, u_int64_t mask);
```

Arguments

runtime PCM runtime instance

var hw_params variable to apply the mask

mask the 64bit bitmap mask

Description

Apply the constraint of the given bitmap mask to a 64-bit mask parameter.

Return

Zero if successful, or a negative error code on failure.

Name

`snd_pcm_hw_constraint_integer` — apply an integer constraint to an interval

Synopsis

```
int snd_pcm_hw_constraint_integer (struct snd_pcm_runtime * runtime,  
snd_pcm_hw_param_t var);
```

Arguments

runtime PCM runtime instance

var hw_params variable to apply the integer constraint

Description

Apply the constraint of integer to an interval parameter.

Return

Positive if the value is changed, zero if it's not changed, or a negative error code.

Name

`snd_pcm_hw_constraint_minmax` — apply a min/max range constraint to an interval

Synopsis

```
int snd_pcm_hw_constraint_minmax (struct snd_pcm_runtime * runtime,
snd_pcm_hw_param_t var, unsigned int min, unsigned int max);
```

Arguments

<i>runtime</i>	PCM runtime instance
<i>var</i>	hw_params variable to apply the range
<i>min</i>	the minimal value
<i>max</i>	the maximal value

Description

Apply the min/max range constraint to an interval parameter.

Return

Positive if the value is changed, zero if it's not changed, or a negative error code.

Name

`snd_pcm_hw_constraint_list` — apply a list of constraints to a parameter

Synopsis

```
int  snd_pcm_hw_constraint_list (struct  snd_pcm_runtime  *  run-
time, unsigned int  cond,  snd_pcm_hw_param_t  var,  const  struct
snd_pcm_hw_constraint_list  *  l);
```

Arguments

runtime PCM runtime instance

cond condition bits

var hw_params variable to apply the list constraint

l list

Description

Apply the list of constraints to an interval parameter.

Return

Zero if successful, or a negative error code on failure.

Name

`snd_pcm_hw_constraint_ranges` — apply list of range constraints to a parameter

Synopsis

```
int  snd_pcm_hw_constraint_ranges (struct  snd_pcm_runtime  *  run-
time, unsigned int  cond,  snd_pcm_hw_param_t  var,  const  struct
snd_pcm_hw_constraint_ranges  *  r);
```

Arguments

<i>runtime</i>	PCM runtime instance
<i>cond</i>	condition bits
<i>var</i>	hw_params variable to apply the list of range constraints
<i>r</i>	ranges

Description

Apply the list of range constraints to an interval parameter.

Return

Zero if successful, or a negative error code on failure.

Name

`snd_pcm_hw_constraint_ratnums` — apply ratnums constraint to a parameter

Synopsis

```
int  snd_pcm_hw_constraint_ratnums (struct snd_pcm_runtime * runtime,
                                     unsigned int cond,   snd_pcm_hw_param_t var,
                                     struct snd_pcm_hw_constraint_ratnums * r);
```

Arguments

runtime PCM runtime instance

cond condition bits

var hw_params variable to apply the ratnums constraint

r struct snd_ratnums constraints

Return

Zero if successful, or a negative error code on failure.

Name

`snd_pcm_hw_constraint_ratdens` — apply ratdens constraint to a parameter

Synopsis

```
int  snd_pcm_hw_constraint_ratdens (struct snd_pcm_runtime * runtime,
                                     unsigned int cond,   snd_pcm_hw_param_t var,
                                     struct snd_pcm_hw_constraint_ratdens * r);
```

Arguments

runtime PCM runtime instance

cond condition bits

var hw_params variable to apply the ratdens constraint

r struct snd_ratdens constraints

Return

Zero if successful, or a negative error code on failure.

Name

`snd_pcm_hw_constraint_msbits` — add a hw constraint msbits rule

Synopsis

```
int snd_pcm_hw_constraint_msbits (struct snd_pcm_runtime * runtime, unsigned int cond, unsigned int width, unsigned int msbits);
```

Arguments

runtime PCM runtime instance

cond condition bits

width sample bits width

msbits msbits width

Description

This constraint will set the number of most significant bits (msbits) if a sample format with the specified width has been select. If width is set to 0 the msbits will be set for any sample format with a width larger than the specified msbits.

Return

Zero if successful, or a negative error code on failure.

Name

`snd_pcm_hw_constraint_step` — add a hw constraint step rule

Synopsis

```
int snd_pcm_hw_constraint_step (struct snd_pcm_runtime * runtime, unsigned int cond, snd_pcm_hw_param_t var, unsigned long step);
```

Arguments

runtime PCM runtime instance

cond condition bits

var hw_params variable to apply the step constraint

step step size

Return

Zero if successful, or a negative error code on failure.

Name

`snd_pcm_hw_constraint_pow2` — add a hw constraint power-of-2 rule

Synopsis

```
int snd_pcm_hw_constraint_pow2 (struct snd_pcm_runtime * runtime, unsigned int cond, snd_pcm_hw_param_t var);
```

Arguments

runtime PCM runtime instance

cond condition bits

var hw_params variable to apply the power-of-2 constraint

Return

Zero if successful, or a negative error code on failure.

Name

`snd_pcm_hw_rule_noresample` — add a rule to allow disabling hw resampling

Synopsis

```
int snd_pcm_hw_rule_noresample (struct snd_pcm_runtime * runtime, unsigned int base_rate);
```

Arguments

runtime PCM runtime instance

base_rate the rate at which the hardware does not resample

Return

Zero if successful, or a negative error code on failure.

Name

`snd_pcm_hw_param_value` — return *params* field *var* value

Synopsis

```
int snd_pcm_hw_param_value (const struct snd_pcm_hw_params * params,
snd_pcm_hw_param_t var, int * dir);
```

Arguments

params the hw_params instance

var parameter to retrieve

dir pointer to the direction (-1,0,1) or NULL

Return

The value for field *var* if it's fixed in configuration space defined by *params*. -EINVAL otherwise.

Name

`snd_pcm_hw_param_first` — refine config space and return minimum value

Synopsis

```
int snd_pcm_hw_param_first (struct snd_pcm_substream * pcm, struct
snd_pcm_hw_params * params, snd_pcm_hw_param_t var, int * dir);
```

Arguments

<i>pcm</i>	PCM instance
<i>params</i>	the <code>hw_params</code> instance
<i>var</i>	parameter to retrieve
<i>dir</i>	pointer to the direction (-1,0,1) or NULL

Description

Inside configuration space defined by *params* remove from *var* all values > minimum. Reduce configuration space accordingly.

Return

The minimum, or a negative error code on failure.

Name

`snd_pcm_hw_param_last` — refine config space and return maximum value

Synopsis

```
int snd_pcm_hw_param_last (struct snd_pcm_substream * pcm, struct
snd_pcm_hw_params * params, snd_pcm_hw_param_t var, int * dir);
```

Arguments

<i>pcm</i>	PCM instance
<i>params</i>	the <code>hw_params</code> instance
<i>var</i>	parameter to retrieve
<i>dir</i>	pointer to the direction (-1,0,1) or NULL

Description

Inside configuration space defined by *params* remove from *var* all values < maximum. Reduce configuration space accordingly.

Return

The maximum, or a negative error code on failure.

Name

`snd_pcm_lib_ioctl` — a generic PCM ioctl callback

Synopsis

```
int snd_pcm_lib_ioctl (struct snd_pcm_substream * substream, unsigned
int cmd, void * arg);
```

Arguments

substream the pcm substream instance

cmd ioctl command

arg ioctl argument

Description

Processes the generic ioctl commands for PCM. Can be passed as the ioctl callback for PCM ops.

Return

Zero if successful, or a negative error code on failure.

Name

`snd_pcm_period_elapsed` — update the pcm status for the next period

Synopsis

```
void snd_pcm_period_elapsed (struct snd_pcm_substream * substream);
```

Arguments

substream the pcm substream instance

Description

This function is called from the interrupt handler when the PCM has processed the period size. It will update the current pointer, wake up sleepers, etc.

Even if more than one periods have elapsed since the last call, you have to call this only once.

Name

`snd_pcm_add_chmap_ctls` — create channel-mapping control elements

Synopsis

```
int snd_pcm_add_chmap_ctls (struct snd_pcm * pcm, int stream, const struct snd_pcm_chmap_elem * chmap, int max_channels, unsigned long private_value, struct snd_pcm_chmap ** info_ret);
```

Arguments

<i>pcm</i>	the assigned PCM instance
<i>stream</i>	stream direction
<i>chmap</i>	channel map elements (for query)
<i>max_channels</i>	the max number of channels for the stream
<i>private_value</i>	the value passed to each kcontrol's <code>private_value</code> field
<i>info_ret</i>	store struct <code>snd_pcm_chmap</code> instance if non-NULL

Description

Create channel-mapping control elements assigned to the given PCM stream(s).

Return

Zero if successful, or a negative error value.

Name

`snd_hwdep_new` — create a new hwdep instance

Synopsis

```
int snd_hwdep_new (struct snd_card * card, char * id, int device, struct
snd_hwdep ** rhwdep);
```

Arguments

card the card instance

id the id string

device the device index (zero-based)

rhwdep the pointer to store the new hwdep instance

Description

Creates a new hwdep instance with the given index on the card. The callbacks (`hwdep->ops`) must be set on the returned instance after this call manually by the caller.

Return

Zero if successful, or a negative error code on failure.

Name

`snd_pcm_stream_lock` — Lock the PCM stream

Synopsis

```
void snd_pcm_stream_lock (struct snd_pcm_substream * substream);
```

Arguments

substream PCM substream

Description

This locks the PCM stream's spinlock or mutex depending on the nonatomic flag of the given substream. This also takes the global link rw lock (or rw sem), too, for avoiding the race with linked streams.

Name

`snd_pcm_stream_unlock` — Unlock the PCM stream

Synopsis

```
void snd_pcm_stream_unlock (struct snd_pcm_substream * substream);
```

Arguments

substream PCM substream

Description

This unlocks the PCM stream that has been locked via `snd_pcm_stream_lock`.

Name

`snd_pcm_stream_lock_irq` — Lock the PCM stream

Synopsis

```
void snd_pcm_stream_lock_irq (struct snd_pcm_substream * substream);
```

Arguments

substream PCM substream

Description

This locks the PCM stream like `snd_pcm_stream_lock` and disables the local IRQ (only when `nonatomic` is false). In nonatomic case, this is identical as `snd_pcm_stream_lock`.

Name

`snd_pcm_stream_unlock_irq` — Unlock the PCM stream

Synopsis

```
void snd_pcm_stream_unlock_irq (struct snd_pcm_substream * substream);
```

Arguments

substream PCM substream

Description

This is a counter-part of `snd_pcm_stream_lock_irq`.

Name

`snd_pcm_stream_unlock_irqrestore` — Unlock the PCM stream

Synopsis

```
void snd_pcm_stream_unlock_irqrestore (struct snd_pcm_substream * sub-  
stream, unsigned long flags);
```

Arguments

substream PCM substream

flags irq flags

Description

This is a counter-part of `snd_pcm_stream_lock_irqsave`.

Name

`snd_pcm_stop` — try to stop all running streams in the substream group

Synopsis

```
int snd_pcm_stop (struct snd_pcm_substream * substream, snd_pcm_state_t
state);
```

Arguments

substream the PCM substream instance

state PCM state after stopping the stream

Description

The state of each stream is then changed to the given state unconditionally.

Return

Zero if successful, or a negative error code.

Name

`snd_pcm_stop_xrun` — stop the running streams as XRUN

Synopsis

```
int snd_pcm_stop_xrun (struct snd_pcm_substream * substream);
```

Arguments

substream the PCM substream instance

Description

This stops the given running substream (and all linked substreams) as XRUN. Unlike `snd_pcm_stop`, this function takes the substream lock by itself.

Return

Zero if successful, or a negative error code.

Name

`snd_pcm_suspend` — trigger SUSPEND to all linked streams

Synopsis

```
int snd_pcm_suspend (struct snd_pcm_substream * substream);
```

Arguments

substream the PCM substream

Description

After this call, all streams are changed to SUSPENDED state.

Return

Zero if successful (or *substream* is NULL), or a negative error code.

Name

`snd_pcm_suspend_all` — trigger SUSPEND to all substreams in the given pcm

Synopsis

```
int snd_pcm_suspend_all (struct snd_pcm * pcm);
```

Arguments

pcm the PCM instance

Description

After this call, all streams are changed to SUSPENDED state.

Return

Zero if successful (or *pcm* is NULL), or a negative error code.

Name

`snd_pcm_lib_default_mmap` — Default PCM data mmap function

Synopsis

```
int snd_pcm_lib_default_mmap (struct snd_pcm_substream * substream,  
struct vm_area_struct * area);
```

Arguments

substream PCM substream

area VMA

Description

This is the default mmap handler for PCM data. When `mmap_pcm_ops` is NULL, this function is invoked implicitly.

Name

`snd_pcm_lib_mmap_iomem` — Default PCM data mmap function for I/O mem

Synopsis

```
int snd_pcm_lib_mmap_iomem (struct snd_pcm_substream * substream, struct
vm_area_struct * area);
```

Arguments

substream PCM substream

area VMA

Description

When your hardware uses the iomapped pages as the hardware buffer and wants to mmap it, pass this function as `mmap pcm_ops`. Note that this is supposed to work only on limited architectures.

Name

`snd_malloc_pages` — allocate pages with the given size

Synopsis

```
void * snd_malloc_pages (size_t size, gfp_t gfp_flags);
```

Arguments

size the size to allocate in bytes

gfp_flags the allocation conditions, GFP_XXX

Description

Allocates the physically contiguous pages with the given size.

Return

The pointer of the buffer, or NULL if no enough memory.

Name

`snd_free_pages` — release the pages

Synopsis

```
void snd_free_pages (void * ptr, size_t size);
```

Arguments

ptr the buffer pointer to release

size the allocated buffer size

Description

Releases the buffer allocated via `snd_malloc_pages`.

Name

`snd_dma_alloc_pages` — allocate the buffer area according to the given type

Synopsis

```
int snd_dma_alloc_pages (int type, struct device * device, size_t size,  
struct snd_dma_buffer * dmab);
```

Arguments

type the DMA buffer type

device the device pointer

size the buffer size to allocate

dmab buffer allocation record to store the allocated data

Description

Calls the memory-allocator function for the corresponding buffer type.

Return

Zero if the buffer with the given size is allocated successfully, otherwise a negative value on error.

Name

`snd_dma_alloc_pages_fallback` — allocate the buffer area according to the given type with fallback

Synopsis

```
int snd_dma_alloc_pages_fallback (int type, struct device * device,
size_t size, struct snd_dma_buffer * dmab);
```

Arguments

type the DMA buffer type

device the device pointer

size the buffer size to allocate

dmab buffer allocation record to store the allocated data

Description

Calls the memory-allocator function for the corresponding buffer type. When no space is left, this function reduces the size and tries to allocate again. The size actually allocated is stored in `res_size` argument.

Return

Zero if the buffer with the given size is allocated successfully, otherwise a negative value on error.

Name

`snd_dma_free_pages` — release the allocated buffer

Synopsis

```
void snd_dma_free_pages (struct snd_dma_buffer * dmab);
```

Arguments

dmab the buffer allocation record to release

Description

Releases the allocated buffer via `snd_dma_alloc_pages`.

Chapter 6. 16x50 UART Driver

Name

`uart_update_timeout` — update per-port FIFO timeout.

Synopsis

```
void uart_update_timeout (struct uart_port * port, unsigned int cflag,  
unsigned int baud);
```

Arguments

port `uart_port` structure describing the port

cflag `termios` `cflag` value

baud speed of the port

Description

Set the port FIFO timeout value. The *cflag* value should reflect the actual hardware settings.

Name

`uart_get_baud_rate` — return baud rate for a particular port

Synopsis

```
unsigned int uart_get_baud_rate (struct uart_port * port, struct
ktermios * termios, struct ktermios * old, unsigned int min, unsigned
int max);
```

Arguments

<i>port</i>	uart_port structure describing the port in question.
<i>termios</i>	desired termios settings.
<i>old</i>	old termios (or NULL)
<i>min</i>	minimum acceptable baud rate
<i>max</i>	maximum acceptable baud rate

Description

Decode the termios structure into a numeric baud rate, taking account of the magic 38400 baud rate (with `spd_*` flags), and mapping the B0 rate to 9600 baud.

If the new baud rate is invalid, try the old termios setting. If it's still invalid, we try 9600 baud.

Update the *termios* structure to reflect the baud rate we're actually going to be using. Don't do this for the case where B0 is requested (“hang up”).

Name

`uart_get_divisor` — return uart clock divisor

Synopsis

```
unsigned int uart_get_divisor (struct uart_port * port, unsigned int  
baud);
```

Arguments

port uart_port structure describing the port.

baud desired baud rate

Description

Calculate the uart clock divisor for the port.

Name

uart_console_write — write a console message to a serial port

Synopsis

```
void uart_console_write (struct uart_port * port, const char * s, unsigned int count, void (*putchar) (struct uart_port *, int));
```

Arguments

<i>port</i>	the port to write the message
<i>s</i>	array of characters
<i>count</i>	number of characters in string to write
<i>putchar</i>	function to write character to port

Name

uart_parse_earlycon — Parse earlycon options

Synopsis

```
int uart_parse_earlycon (char * p, unsigned char * iotype, unsigned long  
* addr, char ** options);
```

Arguments

p ptr to 2nd field (ie., just beyond '<name>,')
iotype ptr for decoded iotype (out)
addr ptr for decoded mapbase/iobase (out)
options ptr for <options> field; NULL if not present (out)

Description

Decodes earlycon kernel command line parameters of the form earlycon=<name>,io|mmio|mmio32,<addr>,<options> console=<name>,io|mmio|mmio32,<addr>,<options>

The optional form earlycon=<name>,0x<addr>,<options> console=<name>,0x<addr>,<options> is also accepted; the returned *iotype* will be UPIO_MEM.

Returns 0 on success or -EINVAL on failure

Name

`uart_parse_options` — Parse serial port baud/parity/bits/flow control.

Synopsis

