libATA Developer's Guide

Jeff Garzik

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by Jeff Garzik

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Chapter 1. Introduction

libATA is a library used inside the Linux kernel to support ATA host controllers and devices. libATA provides an ATA driver API, class transports for ATA and ATAPI devices, and SCSI<->ATA translation for ATA devices according to the T10 SAT specification.

This Guide documents the libATA driver API, library functions, library internals, and a couple sample ATA low-level drivers.

Chapter 2. libata Driver API

struct ata_port_operations is defined for every low-level libata hardware driver, and it controls how the low-level driver interfaces with the ATA and SCSI layers.

FIS-based drivers will hook into the system with ->qc_prep() and ->qc_issue() high-level hooks. Hardware which behaves in a manner similar to PCI IDE hardware may utilize several generic helpers, defining at a bare minimum the bus I/O addresses of the ATA shadow register blocks.

struct ata_port_operations

Disable ATA port

```
void (*port_disable) (struct ata_port *);
```

Called from ata_bus_probe() error path, as well as when unregistering from the SCSI module (rmmod, hot unplug). This function should do whatever needs to be done to take the port out of use. In most cases, ata_port_disable() can be used as this hook.

Called from ata_bus_probe() on a failed probe. Called from ata_scsi_release().

Post-IDENTIFY device configuration

```
void (*dev_config) (struct ata_port *, struct ata_device *);
```

Called after IDENTIFY [PACKET] DEVICE is issued to each device found. Typically used to apply device-specific fixups prior to issue of SET FEATURES - XFER MODE, and prior to operation.

This entry may be specified as NULL in ata_port_operations.

Set PIO/DMA mode

```
void (*set_piomode) (struct ata_port *, struct ata_device *);
void (*set_dmamode) (struct ata_port *, struct ata_device *);
void (*post_set_mode) (struct ata_port *);
unsigned int (*mode_filter) (struct ata_port *, struct ata_device *, unsigned int)
```

Hooks called prior to the issue of SET FEATURES - XFER MODE command. The optional ->mode_filter() hook is called when libata has built a mask of the possible modes. This is passed to the ->mode_filter() function which should return a mask of valid modes after filtering those unsuitable due to hardware limits. It is not valid to use this interface to add modes.

dev->pio_mode and dev->dma_mode are guaranteed to be valid when ->set_piomode() and when ->set_dmamode() is called. The timings for any other drive sharing the cable will also be valid at this point. That is the library records the decisions for the modes of each drive on a channel before it attempts to set any of them.

->post_set_mode() is called unconditionally, after the SET FEATURES - XFER MODE command completes successfully.

->set_piomode() is always called (if present), but ->set_dma_mode() is only called if DMA is possible.

Taskfile read/write

```
void (*sff_tf_load) (struct ata_port *ap, struct ata_taskfile *tf);
void (*sff_tf_read) (struct ata_port *ap, struct ata_taskfile *tf);
```

->tf_load() is called to load the given taskfile into hardware registers / DMA buffers. ->tf_read() is called to read the hardware registers / DMA buffers, to obtain the current set of taskfile register values. Most drivers for taskfile-based hardware (PIO or MMIO) use ata_sff_tf_load() and ata_sff_tf_read() for these hooks.

PIO data read/write

```
void (*sff_data_xfer) (struct ata_device *, unsigned char *, unsigned int, int);
```

All bmdma-style drivers must implement this hook. This is the low-level operation that actually copies the data bytes during a PIO data transfer. Typically the driver will choose one of ata_sff_data_xfer_noirq(), ata_sff_data_xfer(), or ata_sff_data_xfer32().

ATA command execute

```
void (*sff_exec_command)(struct ata_port *ap, struct ata_taskfile *tf);
```

causes an ATA command, previously loaded with ->tf_load(), to be initiated in hardware. Most drivers for taskfile-based hardware use ata_sff_exec_command() for this hook.

Per-cmd ATAPI DMA capabilities filter

```
int (*check_atapi_dma) (struct ata_queued_cmd *qc);
```

Allow low-level driver to filter ATA PACKET commands, returning a status indicating whether or not it is OK to use DMA for the supplied PACKET command.

This hook may be specified as NULL, in which case libata will assume that atapi dma can be supported.

Read specific ATA shadow registers

```
u8   (*sff_check_status)(struct ata_port *ap);
u8   (*sff_check_altstatus)(struct ata_port *ap);
```

Reads the Status/AltStatus ATA shadow register from hardware. On some hardware, reading the Status register has the side effect of clearing the interrupt condition. Most drivers for taskfile-based hardware use ata_sff_check_status() for this hook.

Write specific ATA shadow register

```
void (*sff_set_devctl)(struct ata_port *ap, u8 ctl);
```

Write the device control ATA shadow register to the hardware. Most drivers don't need to define this.

Select ATA device on bus

```
void (*sff_dev_select)(struct ata_port *ap, unsigned int device);
```

Issues the low-level hardware command(s) that causes one of N hardware devices to be considered 'selected' (active and available for use) on the ATA bus. This generally has no meaning on FIS-based devices.

Most drivers for taskfile-based hardware use ata_sff_dev_select() for this hook.

Private tuning method

```
void (*set_mode) (struct ata_port *ap);
```

By default libata performs drive and controller tuning in accordance with the ATA timing rules and also applies blacklists and cable limits. Some controllers need special handling and have custom tuning rules, typically raid controllers that use ATA commands but do not actually do drive timing.

Warning

This hook should not be used to replace the standard controller tuning logic when a controller has quirks. Replacing the default tuning logic in that case would bypass handling for drive and bridge quirks that may be important to data reliability. If a controller needs to filter the mode selection it should use the mode_filter hook instead.

Control PCI IDE BMDMA engine

```
void (*bmdma_setup) (struct ata_queued_cmd *qc);
void (*bmdma_start) (struct ata_queued_cmd *qc);
void (*bmdma_stop) (struct ata_port *ap);
u8   (*bmdma_status) (struct ata_port *ap);
```

When setting up an IDE BMDMA transaction, these hooks arm (->bmdma_setup), fire (->bmdma_start), and halt (->bmdma_stop) the hardware's DMA engine. ->bmdma_status is used to read the standard PCI IDE DMA Status register.

These hooks are typically either no-ops, or simply not implemented, in FIS-based drivers.

Most legacy IDE drivers use ata_bmdma_setup() for the bmdma_setup() hook. ata_bmdma_setup() will write the pointer to the PRD table to the IDE PRD Table Address register, enable DMA in the DMA Command register, and call exec_command() to begin the transfer.

Most legacy IDE drivers use ata_bmdma_start() for the bmdma_start() hook. ata_bmdma_start() will write the ATA_DMA_START flag to the DMA Command register.

Many legacy IDE drivers use ata_bmdma_stop() for the bmdma_stop() hook. ata_bmdma_stop() clears the ATA_DMA_START flag in the DMA command register.

Many legacy IDE drivers use ata_bmdma_status() as the bmdma_status() hook.

High-level taskfile hooks

```
void (*qc_prep) (struct ata_queued_cmd *qc);
int (*qc_issue) (struct ata_queued_cmd *qc);
```

Higher-level hooks, these two hooks can potentially supercede several of the above taskfile/DMA engine hooks. ->qc_prep is called after the buffers have been DMA-mapped, and is typically used to populate the hardware's DMA scatter-gather table. Most drivers use the standard ata_qc_prep() helper function, but more advanced drivers roll their own.