```
void uart_parse_options (char * options, int * baud, int * parity, int  
* bits, int * flow);
```

Arguments

options pointer to option string

baud pointer to an 'int' variable for the baud rate.

parity pointer to an 'int' variable for the parity.

bits pointer to an 'int' variable for the number of data bits.

flow pointer to an 'int' variable for the flow control character.

Description

`uart_parse_options` decodes a string containing the serial console options. The format of the string is `<baud><parity><bits><flow>`,

eg

115200n8r

Name

`uart_set_options` — setup the serial console parameters

Synopsis

```
int uart_set_options (struct uart_port * port, struct console * co, int
baud, int parity, int bits, int flow);
```

Arguments

<i>port</i>	pointer to the serial ports <code>uart_port</code> structure
<i>co</i>	console pointer
<i>baud</i>	baud rate
<i>parity</i>	parity character - 'n' (none), 'o' (odd), 'e' (even)
<i>bits</i>	number of data bits
<i>flow</i>	flow control character - 'r' (rts)

Name

`uart_register_driver` — register a driver with the uart core layer

Synopsis

```
int uart_register_driver (struct uart_driver * drv);
```

Arguments

drv low level driver structure

Description

Register a uart driver with the core driver. We in turn register with the tty layer, and initialise the core driver per-port state.

We have a proc file in `/proc/tty/driver` which is named after the normal driver.

`drv->port` should be NULL, and the per-port structures should be registered using `uart_add_one_port` after this call has succeeded.

Name

`uart_unregister_driver` — remove a driver from the uart core layer

Synopsis

```
void uart_unregister_driver (struct uart_driver * drv);
```

Arguments

drv low level driver structure

Description

Remove all references to a driver from the core driver. The low level driver must have removed all its ports via the `uart_remove_one_port` if it registered them with `uart_add_one_port`. (ie, `drv->port == NULL`)

Name

`uart_add_one_port` — attach a driver-defined port structure

Synopsis

```
int uart_add_one_port (struct uart_driver * drv, struct uart_port *  
uport);
```

Arguments

drv pointer to the uart low level driver structure for this port

uport uart port structure to use for this port.

Description

This allows the driver to register its own `uart_port` structure with the core driver. The main purpose is to allow the low level uart drivers to expand `uart_port`, rather than having yet more levels of structures.

Name

`uart_remove_one_port` — detach a driver defined port structure

Synopsis

```
int uart_remove_one_port (struct uart_driver * drv, struct uart_port  
* uport);
```

Arguments

drv pointer to the uart low level driver structure for this port

uport uart port structure for this port

Description

This unhooks (and hangs up) the specified port structure from the core driver. No further calls will be made to the low-level code for this port.

Name

`uart_handle_dcd_change` — handle a change of carrier detect state

Synopsis

```
void uart_handle_dcd_change (struct uart_port * uport, unsigned int  
status);
```

Arguments

uport `uart_port` structure for the open port

status new carrier detect status, nonzero if active

Description

Caller must hold `uport->lock`

Name

`uart_handle_cts_change` — handle a change of clear-to-send state

Synopsis

```
void uart_handle_cts_change (struct uart_port * uport, unsigned int  
status);
```

Arguments

uport `uart_port` structure for the open port

status new clear to send status, nonzero if active

Description

Caller must hold `uport->lock`

Name

`uart_insert_char` — push a char to the uart layer

Synopsis

```
void uart_insert_char (struct uart_port * port, unsigned int status,  
unsigned int overrun, unsigned int ch, unsigned int flag);
```

Arguments

<i>port</i>	corresponding port
<i>status</i>	state of the serial port RX buffer (LSR for 8250)
<i>overrun</i>	mask of overrun bits in <i>status</i>
<i>ch</i>	character to push
<i>flag</i>	flag for the character (see TTY_NORMAL and friends)

Description

User is responsible to call `tty_flip_buffer_push` when they are done with insertion.

Name

serial8250_get_port — retrieve struct uart_8250_port

Synopsis

```
struct uart_8250_port * serial8250_get_port (int line);
```

Arguments

line serial line number

Description

This function retrieves struct uart_8250_port for the specific line. This struct *must not* be used to perform a 8250 or serial core operation which is not accessible otherwise. Its only purpose is to make the struct accessible to the runtime-pm callbacks for context suspend/restore. The lock assumption made here is none because runtime-pm suspend/resume callbacks should not be invoked if there is any operation performed on the port.

Name

`serial8250_suspend_port` — suspend one serial port

Synopsis

```
void serial8250_suspend_port (int line);
```

Arguments

line serial line number

Description

Suspend one serial port.

Name

`serial8250_resume_port` — resume one serial port

Synopsis

```
void serial8250_resume_port (int line);
```

Arguments

line serial line number

Description

Resume one serial port.

Name

`serial8250_register_8250_port` — register a serial port

Synopsis

```
int serial8250_register_8250_port (struct uart_8250_port * up);
```

Arguments

up serial port template

Description

Configure the serial port specified by the request. If the port exists and is in use, it is hung up and unregistered first.

The port is then probed and if necessary the IRQ is autodetected. If this fails an error is returned.

On success the port is ready to use and the line number is returned.

Name

`serial8250_unregister_port` — remove a 16x50 serial port at runtime

Synopsis

```
void serial8250_unregister_port (int line);
```

Arguments

line serial line number

Description

Remove one serial port. This may not be called from interrupt context. We hand the port back to the our control.

Chapter 7. Frame Buffer Library

The frame buffer drivers depend heavily on four data structures. These structures are declared in `include/linux/fb.h`. They are `fb_info`, `fb_var_screeninfo`, `fb_fix_screeninfo` and `fb_monospecs`. The last three can be made available to and from userland.

`fb_info` defines the current state of a particular video card. Inside `fb_info`, there exists a `fb_ops` structure which is a collection of needed functions to make `fbdev` and `fbcon` work. `fb_info` is only visible to the kernel.

`fb_var_screeninfo` is used to describe the features of a video card that are user defined. With `fb_var_screeninfo`, things such as depth and the resolution may be defined.

The next structure is `fb_fix_screeninfo`. This defines the properties of a card that are created when a mode is set and can't be changed otherwise. A good example of this is the start of the frame buffer memory. This "locks" the address of the frame buffer memory, so that it cannot be changed or moved.

The last structure is `fb_monospecs`. In the old API, there was little importance for `fb_monospecs`. This allowed for forbidden things such as setting a mode of 800x600 on a fix frequency monitor. With the new API, `fb_monospecs` prevents such things, and if used correctly, can prevent a monitor from being cooked. `fb_monospecs` will not be useful until kernels 2.5.x.

Frame Buffer Memory

Name

`register_framebuffer` — registers a frame buffer device

Synopsis

```
int register_framebuffer (struct fb_info * fb_info);
```

Arguments

fb_info frame buffer info structure

Description

Registers a frame buffer device *fb_info*.

Returns negative `errno` on error, or zero for success.

Name

`unregister_framebuffer` — releases a frame buffer device

Synopsis

```
int unregister_framebuffer (struct fb_info * fb_info);
```

Arguments

fb_info frame buffer info structure

Description

Unregisters a frame buffer device *fb_info*.

Returns negative `errno` on error, or zero for success.

This function will also notify the framebuffer console to release the driver.

This is meant to be called within a driver's `module_exit` function. If this is called outside `module_exit`, ensure that the driver implements `fb_open` and `fb_release` to check that no processes are using the device.

Name

`fb_set_suspend` — low level driver signals suspend

Synopsis

```
void fb_set_suspend (struct fb_info * info, int state);
```

Arguments

info framebuffer affected

state 0 = resuming, !=0 = suspending

Description

This is meant to be used by low level drivers to signal suspend/resume to the core & clients. It must be called with the console semaphore held

Frame Buffer Colormap

Name

`fb_dealloc_cmap` — deallocate a colormap

Synopsis

```
void fb_dealloc_cmap (struct fb_cmap * cmap);
```

Arguments

cmap frame buffer colormap structure

Description

Deallocates a colormap that was previously allocated with `fb_alloc_cmap`.

Name

`fb_copy_cmap` — copy a colormap

Synopsis

```
int fb_copy_cmap (const struct fb_cmap * from, struct fb_cmap * to);
```

Arguments

from frame buffer colormap structure

to frame buffer colormap structure

Description

Copy contents of colormap from *from* to *to*.

Name

`fb_set_cmap` — set the colormap

Synopsis

```
int fb_set_cmap (struct fb_cmap * cmap, struct fb_info * info);
```

Arguments

cmap frame buffer colormap structure

info frame buffer info structure

Description

Sets the colormap *cmap* for a screen of device *info*.

Returns negative `errno` on error, or zero on success.

Name

`fb_default_cmap` — get default colormap

Synopsis

```
const struct fb_cmap * fb_default_cmap (int len);
```

Arguments

len size of palette for a depth

Description

Gets the default colormap for a specific screen depth. *len* is the size of the palette for a particular screen depth.

Returns pointer to a frame buffer colormap structure.

Name

`fb_invert_cmaps` — invert all defaults colormaps

Synopsis

```
void fb_invert_cmaps ( void );
```

Arguments

void no arguments

Description

Invert all default colormaps.

Frame Buffer Video Mode Database

Name

`fb_try_mode` — test a video mode

Synopsis

```
int fb_try_mode (struct fb_var_screeninfo * var, struct fb_info * info,  
const struct fb_videomode * mode, unsigned int bpp);
```

Arguments

var frame buffer user defined part of display

info frame buffer info structure

mode frame buffer video mode structure

bpp color depth in bits per pixel

Description

Tries a video mode to test it's validity for device *info*.

Returns 1 on success.

Name

`fb_delete_videomode` — removed videomode entry from modelist

Synopsis

```
void fb_delete_videomode (const struct fb_videomode * mode, struct  
list_head * head);
```

Arguments

mode videomode to remove

head struct list_head of modelist

NOTES

Will remove all matching mode entries

Name

`fb_find_mode` — finds a valid video mode

Synopsis

```
int fb_find_mode (struct fb_var_screeninfo * var, struct fb_info * info,
const char * mode_option, const struct fb_videomode * db, unsigned
int dbsize, const struct fb_videomode * default_mode, unsigned int
default_bpp);
```

Arguments

<i>var</i>	frame buffer user defined part of display
<i>info</i>	frame buffer info structure
<i>mode_option</i>	string video mode to find
<i>db</i>	video mode database
<i>dbsize</i>	size of <i>db</i>
<i>default_mode</i>	default video mode to fall back to
<i>default_bpp</i>	default color depth in bits per pixel

Description

Finds a suitable video mode, starting with the specified mode in *mode_option* with fallback to *default_mode*. If *default_mode* fails, all modes in the video mode database will be tried.

Valid mode specifiers for *mode_option*:

<xres>x<yres>[M][R][<bpp>][@<refresh>][i][m] or <name>[<bpp>][@<refresh>]

with <xres>, <yres>, <bpp> and <refresh> decimal numbers and <name> a string.

If 'M' is present after yres (and before refresh/bpp if present), the function will compute the timings using VESA(tm) Coordinated Video Timings (CVT). If 'R' is present after 'M', will compute with reduced blanking (for flatpanels). If 'i' is present, compute interlaced mode. If 'm' is present, add margins equal to 1.8% of xres rounded down to 8 pixels, and 1.8% of yres. The char 'i' and 'm' must be after 'M' and 'R'. Example:

1024x768MR-860m - Reduced blank with margins at 60Hz.

NOTE

The passed struct *var* is `_not_` cleared! This allows you to supply values for e.g. the grayscale and `accel_flags` fields.

Returns zero for failure, 1 if using specified *mode_option*, 2 if using specified *mode_option* with an ignored refresh rate, 3 if default mode is used, 4 if fall back to any valid mode.

Name

`fb_var_to_videomode` — convert `fb_var_screeninfo` to `fb_videomode`

Synopsis

```
void fb_var_to_videomode (struct fb_videomode * mode, const struct  
fb_var_screeninfo * var);
```

Arguments

mode pointer to struct `fb_videomode`

var pointer to struct `fb_var_screeninfo`

Name

`fb_videomode_to_var` — convert `fb_videomode` to `fb_var_screeninfo`

Synopsis

```
void fb_videomode_to_var (struct fb_var_screeninfo * var, const struct  
fb_videomode * mode);
```

Arguments

var pointer to struct `fb_var_screeninfo`

mode pointer to struct `fb_videomode`

Name

`fb_mode_is_equal` — compare 2 videomodes

Synopsis

```
int fb_mode_is_equal (const struct fb_videomode * mode1, const struct
fb_videomode * mode2);
```

Arguments

mode1 first videomode

mode2 second videomode

RETURNS

1 if equal, 0 if not

Name

`fb_find_best_mode` — find best matching videomode

Synopsis

```
const struct fb_videomode * fb_find_best_mode (const struct
fb_var_screeninfo * var, struct list_head * head);
```

Arguments

var pointer to struct `fb_var_screeninfo`

head pointer to struct `list_head` of modelist

RETURNS

struct `fb_videomode`, NULL if none found

IMPORTANT

This function assumes that all modelist entries in `info->modelist` are valid.

NOTES

Finds best matching videomode which has an equal or greater dimension than `var->xres` and `var->yres`. If more than 1 videomode is found, will return the videomode with the highest refresh rate

Name

`fb_find_nearest_mode` — find closest videomode

Synopsis

```
const struct fb_videomode * fb_find_nearest_mode (const struct
fb_videomode * mode, struct list_head * head);
```

Arguments

mode pointer to struct fb_videomode

head pointer to modelist

Description

Finds best matching videomode, smaller or greater in dimension. If more than 1 videomode is found, will return the videomode with the closest refresh rate.

Name

`fb_match_mode` — find a videomode which exactly matches the timings in `var`

Synopsis

```
const struct fb_videomode * fb_match_mode (const struct
fb_var_screeninfo * var, struct list_head * head);
```

Arguments

var pointer to struct `fb_var_screeninfo`

head pointer to struct `list_head` of modelist

RETURNS

struct `fb_videomode`, NULL if none found

Name

`fb_add_videomode` — adds videomode entry to modelist

Synopsis

```
int fb_add_videomode (const struct fb_videomode * mode, struct list_head  
* head);
```

Arguments

mode videomode to add

head struct list_head of modelist

NOTES

Will only add unmatched mode entries

Name

`fb_destroy_modelist` — destroy modelist

Synopsis

```
void fb_destroy_modelist (struct list_head * head);
```

Arguments

head struct list_head of modelist

Name

`fb_videomode_to_modelist` — convert mode array to mode list

Synopsis

```
void fb_videomode_to_modelist (const struct fb_videomode * modedb, int
    num, struct list_head * head);
```

Arguments

modedb array of struct fb_videomode

num number of entries in array

head struct list_head of modelist

Frame Buffer Macintosh Video Mode Database

Name

`mac_vmode_to_var` — converts vmode/cmode pair to var structure

Synopsis

```
int mac_vmode_to_var (int vmode, int cmode, struct fb_var_screeninfo  
* var);
```

Arguments

vmode MacOS video mode

cmode MacOS color mode

var frame buffer video mode structure

Description

Converts a MacOS vmode/cmode pair to a frame buffer video mode structure.

Returns negative errno on error, or zero for success.

Name

`mac_map_monitor_sense` — Convert monitor sense to vmode

Synopsis

```
int mac_map_monitor_sense (int sense);
```

Arguments

sense Macintosh monitor sense number

Description

Converts a Macintosh monitor sense number to a MacOS vmode number.

Returns MacOS vmode video mode number.

Name

`mac_find_mode` — find a video mode

Synopsis

```
int mac_find_mode (struct fb_var_screeninfo * var, struct fb_info *
info, const char * mode_option, unsigned int default_bpp);
```

Arguments

<i>var</i>	frame buffer user defined part of display
<i>info</i>	frame buffer info structure
<i>mode_option</i>	video mode name (see <code>mac_modedb[]</code>)
<i>default_bpp</i>	default color depth in bits per pixel

Description

Finds a suitable video mode. Tries to set mode specified by *mode_option*. If the name of the wanted mode begins with 'mac', the Mac video mode database will be used, otherwise it will fall back to the standard video mode database.

Note

Function marked as `__init` and can only be used during system boot.

Returns error code from `fb_find_mode` (see `fb_find_mode` function).

Frame Buffer Fonts

Refer to the file `lib/fonts/fonts.c` for more information.

Chapter 8. Input Subsystem

Input core

Name

struct input_value — input value representation

Synopsis

```
struct input_value {  
    __u16 type;  
    __u16 code;  
    __s32 value;  
};
```

Members

type	type of value (EV_KEY, EV_ABS, etc)
code	the value code
value	the value

Name

struct input_dev — represents an input device

Synopsis