->qc_issue is used to make a command active, once the hardware and S/G tables have been prepared. IDE BMDMA drivers use the helper function ata_qc_issue_prot() for taskfile protocol-based dispatch. More advanced drivers implement their own ->qc_issue.

ata_qc_issue_prot() calls ->tf_load(), ->bmdma_setup(), and ->bmdma_start() as necessary to initiate a transfer.

Exception and probe handling (EH)

```
void (*eng_timeout) (struct ata_port *ap);
void (*phy_reset) (struct ata_port *ap);
```

Deprecated. Use ->error_handler() instead.

```
void (*freeze) (struct ata_port *ap);
void (*thaw) (struct ata_port *ap);
```

ata_port_freeze() is called when HSM violations or some other condition disrupts normal operation of the port. A frozen port is not allowed to perform any operation until the port is thawed, which usually follows a successful reset.

The optional ->freeze() callback can be used for freezing the port hardware-wise (e.g. mask interrupt and stop DMA engine). If a port cannot be frozen hardware-wise, the interrupt handler must ack and clear interrupts unconditionally while the port is frozen.

The optional ->thaw() callback is called to perform the opposite of ->freeze(): prepare the port for normal operation once again. Unmask interrupts, start DMA engine, etc.

```
void (*error_handler) (struct ata_port *ap);
```

->error_handler() is a driver's hook into probe, hotplug, and recovery and other exceptional conditions. The primary responsibility of an implementation is to call ata_do_eh() or ata_bmdma_drive_eh() with a set of EH hooks as arguments:

'prereset' hook (may be NULL) is called during an EH reset, before any other actions are taken.

'postreset' hook (may be NULL) is called after the EH reset is performed. Based on existing conditions, severity of the problem, and hardware capabilities,

Either 'softreset' (may be NULL) or 'hardreset' (may be NULL) will be called to perform the low-level EH reset.

```
void (*post_internal_cmd) (struct ata_queued_cmd *qc);
```

Perform any hardware-specific actions necessary to finish processing after executing a probe-time or EH-time command via ata_exec_internal().

Hardware interrupt handling

```
irqreturn_t (*irq_handler)(int, void *, struct pt_regs *);
void (*irq_clear) (struct ata_port *);
```

->irq_handler is the interrupt handling routine registered with the system, by libata. ->irq_clear is called during probe just before the interrupt handler is registered, to be sure hardware is quiet.

The second argument, dev_instance, should be cast to a pointer to struct ata_host_set.

Most legacy IDE drivers use ata_sff_interrupt() for the irq_handler hook, which scans all ports in the host_set, determines which queued command was active (if any), and calls ata_sff_host_intr(ap,qc).

Most legacy IDE drivers use ata_sff_irq_clear() for the irq_clear() hook, which simply clears the interrupt and error flags in the DMA status register.

SATA phy read/write

```
int (*scr_read) (struct ata_port *ap, unsigned int sc_reg,
   u32 *val);
int (*scr_write) (struct ata_port *ap, unsigned int sc_reg,
                  u32 val);
```

Read and write standard SATA phy registers. Currently only used if ->phy_reset hook called the sata_phy_reset() helper function. sc_reg is one of SCR_STATUS, SCR_CONTROL, SCR_ERROR, or SCR_ACTIVE.

Init and shutdown

```
int (*port_start) (struct ata_port *ap);
void (*port_stop) (struct ata_port *ap);
void (*host_stop) (struct ata_host_set *host_set);
```

->port_start() is called just after the data structures for each port are initialized. Typically this is used to alloc per-port DMA buffers / tables / rings, enable DMA engines, and similar tasks. Some drivers also use this entry point as a chance to allocate driver-private memory for ap->private_data.

Many drivers use ata_port_start() as this hook or call it from their own port_start() hooks. ata_port_start() allocates space for a legacy IDE PRD table and returns.

->port_stop() is called after ->host_stop(). Its sole function is to release DMA/memory resources, now that they are no longer actively being used. Many drivers also free driver-private data from port at this time.

->host_stop() is called after all ->port_stop() calls have completed. The hook must finalize hardware shut-down, release DMA and other resources, etc. This hook may be specified as NULL, in which case it is not called.

Chapter 3. Error handling

This chapter describes how errors are handled under libata. Readers are advised to read SCSI EH (Documentation/scsi/scsi_eh.txt) and ATA exceptions doc first.

Origins of commands

In libata, a command is represented with struct ata_queued_cmd or qc. qc's are preallocated during port initialization and repetitively used for command executions. Currently only one qc is allocated per port but yet-to-be-merged NCQ branch allocates one for each tag and maps each qc to NCQ tag 1-to-1.

libata commands can originate from two sources - libata itself and SCSI midlayer. libata internal commands are used for initialization and error handling. All normal blk requests and commands for SCSI emulation are passed as SCSI commands through queuecommand callback of SCSI host template.

How commands are issued

Internal commands

First, qc is allocated and initialized using ata_qc_new_init(). Although ata_qc_new_init() doesn't implement any wait or retry mechanism when qc is not available, internal commands are currently issued only during initialization and error recovery, so no other command is active and allocation is guaranteed to succeed.

Once allocated qc's taskfile is initialized for the command to be executed. qc currently has two mechanisms to notify completion. One is via qc->complete_fn() callback and the other is completion qc->waiting. qc->complete_fn() callback is the asynchronous path used by normal SCSI translated commands and qc->waiting is the synchronous (issuer sleeps in process context) path used by internal commands.

Once initialization is complete, host_set lock is acquired and the qc is issued.

SCSI commands

All libata drivers use ata_scsi_queuecmd() as hostt->queuecommand callback. scmds can either be simulated or translated. No qc is involved in processing a simulated scmd. The result is computed right away and the scmd is completed.

For a translated scmd, ata_qc_new_init() is invoked to allocate a qc and the scmd is translated into the qc. SCSI midlayer's completion notification function pointer is stored into qc->scsidone.

qc->complete_fn() callback is used for completion notification. ATA commands use ata_scsi_qc_complete() while ATAPI commands use atapi_qc_complete(). Both functions end up calling qc->scsidone to notify upper layer when the qc is finished. After translation is completed, the qc is issued with ata_qc_issue().

Note that SCSI midlayer invokes hostt->queuecommand while holding host_set lock, so all above occur while holding host_set lock.

How commands are processed

Depending on which protocol and which controller are used, commands are processed differently. For the purpose of discussion, a controller which uses taskfile interface and all standard callbacks is assumed.

Currently 6 ATA command protocols are used. They can be sorted into the following four categories according to how they are processed.

ATA NO DATA or DMA	ATA_PROT_NODATA and ATA_PROT_DMA fall into this category. These types of commands don't require any software intervention once issued. Device will raise interrupt on completion.
ATA PIO	ATA_PROT_PIO is in this category. libata currently implements PIO with polling. ATA_NIEN bit is set to turn off interrupt and pio_task on ata_wq performs polling and IO.
ATAPI NODATA or DMA	ATA_PROT_ATAPI_NODATA and ATA_PROT_ATAPI_DMA are in this category. packet_task is used to poll BSY bit after issuing PACKET command. Once BSY is turned off by the device, packet_task transfers CDB and hands off processing to interrupt handler.
ATAPI PIO	ATA_PROT_ATAPI is in this category. ATA_NIEN bit is set and, as in ATAPI NODATA or DMA, packet_task submits cdb. However, after submitting cdb, further processing (data transfer) is handed off to pio_task.

How commands are completed

Once issued, all qc's are either completed with ata_qc_complete() or time out. For commands which are handled by interrupts, ata_host_intr() invokes ata_qc_complete(), and, for PIO tasks, pio_task invokes ata_qc_complete(). In error cases, packet_task may also complete commands.

ata_qc_complete() does the following.

1. DMA memory is unmapped.
2. ATA_QCFLAG_ACTIVE is cleared from qc->flags.
3. qc->complete_fn() callback is invoked. If the return value of the callback is not zero. Completion is short circuited and ata_qc_complete() returns.
4. __ata_qc_complete() is called, which does
   a. qc->flags is cleared to zero.
   b. ap->active_tag and qc->tag are poisoned.
   c. qc->waiting is cleared & completed (in that order).
   d. qc is deallocated by clearing appropriate bit in ap->qactive.

So, it basically notifies upper layer and deallocates qc. One exception is short-circuit path in #3 which is used by atapi_qc_complete().

For all non-ATAPI commands, whether it fails or not, almost the same code path is taken and very little error handling takes place. A qc is completed with success status if it succeeded, with failed status otherwise.

However, failed ATAPI commands require more handling as REQUEST SENSE is needed to acquire sense data. If an ATAPI command fails, ata_qc_complete() is invoked with error status, which in turn invokes atapi_qc_complete() via qc->complete_fn() callback.

This makes atapi_qc_complete() set scmd->result to SAM_STAT_CHECK_CONDITION, complete the scmd and return 1. As the sense data is empty but scmd->result is CHECK CONDITION, SCSI midlayer will invoke EH for the scmd, and returning 1 makes ata_qc_complete() to return without deallocating the qc. This leads us to ata_scsi_error() with partially completed qc.

ata_scsi_error()

ata_scsi_error() is the current transportt->eh_strategy_handler() for libata. As discussed above, this will be entered in two cases - timeout and ATAPI error completion. This function calls low level libata driver's eng_timeout() callback, the standard callback for which is ata_eng_timeout(). It checks if a qc is active and calls ata_qc_timeout() on the qc if so. Actual error handling occurs in ata_qc_timeout().

If EH is invoked for timeout, ata_qc_timeout() stops BMDMA and completes the qc. Note that as we're currently in EH, we cannot call scsi_done. As described in SCSI EH doc, a recovered scmd should be either retried with scsi_queue_insert() or finished with scsi_finish_command(). Here, we override qc->scsidone with scsi_finish_command() and calls ata_qc_complete().

If EH is invoked due to a failed ATAPI qc, the qc here is completed but not deallocated. The purpose of this half-completion is to use the qc as place holder to make EH code reach this place. This is a bit hackish, but it works.

Once control reaches here, the qc is deallocated by invoking __ata_qc_complete() explicitly. Then, internal qc for REQUEST SENSE is issued. Once sense data is acquired, scmd is finished by directly invoking scsi_finish_command() on the scmd. Note that as we already have completed and deallocated the qc which was associated with the scmd, we don't need to/cannot call ata_qc_complete() again.

Problems with the current EH

- Error representation is too crude. Currently any and all error conditions are represented with ATA STATUS and ERROR registers. Errors which aren't ATA device errors are treated as ATA device errors by setting ATA_ERR bit. Better error descriptor which can properly represent ATA and other errors/exceptions is needed.
- When handling timeouts, no action is taken to make device forget about the timed out command and ready for new commands.
- EH handling via ata_scsi_error() is not properly protected from usual command processing. On EH entrance, the device is not in quiescent state. Timed out commands may succeed or fail any time. pio_task and atapi_task may still be running.
- Too weak error recovery. Devices / controllers causing HSM mismatch errors and other errors quite often require reset to return to known state. Also, advanced error handling is necessary to support features like NCQ and hotplug.
- ATA errors are directly handled in the interrupt handler and PIO errors in pio_task. This is problematic for advanced error handling for the following reasons.

  First, advanced error handling often requires context and internal qc execution.

  Second, even a simple failure (say, CRC error) needs information gathering and could trigger complex error handling (say, resetting & reconfiguring). Having multiple code paths to gather information, enter EH and trigger actions makes life painful.

Third, scattered EH code makes implementing low level drivers difficult. Low level drivers override libata callbacks. If EH is scattered over several places, each affected callbacks should perform its part of error handling. This can be error prone and painful.

Chapter 4. libata Library

Name

ata_link_next — link iteration helper

Synopsis

```
struct ata_link * ata_link_next (struct ata_link * link, struct ata_port
* ap, enum ata_link_iter_mode mode);
```

Arguments

link the previous link, NULL to start

ap ATA port containing links to iterate

mode iteration mode, one of ATA_LITER_*

LOCKING

Host lock or EH context.

RETURNS

Pointer to the next link.

Name

ata_dev_next — device iteration helper

Synopsis

```
struct ata_device * ata_dev_next (struct ata_device * dev, struct ata_link * link, enum ata_dev_iter_mode mode);
```

Arguments

dev the previous device, NULL to start

link ATA link containing devices to iterate

mode iteration mode, one of ATA_DITER_*

LOCKING

Host lock or EH context.

RETURNS

Pointer to the next device.

Name

atapi_cmd_type — Determine ATAPI command type from SCSI opcode

Synopsis

```
int atapi_cmd_type (u8 opcode);
```

Arguments

opcode SCSI opcode

Description

Determine ATAPI command type from *opcode*.

LOCKING

None.

RETURNS

ATAPI_{READ|WRITE|READ_CD|PASS_THRU|MISC}

Name

ata_tf_to_fis — Convert ATA taskfile to SATA FIS structure

Synopsis

```
void ata_tf_to_fis (const struct ata_taskfile * tf, u8 pmp, int is_cmd,
u8 * fis);
```

Arguments

tf	Taskfile to convert
pmp	Port multiplier port
is_cmd	This FIS is for command
fis	Buffer into which data will output

Description

Converts a standard ATA taskfile to a Serial ATA FIS structure (Register - Host to Device).

LOCKING

Inherited from caller.

Name

ata_tf_from_fis — Convert SATA FIS to ATA taskfile

Synopsis

```
void ata_tf_from_fis (const u8 * fis, struct ata_taskfile * tf);
```

Arguments

fis Buffer from which data will be input

tf Taskfile to output

Description

Converts a serial ATA FIS structure to a standard ATA taskfile.

LOCKING

Inherited from caller.

Name

ata_pack_xfermask — Pack pio, mwdma and udma masks into xfer_mask

Synopsis

```
unsigned long ata_pack_xfermask (unsigned long pio_mask, unsigned long
mwdma_mask, unsigned long udma_mask);
```

Arguments

pio_mask pio_mask

mwdma_mask mwdma_mask

udma_mask udma_mask

Description

Pack *pio_mask*, *mwdma_mask* and *udma_mask* into a single unsigned int xfer_mask.

LOCKING

None.

RETURNS

Packed xfer_mask.

Name

ata_unpack_xfermask — Unpack xfer_mask into pio, mwdma and udma masks

Synopsis

```
void ata_unpack_xfermask (unsigned long xfer_mask, unsigned long * pio_mask, unsigned long * mwdma_mask, unsigned long * udma_mask);
```

Arguments

xfer_mask xfer_mask to unpack

pio_mask resulting pio_mask

mwdma_mask resulting mwdma_mask

udma_mask resulting udma_mask

Description

Unpack *xfer_mask* into *pio_mask*, *mwdma_mask* and *udma_mask*. Any NULL distination masks will be ignored.