```
struct input_dev {
    const char * name;
    const char * phys;
    const char * uniq;
    struct input_id id;
    unsigned long propbit[BITS_TO_LONGS(INPUT_PROP_CNT)];
    unsigned long evbit[BITS_TO_LONGS(EV_CNT)];
    unsigned long keybit[BITS_TO_LONGS(KEY_CNT)];
    unsigned long relbit[BITS_TO_LONGS(REL_CNT)];
    unsigned long absbit[BITS_TO_LONGS(ABS_CNT)];
    unsigned long mscbit[BITS_TO_LONGS(MSC_CNT)];
    unsigned long ledbit[BITS_TO_LONGS(LED_CNT)];
    unsigned long sndbit[BITS_TO_LONGS(SND_CNT)];
    unsigned long ffbit[BITS_TO_LONGS(FF_CNT)];
    unsigned long swbit[BITS_TO_LONGS(SW_CNT)];
    unsigned int hint_events_per_packet;
    unsigned int keycodemax;
    unsigned int keycodesize;
    void * keycode;
    int (* setkeycode) (struct input_dev *dev, const struct input_keymap_entry *ke, unsigned int code);
    int (* getkeycode) (struct input_dev *dev, struct input_keymap_entry *ke);
    struct ff_device * ff;
    unsigned int repeat_key;
    struct timer_list timer;
    int rep[REP_CNT];
    struct input_mt * mt;
    struct input_absinfo * absinfo;
    unsigned long key[BITS_TO_LONGS(KEY_CNT)];
    unsigned long led[BITS_TO_LONGS(LED_CNT)];
    unsigned long snd[BITS_TO_LONGS(SND_CNT)];
    unsigned long sw[BITS_TO_LONGS(SW_CNT)];
    int (* open) (struct input_dev *dev);
    void (* close) (struct input_dev *dev);
    int (* flush) (struct input_dev *dev, struct file *file);
    int (* event) (struct input_dev *dev, unsigned int type, unsigned int code, int value);
    struct input_handle __rcu * grab;
    spinlock_t event_lock;
    struct mutex mutex;
    unsigned int users;
    bool going_away;
    struct device dev;
    struct list_head h_list;
    struct list_head node;
    unsigned int num_vals;
    unsigned int max_vals;
    struct input_value * vals;
    bool devres_managed;
```

```
} ;
```

Members

name	name of the device
phys	physical path to the device in the system hierarchy
uniq	unique identification code for the device (if device has it)
id	id of the device (struct input_id)
propbit[BITS_TO_LONGS(INPUT_PROP_CNT)]	bitmap of device properties and quirks
evbit[BITS_TO_LONGS(EV_CNT)]	bitmap of types of events supported by the device (EV_KEY, EV_REL, etc.)
keybit[BITS_TO_LONGS(KEY_CNT)]	bitmap of keys/buttons this device has
relbit[BITS_TO_LONGS(REL_CNT)]	bitmap of relative axes for the device
absbit[BITS_TO_LONGS(ABS_CNT)]	bitmap of absolute axes for the device
mscbit[BITS_TO_LONGS(MSC_CNT)]	map of miscellaneous events supported by the device
ledbit[BITS_TO_LONGS(LED_CNT)]	bitmap of leds present on the device
sndbit[BITS_TO_LONGS(SND_CNT)]	bitmap of sound effects supported by the device
ffbit[BITS_TO_LONGS(FF_CNT)]	bitmap of force feedback effects supported by the device
swbit[BITS_TO_LONGS(SW_CNT)]	bitmap of switches present on the device
hint_events_per_packet	average number of events generated by the device in a packet (between EV_SYN/SYN_REPORT events). Used by event handlers to estimate size of the buffer needed to hold events.
keycodemax	size of keycode table
keycodesize	size of elements in keycode table
keycode	map of scancodes to keycodes for this device
setkeycode	optional method to alter current keymap, used to implement sparse keymaps. If not supplied default mechanism will be used. The method is being called while holding event_lock and thus must not sleep
getkeycode	optional legacy method to retrieve current keymap.
ff	force feedback structure associated with the device if device supports force feedback effects
repeat_key	stores key code of the last key pressed; used to implement software autorepeat
timer	timer for software autorepeat

<code>rep[REP_CNT]</code>	current values for autorepeat parameters (delay, rate)
<code>mt</code>	pointer to multitouch state
<code>absinfo</code>	array of struct <code>input_absinfo</code> elements holding information about absolute axes (current value, min, max, flat, fuzz, resolution)
<code>key[BITS_TO_LONGS(KEY_CNT)]</code>	reflects current state of device's keys/buttons
<code>led[BITS_TO_LONGS(LED_CNT)]</code>	reflects current state of device's LEDs
<code>snd[BITS_TO_LONGS(SND_CNT)]</code>	reflects current state of sound effects
<code>sw[BITS_TO_LONGS(SW_CNT)]</code>	reflects current state of device's switches
<code>open</code>	this method is called when the very first user calls <code>input_open_device</code> . The driver must prepare the device to start generating events (start polling thread, request an IRQ, submit URB, etc.)
<code>close</code>	this method is called when the very last user calls <code>input_close_device</code> .
<code>flush</code>	purges the device. Most commonly used to get rid of force feedback effects loaded into the device when disconnecting from it
<code>event</code>	event handler for events sent <code>_to_</code> the device, like <code>EV_LED</code> or <code>EV_SND</code> . The device is expected to carry out the requested action (turn on a LED, play sound, etc.) The call is protected by <code>event_lock</code> and must not sleep
<code>grab</code>	input handle that currently has the device grabbed (via <code>EVIOC-GRAB</code> ioctl). When a handle grabs a device it becomes sole recipient for all input events coming from the device
<code>event_lock</code>	this spinlock is is taken when input core receives and processes a new event for the device (in <code>input_event</code>). Code that accesses and/or modifies parameters of a device (such as keymap or absmin, absmax, absfuzz, etc.) after device has been registered with input core must take this lock.
<code>mutex</code>	serializes calls to <code>open</code> , <code>close</code> and <code>flush</code> methods
<code>users</code>	stores number of users (input handlers) that opened this device. It is used by <code>input_open_device</code> and <code>input_close_device</code> to make sure that <code>dev->open</code> is only called when the first user opens device and <code>dev->close</code> is called when the very last user closes the device
<code>going_away</code>	marks devices that are in a middle of unregistering and causes <code>input_open_device*()</code> fail with <code>-ENODEV</code> .
<code>dev</code>	driver model's view of this device
<code>h_list</code>	list of input handles associated with the device. When accessing the list <code>dev->mutex</code> must be held

node	used to place the device onto input_dev_list
num_vals	number of values queued in the current frame
max_vals	maximum number of values queued in a frame
vals	array of values queued in the current frame
devres_managed	indicates that devices is managed with devres framework and needs not be explicitly unregistered or freed.

Name

struct input_handler — implements one of interfaces for input devices

Synopsis

```
struct input_handler {
    void * private;
    void (* event) (struct input_handle *handle, unsigned int type, unsigned int code);
    void (* events) (struct input_handle *handle, const struct input_value *vals, unsigned int count);
    bool (* filter) (struct input_handle *handle, unsigned int type, unsigned int code);
    bool (* match) (struct input_handler *handler, struct input_dev *dev);
    int (* connect) (struct input_handler *handler, struct input_dev *dev, const struct input_device_id *id);
    void (* disconnect) (struct input_handle *handle);
    void (* start) (struct input_handle *handle);
    bool legacy_minors;
    int minor;
    const char * name;
    const struct input_device_id * id_table;
    struct list_head h_list;
    struct list_head node;
};
```

Members

private	driver-specific data
event	event handler. This method is being called by input core with interrupts disabled and dev->event_lock spinlock held and so it may not sleep
events	event sequence handler. This method is being called by input core with interrupts disabled and dev->event_lock spinlock held and so it may not sleep
filter	similar to <i>event</i> ; separates normal event handlers from “filters”.
match	called after comparing device's id with handler's id_table to perform fine-grained matching between device and handler
connect	called when attaching a handler to an input device
disconnect	disconnects a handler from input device
start	starts handler for given handle. This function is called by input core right after connect method and also when a process that “grabbed” a device releases it
legacy_minors	set to true by drivers using legacy minor ranges
minor	beginning of range of 32 legacy minors for devices this driver can provide
name	name of the handler, to be shown in /proc/bus/input/handlers
id_table	pointer to a table of input_device_ids this driver can handle
h_list	list of input handles associated with the handler
node	for placing the driver onto input_handler_list

Description

Input handlers attach to input devices and create input handles. There are likely several handlers attached to any given input device at the same time. All of them will get their copy of input event generated by the device.

The very same structure is used to implement input filters. Input core allows filters to run first and will not pass event to regular handlers if any of the filters indicate that the event should be filtered (by returning `true` from their `filter` method).

Note that input core serializes calls to `connect` and `disconnect` methods.

Name

struct input_handle — links input device with an input handler

Synopsis

```
struct input_handle {  
    void * private;  
    int open;  
    const char * name;  
    struct input_dev * dev;  
    struct input_handler * handler;  
    struct list_head d_node;  
    struct list_head h_node;  
};
```

Members

private	handler-specific data
open	counter showing whether the handle is 'open', i.e. should deliver events from its device
name	name given to the handle by handler that created it
dev	input device the handle is attached to
handler	handler that works with the device through this handle
d_node	used to put the handle on device's list of attached handles
h_node	used to put the handle on handler's list of handles from which it gets events

Name

`input_set_events_per_packet` — tell handlers about the driver event rate

Synopsis

```
void input_set_events_per_packet (struct input_dev * dev, int n_events);
```

Arguments

dev the input device used by the driver

n_events the average number of events between calls to `input_sync`

Description

If the event rate sent from a device is unusually large, use this function to set the expected event rate. This will allow handlers to set up an appropriate buffer size for the event stream, in order to minimize information loss.

Name

struct ff_device — force-feedback part of an input device

Synopsis

```
struct ff_device {
    int (* upload) (struct input_dev *dev, struct ff_effect *effect, struct ff_effect *effect);
    int (* erase) (struct input_dev *dev, int effect_id);
    int (* playback) (struct input_dev *dev, int effect_id, int value);
    void (* set_gain) (struct input_dev *dev, u16 gain);
    void (* set_autocenter) (struct input_dev *dev, u16 magnitude);
    void (* destroy) (struct ff_device *);
    void * private;
    unsigned long ffbits[BITS_TO_LONGS(FF_CNT)];
    struct mutex mutex;
    int max_effects;
    struct ff_effect * effects;
    struct file * effect_owners[];
};
```

Members

upload	Called to upload an new effect into device
erase	Called to erase an effect from device
playback	Called to request device to start playing specified effect
set_gain	Called to set specified gain
set_autocenter	Called to auto-center device
destroy	called by input core when parent input device is being destroyed
private	driver-specific data, will be freed automatically
ffbits[BITS_TO_LONGS(FF_CNT)]	bitmap of force feedback capabilities truly supported by device (not emulated like ones in input_dev->ffbits)
mutex	mutex for serializing access to the device
max_effects	maximum number of effects supported by device
effects	pointer to an array of effects currently loaded into device
effect_owners[]	array of effect owners; when file handle owning an effect gets closed the effect is automatically erased

Description

Every force-feedback device must implement upload and playback methods; erase is optional. set_gain and set_autocenter need only be implemented if driver sets up FF_GAIN and FF_AUTOCENTER bits.

Note that `playback`, `set_gain` and `set_autocenter` are called with `dev->event_lock` spinlock held and interrupts off and thus may not sleep.

Name

`input_event` — report new input event

Synopsis

```
void input_event (struct input_dev * dev, unsigned int type, unsigned  
int code, int value);
```

Arguments

dev device that generated the event

type type of the event

code event code

value value of the event

Description

This function should be used by drivers implementing various input devices to report input events. See also `input_inject_event`.

NOTE

`input_event` may be safely used right after input device was allocated with `input_allocate_device`, even before it is registered with `input_register_device`, but the event will not reach any of the input handlers. Such early invocation of `input_event` may be used to 'seed' initial state of a switch or initial position of absolute axis, etc.

Name

`input_inject_event` — send input event from input handler

Synopsis

```
void input_inject_event (struct input_handle * handle, unsigned int  
type, unsigned int code, int value);
```

Arguments

handle input handle to send event through

type type of the event

code event code

value value of the event

Description

Similar to `input_event` but will ignore event if device is “grabbed” and handle injecting event is not the one that owns the device.

Name

`input_alloc_absinfo` — allocates array of `input_absinfo` structs

Synopsis

```
void input_alloc_absinfo (struct input_dev * dev);
```

Arguments

dev the input device emitting absolute events

Description

If the `absinfo` struct the caller asked for is already allocated, this functions will not do anything.

Name

`input_grab_device` — grabs device for exclusive use

Synopsis

```
int input_grab_device (struct input_handle * handle);
```

Arguments

handle input handle that wants to own the device

Description

When a device is grabbed by an input handle all events generated by the device are delivered only to this handle. Also events injected by other input handles are ignored while device is grabbed.

Name

`input_release_device` — release previously grabbed device

Synopsis

```
void input_release_device (struct input_handle * handle);
```

Arguments

handle input handle that owns the device

Description

Releases previously grabbed device so that other input handles can start receiving input events. Upon release all handlers attached to the device have their `start` method called so they have a change to synchronize device state with the rest of the system.

Name

`input_open_device` — open input device

Synopsis

```
int input_open_device (struct input_handle * handle);
```

Arguments

handle handle through which device is being accessed

Description

This function should be called by input handlers when they want to start receive events from given input device.

Name

`input_close_device` — close input device

Synopsis

```
void input_close_device (struct input_handle * handle);
```

Arguments

handle handle through which device is being accessed

Description

This function should be called by input handlers when they want to stop receive events from given input device.

Name

`input_scancode_to_scalar` — converts scancode in struct `input_keymap_entry`

Synopsis

```
int input_scancode_to_scalar (const struct input_keymap_entry * ke,
unsigned int * scancode);
```

Arguments

ke keymap entry containing scancode to be converted.

scancode pointer to the location where converted scancode should be stored.

Description

This function is used to convert scancode stored in struct `keymap_entry` into scalar form understood by legacy keymap handling methods. These methods expect scancodes to be represented as 'unsigned int'.

Name

`input_get_keycode` — retrieve keycode currently mapped to a given scancode

Synopsis

```
int input_get_keycode (struct input_dev * dev, struct input_keymap_entry  
* ke);
```

Arguments

dev input device which keymap is being queried

ke keymap entry

Description

This function should be called by anyone interested in retrieving current keymap. Presently evdev handlers use it.

Name

`input_set_keycode` — attribute a keycode to a given scancode

Synopsis

```
int  input_set_keycode (struct  input_dev  *  dev,  const  struct
input_keymap_entry *  ke);
```

Arguments

dev input device which keymap is being updated

ke new keymap entry

Description

This function should be called by anyone needing to update current keymap. Presently keyboard and evdev handlers use it.

Name

`input_reset_device` — reset/restore the state of input device

Synopsis

```
void input_reset_device (struct input_dev * dev);
```

Arguments

dev input device whose state needs to be reset

Description

This function tries to reset the state of an opened input device and bring internal state and state if the hardware in sync with each other. We mark all keys as released, restore LED state, repeat rate, etc.

Name

`input_allocate_device` — allocate memory for new input device

Synopsis

```
struct input_dev * input_allocate_device ( void );
```

Arguments

void no arguments

Description

Returns prepared struct `input_dev` or `NULL`.

NOTE

Use `input_free_device` to free devices that have not been registered; `input_unregister_device` should be used for already registered devices.

Name

`devm_input_allocate_device` — allocate managed input device

Synopsis

```
struct input_dev * devm_input_allocate_device (struct device * dev);
```

Arguments

dev device owning the input device being created

Description

Returns prepared struct `input_dev` or `NULL`.

Managed input devices do not need to be explicitly unregistered or freed as it will be done automatically when owner device unbinds from its driver (or binding fails). Once managed input device is allocated, it is ready to be set up and registered in the same fashion as regular input device. There are no special `devm_input_device_[un]register` variants, regular ones work with both managed and unmanaged devices, should you need them. In most cases however, managed input device need not be explicitly unregistered or freed.

NOTE

the owner device is set up as parent of input device and users should not override it.

Name

`input_free_device` — free memory occupied by `input_dev` structure

Synopsis

```
void input_free_device (struct input_dev * dev);
```

Arguments

dev input device to free

Description

This function should only be used if `input_register_device` was not called yet or if it failed. Once device was registered use `input_unregister_device` and memory will be freed once last reference to the device is dropped.

Device should be allocated by `input_allocate_device`.

NOTE

If there are references to the input device then memory will not be freed until last reference is dropped.

Name

`input_set_capability` — mark device as capable of a certain event

Synopsis

```
void input_set_capability (struct input_dev * dev, unsigned int type,  
unsigned int code);
```

Arguments

dev device that is capable of emitting or accepting event

type type of the event (EV_KEY, EV_REL, etc...)

code event code

Description

In addition to setting up corresponding bit in appropriate capability bitmap the function also adjusts `dev->evbit`.

Name

`input_register_device` — register device with input core

Synopsis

```
int input_register_device (struct input_dev * dev);
```

Arguments

dev device to be registered

Description

This function registers device with input core. The device must be allocated with `input_allocate_device` and all its capabilities set up before registering. If function fails the device must be freed with `input_free_device`. Once device has been successfully registered it can be unregistered with `input_unregister_device`; `input_free_device` should not be called in this case.

Note that this function is also used to register managed input devices (ones allocated with `devm_input_allocate_device`). Such managed input devices need not be explicitly unregistered or freed, their tear down is controlled by the devres infrastructure. It is also worth noting that tear down of managed input devices is internally a 2-step process: registered managed input device is first unregistered, but stays in memory and can still handle `input_event` calls (although events will not be delivered anywhere). The freeing of managed input device will happen later, when devres stack is unwound to the point where device allocation was made.

Name

`input_unregister_device` — unregister previously registered device

Synopsis

```
void input_unregister_device (struct input_dev * dev);
```

Arguments

dev device to be unregistered

Description

This function unregisters an input device. Once device is unregistered the caller should not try to access it as it may get freed at any moment.

Name

`input_register_handler` — register a new input handler

Synopsis

```
int input_register_handler (struct input_handler * handler);
```

Arguments

handler handler to be registered

Description

This function registers a new input handler (interface) for input devices in the system and attaches it to all input devices that are compatible with the handler.

Name

`input_unregister_handler` — unregisters an input handler

Synopsis

```
void input_unregister_handler (struct input_handler * handler);
```

Arguments

handler handler to be unregistered

Description

This function disconnects a handler from its input devices and removes it from lists of known handlers.

Name

`input_handler_for_each_handle` — handle iterator

Synopsis

```
int input_handler_for_each_handle (struct input_handler * handler, void  
* data, int (*fn) (struct input_handle *, void *));
```

Arguments

handler input handler to iterate

data data for the callback

fn function to be called for each handle

Description

Iterate over *bus*'s list of devices, and call *fn* for each, passing it *data* and stop when *fn* returns a non-zero value. The function is using RCU to traverse the list and therefore may be used in atonic contexts. The *fn* callback is invoked from RCU critical section and thus must not sleep.

Name

`input_register_handle` — register a new input handle

Synopsis

```
int input_register_handle (struct input_handle * handle);
```

Arguments

handle handle to register

Description

This function puts a new input handle onto device's and handler's lists so that events can flow through it once it is opened using `input_open_device`.

This function is supposed to be called from handler's `connect` method.

Name

`input_unregister_handle` — unregister an input handle

Synopsis

```
void input_unregister_handle (struct input_handle * handle);
```

Arguments

handle handle to unregister

Description

This function removes input handle from device's and handler's lists.

This function is supposed to be called from handler's `disconnect` method.

Name

`input_get_new_minor` — allocates a new input minor number

Synopsis

```
int input_get_new_minor (int legacy_base, unsigned int legacy_num, bool  
allow_dynamic);
```

Arguments

legacy_base beginning of the legacy range to be searched

legacy_num size of legacy range

allow_dynamic whether we can also take ID from the dynamic range

Description

This function allocates a new device minor for from input major namespace. Caller can request legacy minor by specifying *legacy_base* and *legacy_num* parameters and whether ID can be allocated from dynamic range if there are no free IDs in legacy range.

Name

`input_free_minor` — release previously allocated minor

Synopsis

```
void input_free_minor (unsigned int minor);
```

Arguments

minor minor to be released

Description

This function releases previously allocated input minor so that it can be reused later.

Name

`input_ff_upload` — upload effect into force-feedback device

Synopsis

```
int input_ff_upload (struct input_dev * dev, struct ff_effect * effect,  
struct file * file);
```

Arguments

<i>dev</i>	input device
<i>effect</i>	effect to be uploaded
<i>file</i>	owner of the effect

Name

`input_ff_erase` — erase a force-feedback effect from device

Synopsis

```
int input_ff_erase (struct input_dev * dev, int effect_id, struct file  
* file);
```

Arguments

dev input device to erase effect from

effect_id id of the effect to be erased

file purported owner of the request

Description

This function erases a force-feedback effect from specified device. The effect will only be erased if it was uploaded through the same file handle that is requesting erase.

Name

`input_ff_event` — generic handler for force-feedback events

Synopsis

```
int input_ff_event (struct input_dev * dev, unsigned int type, unsigned  
int code, int value);
```

Arguments

<i>dev</i>	input device to send the effect to
<i>type</i>	event type (anything but EV_FF is ignored)
<i>code</i>	event code
<i>value</i>	event value

Name

`input_ff_create` — create force-feedback device

Synopsis

```
int input_ff_create (struct input_dev * dev, unsigned int max_effects);
```

Arguments

dev input device supporting force-feedback

max_effects maximum number of effects supported by the device

Description

This function allocates all necessary memory for a force feedback portion of an input device and installs all default handlers. *dev->ffbit* should be already set up before calling this function. Once ff device is created you need to setup its upload, erase, playback and other handlers before registering input device

Name

`input_ff_destroy` — frees force feedback portion of input device

Synopsis

```
void input_ff_destroy (struct input_dev * dev);
```

Arguments

dev input device supporting force feedback

Description

This function is only needed in error path as input core will automatically free force feedback structures when device is destroyed.

Name

`input_ff_create_memless` — create memoryless force-feedback device

Synopsis

```
int input_ff_create_memless (struct input_dev * dev, void * data, int
(*play_effect) (struct input_dev *, void *, struct ff_effect *));
```

Arguments

<i>dev</i>	input device supporting force-feedback
<i>data</i>	driver-specific data to be passed into <i>play_effect</i>
<i>play_effect</i>	driver-specific method for playing FF effect

Multitouch Library

Name

struct input_mt_slot — represents the state of an input MT slot

Synopsis

```
struct input_mt_slot {  
    int abs[ABS_MT_LAST - ABS_MT_FIRST + 1];  
    unsigned int frame;  
    unsigned int key;  
};
```

Members

abs[ABS_MT_LAST - ABS_MT_FIRST + 1]	holds current values of ABS_MT axes for this slot
frame	last frame at which input_mt_report_slot_state was called
key	optional driver designation of this slot

Name

struct input_mt — state of tracked contacts

Synopsis

```
struct input_mt {  
    int trkid;  
    int num_slots;  
    int slot;  
    unsigned int flags;  
    unsigned int frame;  
    int * red;  
    struct input_mt_slot slots[];  
};
```

Members

trkid	stores MT tracking ID for the next contact
num_slots	number of MT slots the device uses
slot	MT slot currently being transmitted
flags	input_mt operation flags
frame	increases every time <code>input_mt_sync_frame</code> is called
red	reduced cost matrix for in-kernel tracking
slots[]	array of slots holding current values of tracked contacts

Name

struct input_mt_pos — contact position

Synopsis

```
struct input_mt_pos {  
    s16 x;  
    s16 y;  
};
```

Members

x horizontal coordinate

y vertical coordinate

Name

`input_mt_init_slots` — initialize MT input slots

Synopsis

```
int input_mt_init_slots (struct input_dev * dev, unsigned int num_slots,  
unsigned int flags);
```

Arguments

dev input device supporting MT events and finger tracking

num_slots number of slots used by the device

flags mt tasks to handle in core

Description

This function allocates all necessary memory for MT slot handling in the input device, prepares the ABS_MT_SLOT and ABS_MT_TRACKING_ID events for use and sets up appropriate buffers. Depending on the flags set, it also performs pointer emulation and frame synchronization.

May be called repeatedly. Returns -EINVAL if attempting to reinitialize with a different number of slots.

Name

`input_mt_destroy_slots` — frees the MT slots of the input device

Synopsis

```
void input_mt_destroy_slots (struct input_dev * dev);
```

Arguments

dev input device with allocated MT slots

Description

This function is only needed in error path as the input core will automatically free the MT slots when the device is destroyed.

Name

`input_mt_report_slot_state` — report contact state

Synopsis

```
void input_mt_report_slot_state (struct input_dev * dev, unsigned int  
tool_type, bool active);
```

Arguments

<i>dev</i>	input device with allocated MT slots
<i>tool_type</i>	the tool type to use in this slot
<i>active</i>	true if contact is active, false otherwise

Description

Reports a contact via `ABS_MT_TRACKING_ID`, and optionally `ABS_MT_TOOL_TYPE`. If `active` is true and the slot is currently inactive, or if the tool type is changed, a new tracking id is assigned to the slot. The tool type is only reported if the corresponding `absbit` field is set.

Name

`input_mt_report_finger_count` — report contact count

Synopsis

```
void input_mt_report_finger_count (struct input_dev * dev, int count);
```

Arguments

dev input device with allocated MT slots

count the number of contacts

Description

Reports the contact count via `BTN_TOOL_FINGER`, `BTN_TOOL_DOUBLETAP`, `BTN_TOOL_TRIPLETAP` and `BTN_TOOL_QUADTAP`.

The input core ensures only the KEY events already setup for this device will produce output.

Name

`input_mt_report_pointer_emulation` — common pointer emulation

Synopsis

```
void input_mt_report_pointer_emulation (struct input_dev * dev, bool  
use_count);
```

Arguments

dev input device with allocated MT slots

use_count report number of active contacts as finger count

Description

Performs legacy pointer emulation via `BTN_TOUCH`, `ABS_X`, `ABS_Y` and `ABS_PRESSURE`. Touchpad finger count is emulated if `use_count` is true.

The input core ensures only the `KEY` and `ABS` axes already setup for this device will produce output.

Name

`input_mt_drop_unused` — Inactivate slots not seen in this frame

Synopsis

```
void input_mt_drop_unused (struct input_dev * dev);
```

Arguments

dev input device with allocated MT slots

Description

Lift all slots not seen since the last call to this function.

Name

`input_mt_sync_frame` — synchronize mt frame

Synopsis

```
void input_mt_sync_frame (struct input_dev * dev);
```

Arguments

dev input device with allocated MT slots

Description

Close the frame and prepare the internal state for a new one. Depending on the flags, marks unused slots as inactive and performs pointer emulation.

Name

`input_mt_assign_slots` — perform a best-match assignment

Synopsis

```
int input_mt_assign_slots (struct input_dev * dev, int * slots, const
struct input_mt_pos * pos, int num_pos, int dmax);
```

Arguments

<i>dev</i>	input device with allocated MT slots
<i>slots</i>	the slot assignment to be filled
<i>pos</i>	the position array to match
<i>num_pos</i>	number of positions
<i>dmax</i>	maximum ABS_MT_POSITION displacement (zero for infinite)

Description

Performs a best match against the current contacts and returns the slot assignment list. New contacts are assigned to unused slots.

The assignments are balanced so that all coordinate displacements are below the euclidian distance `dmax`. If no such assignment can be found, some contacts are assigned to unused slots.

Returns zero on success, or negative error in case of failure.

Name

`input_mt_get_slot_by_key` — return slot matching key

Synopsis

```
int input_mt_get_slot_by_key (struct input_dev * dev, int key);
```

Arguments

dev input device with allocated MT slots

key the key of the sought slot

Description

Returns the slot of the given key, if it exists, otherwise set the key on the first unused slot and return.

If no available slot can be found, -1 is returned. Note that for this function to work properly, `input_mt_sync_frame` has to be called at each frame.

Polled input devices

Name

struct input_polled_dev — simple polled input device

Synopsis

```
struct input_polled_dev {
    void * private;
    void (* open) (struct input_polled_dev *dev);
    void (* close) (struct input_polled_dev *dev);
    void (* poll) (struct input_polled_dev *dev);
    unsigned int poll_interval;
    unsigned int poll_interval_max;
    unsigned int poll_interval_min;
    struct input_dev * input;
};
```

Members

private	private driver data.
open	driver-supplied method that prepares device for polling (enabled the device and maybe flushes device state).
close	driver-supplied method that is called when device is no longer being polled. Used to put device into low power mode.
poll	driver-supplied method that polls the device and posts input events (mandatory).
poll_interval	specifies how often the <code>poll</code> method should be called. Defaults to 500 msec unless overridden when registering the device.
poll_interval_max	specifies upper bound for the poll interval. Defaults to the initial value of <i>poll_interval</i> .
poll_interval_min	specifies lower bound for the poll interval. Defaults to 0.
input	input device structure associated with the polled device. Must be properly initialized by the driver (id, name, phys, bits).

Description

Polled input device provides a skeleton for supporting simple input devices that do not raise interrupts but have to be periodically scanned or polled to detect changes in their state.

Name

input_allocate_polled_device — allocate memory for polled device

Synopsis

```
struct input_polled_dev * input_allocate_polled_device ( void );
```

Arguments

void no arguments

Description

The function allocates memory for a polled device and also for an input device associated with this polled device.

Name

`devm_input_allocate_polled_device` — allocate managed polled device

Synopsis

```
struct input_polled_dev * devm_input_allocate_polled_device (struct de-  
vice * dev);
```

Arguments

dev device owning the polled device being created

Description

Returns prepared struct `input_polled_dev` or `NULL`.

Managed polled input devices do not need to be explicitly unregistered or freed as it will be done automatically when owner device unbinds from * its driver (or binding fails). Once such managed polled device is allocated, it is ready to be set up and registered in the same fashion as regular polled input devices (using `input_register_polled_device` function).

If you want to manually unregister and free such managed polled devices, it can be still done by calling `input_unregister_polled_device` and `input_free_polled_device`, although it is rarely needed.

NOTE

the owner device is set up as parent of input device and users should not override it.

Name

`input_free_polled_device` — free memory allocated for polled device

Synopsis

```
void input_free_polled_device (struct input_polled_dev * dev);
```

Arguments

dev device to free

Description

The function frees memory allocated for polling device and drops reference to the associated input device.

Name

`input_register_polled_device` — register polled device

Synopsis

```
int input_register_polled_device (struct input_polled_dev * dev);
```

Arguments

dev device to register

Description

The function registers previously initialized polled input device with input layer. The device should be allocated with call to `input_allocate_polled_device`. Callers should also set up `poll` method and set up capabilities (id, name, phys, bits) of the corresponding `input_dev` structure.

Name

`input_unregister_polled_device` — unregister polled device

Synopsis

```
void input_unregister_polled_device (struct input_polled_dev * dev);
```

Arguments

dev device to unregister

Description

The function unregisters previously registered polled input device from input layer. Polling is stopped and device is ready to be freed with call to `input_free_polled_device`.

Matrix keyboards/keypads

Name

struct matrix_keymap_data — keymap for matrix keyboards

Synopsis

```
struct matrix_keymap_data {  
    const uint32_t * keymap;  
    unsigned int keymap_size;  
};
```

Members

keymap	pointer to array of uint32 values encoded with KEY macro representing keymap
keymap_size	number of entries (initialized) in this keymap

Description

This structure is supposed to be used by platform code to supply keymaps to drivers that implement matrix-like keypads/keyboards.

Name

struct matrix_keypad_platform_data — platform-dependent keypad data

Synopsis

```
struct matrix_keypad_platform_data {
    const struct matrix_keymap_data * keymap_data;
    const unsigned int * row_gpios;
    const unsigned int * col_gpios;
    unsigned int num_row_gpios;
    unsigned int num_col_gpios;
    unsigned int col_scan_delay_us;
    unsigned int debounce_ms;
    unsigned int clustered_irq;
    unsigned int clustered_irq_flags;
    bool active_low;
    bool wakeup;
    bool no_autorepeat;
};
```

Members

keymap_data	pointer to matrix_keymap_data
row_gpios	pointer to array of gpio numbers representing rows
col_gpios	pointer to array of gpio numbers representing columns
num_row_gpios	actual number of row gpios used by device
num_col_gpios	actual number of col gpios used by device
col_scan_delay_us	delay, measured in microseconds, that is needed before we can keypad after activating column gpio
debounce_ms	debounce interval in milliseconds
clustered_irq	may be specified if interrupts of all row/column GPIOs are bundled to one single irq
clustered_irq_flags	flags that are needed for the clustered irq
active_low	gpio polarity
wakeup	controls whether the device should be set up as wakeup source
no_autorepeat	disable key autorepeat

Description

This structure represents platform-specific data that use used by matrix_keypad driver to perform proper initialization.

Name

`matrix_keypad_parse_of_params` — Read parameters from matrix-keypad node

Synopsis

```
int matrix_keypad_parse_of_params (struct device * dev, unsigned int *  
rows, unsigned int * cols);
```

Arguments

dev Device containing of_node

rows Returns number of matrix rows

cols Returns number of matrix columns *return* 0 if OK, <0 on error

Sparse keymap support

Name

struct key_entry — keymap entry for use in sparse keymap

Synopsis

```
struct key_entry {
    int type;
    u32 code;
    union {unnamed_union};
};
```

Members

type	Type of the key entry (KE_KEY, KE_SW, KE_VSW, KE_END); drivers are allowed to extend the list with their own private definitions.
code	Device-specific data identifying the button/switch
{unnamed_union}	anonymous

Description

This structure defines an entry in a sparse keymap used by some input devices for which traditional table-based approach is not suitable.

Name

`sparse_keymap_entry_from_scancode` — perform sparse keymap lookup

Synopsis

```
struct key_entry * sparse_keymap_entry_from_scancode (struct input_dev  
* dev, unsigned int code);
```

Arguments

dev Input device using sparse keymap

code Scan code

Description

This function is used to perform struct `key_entry` lookup in an input device using sparse keymap.

Name

`sparse_keymap_entry_from_keycode` — perform sparse keymap lookup

Synopsis

```
struct key_entry * sparse_keymap_entry_from_keycode (struct input_dev  
* dev, unsigned int keycode);
```

Arguments

dev Input device using sparse keymap

keycode Key code

Description

This function is used to perform struct `key_entry` lookup in an input device using sparse keymap.

Name

`sparse_keymap_setup` — set up sparse keymap for an input device

Synopsis

```
int sparse_keymap_setup (struct input_dev * dev, const struct key_entry  
* keymap, int (*setup) (struct input_dev *, struct key_entry *));
```

Arguments

dev Input device

keymap Keymap in form of array of `key_entry` structures ending with `KE_END` type entry

setup Function that can be used to adjust keymap entries depending on device's deeds, may be `NULL`

Description

The function calculates size and allocates copy of the original keymap after which sets up input device event bits appropriately. Before destroying input device allocated keymap should be freed with a call to `sparse_keymap_free`.

Name

`sparse_keymap_free` — free memory allocated for sparse keymap

Synopsis

```
void sparse_keymap_free (struct input_dev * dev);
```

Arguments

dev Input device using sparse keymap

Description

This function is used to free memory allocated by sparse keymap in an input device that was set up by `sparse_keymap_setup`.

NOTE

It is safe to call this function while input device is still registered (however the drivers should care not to try to use freed keymap and thus have to shut off interrupts/polling before freeing the keymap).

Name

`sparse_keymap_report_entry` — report event corresponding to given key entry

Synopsis

```
void sparse_keymap_report_entry (struct input_dev * dev, const struct  
key_entry * ke, unsigned int value, bool autorelease);
```

Arguments

<i>dev</i>	Input device for which event should be reported
<i>ke</i>	key entry describing event
<i>value</i>	Value that should be reported (ignored by KE_SW entries)
<i>autorelease</i>	Signals whether release event should be emitted for KE_KEY entries right after reporting press event, ignored by all other entries

Description

This function is used to report input event described by given struct `key_entry`.

Name

`sparse_keymap_report_event` — report event corresponding to given scancode

Synopsis