Name

ata_xfer_mask2mode — Find matching XFER_* for the given xfer_mask

Synopsis

```
u8 ata_xfer_mask2mode (unsigned long xfer_mask);
```

Arguments

xfer_mask xfer_mask of interest

Description

Return matching XFER_* value for *xfer_mask*. Only the highest bit of *xfer_mask* is considered.

LOCKING

None.

RETURNS

Matching XFER_* value, 0xff if no match found.

Name

ata_xfer_mode2mask — Find matching xfer_mask for XFER_*

Synopsis

```
unsigned long ata_xfer_mode2mask (u8 xfer_mode);
```

Arguments

xfer_mode XFER_* of interest

Description

Return matching xfer_mask for *xfer_mode*.

LOCKING

None.

RETURNS

Matching xfer_mask, 0 if no match found.

Name

ata_xfer_mode2shift — Find matching xfer_shift for XFER_*

Synopsis

```
int ata_xfer_mode2shift (unsigned long xfer_mode);
```

Arguments

xfer_mode XFER_* of interest

Description

Return matching xfer_shift for *xfer_mode*.

LOCKING

None.

RETURNS

Matching xfer_shift, -1 if no match found.

Name

ata_mode_string — convert xfer_mask to string

Synopsis

```
const char * ata_mode_string (unsigned long xfer_mask);
```

Arguments

xfer_mask mask of bits supported; only highest bit counts.

Description

Determine string which represents the highest speed (highest bit in *modemask*).

LOCKING

None.

RETURNS

Constant C string representing highest speed listed in *mode_mask*, or the constant C string “<n/a>”.

Name

ata_dev_classify — determine device type based on ATA-spec signature

Synopsis

```
unsigned int ata_dev_classify (const struct ata_taskfile * tf);
```

Arguments

tf ATA taskfile register set for device to be identified

Description

Determine from taskfile register contents whether a device is ATA or ATAPI, as per “Signature and persistence” section of ATA/PI spec (volume 1, sect 5.14).

LOCKING

None.

RETURNS

Device type, `ATA_DEV_ATA`, `ATA_DEV_ATAPI`, `ATA_DEV_PMP`, `ATA_DEV_ZAC`, or `ATA_DEV_UNKNOWN` the event of failure.

Name

ata_id_string — Convert IDENTIFY DEVICE page into string

Synopsis

```
void ata_id_string (const u16 * id, unsigned char * s, unsigned int ofs, unsigned int len);
```

Arguments

id IDENTIFY DEVICE results we will examine

s string into which data is output

ofs offset into identify device page

len length of string to return. must be an even number.

Description

The strings in the IDENTIFY DEVICE page are broken up into 16-bit chunks. Run through the string, and output each 8-bit chunk linearly, regardless of platform.

LOCKING

caller.

Name

ata_id_c_string — Convert IDENTIFY DEVICE page into C string

Synopsis

```
void ata_id_c_string (const u16 * id, unsigned char * s, unsigned int ofs, unsigned int len);
```

Arguments

id IDENTIFY DEVICE results we will examine

s string into which data is output

ofs offset into identify device page

len length of string to return. must be an odd number.

Description

This function is identical to ata_id_string except that it trims trailing spaces and terminates the resulting string with null. *len* must be actual maximum length (even number) + 1.

LOCKING

caller.

Name

ata_id_xfermask — Compute xfermask from the given IDENTIFY data

Synopsis

```
unsigned long ata_id_xfermask (const u16 * id);
```

Arguments

id IDENTIFY data to compute xfer mask from

Description

Compute the xfermask for this device. This is not as trivial as it seems if we must consider early devices correctly.

FIXME

pre IDE drive timing (do we care ?).

LOCKING

None.

RETURNS

Computed xfermask

Name

ata_pio_need_iordy — check if iordy needed

Synopsis

```
unsigned int ata_pio_need_iordy (const struct ata_device * adev);
```

Arguments

adev ATA device

Description

Check if the current speed of the device requires IORDY. Used by various controllers for chip configuration.

Name

ata_do_dev_read_id — default ID read method

Synopsis

```
unsigned int ata_do_dev_read_id (struct ata_device * dev, struct
ata_taskfile * tf, u16 * id);
```

Arguments

dev device

tf proposed taskfile

id data buffer

Description

Issue the identify taskfile and hand back the buffer containing identify data. For some RAID controllers and for pre ATA devices this function is wrapped or replaced by the driver

Name

ata_cable_40wire — return 40 wire cable type

Synopsis

```
int ata_cable_40wire (struct ata_port * ap);
```

Arguments

ap port

Description

Helper method for drivers which want to hardwire 40 wire cable detection.

Name

ata_cable_80wire — return 80 wire cable type

Synopsis

```
int ata_cable_80wire (struct ata_port * ap);
```

Arguments

ap port

Description

Helper method for drivers which want to hardwire 80 wire cable detection.

Name

ata_cable_unknown — return unknown PATA cable.

Synopsis

```
int ata_cable_unknown (struct ata_port * ap);
```

Arguments

ap port

Description

Helper method for drivers which have no PATA cable detection.

Name

ata_cable_ignore — return ignored PATA cable.

Synopsis

```
int ata_cable_ignore (struct ata_port * ap);
```

Arguments

ap port

Description

Helper method for drivers which don't use cable type to limit transfer mode.

Name

ata_cable_sata — return SATA cable type

Synopsis

```
int ata_cable_sata (struct ata_port * ap);
```

Arguments

ap port

Description

Helper method for drivers which have SATA cables

Name

ata_dev_pair — return other device on cable

Synopsis

```
struct ata_device * ata_dev_pair (struct ata_device * adev);
```

Arguments

adev device

Description

Obtain the other device on the same cable, or if none is present NULL is returned

Name

sata_set_spd — set SATA spd according to spd limit

Synopsis

```
int sata_set_spd (struct ata_link * link);
```

Arguments

link Link to set SATA spd for

Description

Set SATA spd of *link* according to sata_spd_limit.

LOCKING

Inherited from caller.

RETURNS

0 if spd doesn't need to be changed, 1 if spd has been changed. Negative errno if SCR registers are inaccessible.

Name

ata_timing_cycle2mode — find xfer mode for the specified cycle duration

Synopsis

```
u8 ata_timing_cycle2mode (unsigned int xfer_shift, int cycle);
```

Arguments

xfer_shift ATA_SHIFT_* value for transfer type to examine.

cycle cycle duration in ns

Description

Return matching xfer mode for *cycle*. The returned mode is of the transfer type specified by *xfer_shift*. If *cycle* is too slow for *xfer_shift*, 0xff is returned. If *cycle* is faster than the fastest known mode, the fasted mode is returned.

LOCKING

None.

RETURNS

Matching xfer_mode, 0xff if no match found.

Name

ata_do_set_mode — Program timings and issue SET FEATURES - XFER

Synopsis

```
int ata_do_set_mode (struct ata_link * link, struct ata_device ** r_failed_dev);
```

Arguments

link	link on which timings will be programmed
r_failed_dev	out parameter for failed device

Description

Standard implementation of the function used to tune and set ATA device disk transfer mode (PIO3, UDMA6, etc.). If `ata_dev_set_mode` fails, pointer to the failing device is returned in *r_failed_dev*.

LOCKING

PCI/etc. bus probe sem.

RETURNS

0 on success, negative errno otherwise

Name

ata_wait_after_reset — wait for link to become ready after reset

Synopsis

```
int ata_wait_after_reset (struct ata_link * link, unsigned long dead-
line, int (*check_ready) (struct ata_link *link));
```

Arguments

link	link to be waited on
deadline	deadline jiffies for the operation
check_ready	callback to check link readiness

Description

Wait for *link* to become ready after reset.