```
bool sparse_keymap_report_event (struct input_dev * dev, unsigned int
code, unsigned int value, bool autorelease);
```

Arguments

<i>dev</i>	Input device using sparse keymap
<i>code</i>	Scan code
<i>value</i>	Value that should be reported (ignored by KE_SW entries)
<i>autorelease</i>	Signals whether release event should be emitted for KE_KEY entries right after reporting press event, ignored by all other entries

Description

This function is used to perform lookup in an input device using sparse keymap and report corresponding event. Returns `true` if lookup was successful and `false` otherwise.

Chapter 9. Serial Peripheral Interface (SPI)

SPI is the "Serial Peripheral Interface", widely used with embedded systems because it is a simple and efficient interface: basically a multiplexed shift register. Its three signal wires hold a clock (SCK, often in the range of 1-20 MHz), a "Master Out, Slave In" (MOSI) data line, and a "Master In, Slave Out" (MISO) data line. SPI is a full duplex protocol; for each bit shifted out the MOSI line (one per clock) another is shifted in on the MISO line. Those bits are assembled into words of various sizes on the way to and from system memory. An additional chipselect line is usually active-low (nCS); four signals are normally used for each peripheral, plus sometimes an interrupt.

The SPI bus facilities listed here provide a generalized interface to declare SPI busses and devices, manage them according to the standard Linux driver model, and perform input/output operations. At this time, only "master" side interfaces are supported, where Linux talks to SPI peripherals and does not implement such a peripheral itself. (Interfaces to support implementing SPI slaves would necessarily look different.)

The programming interface is structured around two kinds of driver, and two kinds of device. A "Controller Driver" abstracts the controller hardware, which may be as simple as a set of GPIO pins or as complex as a pair of FIFOs connected to dual DMA engines on the other side of the SPI shift register (maximizing throughput). Such drivers bridge between whatever bus they sit on (often the platform bus) and SPI, and expose the SPI side of their device as a struct `spi_master`. SPI devices are children of that master, represented as a struct `spi_device` and manufactured from struct `spi_board_info` descriptors which are usually provided by board-specific initialization code. A struct `spi_driver` is called a "Protocol Driver", and is bound to a `spi_device` using normal driver model calls.

The I/O model is a set of queued messages. Protocol drivers submit one or more struct `spi_message` objects, which are processed and completed asynchronously. (There are synchronous wrappers, however.) Messages are built from one or more struct `spi_transfer` objects, each of which wraps a full duplex SPI transfer. A variety of protocol tweaking options are needed, because different chips adopt very different policies for how they use the bits transferred with SPI.

Name

struct spi_device — Master side proxy for an SPI slave device

Synopsis

```
struct spi_device {
    struct device dev;
    struct spi_master * master;
    u32 max_speed_hz;
    u8 chip_select;
    u8 bits_per_word;
    ul6 mode;
#define SPI_CPHA 0x01
#define SPI_CPOL 0x02
#define SPI_MODE_0 (0|0)
#define SPI_MODE_1 (0|SPI_CPHA)
#define SPI_MODE_2 (SPI_CPOL|0)
#define SPI_MODE_3 (SPI_CPOL|SPI_CPHA)
#define SPI_CS_HIGH 0x04
#define SPI_LSB_FIRST 0x08
#define SPI_3WIRE 0x10
#define SPI_LOOP 0x20
#define SPI_NO_CS 0x40
#define SPI_READY 0x80
#define SPI_TX_DUAL 0x100
#define SPI_TX_QUAD 0x200
#define SPI_RX_DUAL 0x400
#define SPI_RX_QUAD 0x800
    int irq;
    void * controller_state;
    void * controller_data;
    char modalias[SPI_NAME_SIZE];
    int cs_gpio;
};
```

Members

dev	Driver model representation of the device.
master	SPI controller used with the device.
max_speed_hz	Maximum clock rate to be used with this chip (on this board); may be changed by the device's driver. The spi_transfer.speed_hz can override this for each transfer.
chip_select	Chipselect, distinguishing chips handled by <i>master</i> .
bits_per_word	Data transfers involve one or more words; word sizes like eight or 12 bits are common. In-memory wordsizes are powers of two bytes (e.g. 20 bit samples use 32 bits). This may be changed by the device's driver, or left at the default (0) indicating protocol words are eight bit bytes. The spi_transfer.bits_per_word can override this for each transfer.

mode	The spi mode defines how data is clocked out and in. This may be changed by the device's driver. The “active low” default for chipselect mode can be overridden (by specifying <code>SPI_CS_HIGH</code>) as can the “MSB first” default for each word in a transfer (by specifying <code>SPI_LSB_FIRST</code>).
irq	Negative, or the number passed to <code>request_irq</code> to receive interrupts from this device.
controller_state	Controller's runtime state
controller_data	Board-specific definitions for controller, such as FIFO initialization parameters; from <code>board_info.controller_data</code>
modalias[SPI_NAME_SIZE]	Name of the driver to use with this device, or an alias for that name. This appears in the sysfs “modalias” attribute for driver coldplugging, and in uevents used for hotplugging
cs_gpio	gpio number of the chipselect line (optional, <code>-ENOENT</code> when not using a GPIO line)

Description

A *spi_device* is used to interchange data between an SPI slave (usually a discrete chip) and CPU memory.

In *dev*, the `platform_data` is used to hold information about this device that's meaningful to the device's protocol driver, but not to its controller. One example might be an identifier for a chip variant with slightly different functionality; another might be information about how this particular board wires the chip's pins.

Name

struct spi_driver — Host side “protocol” driver

Synopsis

```
struct spi_driver {
    const struct spi_device_id * id_table;
    int (* probe) (struct spi_device *spi);
    int (* remove) (struct spi_device *spi);
    void (* shutdown) (struct spi_device *spi);
    struct device_driver driver;
};
```

Members

id_table	List of SPI devices supported by this driver
probe	Binds this driver to the spi device. Drivers can verify that the device is actually present, and may need to configure characteristics (such as bits_per_word) which weren't needed for the initial configuration done during system setup.
remove	Unbinds this driver from the spi device
shutdown	Standard shutdown callback used during system state transitions such as powerdown/halt and kexec
driver	SPI device drivers should initialize the name and owner field of this structure.

Description

This represents the kind of device driver that uses SPI messages to interact with the hardware at the other end of a SPI link. It's called a “protocol” driver because it works through messages rather than talking directly to SPI hardware (which is what the underlying SPI controller driver does to pass those messages). These protocols are defined in the specification for the device(s) supported by the driver.

As a rule, those device protocols represent the lowest level interface supported by a driver, and it will support upper level interfaces too. Examples of such upper levels include frameworks like MTD, networking, MMC, RTC, filesystem character device nodes, and hardware monitoring.

Name

`spi_unregister_driver` — reverse effect of `spi_register_driver`

Synopsis

```
void spi_unregister_driver (struct spi_driver * sdrv);
```

Arguments

sdrv the driver to unregister

Context

can sleep

Name

`module_spi_driver` — Helper macro for registering a SPI driver

Synopsis

```
module_spi_driver ( __spi_driver );
```

Arguments

`__spi_driver` spi_driver struct

Description

Helper macro for SPI drivers which do not do anything special in module init/exit. This eliminates a lot of boilerplate. Each module may only use this macro once, and calling it replaces `module_init` and `module_exit`

Name

struct spi_master — interface to SPI master controller

Synopsis

```
struct spi_master {
    struct device dev;
    struct list_head list;
    s16 bus_num;
    u16 num_chipselect;
    u16 dma_alignment;
    u16 mode_bits;
    u32 bits_per_word_mask;
#define SPI_BPW_MASK(bits) BIT((bits) - 1)
#define SPI_BIT_MASK(bits) (((bits) == 32) ? ~0U : (BIT(bits) - 1))
#define SPI_BPW_RANGE_MASK(min# max) (SPI_BIT_MASK(max) - SPI_BIT_MASK(min - 1))
    u32 min_speed_hz;
    u32 max_speed_hz;
    u16 flags;
#define SPI_MASTER_HALF_DUPLEX BIT(0)
#define SPI_MASTER_NO_RX BIT(1)
#define SPI_MASTER_NO_TX BIT(2)
#define SPI_MASTER_MUST_RX BIT(3)
#define SPI_MASTER_MUST_TX BIT(4)
    spinlock_t bus_lock_spinlock;
    struct mutex bus_lock_mutex;
    bool bus_lock_flag;
    int (* setup) (struct spi_device *spi);
    int (* transfer) (struct spi_device *spi, struct spi_message *mesg);
    void (* cleanup) (struct spi_device *spi);
    bool (* can_dma) (struct spi_master *master, struct spi_device *spi, struct spi_tr
    bool queued;
    struct kthread_worker kworker;
    struct task_struct * kworker_task;
    struct kthread_work pump_messages;
    spinlock_t queue_lock;
    struct list_head queue;
    struct spi_message * cur_msg;
    bool idling;
    bool busy;
    bool running;
    bool rt;
    bool auto_runtime_pm;
    bool cur_msg_prepared;
    bool cur_msg_mapped;
    struct completion xfer_completion;
    size_t max_dma_len;
    int (* prepare_transfer_hardware) (struct spi_master *master);
    int (* transfer_one_message) (struct spi_master *master, struct spi_message *mesg
    int (* unprepare_transfer_hardware) (struct spi_master *master);
    int (* prepare_message) (struct spi_master *master, struct spi_message *message);
    int (* unprepare_message) (struct spi_master *master, struct spi_message *message
```

```
void (* set_cs) (struct spi_device *spi, bool enable);
int (* transfer_one) (struct spi_master *master, struct spi_device *spi, struct s
void (* handle_err) (struct spi_master *master, struct spi_message *message);
int * cs_gpios;
struct dma_chan * dma_tx;
struct dma_chan * dma_rx;
void * dummy_rx;
void * dummy_tx;
};
```

Members

dev	device interface to this driver
list	link with the global spi_master list
bus_num	board-specific (and often SOC-specific) identifier for a given SPI controller.
num_chipselect	chipselects are used to distinguish individual SPI slaves, and are numbered from zero to num_chipselects. each slave has a chipselect signal, but it's common that not every chipselect is connected to a slave.
dma_alignment	SPI controller constraint on DMA buffers alignment.
mode_bits	flags understood by this controller driver
bits_per_word_mask	A mask indicating which values of bits_per_word are supported by the driver. Bit n indicates that a bits_per_word n+1 is supported. If set, the SPI core will reject any transfer with an unsupported bits_per_word. If not set, this value is simply ignored, and it's up to the individual driver to perform any validation.
min_speed_hz	Lowest supported transfer speed
max_speed_hz	Highest supported transfer speed
flags	other constraints relevant to this driver
bus_lock_spinlock	spinlock for SPI bus locking
bus_lock_mutex	mutex for SPI bus locking
bus_lock_flag	indicates that the SPI bus is locked for exclusive use
setup	updates the device mode and clocking records used by a device's SPI controller; protocol code may call this. This must fail if an unrecognized or unsupported mode is requested. It's always safe to call this unless transfers are pending on the device whose settings are being modified.
transfer	adds a message to the controller's transfer queue.
cleanup	frees controller-specific state
can_dma	determine whether this master supports DMA

queued	whether this master is providing an internal message queue
kworker	thread struct for message pump
kworker_task	pointer to task for message pump kworker thread
pump_messages	work struct for scheduling work to the message pump
queue_lock	spinlock to synchronise access to message queue
queue	message queue
cur_msg	the currently in-flight message
idling	the device is entering idle state
busy	message pump is busy
running	message pump is running
rt	whether this queue is set to run as a realtime task
auto_runtime_pm	the core should ensure a runtime PM reference is held while the hardware is prepared, using the parent device for the spidev
cur_msg_prepared	spi_prepare_message was called for the currently in-flight message
cur_msg_mapped	message has been mapped for DMA
xfer_completion	used by core transfer_one_message
max_dma_len	Maximum length of a DMA transfer for the device.
prepare_transfer_hardware	a message will soon arrive from the queue so the subsystem requests the driver to prepare the transfer hardware by issuing this call
transfer_one_message	the subsystem calls the driver to transfer a single message while queuing transfers that arrive in the meantime. When the driver is finished with this message, it must call spi_finalize_current_message so the subsystem can issue the next message
unprepare_transfer_hardware	there are currently no more messages on the queue so the subsystem notifies the driver that it may relax the hardware by issuing this call
prepare_message	set up the controller to transfer a single message, for example doing DMA mapping. Called from threaded context.
unprepare_message	undo any work done by prepare_message.
set_cs	set the logic level of the chip select line. May be called from interrupt context.
transfer_one	transfer a single spi_transfer. - return 0 if the transfer is finished, - return 1 if the transfer is still in progress. When the driver is finished with this transfer it must call spi_finalize_current_transfer so the subsystem can issue the next transfer. Note: transfer_one and

	transfer_one_message are mutually exclusive; when both are set, the generic subsystem does not call your transfer_one callback.
handle_err	the subsystem calls the driver to handle an error that occurs in the generic implementation of transfer_one_message.
cs_gpios	Array of GPIOs to use as chip select lines; one per CS number. Any individual value may be -ENOENT for CS lines that are not GPIOs (driven by the SPI controller itself).
dma_tx	DMA transmit channel
dma_rx	DMA receive channel
dummy_rx	dummy receive buffer for full-duplex devices
dummy_tx	dummy transmit buffer for full-duplex devices

Description

Each SPI master controller can communicate with one or more *spi_device* children. These make a small bus, sharing MOSI, MISO and SCK signals but not chip select signals. Each device may be configured to use a different clock rate, since those shared signals are ignored unless the chip is selected.

The driver for an SPI controller manages access to those devices through a queue of spi_message transactions, copying data between CPU memory and an SPI slave device. For each such message it queues, it calls the message's completion function when the transaction completes.

Name

struct spi_transfer — a read/write buffer pair

Synopsis

```
struct spi_transfer {
    const void * tx_buf;
    void * rx_buf;
    unsigned len;
    dma_addr_t tx_dma;
    dma_addr_t rx_dma;
    struct sg_table tx_sg;
    struct sg_table rx_sg;
    unsigned cs_change:1;
    unsigned tx_nbits:3;
    unsigned rx_nbits:3;
#define SPI_NBITS_SINGLE 0x01
#define SPI_NBITS_DUAL   0x02
#define SPI_NBITS_QUAD   0x04
    u8 bits_per_word;
    u16 delay_usecs;
    u32 speed_hz;
    struct list_head transfer_list;
};
```

Members

tx_buf	data to be written (dma-safe memory), or NULL
rx_buf	data to be read (dma-safe memory), or NULL
len	size of rx and tx buffers (in bytes)
tx_dma	DMA address of tx_buf, if <i>spi_message.is_dma_mapped</i>
rx_dma	DMA address of rx_buf, if <i>spi_message.is_dma_mapped</i>
tx_sg	Scatterlist for transmit, currently not for client use
rx_sg	Scatterlist for receive, currently not for client use
cs_change	affects chipselect after this transfer completes
tx_nbits	number of bits used for writing. If 0 the default (SPI_NBITS_SINGLE) is used.
rx_nbits	number of bits used for reading. If 0 the default (SPI_NBITS_SINGLE) is used.
bits_per_word	select a bits_per_word other than the device default for this transfer. If 0 the default (from <i>spi_device</i>) is used.
delay_usecs	microseconds to delay after this transfer before (optionally) changing the chipselect status, then starting the next transfer or completing this <i>spi_message</i> .

<code>speed_hz</code>	Select a speed other than the device default for this transfer. If 0 the default (from <i>spi_device</i>) is used.
<code>transfer_list</code>	transfers are sequenced through <i>spi_message.transfers</i>

Description

SPI transfers always write the same number of bytes as they read. Protocol drivers should always provide *rx_buf* and/or *tx_buf*. In some cases, they may also want to provide DMA addresses for the data being transferred; that may reduce overhead, when the underlying driver uses dma.

If the transmit buffer is null, zeroes will be shifted out while filling *rx_buf*. If the receive buffer is null, the data shifted in will be discarded. Only “len” bytes shift out (or in). It's an error to try to shift out a partial word. (For example, by shifting out three bytes with word size of sixteen or twenty bits; the former uses two bytes per word, the latter uses four bytes.)

In-memory data values are always in native CPU byte order, translated from the wire byte order (big-endian except with `SPI_LSB_FIRST`). So for example when `bits_per_word` is sixteen, buffers are 2N bytes long (*len* = 2N) and hold N sixteen bit words in CPU byte order.

When the word size of the SPI transfer is not a power-of-two multiple of eight bits, those in-memory words include extra bits. In-memory words are always seen by protocol drivers as right-justified, so the undefined (rx) or unused (tx) bits are always the most significant bits.

All SPI transfers start with the relevant chipselect active. Normally it stays selected until after the last transfer in a message. Drivers can affect the chipselect signal using `cs_change`.

(i) If the transfer isn't the last one in the message, this flag is used to make the chipselect briefly go inactive in the middle of the message. Toggling chipselect in this way may be needed to terminate a chip command, letting a single *spi_message* perform all of group of chip transactions together.

(ii) When the transfer is the last one in the message, the chip may stay selected until the next transfer. On multi-device SPI busses with nothing blocking messages going to other devices, this is just a performance hint; starting a message to another device deselects this one. But in other cases, this can be used to ensure correctness. Some devices need protocol transactions to be built from a series of *spi_message* submissions, where the content of one message is determined by the results of previous messages and where the whole transaction ends when the chipselect goes inactive.

When SPI can transfer in 1x, 2x or 4x. It can get this transfer information from device through *tx_nbits* and *rx_nbits*. In Bi-direction, these two should both be set. User can set transfer mode with `SPI_NBITS_SINGLE(1x)` `SPI_NBITS_DUAL(2x)` and `SPI_NBITS_QUAD(4x)` to support these three transfer.

The code that submits an *spi_message* (and its *spi_transfers*) to the lower layers is responsible for managing its memory. Zero-initialize every field you don't set up explicitly, to insulate against future API updates. After you submit a message and its transfers, ignore them until its completion callback.

Name

struct spi_message — one multi-segment SPI transaction

Synopsis

```
struct spi_message {
    struct list_head transfers;
    struct spi_device * spi;
    unsigned is_dma_mapped:1;
    void (* complete) (void *context);
    void * context;
    unsigned frame_length;
    unsigned actual_length;
    int status;
    struct list_head queue;
    void * state;
};
```

Members

transfers	list of transfer segments in this transaction
spi	SPI device to which the transaction is queued
is_dma_mapped	if true, the caller provided both dma and cpu virtual addresses for each transfer buffer
complete	called to report transaction completions
context	the argument to <code>complete</code> when it's called
frame_length	the total number of bytes in the message
actual_length	the total number of bytes that were transferred in all successful segments
status	zero for success, else negative errno
queue	for use by whichever driver currently owns the message
state	for use by whichever driver currently owns the message

Description

A *spi_message* is used to execute an atomic sequence of data transfers, each represented by a struct *spi_transfer*. The sequence is “atomic” in the sense that no other *spi_message* may use that SPI bus until that sequence completes. On some systems, many such sequences can execute as as single programmed DMA transfer. On all systems, these messages are queued, and might complete after transactions to other devices. Messages sent to a given *spi_device* are always executed in FIFO order.

The code that submits an *spi_message* (and its *spi_transfers*) to the lower layers is responsible for managing its memory. Zero-initialize every field you don't set up explicitly, to insulate against future API updates. After you submit a message and its transfers, ignore them until its completion callback.

Name

`spi_message_init_with_transfers` — Initialize `spi_message` and append transfers

Synopsis

```
void spi_message_init_with_transfers (struct spi_message * m, struct  
spi_transfer * xfers, unsigned int num_xfers);
```

Arguments

<i>m</i>	<code>spi_message</code> to be initialized
<i>xfers</i>	An array of spi transfers
<i>num_xfers</i>	Number of items in the xfer array

Description

This function initializes the given `spi_message` and adds each `spi_transfer` in the given array to the message.

Name

`spi_write` — SPI synchronous write

Synopsis

```
int spi_write (struct spi_device * spi, const void * buf, size_t len);
```

Arguments

spi device to which data will be written

buf data buffer

len data buffer size

Context

can sleep

Description

This writes the buffer and returns zero or a negative error code. Callable only from contexts that can sleep.

Name

`spi_read` — SPI synchronous read

Synopsis

```
int spi_read (struct spi_device * spi, void * buf, size_t len);
```

Arguments

spi device from which data will be read

buf data buffer

len data buffer size

Context

can sleep

Description

This reads the buffer and returns zero or a negative error code. Callable only from contexts that can sleep.

Name

`spi_sync_transfer` — synchronous SPI data transfer

Synopsis

```
int spi_sync_transfer (struct spi_device * spi, struct spi_transfer *  
xfers, unsigned int num_xfers);
```

Arguments

spi device with which data will be exchanged

xfers An array of `spi_transfers`

num_xfers Number of items in the xfer array

Context

can sleep

Description

Does a synchronous SPI data transfer of the given `spi_transfer` array.

For more specific semantics see `spi_sync`.

It returns zero on success, else a negative error code.

Name

`spi_w8r8` — SPI synchronous 8 bit write followed by 8 bit read

Synopsis

```
ssize_t spi_w8r8 (struct spi_device * spi, u8 cmd);
```

Arguments

spi device with which data will be exchanged

cmd command to be written before data is read back

Context

can sleep

Description

This returns the (unsigned) eight bit number returned by the device, or else a negative error code. Callable only from contexts that can sleep.

Name

`spi_w8r16` — SPI synchronous 8 bit write followed by 16 bit read

Synopsis

```
ssize_t spi_w8r16 (struct spi_device * spi, u8 cmd);
```

Arguments

spi device with which data will be exchanged

cmd command to be written before data is read back

Context

can sleep

Description

This returns the (unsigned) sixteen bit number returned by the device, or else a negative error code. Callable only from contexts that can sleep.

The number is returned in wire-order, which is at least sometimes big-endian.

Name

`spi_w8r16be` — SPI synchronous 8 bit write followed by 16 bit big-endian read

Synopsis

```
ssize_t spi_w8r16be (struct spi_device * spi, u8 cmd);
```

Arguments

spi device with which data will be exchanged

cmd command to be written before data is read back

Context

can sleep

Description

This returns the (unsigned) sixteen bit number returned by the device in cpu endianness, or else a negative error code. Callable only from contexts that can sleep.

This function is similar to `spi_w8r16`, with the exception that it will convert the read 16 bit data word from big-endian to native endianness.

Name

struct spi_board_info — board-specific template for a SPI device

Synopsis

```
struct spi_board_info {
    char modalias[SPI_NAME_SIZE];
    const void * platform_data;
    void * controller_data;
    int irq;
    u32 max_speed_hz;
    u16 bus_num;
    u16 chip_select;
    u16 mode;
};
```

Members

modalias[SPI_NAME_SIZE]	Initializes spi_device.modalias; identifies the driver.
platform_data	Initializes spi_device.platform_data; the particular data stored there is driver-specific.
controller_data	Initializes spi_device.controller_data; some controllers need hints about hardware setup, e.g. for DMA.
irq	Initializes spi_device.irq; depends on how the board is wired.
max_speed_hz	Initializes spi_device.max_speed_hz; based on limits from the chip datasheet and board-specific signal quality issues.
bus_num	Identifies which spi_master parents the spi_device; unused by spi_new_device, and otherwise depends on board wiring.
chip_select	Initializes spi_device.chip_select; depends on how the board is wired.
mode	Initializes spi_device.mode; based on the chip datasheet, board wiring (some devices support both 3WIRE and standard modes), and possibly presence of an inverter in the chipselect path.

Description

When adding new SPI devices to the device tree, these structures serve as a partial device template. They hold information which can't always be determined by drivers. Information that probe can establish (such as the default transfer wordsize) is not included here.

These structures are used in two places. Their primary role is to be stored in tables of board-specific device descriptors, which are declared early in board initialization and then used (much later) to populate a controller's device tree after the that controller's driver initializes. A secondary (and atypical) role is as a parameter to spi_new_device call, which happens after those controller drivers are active in some dynamic board configuration models.

Name

`spi_register_board_info` — register SPI devices for a given board

Synopsis

```
int spi_register_board_info (struct spi_board_info const * info, unsigned n);
```

Arguments

info array of chip descriptors

n how many descriptors are provided

Context

can sleep

Description

Board-specific early init code calls this (probably during `arch_initcall`) with segments of the SPI device table. Any device nodes are created later, after the relevant parent SPI controller (`bus_num`) is defined. We keep this table of devices forever, so that reloading a controller driver will not make Linux forget about these hard-wired devices.

Other code can also call this, e.g. a particular add-on board might provide SPI devices through its expansion connector, so code initializing that board would naturally declare its SPI devices.

The board info passed can safely be `__initdata` ... but be careful of any embedded pointers (`platform_data`, etc), they're copied as-is.

Name

`spi_register_driver` — register a SPI driver

Synopsis

```
int spi_register_driver (struct spi_driver * sdrv);
```

Arguments

sdrv the driver to register

Context

can sleep

Name

`spi_alloc_device` — Allocate a new SPI device

Synopsis

```
struct spi_device * spi_alloc_device (struct spi_master * master);
```

Arguments

master Controller to which device is connected

Context

can sleep

Description

Allows a driver to allocate and initialize a `spi_device` without registering it immediately. This allows a driver to directly fill the `spi_device` with device parameters before calling `spi_add_device` on it.

Caller is responsible to call `spi_add_device` on the returned `spi_device` structure to add it to the SPI master. If the caller needs to discard the `spi_device` without adding it, then it should call `spi_dev_put` on it.

Returns a pointer to the new device, or NULL.

Name

`spi_add_device` — Add `spi_device` allocated with `spi_alloc_device`

Synopsis

```
int spi_add_device (struct spi_device * spi);
```

Arguments

spi `spi_device` to register

Description

Companion function to `spi_alloc_device`. Devices allocated with `spi_alloc_device` can be added onto the `spi` bus with this function.

Returns 0 on success; negative `errno` on failure

Name

`spi_new_device` — instantiate one new SPI device

Synopsis

```
struct spi_device * spi_new_device (struct spi_master * master, struct  
spi_board_info * chip);
```

Arguments

master Controller to which device is connected

chip Describes the SPI device

Context

can sleep

Description

On typical mainboards, this is purely internal; and it's not needed after board init creates the hard-wired devices. Some development platforms may not be able to use `spi_register_board_info` though, and this is exported so that for example a USB or parport based adapter driver could add devices (which it would learn about out-of-band).

Returns the new device, or NULL.

Name

`spi_finalize_current_transfer` — report completion of a transfer

Synopsis

```
void spi_finalize_current_transfer (struct spi_master * master);
```

Arguments

master the master reporting completion

Description

Called by SPI drivers using the core `transfer_one_message` implementation to notify it that the current interrupt driven transfer has finished and the next one may be scheduled.

Name

`spi_get_next_queued_message` — called by driver to check for queued messages

Synopsis

```
struct spi_message * spi_get_next_queued_message (struct spi_master *  
master);
```

Arguments

master the master to check for queued messages

Description

If there are more messages in the queue, the next message is returned from this call.

Name

`spi_finalize_current_message` — the current message is complete

Synopsis

```
void spi_finalize_current_message (struct spi_master * master);
```

Arguments

master the master to return the message to

Description

Called by the driver to notify the core that the message in the front of the queue is complete and can be removed from the queue.

Name

`spi_alloc_master` — allocate SPI master controller

Synopsis

```
struct spi_master * spi_alloc_master (struct device * dev, unsigned
size);
```

Arguments

dev the controller, possibly using the `platform_bus`

size how much zeroed driver-private data to allocate; the pointer to this memory is in the `driver_data` field of the returned device, accessible with `spi_master_get_devdata`.

Context

can sleep

Description

This call is used only by SPI master controller drivers, which are the only ones directly touching chip registers. It's how they allocate an `spi_master` structure, prior to calling `spi_register_master`.

This must be called from context that can sleep. It returns the SPI master structure on success, else `NULL`.

The caller is responsible for assigning the bus number and initializing the master's methods before calling `spi_register_master`; and (after errors adding the device) calling `spi_master_put` to prevent a memory leak.

Name

`spi_register_master` — register SPI master controller

Synopsis

```
int spi_register_master (struct spi_master * master);
```

Arguments

master initialized master, originally from `spi_alloc_master`

Context

can sleep

Description

SPI master controllers connect to their drivers using some non-SPI bus, such as the platform bus. The final stage of `probe` in that code includes calling `spi_register_master` to hook up to this SPI bus glue.

SPI controllers use board specific (often SOC specific) bus numbers, and board-specific addressing for SPI devices combines those numbers with chip select numbers. Since SPI does not directly support dynamic device identification, boards need configuration tables telling which chip is at which address.

This must be called from context that can sleep. It returns zero on success, else a negative error code (dropping the master's refcount). After a successful return, the caller is responsible for calling `spi_unregister_master`.

Name

`devm_spi_register_master` — register managed SPI master controller

Synopsis

```
int devm_spi_register_master (struct device * dev, struct spi_master
* master);
```

Arguments

dev device managing SPI master

master initialized master, originally from `spi_alloc_master`

Context

can sleep

Description

Register a SPI device as with `spi_register_master` which will automatically be unregister

Name

`spi_unregister_master` — unregister SPI master controller

Synopsis

```
void spi_unregister_master (struct spi_master * master);
```

Arguments

master the master being unregistered

Context

can sleep

Description

This call is used only by SPI master controller drivers, which are the only ones directly touching chip registers.

This must be called from context that can sleep.

Name

`spi_busnum_to_master` — look up master associated with `bus_num`

Synopsis

```
struct spi_master * spi_busnum_to_master (u16 bus_num);
```

Arguments

bus_num the master's bus number

Context

can sleep

Description

This call may be used with devices that are registered after arch init time. It returns a refcounted pointer to the relevant `spi_master` (which the caller must release), or NULL if there is no such master registered.

Name

`spi_setup` — setup SPI mode and clock rate

Synopsis

```
int spi_setup (struct spi_device * spi);
```

Arguments

spi the device whose settings are being modified

Context

can sleep, and no requests are queued to the device

Description

SPI protocol drivers may need to update the transfer mode if the device doesn't work with its default. They may likewise need to update clock rates or word sizes from initial values. This function changes those settings, and must be called from a context that can sleep. Except for `SPI_CS_HIGH`, which takes effect immediately, the changes take effect the next time the device is selected and data is transferred to or from it. When this function returns, the spi device is deselected.

Note that this call will fail if the protocol driver specifies an option that the underlying controller or its driver does not support. For example, not all hardware supports wire transfers using nine bit words, LSB-first wire encoding, or active-high chipselects.

Name

`spi_async` — asynchronous SPI transfer

Synopsis

```
int spi_async (struct spi_device * spi, struct spi_message * message);
```

Arguments

spi device with which data will be exchanged

message describes the data transfers, including completion callback

Context

any (irqs may be blocked, etc)

Description

This call may be used in_irq and other contexts which can't sleep, as well as from task contexts which can sleep.

The completion callback is invoked in a context which can't sleep. Before that invocation, the value of `message->status` is undefined. When the callback is issued, `message->status` holds either zero (to indicate complete success) or a negative error code. After that callback returns, the driver which issued the transfer request may deallocate the associated memory; it's no longer in use by any SPI core or controller driver code.

Note that although all messages to a `spi_device` are handled in FIFO order, messages may go to different devices in other orders. Some device might be higher priority, or have various “hard” access time requirements, for example.

On detection of any fault during the transfer, processing of the entire message is aborted, and the device is deselected. Until returning from the associated message completion callback, no other `spi_message` queued to that device will be processed. (This rule applies equally to all the synchronous transfer calls, which are wrappers around this core asynchronous primitive.)

Name

`spi_async_locked` — version of `spi_async` with exclusive bus usage

Synopsis

```
int spi_async_locked (struct spi_device * spi, struct spi_message *  
message);
```

Arguments

spi device with which data will be exchanged

message describes the data transfers, including completion callback

Context

any (irqs may be blocked, etc)

Description

This call may be used in_irq and other contexts which can't sleep, as well as from task contexts which can sleep.

The completion callback is invoked in a context which can't sleep. Before that invocation, the value of `message->status` is undefined. When the callback is issued, `message->status` holds either zero (to indicate complete success) or a negative error code. After that callback returns, the driver which issued the transfer request may deallocate the associated memory; it's no longer in use by any SPI core or controller driver code.

Note that although all messages to a `spi_device` are handled in FIFO order, messages may go to different devices in other orders. Some device might be higher priority, or have various “hard” access time requirements, for example.

On detection of any fault during the transfer, processing of the entire message is aborted, and the device is deselected. Until returning from the associated message completion callback, no other `spi_message` queued to that device will be processed. (This rule applies equally to all the synchronous transfer calls, which are wrappers around this core asynchronous primitive.)

Name

`spi_sync` — blocking/synchronous SPI data transfers

Synopsis

```
int spi_sync (struct spi_device * spi, struct spi_message * message);
```

Arguments

spi device with which data will be exchanged

message describes the data transfers

Context

can sleep

Description

This call may only be used from a context that may sleep. The sleep is non-interruptible, and has no timeout. Low-overhead controller drivers may DMA directly into and out of the message buffers.

Note that the SPI device's chip select is active during the message, and then is normally disabled between messages. Drivers for some frequently-used devices may want to minimize costs of selecting a chip, by leaving it selected in anticipation that the next message will go to the same chip. (That may increase power usage.)

Also, the caller is guaranteeing that the memory associated with the message will not be freed before this call returns.

It returns zero on success, else a negative error code.

Name

`spi_sync_locked` — version of `spi_sync` with exclusive bus usage

Synopsis

```
int spi_sync_locked (struct spi_device * spi, struct spi_message *  
message);
```

Arguments

spi device with which data will be exchanged

message describes the data transfers

Context

can sleep

Description

This call may only be used from a context that may sleep. The sleep is non-interruptible, and has no timeout. Low-overhead controller drivers may DMA directly into and out of the message buffers.

This call should be used by drivers that require exclusive access to the SPI bus. It has to be preceded by a `spi_bus_lock` call. The SPI bus must be released by a `spi_bus_unlock` call when the exclusive access is over.

It returns zero on success, else a negative error code.

Name

`spi_bus_lock` — obtain a lock for exclusive SPI bus usage

Synopsis

```
int spi_bus_lock (struct spi_master * master);
```

Arguments

master SPI bus master that should be locked for exclusive bus access

Context

can sleep

Description

This call may only be used from a context that may sleep. The sleep is non-interruptible, and has no timeout.

This call should be used by drivers that require exclusive access to the SPI bus. The SPI bus must be released by a `spi_bus_unlock` call when the exclusive access is over. Data transfer must be done by `spi_sync_locked` and `spi_async_locked` calls when the SPI bus lock is held.

It returns zero on success, else a negative error code.

Name

`spi_bus_unlock` — release the lock for exclusive SPI bus usage

Synopsis

```
int spi_bus_unlock (struct spi_master * master);
```

Arguments

master SPI bus master that was locked for exclusive bus access

Context

can sleep

Description

This call may only be used from a context that may sleep. The sleep is non-interruptible, and has no timeout.

This call releases an SPI bus lock previously obtained by an `spi_bus_lock` call.

It returns zero on success, else a negative error code.

Name

`spi_write_then_read` — SPI synchronous write followed by read

Synopsis