LOCKING

EH context.

RETURNS

0 if *linke* is ready before *deadline*; otherwise, -errno.

Name

sata_link_debounce — debounce SATA phy status

Synopsis

```
int sata_link_debounce (struct ata_link * link, const unsigned long *
params, unsigned long deadline);
```

Arguments

link	ATA link to debounce SATA phy status for
params	timing parameters { interval, duratinon, timeout } in msec
deadline	deadline jiffies for the operation

Description

Make sure SStatus of *link* reaches stable state, determined by holding the same value where DET is not 1 for *duration* polled every *interval*, before *timeout*. Timeout constraints the beginning of the stable state. Because DET gets stuck at 1 on some controllers after hot unplugging, this functions waits until timeout then returns 0 if DET is stable at 1.

timeout is further limited by *deadline*. The sooner of the two is used.

LOCKING

Kernel thread context (may sleep)

RETURNS

0 on success, -errno on failure.

Name

sata_link_resume — resume SATA link

Synopsis

```
int sata_link_resume (struct ata_link * link, const unsigned long *
params, unsigned long deadline);
```

Arguments

link	ATA link to resume SATA
params	timing parameters { interval, duratinon, timeout } in msec
deadline	deadline jiffies for the operation

Description

Resume SATA phy *link* and debounce it.

LOCKING

Kernel thread context (may sleep)

RETURNS

0 on success, -errno on failure.

Name

sata_link_scr_lpm — manipulate SControl IPM and SPM fields

Synopsis

```
int sata_link_scr_lpm (struct ata_link * link, enum ata_lpm_policy policy, bool spm_wakeup);
```

Arguments

link	ATA link to manipulate SControl for
policy	LPM policy to configure
spm_wakeup	initiate LPM transition to active state

Description

Manipulate the IPM field of the SControl register of *link* according to *policy*. If *policy* is ATA_LPM_MAX_POWER and *spm_wakeup* is `true`, the SPM field is manipulated to wake up the link. This function also clears PHYRDY_CHG before returning.

LOCKING

EH context.

RETURNS

0 on success, -errno otherwise.

Name

ata_std_prereset — prepare for reset

Synopsis

```
int ata_std_prereset (struct ata_link * link, unsigned long deadline);
```

Arguments

link ATA link to be reset

deadline deadline jiffies for the operation

Description

link is about to be reset. Initialize it. Failure from prereset makes libata abort whole reset sequence and give up that port, so prereset should be best-effort. It does its best to prepare for reset sequence but if things go wrong, it should just whine, not fail.

LOCKING

Kernel thread context (may sleep)

RETURNS

0 on success, -errno otherwise.

Name

sata_link_hardreset — reset link via SATA phy reset

Synopsis

```
int sata_link_hardreset (struct ata_link * link, const unsigned long
* timing, unsigned long deadline, bool * online, int (*check_ready)
(struct ata_link *));
```

Arguments

link	link to reset
timing	timing parameters { interval, duratinon, timeout } in msec
deadline	deadline jiffies for the operation
online	optional out parameter indicating link onlineness
check_ready	optional callback to check link readiness

Description

SATA phy-reset *link* using DET bits of SControl register. After hardreset, link readiness is waited upon using `ata_wait_ready` if *check_ready* is specified. LLDs are allowed to not specify *check_ready* and wait itself after this function returns. Device classification is LLD's responsibility.

**online* is set to one iff reset succeeded and *link* is online after reset.

LOCKING

Kernel thread context (may sleep)

RETURNS

0 on success, -errno otherwise.

Name

sata_std_hardreset — COMRESET w/o waiting or classification

Synopsis

```
int sata_std_hardreset (struct ata_link * link, unsigned int * class,
unsigned long deadline);
```

Arguments

link	link to reset
class	resulting class of attached device
deadline	deadline jiffies for the operation

Description

Standard SATA COMRESET w/o waiting or classification.

LOCKING

Kernel thread context (may sleep)

RETURNS

0 if link offline, -EAGAIN if link online, -errno on errors.

Name

ata_std_postreset — standard postreset callback

Synopsis

```
void ata_std_postreset (struct ata_link * link, unsigned int * classes);
```

Arguments

link the target ata_link

classes classes of attached devices

Description

This function is invoked after a successful reset. Note that the device might have been reset more than once using different reset methods before postreset is invoked.

LOCKING

Kernel thread context (may sleep)

Name

ata_dev_set_feature — Issue SET FEATURES - SATA FEATURES

Synopsis

```
unsigned int ata_dev_set_feature (struct ata_device * dev, u8 enable,
u8 feature);
```

Arguments

dev Device to which command will be sent

enable Whether to enable or disable the feature

feature The sector count represents the feature to set

Description

Issue SET FEATURES - SATA FEATURES command to device *dev* on port *ap* with sector count

LOCKING

PCI/etc. bus probe sem.

RETURNS

0 on success, AC_ERR_* mask otherwise.

Name

ata_std_qc_defer — Check whether a qc needs to be deferred

Synopsis

```
int ata_std_qc_defer (struct ata_queued_cmd * qc);
```

Arguments

qc ATA command in question

Description

Non-NCQ commands cannot run with any other command, NCQ or not. As upper layer only knows the queue depth, we are responsible for maintaining exclusion. This function checks whether a new command *qc* can be issued.

LOCKING

spin_lock_irqsave(host lock)

RETURNS

ATA_DEFER_* if deferring is needed, 0 otherwise.

Name

ata_sg_init — Associate command with scatter-gather table.

Synopsis

```
void ata_sg_init (struct ata_queued_cmd * qc, struct scatterlist * sg,
unsigned int n_elem);
```

Arguments

qc Command to be associated

sg Scatter-gather table.

n_elem Number of elements in s/g table.

Description

Initialize the data-related elements of queued_cmd *qc* to point to a scatter-gather table *sg*, containing *n_elem* elements.

LOCKING

spin_lock_irqsave(host lock)

Name

ata_qc_complete — Complete an active ATA command

Synopsis

```
void ata_qc_complete (struct ata_queued_cmd * qc);
```

Arguments

qc Command to complete

Description

Indicate to the mid and upper layers that an ATA command has completed, with either an ok or not-ok status.

Refrain from calling this function multiple times when successfully completing multiple NCQ commands. `ata_qc_complete_multiple` should be used instead, which will properly update IRQ expect state.

LOCKING

spin_lock_irqsave(host lock)

Name

ata_qc_complete_multiple — Complete multiple qcs successfully

Synopsis

```
int ata_qc_complete_multiple (struct ata_port * ap, u32 qc_active);
```

Arguments

ap port in question

qc_active new qc_active mask

Description

Complete in-flight commands. This functions is meant to be called from low-level driver's interrupt routine to complete requests normally. ap->qc_active and *qc_active* is compared and commands are completed accordingly.

Always use this function when completing multiple NCQ commands from IRQ handlers instead of calling `ata_qc_complete` multiple times to keep IRQ expect status properly in sync.

LOCKING

spin_lock_irqsave(host lock)

RETURNS

Number of completed commands on success, -errno otherwise.

Name

sata_scr_valid — test whether SCRs are accessible

Synopsis

```
int sata_scr_valid (struct ata_link * link);
```

Arguments

link ATA link to test SCR accessibility for

Description

Test whether SCRs are accessible for *link*.

LOCKING

None.

RETURNS

1 if SCRs are accessible, 0 otherwise.