```
int spi_write_then_read (struct spi_device * spi, const void * txbuf,  
unsigned n_tx, void * rxbuf, unsigned n_rx);
```

Arguments

spi device with which data will be exchanged

txbuf data to be written (need not be dma-safe)

n_tx size of txbuf, in bytes

rxbuf buffer into which data will be read (need not be dma-safe)

n_rx size of rxbuf, in bytes

Context

can sleep

Description

This performs a half duplex MicroWire style transaction with the device, sending txbuf and then reading rxbuf. The return value is zero for success, else a negative errno status code. This call may only be used from a context that may sleep.

Parameters to this routine are always copied using a small buffer; portable code should never use this for more than 32 bytes. Performance-sensitive or bulk transfer code should instead use `spi_{async,sync}()` calls with dma-safe buffers.

Chapter 10. I²C and SMBus Subsystem

I²C (or without fancy typography, "I2C") is an acronym for the "Inter-IC" bus, a simple bus protocol which is widely used where low data rate communications suffice. Since it's also a licensed trademark, some vendors use another name (such as "Two-Wire Interface", TWI) for the same bus. I2C only needs two signals (SCL for clock, SDA for data), conserving board real estate and minimizing signal quality issues. Most I2C devices use seven bit addresses, and bus speeds of up to 400 kHz; there's a high speed extension (3.4 MHz) that's not yet found wide use. I2C is a multi-master bus; open drain signaling is used to arbitrate between masters, as well as to handshake and to synchronize clocks from slower clients.

The Linux I2C programming interfaces support only the master side of bus interactions, not the slave side. The programming interface is structured around two kinds of driver, and two kinds of device. An I2C "Adapter Driver" abstracts the controller hardware; it binds to a physical device (perhaps a PCI device or platform_device) and exposes a struct `i2c_adapter` representing each I2C bus segment it manages. On each I2C bus segment will be I2C devices represented by a struct `i2c_client`. Those devices will be bound to a struct `i2c_driver`, which should follow the standard Linux driver model. (At this writing, a legacy model is more widely used.) There are functions to perform various I2C protocol operations; at this writing all such functions are usable only from task context.

The System Management Bus (SMBus) is a sibling protocol. Most SMBus systems are also I2C conformant. The electrical constraints are tighter for SMBus, and it standardizes particular protocol messages and idioms. Controllers that support I2C can also support most SMBus operations, but SMBus controllers don't support all the protocol options that an I2C controller will. There are functions to perform various SMBus protocol operations, either using I2C primitives or by issuing SMBus commands to `i2c_adapter` devices which don't support those I2C operations.

Name

struct i2c_driver — represent an I2C device driver

Synopsis

```
struct i2c_driver {
    unsigned int class;
    int (* attach_adapter) (struct i2c_adapter *);
    int (* probe) (struct i2c_client *, const struct i2c_device_id *);
    int (* remove) (struct i2c_client *);
    void (* shutdown) (struct i2c_client *);
    void (* alert) (struct i2c_client *, unsigned int data);
    int (* command) (struct i2c_client *client, unsigned int cmd, void *arg);
    struct device_driver driver;
    const struct i2c_device_id * id_table;
    int (* detect) (struct i2c_client *, struct i2c_board_info *);
    const unsigned short * address_list;
    struct list_head clients;
};
```

Members

class	What kind of i2c device we instantiate (for detect)
attach_adapter	Callback for bus addition (deprecated)
probe	Callback for device binding
remove	Callback for device unbinding
shutdown	Callback for device shutdown
alert	Alert callback, for example for the SMBus alert protocol
command	Callback for bus-wide signaling (optional)
driver	Device driver model driver
id_table	List of I2C devices supported by this driver
detect	Callback for device detection
address_list	The I2C addresses to probe (for detect)
clients	List of detected clients we created (for i2c-core use only)

Description

The driver.owner field should be set to the module owner of this driver. The driver.name field should be set to the name of this driver.

For automatic device detection, both *detect* and *address_list* must be defined. *class* should also be set, otherwise only devices forced with module parameters will be created. The detect function must fill

at least the name field of the `i2c_board_info` structure it is handed upon successful detection, and possibly also the flags field.

If *detect* is missing, the driver will still work fine for enumerated devices. Detected devices simply won't be supported. This is expected for the many I2C/SMBus devices which can't be detected reliably, and the ones which can always be enumerated in practice.

The `i2c_client` structure which is handed to the *detect* callback is not a real `i2c_client`. It is initialized just enough so that you can call `i2c_smbus_read_byte_data` and friends on it. Don't do anything else with it. In particular, calling `dev_dbg` and friends on it is not allowed.

Name

struct i2c_client — represent an I2C slave device

Synopsis

```
struct i2c_client {
    unsigned short flags;
    unsigned short addr;
    char name[I2C_NAME_SIZE];
    struct i2c_adapter * adapter;
    struct device dev;
    int irq;
    struct list_head detected;
#ifdef IS_ENABLED(CONFIG_I2C_SLAVE)
    i2c_slave_cb_t slave_cb;
#endif
};
```

Members

flags	I2C_CLIENT_TEN indicates the device uses a ten bit chip address; I2C_CLIENT_PEC indicates it uses SMBus Packet Error Checking
addr	Address used on the I2C bus connected to the parent adapter.
name[I2C_NAME_SIZE]	Indicates the type of the device, usually a chip name that's generic enough to hide second-sourcing and compatible revisions.
adapter	manages the bus segment hosting this I2C device
dev	Driver model device node for the slave.
irq	indicates the IRQ generated by this device (if any)
detected	member of an i2c_driver.clients list or i2c-core's userspace_devices list
slave_cb	Callback when I2C slave mode of an adapter is used. The adapter calls it to pass on slave events to the slave driver.

Description

An i2c_client identifies a single device (i.e. chip) connected to an i2c bus. The behaviour exposed to Linux is defined by the driver managing the device.

Name

struct i2c_board_info — template for device creation

Synopsis

```
struct i2c_board_info {
    char type[I2C_NAME_SIZE];
    unsigned short flags;
    unsigned short addr;
    void * platform_data;
    struct dev_archdata * archdata;
    struct device_node * of_node;
    struct fwnode_handle * fwnode;
    int irq;
};
```

Members

type[I2C_NAME_SIZE]	chip type, to initialize i2c_client.name
flags	to initialize i2c_client.flags
addr	stored in i2c_client.addr
platform_data	stored in i2c_client.dev.platform_data
archdata	copied into i2c_client.dev.archdata
of_node	pointer to OpenFirmware device node
fwnode	device node supplied by the platform firmware
irq	stored in i2c_client.irq

Description

I2C doesn't actually support hardware probing, although controllers and devices may be able to use I2C_SMBUS_QUICK to tell whether or not there's a device at a given address. Drivers commonly need more information than that, such as chip type, configuration, associated IRQ, and so on.

i2c_board_info is used to build tables of information listing I2C devices that are present. This information is used to grow the driver model tree. For mainboards this is done statically using i2c_register_board_info; bus numbers identify adapters that aren't yet available. For add-on boards, i2c_new_device does this dynamically with the adapter already known.

Name

I2C_BOARD_INFO — macro used to list an i2c device and its address

Synopsis

```
I2C_BOARD_INFO ( dev_type, dev_addr );
```

Arguments

dev_type identifies the device type

dev_addr the device's address on the bus.

Description

This macro initializes essential fields of a struct `i2c_board_info`, declaring what has been provided on a particular board. Optional fields (such as associated `irq`, or device-specific `platform_data`) are provided using conventional syntax.

Name

struct i2c_algorithm — represent I2C transfer method

Synopsis

```
struct i2c_algorithm {
    int (* master_xfer) (struct i2c_adapter *adap, struct i2c_msg *msgs,int num);
    int (* smbus_xfer) (struct i2c_adapter *adap, ul6 addr,unsigned short flags, cha
    u32 (* functionality) (struct i2c_adapter *);
#ifdef IS_ENABLED(CONFIG_I2C_SLAVE)
    int (* reg_slave) (struct i2c_client *client);
    int (* unreg_slave) (struct i2c_client *client);
#endif
};
```

Members

master_xfer	Issue a set of i2c transactions to the given I2C adapter defined by the msgs array, with num messages available to transfer via the adapter specified by adap.
smbus_xfer	Issue smbus transactions to the given I2C adapter. If this is not present, then the bus layer will try and convert the SMBus calls into I2C transfers instead.
functionality	Return the flags that this algorithm/adapter pair supports from the I2C_FUNC_* flags.
reg_slave	Register given client to I2C slave mode of this adapter
unreg_slave	Unregister given client from I2C slave mode of this adapter

The following structs are for those who like to implement new bus drivers

i2c_algorithm is the interface to a class of hardware solutions which can be addressed using the same bus algorithms - i.e. bit-banging or the PCF8584 to name two of the most common.

The return codes from the *master_xfer* field should indicate the type of error code that occurred during the transfer, as documented in the kernel Documentation file Documentation/i2c/fault-codes.

Name

struct i2c_bus_recovery_info — I2C bus recovery information

Synopsis

```
struct i2c_bus_recovery_info {
    int (* recover_bus) (struct i2c_adapter *);
    int (* get_scl) (struct i2c_adapter *);
    void (* set_scl) (struct i2c_adapter *, int val);
    int (* get_sda) (struct i2c_adapter *);
    void (* prepare_recovery) (struct i2c_adapter *);
    void (* unprepare_recovery) (struct i2c_adapter *);
    int scl_gpio;
    int sda_gpio;
};
```

Members

recover_bus	Recover routine. Either pass driver's <code>recover_bus</code> routine, or <code>i2c_generic_scl_recovery</code> or <code>i2c_generic_gpio_recovery</code> .
get_scl	This gets current value of SCL line. Mandatory for generic SCL recovery. Used internally for generic GPIO recovery.
set_scl	This sets/clears SCL line. Mandatory for generic SCL recovery. Used internally for generic GPIO recovery.
get_sda	This gets current value of SDA line. Optional for generic SCL recovery. Used internally, if <code>sda_gpio</code> is a valid GPIO, for generic GPIO recovery.
prepare_recovery	This will be called before starting recovery. Platform may configure padmux here for SDA/SCL line or something else they want.
unprepare_recovery	This will be called after completing recovery. Platform may configure padmux here for SDA/SCL line or something else they want.
scl_gpio	gpio number of the SCL line. Only required for GPIO recovery.
sda_gpio	gpio number of the SDA line. Only required for GPIO recovery.

Name

struct i2c_adapter_quirks — describe flaws of an i2c adapter

Synopsis

```
struct i2c_adapter_quirks {  
    u64 flags;  
    int max_num_msgs;  
    u16 max_write_len;  
    u16 max_read_len;  
    u16 max_comb_1st_msg_len;  
    u16 max_comb_2nd_msg_len;  
};
```

Members

flags	see I2C_AQ_* for possible flags and read below
max_num_msgs	maximum number of messages per transfer
max_write_len	maximum length of a write message
max_read_len	maximum length of a read message
max_comb_1st_msg_len	maximum length of the first msg in a combined message
max_comb_2nd_msg_len	maximum length of the second msg in a combined message

Note about combined messages

Some I2C controllers can only send one message per transfer, plus something called combined message or write-then-read. This is (usually) a small write message followed by a read message and barely enough to access register based devices like EEPROMs. There is a flag to support this mode. It implies `max_num_msg = 2` and does the length checks with `max_comb_*_len` because combined message mode usually has its own limitations. Because of HW implementations, some controllers can actually do write-then-anything or other variants. To support that, write-then-read has been broken out into smaller bits like write-first and read-second which can be combined as needed.

Name

`module_i2c_driver` — Helper macro for registering a I2C driver

Synopsis

```
module_i2c_driver ( __i2c_driver);
```

Arguments

`__i2c_driver` i2c_driver struct

Description

Helper macro for I2C drivers which do not do anything special in module init/exit. This eliminates a lot of boilerplate. Each module may only use this macro once, and calling it replaces `module_init` and `module_exit`

Name

`i2c_register_board_info` — statically declare I2C devices

Synopsis

```
int i2c_register_board_info (int busnum, struct i2c_board_info const *  
info, unsigned len);
```

Arguments

busnum identifies the bus to which these devices belong

info vector of i2c device descriptors

len how many descriptors in the vector; may be zero to reserve the specified bus number.

Description

Systems using the Linux I2C driver stack can declare tables of board info while they initialize. This should be done in board-specific init code near `arch_initcall` time, or equivalent, before any I2C adapter driver is registered. For example, mainboard init code could define several devices, as could the init code for each daughtercard in a board stack.

The I2C devices will be created later, after the adapter for the relevant bus has been registered. After that moment, standard driver model tools are used to bind “new style” I2C drivers to the devices. The bus number for any device declared using this routine is not available for dynamic allocation.

The board info passed can safely be `__initdata`, but be careful of embedded pointers (for `platform_data`, functions, etc) since that won't be copied.

Name

`i2c_verify_client` — return parameter as `i2c_client`, or `NULL`

Synopsis

```
struct i2c_client * i2c_verify_client (struct device * dev);
```

Arguments

dev device, probably from some driver model iterator

Description

When traversing the driver model tree, perhaps using driver model iterators like `device_for_each_child()`, you can't assume very much about the nodes you find. Use this function to avoid oopses caused by wrongly treating some non-I2C device as an `i2c_client`.

Name

`i2c_lock_adapter` — Get exclusive access to an I2C bus segment

Synopsis

```
void i2c_lock_adapter (struct i2c_adapter * adapter);
```

Arguments

adapter Target I2C bus segment

Name

`i2c_unlock_adapter` — Release exclusive access to an I2C bus segment

Synopsis

```
void i2c_unlock_adapter (struct i2c_adapter * adapter);
```

Arguments

adapter Target I2C bus segment

Name

`i2c_new_device` — instantiate an i2c device

Synopsis

```
struct i2c_client * i2c_new_device (struct i2c_adapter * adap, struct  
i2c_board_info const * info);
```

Arguments

adap the adapter managing the device

info describes one I2C device; `bus_num` is ignored

Context

can sleep

Description

Create an i2c device. Binding is handled through driver model `probe/remove` methods. A driver may be bound to this device when we return from this function, or any later moment (e.g. maybe hotplugging will load the driver module). This call is not appropriate for use by mainboard initialization logic, which usually runs during an `arch_initcall` long before any `i2c_adapter` could exist.

This returns the new i2c client, which may be saved for later use with `i2c_unregister_device`; or `NULL` to indicate an error.

Name

`i2c_unregister_device` — reverse effect of `i2c_new_device`

Synopsis

```
void i2c_unregister_device (struct i2c_client * client);
```

Arguments

client value returned from `i2c_new_device`

Context

can sleep

Name

`i2c_new_dummy` — return a new i2c device bound to a dummy driver

Synopsis

```
struct i2c_client * i2c_new_dummy (struct i2c_adapter * adapter, u16  
address);
```

Arguments

adapter the adapter managing the device

address seven bit address to be used

Context

can sleep

Description

This returns an I2C client bound to the “dummy” driver, intended for use with devices that consume multiple addresses. Examples of such chips include various EEPROMS (like 24c04 and 24c08 models).

These dummy devices have two main uses. First, most I2C and SMBus calls except `i2c_transfer` need a client handle; the dummy will be that handle. And second, this prevents the specified address from being bound to a different driver.

This returns the new i2c client, which should be saved for later use with `i2c_unregister_device`; or NULL to indicate an error.

Name

`i2c_verify_adapter` — return parameter as `i2c_adapter` or `NULL`

Synopsis

```
struct i2c_adapter * i2c_verify_adapter (struct device * dev);
```

Arguments

dev device, probably from some driver model iterator

Description

When traversing the driver model tree, perhaps using driver model iterators like `device_for_each_child()`, you can't assume very much about the nodes you find. Use this function to avoid oopses caused by wrongly treating some non-I2C device as an `i2c_adapter`.

Name

`i2c_add_adapter` — declare i2c adapter, use dynamic bus number

Synopsis

```
int i2c_add_adapter (struct i2c_adapter * adapter);
```

Arguments

adapter the adapter to add

Context

can sleep

Description

This routine is used to declare an I2C adapter when its bus number doesn't matter or when its bus number is specified by an dt alias. Examples of bases when the bus number doesn't matter: I2C adapters dynamically added by USB links or PCI plugin cards.

When this returns zero, a new bus number was allocated and stored in `adap->nr`, and the specified adapter became available for clients. Otherwise, a negative `errno` value is returned.

Name

`i2c_add_numbered_adapter` — declare i2c adapter, use static bus number

Synopsis

```
int i2c_add_numbered_adapter (struct i2c_adapter * adap);
```

Arguments

adap the adapter to register (with `adap->nr` initialized)

Context

can sleep

Description

This routine is used to declare an I2C adapter when its bus number matters. For example, use it for I2C adapters from system-on-chip CPUs, or otherwise built in to the system's mainboard, and where `i2c_board_info` is used to properly configure I2C devices.

If the requested bus number is set to -1, then this function will behave identically to `i2c_add_adapter`, and will dynamically assign a bus number.

If no devices have pre-been declared for this bus, then be sure to register the adapter before any dynamically allocated ones. Otherwise the required bus ID may not be available.

When this returns zero, the specified adapter became available for clients using the bus number provided in `adap->nr`. Also, the table of I2C devices pre-declared using `i2c_register_board_info` is scanned, and the appropriate driver model device nodes are created. Otherwise, a negative `errno` value is returned.

Name

`i2c_del_adapter` — unregister I2C adapter

Synopsis

```
void i2c_del_adapter (struct i2c_adapter * adap);
```

Arguments

adap the adapter being unregistered

Context

can sleep

Description

This unregisters an I2C adapter which was previously registered by `i2c_add_adapter` or `i2c_add_numbered_adapter`.

Name

`i2c_del_driver` — unregister I2C driver

Synopsis

```
void i2c_del_driver (struct i2c_driver * driver);
```

Arguments

driver the driver being unregistered

Context

can sleep

Name

`i2c_use_client` — increments the reference count of the i2c client structure

Synopsis

```
struct i2c_client * i2c_use_client (struct i2c_client * client);
```

Arguments

client the client being referenced

Description

Each live reference to a client should be refcounted. The driver model does that automatically as part of driver binding, so that most drivers don't

need to do this explicitly

they hold a reference until they're unbound from the device.

A pointer to the client with the incremented reference counter is returned.

Name

`i2c_release_client` — release a use of the i2c client structure

Synopsis

```
void i2c_release_client (struct i2c_client * client);
```

Arguments

client the client being no longer referenced

Description

Must be called when a user of a client is finished with it.

Name

`__i2c_transfer` — unlocked flavor of `i2c_transfer`

Synopsis

```
int __i2c_transfer (struct i2c_adapter * adap, struct i2c_msg * msgs,  
int num);
```

Arguments

adap Handle to I2C bus

msgs One or more messages to execute before STOP is issued to terminate the operation; each message begins with a START.

num Number of messages to be executed.

Description

Returns negative errno, else the number of messages executed.

Adapter lock must be held when calling this function. No debug logging takes place. `adap->algo->master_xfer` existence isn't checked.

Name

`i2c_transfer` — execute a single or combined I2C message

Synopsis

```
int i2c_transfer (struct i2c_adapter * adap, struct i2c_msg * msgs,
int num);
```

Arguments

adap Handle to I2C bus

msgs One or more messages to execute before STOP is issued to terminate the operation; each message begins with a START.

num Number of messages to be executed.

Description

Returns negative errno, else the number of messages executed.

Note that there is no requirement that each message be sent to the same slave address, although that is the most common model.

Name

`i2c_master_send` — issue a single I2C message in master transmit mode

Synopsis

```
int i2c_master_send (const struct i2c_client * client, const char *  
buf, int count);
```

Arguments

client Handle to slave device

buf Data that will be written to the slave

count How many bytes to write, must be less than 64k since `msg.len` is `u16`

Description

Returns negative `errno`, or else the number of bytes written.

Name

`i2c_master_recv` — issue a single I2C message in master receive mode

Synopsis

```
int i2c_master_recv (const struct i2c_client * client, char * buf, int  
count);
```

Arguments

client Handle to slave device

buf Where to store data read from slave

count How many bytes to read, must be less than 64k since msg.len is u16

Description

Returns negative errno, or else the number of bytes read.

Name

i2c_smbus_read_byte — SMBus “receive byte” protocol

Synopsis

```
s32 i2c_smbus_read_byte (const struct i2c_client * client);
```

Arguments

client Handle to slave device

Description

This executes the SMBus “receive byte” protocol, returning negative errno else the byte received from the device.

Name

i2c_smbus_write_byte — SMBus “send byte” protocol

Synopsis

```
s32 i2c_smbus_write_byte (const struct i2c_client * client, u8 value);
```

Arguments

client Handle to slave device

value Byte to be sent

Description

This executes the SMBus “send byte” protocol, returning negative errno else zero on success.

Name

`i2c_smbus_read_byte_data` — SMBus “read byte” protocol

Synopsis

```
s32 i2c_smbus_read_byte_data (const struct i2c_client * client, u8 command);
```

Arguments

client Handle to slave device

command Byte interpreted by slave

Description

This executes the SMBus “read byte” protocol, returning negative `errno` else a data byte received from the device.

Name

`i2c_smbus_write_byte_data` — SMBus “write byte” protocol

Synopsis

```
s32 i2c_smbus_write_byte_data (const struct i2c_client * client, u8
command, u8 value);
```

Arguments

client Handle to slave device

command Byte interpreted by slave

value Byte being written

Description

This executes the SMBus “write byte” protocol, returning negative `errno` else zero on success.

Name

`i2c_smbus_read_word_data` — SMBus “read word” protocol

Synopsis

```
s32 i2c_smbus_read_word_data (const struct i2c_client * client, u8 command);
```

Arguments

client Handle to slave device

command Byte interpreted by slave

Description

This executes the SMBus “read word” protocol, returning negative `errno` else a 16-bit unsigned “word” received from the device.

Name

`i2c_smbus_write_word_data` — SMBus “write word” protocol

Synopsis

```
s32 i2c_smbus_write_word_data (const struct i2c_client * client, u8
command, u16 value);
```

Arguments

client Handle to slave device

command Byte interpreted by slave

value 16-bit “word” being written

Description

This executes the SMBus “write word” protocol, returning negative `errno` else zero on success.

Name

`i2c_smbus_read_block_data` — SMBus “block read” protocol

Synopsis

```
s32 i2c_smbus_read_block_data (const struct i2c_client * client, u8
command, u8 * values);
```

Arguments

client Handle to slave device

command Byte interpreted by slave

values Byte array into which data will be read; big enough to hold the data returned by the slave.
SMBus allows at most 32 bytes.

Description

This executes the SMBus “block read” protocol, returning negative `errno` else the number of data bytes in the slave's response.

Note that using this function requires that the client's adapter support the `I2C_FUNC_SMBUS_READ_BLOCK_DATA` functionality. Not all adapter drivers support this; its emulation through I2C messaging relies on a specific mechanism (`I2C_M_RECV_LEN`) which may not be implemented.

Name

`i2c_smbus_write_block_data` — SMBus “block write” protocol

Synopsis

```
s32 i2c_smbus_write_block_data (const struct i2c_client * client, u8
command, u8 length, const u8 * values);
```

Arguments

client Handle to slave device

command Byte interpreted by slave

length Size of data block; SMBus allows at most 32 bytes

values Byte array which will be written.

Description

This executes the SMBus “block write” protocol, returning negative `errno` else zero on success.

Name

`i2c_smbus_xfer` — execute SMBus protocol operations

Synopsis

```
s32 i2c_smbus_xfer (struct i2c_adapter * adapter, u16 addr, unsigned short flags, char read_write, u8 command, int protocol, union i2c_smbus_data * data);
```

Arguments

<i>adapter</i>	Handle to I2C bus
<i>addr</i>	Address of SMBus slave on that bus
<i>flags</i>	I2C_CLIENT_* flags (usually zero or I2C_CLIENT_PEC)
<i>read_write</i>	I2C_SMBUS_READ or I2C_SMBUS_WRITE
<i>command</i>	Byte interpreted by slave, for protocols which use such bytes
<i>protocol</i>	SMBus protocol operation to execute, such as I2C_SMBUS_PROC_CALL
<i>data</i>	Data to be read or written

Description

This executes an SMBus protocol operation, and returns a negative errno code else zero on success.

Chapter 11. High Speed Synchronous Serial Interface (HSI)

High Speed Synchronous Serial Interface (HSI) is a serial interface mainly used for connecting application engines (APE) with cellular modem engines (CMT) in cellular handsets. HSI provides multiplexing for up to 16 logical channels, low-latency and full duplex communication.

Name

struct hsi_channel — channel resource used by the hsi clients

Synopsis

```
struct hsi_channel {  
    unsigned int id;  
    const char * name;  
};
```

Members

id	Channel number
name	Channel name

Name

struct hsi_config — Configuration for RX/TX HSI modules

Synopsis

```
struct hsi_config {  
    unsigned int mode;  
    struct hsi_channel * channels;  
    unsigned int num_channels;  
    unsigned int num_hw_channels;  
    unsigned int speed;  
    union {unnamed_union};  
};
```

Members

mode	Bit transmission mode (STREAM or FRAME)
channels	Channel resources used by the client
num_channels	Number of channel resources
num_hw_channels	Number of channels the transceiver is configured for [1..16]
speed	Max bit transmission speed (Kbit/s)
{unnamed_union}	anonymous

Name

struct hsi_board_info — HSI client board info

Synopsis

```
struct hsi_board_info {  
    const char * name;  
    unsigned int hsi_id;  
    unsigned int port;  
    struct hsi_config tx_cfg;  
    struct hsi_config rx_cfg;  
    void * platform_data;  
    struct dev_archdata * archdata;  
};
```

Members

name	Name for the HSI device
hsi_id	HSI controller id where the client sits
port	Port number in the controller where the client sits
tx_cfg	HSI TX configuration
rx_cfg	HSI RX configuration
platform_data	Platform related data
archdata	Architecture-dependent device data

Name

struct hsi_client — HSI client attached to an HSI port

Synopsis

```
struct hsi_client {  
    struct device device;  
    struct hsi_config tx_cfg;  
    struct hsi_config rx_cfg;  
};
```

Members

device	Driver model representation of the device
tx_cfg	HSI TX configuration
rx_cfg	HSI RX configuration

Name

struct hsi_client_driver — Driver associated to an HSI client

Synopsis

```
struct hsi_client_driver {  
    struct device_driver driver;  
};
```

Members

driver Driver model representation of the driver

Name

struct hsi_msg — HSI message descriptor

Synopsis

```
struct hsi_msg {
    struct list_head link;
    struct hsi_client * cl;
    struct sg_table sgt;
    void * context;
    void (* complete) (struct hsi_msg *msg);
    void (* destructor) (struct hsi_msg *msg);
    int status;
    unsigned int actual_len;
    unsigned int channel;
    unsigned int ttype:1;
    unsigned int break_frame:1;
};
```

Members

link	Free to use by the current descriptor owner
cl	HSI device client that issues the transfer
sgt	Head of the scatterlist array
context	Client context data associated to the transfer
complete	Transfer completion callback
destructor	Destructor to free resources when flushing
status	Status of the transfer when completed
actual_len	Actual length of data transferred on completion
channel	Channel were to TX/RX the message
ttype	Transfer type (TX if set, RX otherwise)
break_frame	if true HSI will send/receive a break frame. Data buffers are ignored in the request.

Name

struct hsi_port — HSI port device

Synopsis

```
struct hsi_port {
    struct device device;
    struct hsi_config tx_cfg;
    struct hsi_config rx_cfg;
    unsigned int num;
    unsigned int shared:1;
    int claimed;
    struct mutex lock;
    int (* async) (struct hsi_msg *msg);
    int (* setup) (struct hsi_client *cl);
    int (* flush) (struct hsi_client *cl);
    int (* start_tx) (struct hsi_client *cl);
    int (* stop_tx) (struct hsi_client *cl);
    int (* release) (struct hsi_client *cl);
    struct atomic_notifier_head n_head;
};
```

Members

device	Driver model representation of the device
tx_cfg	Current TX path configuration
rx_cfg	Current RX path configuration
num	Port number
shared	Set when port can be shared by different clients
claimed	Reference count of clients which claimed the port
lock	Serialize port claim
async	Asynchronous transfer callback
setup	Callback to set the HSI client configuration
flush	Callback to clean the HW state and destroy all pending transfers
start_tx	Callback to inform that a client wants to TX data
stop_tx	Callback to inform that a client no longer wishes to TX data
release	Callback to inform that a client no longer uses the port
n_head	Notifier chain for signaling port events to the clients.

Name

struct hsi_controller — HSI controller device

Synopsis

```
struct hsi_controller {  
    struct device device;  
    struct module * owner;  
    unsigned int id;  
    unsigned int num_ports;  
    struct hsi_port ** port;  
};
```

Members

device	Driver model representation of the device
owner	Pointer to the module owning the controller
id	HSI controller ID
num_ports	Number of ports in the HSI controller
port	Array of HSI ports

Name

`hsi_id` — Get HSI controller ID associated to a client

Synopsis

```
unsigned int hsi_id (struct hsi_client * cl);
```

Arguments

cl Pointer to a HSI client

Description

Return the controller id where the client is attached to

Name

`hsi_port_id` — Gets the port number a client is attached to

Synopsis

```
unsigned int hsi_port_id (struct hsi_client * cl);
```

Arguments

cl Pointer to HSI client

Description

Return the port number associated to the client

Name

`hsi_setup` — Configure the client's port

Synopsis

```
int hsi_setup (struct hsi_client * cl);
```

Arguments

cl Pointer to the HSI client

Description

When sharing ports, clients should either relay on a single client setup or have the same setup for all of them.

Return `-errno` on failure, 0 on success

Name

`hsi_flush` — Flush all pending transactions on the client's port

Synopsis

```
int hsi_flush (struct hsi_client * cl);
```

Arguments

cl Pointer to the HSI client

Description

This function will destroy all pending `hsi_msg` in the port and reset the HW port so it is ready to receive and transmit from a clean state.

Return `-errno` on failure, 0 on success

Name

`hsi_async_read` — Submit a read transfer

Synopsis

```
int hsi_async_read (struct hsi_client * cl, struct hsi_msg * msg);
```

Arguments

cl Pointer to the HSI client

msg HSI message descriptor of the transfer

Description

Return `-errno` on failure, 0 on success

Name

`hsi_async_write` — Submit a write transfer

Synopsis

```
int hsi_async_write (struct hsi_client * cl, struct hsi_msg * msg);
```

Arguments

cl Pointer to the HSI client

msg HSI message descriptor of the transfer

Description

Return `-errno` on failure, 0 on success

Name

`hsi_start_tx` — Signal the port that the client wants to start a TX

Synopsis

```
int hsi_start_tx (struct hsi_client * cl);
```

Arguments

cl Pointer to the HSI client

Description

Return `-errno` on failure, 0 on success

Name

`hsi_stop_tx` — Signal the port that the client no longer wants to transmit

Synopsis

```
int hsi_stop_tx (struct hsi_client * cl);
```

Arguments

cl Pointer to the HSI client

Description

Return `-errno` on failure, 0 on success

Name

`hsi_port_unregister_clients` — Unregister an HSI port

Synopsis

```
void hsi_port_unregister_clients (struct hsi_port * port);
```

Arguments

port The HSI port to unregister

Name

`hsi_unregister_controller` — Unregister an HSI controller

Synopsis

```
void hsi_unregister_controller (struct hsi_controller * hsi);
```

Arguments

hsi The HSI controller to register

Name

`hsi_register_controller` — Register an HSI controller and its ports

Synopsis

```
int hsi_register_controller (struct hsi_controller * hsi);
```

Arguments

hsi The HSI controller to register

Description

Returns `-errno` on failure, 0 on success.

Name

`hsi_register_client_driver` — Register an HSI client to the HSI bus

Synopsis

```
int hsi_register_client_driver (struct hsi_client_driver * drv);
```

Arguments

drv HSI client driver to register

Description

Returns `-errno` on failure, 0 on success.

Name

`hsi_put_controller` — Free an HSI controller

Synopsis

```
void hsi_put_controller (struct hsi_controller * hsi);
```

Arguments

hsi Pointer to the HSI controller to freed

Description

HSI controller drivers should only use this function if they need to free their allocated `hsi_controller` structures before a successful call to `hsi_register_controller`. Other use is not allowed.

Name

`hsi_alloc_controller` — Allocate an HSI controller and its ports

Synopsis

```
struct hsi_controller * hsi_alloc_controller (unsigned int n_ports,  
gfp_t flags);
```

Arguments

n_ports Number of ports on the HSI controller

flags Kernel allocation flags

Description

Return NULL on failure or a pointer to an `hsi_controller` on success.

Name

`hsi_free_msg` — Free an HSI message

Synopsis

```
void hsi_free_msg (struct hsi_msg * msg);
```

Arguments

msg Pointer to the HSI message

Description

Client is responsible to free the buffers pointed by the scatterlists.

Name

`hsi_alloc_msg` — Allocate an HSI message

Synopsis

```
struct hsi_msg * hsi_alloc_msg (unsigned int nents, gfp_t flags);
```

Arguments

nents Number of memory entries

flags Kernel allocation flags

Description

nents can be 0. This mainly makes sense for read transfer. In that case, HSI drivers will call the complete callback when there is data to be read without consuming it.

Return NULL on failure or a pointer to an `hsi_msg` on success.

Name

`hsi_async` — Submit an HSI transfer to the controller

Synopsis

```
int hsi_async (struct hsi_client * cl, struct hsi_msg * msg);
```

Arguments

cl HSI client sending the transfer

msg The HSI transfer passed to controller

Description

The HSI message must have the channel, ttype, complete and destructor fields set beforehand. If nents > 0 then the client has to initialize also the scatterlists to point to the buffers to write to or read from.

HSI controllers relay on pre-allocated buffers from their clients and they do not allocate buffers on their own.

Once the HSI message transfer finishes, the HSI controller calls the complete callback with the status and actual_len fields of the HSI message updated. The complete callback can be called before returning from `hsi_async`.

Returns -errno on failure or 0 on success

Name

`hsi_claim_port` — Claim the HSI client's port

Synopsis

```
int hsi_claim_port (struct hsi_client * cl, unsigned int share);
```

Arguments

cl HSI client that wants to claim its port

share Flag to indicate if the client wants to share the port or not.

Description

Returns `-errno` on failure, 0 on success.

Name

`hsi_release_port` — Release the HSI client's port

Synopsis

```
void hsi_release_port (struct hsi_client * cl);
```

Arguments

cl HSI client which previously claimed its port

Name

`hsi_register_port_event` — Register a client to receive port events

Synopsis

```
int hsi_register_port_event (struct hsi_client * cl, void (*handler)  
(struct hsi_client *, unsigned long));
```

Arguments

cl HSI client that wants to receive port events

handler Event handler callback

Description

Clients should register a callback to be able to receive events from the ports. Registration should happen after claiming the port. The handler can be called in interrupt context.

Returns -errno on error, or 0 on success.

Name

`hsi_unregister_port_event` — Stop receiving port events for a client

Synopsis

```
int hsi_unregister_port_event (struct hsi_client * cl);
```

Arguments

cl HSI client that wants to stop receiving port events

Description

Clients should call this function before releasing their associated port.

Returns `-errno` on error, or `0` on success.

Name

`hsi_event` — Notifies clients about port events

Synopsis

```
int hsi_event (struct hsi_port * port, unsigned long event);
```

Arguments

port Port where the event occurred

event The event type

Description

Clients should not be concerned about wake line behavior. However, due to a race condition in HSI HW protocol, clients need to be notified about wake line changes, so they can implement a workaround for it.

Events

HSI_EVENT_START_RX - Incoming wake line high
HSI_EVENT_STOP_RX - Incoming wake line down

Returns -errno on error, or 0 on success.

Name

`hsi_get_channel_id_by_name` — acquire channel id by channel name

Synopsis

```
int hsi_get_channel_id_by_name (struct hsi_client * cl, char * name);
```

Arguments

cl HSI client, which uses the channel

name name the channel is known under

Description

Clients can call this function to get the hsi channel ids similar to requesting IRQs or GPIOs by name. This function assumes the same channel configuration is used for RX and TX.

Returns -errno on error or channel id on success.