Name

sata_scr_read — read SCR register of the specified port

Synopsis

```
int sata_scr_read (struct ata_link * link, int reg, u32 * val);
```

Arguments

link ATA link to read SCR for

reg SCR to read

val Place to store read value

Description

Read SCR register *reg* of *link* into **val*. This function is guaranteed to succeed if *link* is ap->link, the cable type of the port is SATA and the port implements ->scr_read.

LOCKING

None if *link* is ap->link. Kernel thread context otherwise.

RETURNS

0 on success, negative errno on failure.

Name

sata_scr_write — write SCR register of the specified port

Synopsis

```
int sata_scr_write (struct ata_link * link, int reg, u32 val);
```

Arguments

link ATA link to write SCR for

reg SCR to write

val value to write

Description

Write *val* to SCR register *reg* of *link*. This function is guaranteed to succeed if *link* is ap->link, the cable type of the port is SATA and the port implements ->scr_read.

LOCKING

None if *link* is ap->link. Kernel thread context otherwise.

RETURNS

0 on success, negative errno on failure.

Name

sata_scr_write_flush — write SCR register of the specified port and flush

Synopsis

```
int sata_scr_write_flush (struct ata_link * link, int reg, u32 val);
```

Arguments

link ATA link to write SCR for

reg SCR to write

val value to write

Description

This function is identical to `sata_scr_write` except that this function performs flush after writing to the register.

LOCKING

None if *link* is ap->link. Kernel thread context otherwise.

RETURNS

0 on success, negative errno on failure.

Name

ata_link_online — test whether the given link is online

Synopsis

```
bool ata_link_online (struct ata_link * link);
```

Arguments

link ATA link to test

Description

Test whether *link* is online. This is identical to `ata_phys_link_online` when there's no slave link. When there's a slave link, this function should only be called on the master link and will return true if any of M/S links is online.

LOCKING

None.

RETURNS

True if the port online status is available and online.

Name

ata_link_offline — test whether the given link is offline

Synopsis

```
bool ata_link_offline (struct ata_link * link);
```

Arguments

link ATA link to test

Description

Test whether *link* is offline. This is identical to `ata_phys_link_offline` when there's no slave link. When there's a slave link, this function should only be called on the master link and will return true if both M/S links are offline.

LOCKING

None.

RETURNS

True if the port offline status is available and offline.

Name

ata_host_suspend — suspend host

Synopsis

```
int ata_host_suspend (struct ata_host * host, pm_message_t mesg);
```

Arguments

host host to suspend

mesg PM message

Description

Suspend *host*. Actual operation is performed by port suspend.

Name

ata_host_resume — resume host

Synopsis

```
void ata_host_resume (struct ata_host * host);
```

Arguments

host host to resume

Description

Resume *host*. Actual operation is performed by port resume.

Name

ata_host_alloc — allocate and init basic ATA host resources

Synopsis

```
struct ata_host * ata_host_alloc (struct device * dev, int max_ports);
```

Arguments

dev generic device this host is associated with

max_ports maximum number of ATA ports associated with this host

Description

Allocate and initialize basic ATA host resources. LLD calls this function to allocate a host, initializes it fully and attaches it using `ata_host_register`.

max_ports ports are allocated and host->n_ports is initialized to *max_ports*. The caller is allowed to decrease host->n_ports before calling `ata_host_register`. The unused ports will be automatically freed on registration.

RETURNS

Allocate ATA host on success, NULL on failure.

LOCKING

Inherited from calling layer (may sleep).

Name

ata_host_alloc_pinfo — alloc host and init with port_info array

Synopsis

```
struct ata_host * ata_host_alloc_pinfo (struct device * dev, const
struct ata_port_info *const * ppi, int n_ports);
```

Arguments

dev generic device this host is associated with

ppi array of ATA port_info to initialize host with

n_ports number of ATA ports attached to this host

Description

Allocate ATA host and initialize with info from *ppi*. If NULL terminated, *ppi* may contain fewer entries than *n_ports*. The last entry will be used for the remaining ports.

RETURNS

Allocate ATA host on success, NULL on failure.

LOCKING

Inherited from calling layer (may sleep).

Name

ata_slave_link_init — initialize slave link

Synopsis

```
int ata_slave_link_init (struct ata_port * ap);
```

Arguments

ap port to initialize slave link for

Description

Create and initialize slave link for *ap*. This enables slave link handling on the port.

In libata, a port contains links and a link contains devices. There is single host link but if a PMP is attached to it, there can be multiple fan-out links. On SATA, there's usually a single device connected to a link but PATA and SATA controllers emulating TF based interface can have two - master and slave.

However, there are a few controllers which don't fit into this abstraction too well - SATA controllers which emulate TF interface with both master and slave devices but also have separate SCR register sets for each device. These controllers need separate links for physical link handling (e.g. onlineness, link speed) but should be treated like a traditional M/S controller for everything else (e.g. command issue, softreset).

slave_link is libata's way of handling this class of controllers without impacting core layer too much. For anything other than physical link handling, the default host link is used for both master and slave. For physical link handling, separate *ap*->slave_link is used. All dirty details are implemented inside libata core layer. From LLD's POV, the only difference is that prereset, hardreset and postreset are called once more for the slave link, so the reset sequence looks like the following.

prereset(M) -> prereset(S) -> hardreset(M) -> hardreset(S) -> softreset(M) -> postreset(M) -> postreset(S)

Note that softreset is called only for the master. Softreset resets both M/S by definition, so SRST on master should handle both (the standard method will work just fine).

LOCKING

Should be called before host is registered.

RETURNS

0 on success, -errno on failure.

Name

ata_host_start — start and freeze ports of an ATA host

Synopsis

```
int ata_host_start (struct ata_host * host);
```

Arguments

host ATA host to start ports for

Description

Start and then freeze ports of *host*. Started status is recorded in host->flags, so this function can be called multiple times. Ports are guaranteed to get started only once. If host->ops isn't initialized yet, its set to the first non-dummy port ops.

LOCKING

Inherited from calling layer (may sleep).

RETURNS

0 if all ports are started successfully, -errno otherwise.

Name

ata_host_init — Initialize a host struct for sas (ipr, libsas)

Synopsis

```
void ata_host_init (struct ata_host * host, struct device * dev, struct
ata_port_operations * ops);
```

Arguments

host host to initialize

dev device host is attached to

ops port_ops

Name

ata_host_register — register initialized ATA host

Synopsis

```
int ata_host_register (struct ata_host * host, struct scsi_host_template
* sht);
```

Arguments

host ATA host to register

sht template for SCSI host

Description

Register initialized ATA host. *host* is allocated using `ata_host_alloc` and fully initialized by LLD. This function starts ports, registers *host* with ATA and SCSI layers and probe registered devices.

LOCKING

Inherited from calling layer (may sleep).

RETURNS

0 on success, -errno otherwise.

Name

ata_host_activate — start host, request IRQ and register it

Synopsis

```
int ata_host_activate (struct ata_host * host, int irq, irq_handler_t
irq_handler, unsigned long irq_flags, struct scsi_host_template * sht);
```

Arguments

host	target ATA host
irq	IRQ to request
irq_handler	irq_handler used when requesting IRQ
irq_flags	irq_flags used when requesting IRQ
sht	scsi_host_template to use when registering the host

Description

After allocating an ATA host and initializing it, most libata LLDs perform three steps to activate the host - start host, request IRQ and register it. This helper takes necessasry arguments and performs the three steps in one go.

An invalid IRQ skips the IRQ registration and expects the host to have set polling mode on the port. In this case, *irq_handler* should be NULL.

LOCKING

Inherited from calling layer (may sleep).

RETURNS

0 on success, -errno otherwise.

Name

ata_host_detach — Detach all ports of an ATA host

Synopsis

```
void ata_host_detach (struct ata_host * host);
```

Arguments

host Host to detach

Description

Detach all ports of *host*.

LOCKING

Kernel thread context (may sleep).

Name

ata_pci_remove_one — PCI layer callback for device removal

Synopsis

```
void ata_pci_remove_one (struct pci_dev * pdev);
```

Arguments

pdev PCI device that was removed

Description

PCI layer indicates to libata via this hook that hot-unplug or module unload event has occurred. Detach all ports. Resource release is handled via devres.

LOCKING

Inherited from PCI layer (may sleep).

Name

ata_platform_remove_one — Platform layer callback for device removal

Synopsis

```
int ata_platform_remove_one (struct platform_device * pdev);
```

Arguments

pdev Platform device that was removed

Description

Platform layer indicates to libata via this hook that hot-unplug or module unload event has occurred. Detach all ports. Resource release is handled via devres.

LOCKING

Inherited from platform layer (may sleep).

Name

ata_msleep — ATA EH owner aware msleep

Synopsis

```
void ata_msleep (struct ata_port * ap, unsigned int msecs);
```

Arguments

ap ATA port to attribute the sleep to

msecs duration to sleep in milliseconds

Description

Sleeps *msecs*. If the current task is owner of *ap*'s EH, the ownership is released before going to sleep and reacquired after the sleep is complete. IOW, other ports sharing the *ap*->host will be allowed to own the EH while this task is sleeping.

LOCKING

Might sleep.

Name

ata_wait_register — wait until register value changes

Synopsis

```
u32 ata_wait_register (struct ata_port * ap, void __iomem * reg, u32 mask, u32 val, unsigned long interval, unsigned long timeout);
```

Arguments

ap	ATA port to wait register for, can be NULL
reg	IO-mapped register
mask	Mask to apply to read register value
val	Wait condition
interval	polling interval in milliseconds
timeout	timeout in milliseconds

Description

Waiting for some bits of register to change is a common operation for ATA controllers. This function reads 32bit LE IO-mapped register *reg* and tests for the following condition.

(**reg* & mask) != val

If the condition is met, it returns; otherwise, the process is repeated after *interval_msec* until timeout.

LOCKING

Kernel thread context (may sleep)

RETURNS

The final register value.

Name

sata_lpm_ignore_phy_events — test if PHY event should be ignored

Synopsis

```
bool sata_lpm_ignore_phy_events (struct ata_link * link);
```

Arguments

link Link receiving the event

Description

Test whether the received PHY event has to be ignored or not.

RETURNS

True if the event has to be ignored.

Chapter 5. libata Core Internals

Name

ata_dev_phys_link — find physical link for a device

Synopsis

```
struct ata_link * ata_dev_phys_link (struct ata_device * dev);
```

Arguments

dev ATA device to look up physical link for

Description

Look up physical link which *dev* is attached to. Note that this is different from *dev*->link only when *dev* is on slave link. For all other cases, it's the same as *dev*->link.

LOCKING

Don't care.

RETURNS

Pointer to the found physical link.

Name

ata_force_cbl — force cable type according to libata.force

Synopsis

```
void ata_force_cbl (struct ata_port * ap);
```

Arguments

ap ATA port of interest

Description

Force cable type according to libata.force and whine about it. The last entry which has matching port number is used, so it can be specified as part of device force parameters. For example, both “a:40c,1.00:udma4” and “1.00:40c,udma4” have the same effect.

LOCKING

EH context.

Name

ata_force_link_limits — force link limits according to libata.force

Synopsis

```
void ata_force_link_limits (struct ata_link * link);
```

Arguments

link ATA link of interest

Description

Force link flags and SATA spd limit according to libata.force and whine about it. When only the port part is specified (e.g. 1:), the limit applies to all links connected to both the host link and all fan-out ports connected via PMP. If the device part is specified as 0 (e.g. 1.00:), it specifies the first fan-out link not the host link. Device number 15 always points to the host link whether PMP is attached or not. If the controller has slave link, device number 16 points to it.

LOCKING

EH context.

Name

ata_force_xfermask — force xfermask according to libata.force

Synopsis

```
void ata_force_xfermask (struct ata_device * dev);
```

Arguments

dev ATA device of interest

Description

Force xfer_mask according to libata.force and whine about it. For consistency with link selection, device number 15 selects the first device connected to the host link.

LOCKING

EH context.

Name

ata_force_horkage — force horkage according to libata.force

Synopsis

```
void ata_force_horkage (struct ata_device * dev);
```

Arguments

dev ATA device of interest

Description

Force horkage according to libata.force and whine about it. For consistency with link selection, device number 15 selects the first device connected to the host link.

LOCKING

EH context.

Name

ata_rwcmd_protocol — set taskfile r/w commands and protocol

Synopsis

```
int ata_rwcmd_protocol (struct ata_taskfile * tf, struct ata_device *
dev);
```

Arguments

tf command to examine and configure

dev device tf belongs to

Description

Examine the device configuration and tf->flags to calculate the proper read/write commands and protocol to use.

LOCKING

caller.

Name

ata_tf_read_block — Read block address from ATA taskfile

Synopsis

```
u64 ata_tf_read_block (const struct ata_taskfile * tf, struct ata_device
* dev);
```

Arguments

tf ATA taskfile of interest

dev ATA device *tf* belongs to

LOCKING

None.

Read block address from *tf*. This function can handle all three address formats - LBA, LBA48 and CHS. tf->protocol and flags select the address format to use.

RETURNS

Block address read from *tf*.

Name

ata_build_rw_tf — Build ATA taskfile for given read/write request

Synopsis

```
int ata_build_rw_tf (struct ata_taskfile * tf, struct ata_device * dev,
u64 block, u32 n_block, unsigned int tf_flags, unsigned int tag, int
class);
```

Arguments

tf	Target ATA taskfile
dev	ATA device *tf* belongs to
block	Block address
n_block	Number of blocks
tf_flags	RW/FUA etc...
tag	tag
class	IO priority class

LOCKING

None.

Build ATA taskfile *tf* for read/write request described by *block*, *n_block*, *tf_flags* and *tag* on *dev*.

RETURNS

0 on success, -ERANGE if the request is too large for *dev*, -EINVAL if the request is invalid.

Name

ata_read_native_max_address — Read native max address

Synopsis

```
int ata_read_native_max_address (struct ata_device * dev, u64 * max_sectors);
```

Arguments

dev	target device
max_sectors	out parameter for the result native max address

Description

Perform an LBA48 or LBA28 native size query upon the device in question.

RETURNS

0 on success, -EACCES if command is aborted by the drive. -EIO on other errors.

Name

ata_set_max_sectors — Set max sectors

Synopsis

```
int ata_set_max_sectors (struct ata_device * dev, u64 new_sectors);
```

Arguments

dev target device

new_sectors new max sectors value to set for the device

Description

Set max sectors of *dev* to *new_sectors*.

RETURNS

0 on success, -EACCES if command is aborted or denied (due to previous non-volatile SET_MAX) by the drive. -EIO on other errors.

Name

ata_hpa_resize — Resize a device with an HPA set

Synopsis

```
int ata_hpa_resize (struct ata_device * dev);
```

Arguments

dev Device to resize

Description

Read the size of an LBA28 or LBA48 disk with HPA features and resize it if required to the full size of the media. The caller must check the drive has the HPA feature set enabled.

RETURNS

0 on success, -errno on failure.

Name

ata_dump_id — IDENTIFY DEVICE info debugging output

Synopsis

```
void ata_dump_id (const u16 * id);
```

Arguments

id IDENTIFY DEVICE page to dump

Description

Dump selected 16-bit words from the given IDENTIFY DEVICE page.

LOCKING

caller.

Name

ata_exec_internal_sg — execute libata internal command

Synopsis

```
unsigned ata_exec_internal_sg (struct ata_device * dev, struct ata_task-
file * tf, const u8 * cdb, int dma_dir, struct scatterlist * sgl, un-
signed int n_elem, unsigned long timeout);
```

Arguments

dev	Device to which the command is sent
tf	Taskfile registers for the command and the result
cdb	CDB for packet command
dma_dir	Data transfer direction of the command
sgl	sg list for the data buffer of the command
n_elem	Number of sg entries
timeout	Timeout in msecs (0 for default)

Description

Executes libata internal command with timeout. *tf* contains command on entry and result on return. Timeout and error conditions are reported via return value. No recovery action is taken after a command times out. It's caller's duty to clean up after timeout.

LOCKING

None. Should be called with kernel context, might sleep.

RETURNS

Zero on success, AC_ERR_* mask on failure

Name

ata_exec_internal — execute libata internal command

Synopsis

```
unsigned ata_exec_internal (struct ata_device * dev, struct ata_taskfile
* tf, const u8 * cdb, int dma_dir, void * buf, unsigned int buflen,
unsigned long timeout);
```

Arguments

dev	Device to which the command is sent
tf	Taskfile registers for the command and the result
cdb	CDB for packet command
dma_dir	Data transfer direction of the command
buf	Data buffer of the command
buflen	Length of data buffer
timeout	Timeout in msecs (0 for default)

Description

Wrapper around `ata_exec_internal_sg` which takes simple buffer instead of sg list.

LOCKING

None. Should be called with kernel context, might sleep.

RETURNS

Zero on success, AC_ERR_* mask on failure

Name

ata_pio_mask_no_iordy — Return the non IORDY mask

Synopsis

```
u32 ata_pio_mask_no_iordy (const struct ata_device * adev);
```

Arguments

adev ATA device

Description

Compute the highest mode possible if we are not using iordy. Return -1 if no iordy mode is available.

Name

ata_dev_read_id — Read ID data from the specified device

Synopsis

```
int ata_dev_read_id (struct ata_device * dev, unsigned int * p_class,
unsigned int flags, u16 * id);
```

Arguments

dev	target device
p_class	pointer to class of the target device (may be changed)
flags	ATA_READID_* flags
id	buffer to read IDENTIFY data into

Description

Read ID data from the specified device. ATA_CMD_ID_ATA is performed on ATA devices and ATA_CMD_ID_ATAPI on ATAPI devices. This function also issues ATA_CMD_INIT_DEV_PARAMS for pre-ATA4 drives.

FIXME

ATA_CMD_ID_ATA is optional for early drives and right now we abort if we hit that case.

LOCKING

Kernel thread context (may sleep)

RETURNS

0 on success, -errno otherwise.

Name

ata_dev_configure — Configure the specified ATA/ATAPI device

Synopsis

```
int ata_dev_configure (struct ata_device * dev);
```

Arguments

dev Target device to configure

Description

Configure *dev* according to *dev*->id. Generic and low-level driver specific fixups are also applied.

LOCKING

Kernel thread context (may sleep)

RETURNS

0 on success, -errno otherwise

Name

ata_bus_probe — Reset and probe ATA bus

Synopsis

```
int ata_bus_probe (struct ata_port * ap);
```

Arguments

ap Bus to probe

Description

Master ATA bus probing function. Initiates a hardware-dependent bus reset, then attempts to identify any devices found on the bus.

LOCKING

PCI/etc. bus probe sem.

RETURNS

Zero on success, negative errno otherwise.

Name

sata_print_link_status — Print SATA link status

Synopsis

```
void sata_print_link_status (struct ata_link * link);
```

Arguments

link SATA link to printk link status about

Description

This function prints link speed and status of a SATA link.

LOCKING

None.

Name

sata_down_spd_limit — adjust SATA spd limit downward

Synopsis

```
int sata_down_spd_limit (struct ata_link * link, u32 spd_limit);
```

Arguments

link Link to adjust SATA spd limit for

spd_limit Additional limit

Description

Adjust SATA spd limit of *link* downward. Note that this function only adjusts the limit. The change must be applied using sata_set_spd.

If *spd_limit* is non-zero, the speed is limited to equal to or lower than *spd_limit* if such speed is supported. If *spd_limit* is slower than any supported speed, only the lowest supported speed is allowed.

LOCKING

Inherited from caller.

RETURNS

0 on success, negative errno on failure

Name

sata_set_spd_needed — is SATA spd configuration needed

Synopsis

```
int sata_set_spd_needed (struct ata_link * link);
```

Arguments

link Link in question

Description

Test whether the spd limit in SControl matches *link*->sata_spd_limit. This function is used to determine whether hardreset is necessary to apply SATA spd configuration.

LOCKING

Inherited from caller.

RETURNS

1 if SATA spd configuration is needed, 0 otherwise.

Name

ata_down_xfermask_limit — adjust dev xfer masks downward

Synopsis

```
int ata_down_xfermask_limit (struct ata_device * dev, unsigned int sel);
```

Arguments

dev Device to adjust xfer masks

sel ATA_DNXFER_* selector

Description

Adjust xfer masks of *dev* downward. Note that this function does not apply the change. Invoking `ata_set_mode` afterwards will apply the limit.

LOCKING

Inherited from caller.

RETURNS

0 on success, negative errno on failure

Name

ata_wait_ready — wait for link to become ready

Synopsis

```
int ata_wait_ready (struct ata_link * link, unsigned long deadline, int
(*check_ready) (struct ata_link *link));
```

Arguments

link	link to be waited on
deadline	deadline jiffies for the operation
check_ready	callback to check link readiness

Description

Wait for *link* to become ready. *check_ready* should return positive number if *link* is ready, 0 if it isn't, -ENODEV if link doesn't seem to be occupied, other errno for other error conditions.

Transient -ENODEV conditions are allowed for ATA_TMOUT_FF_WAIT.

LOCKING

EH context.

RETURNS

0 if *linke* is ready before *deadline*; otherwise, -errno.

Name

ata_dev_same_device — Determine whether new ID matches configured device

Synopsis

```
int ata_dev_same_device (struct ata_device * dev, unsigned int new_class, const u16 * new_id);
```

Arguments

dev	device to compare against
new_class	class of the new device
new_id	IDENTIFY page of the new device

Description

Compare *new_class* and *new_id* against *dev* and determine whether *dev* is the device indicated by *new_class* and *new_id*.

LOCKING

None.

RETURNS

1 if *dev* matches *new_class* and *new_id*, 0 otherwise.

Name

ata_dev_reread_id — Re-read IDENTIFY data

Synopsis

```
int ata_dev_reread_id (struct ata_device * dev, unsigned int readid_flags);
```

Arguments

dev	target ATA device
readid_flags	read ID flags

Description

Re-read IDENTIFY page and make sure *dev* is still attached to the port.

LOCKING

Kernel thread context (may sleep)

RETURNS

0 on success, negative errno otherwise

Name

ata_dev_revalidate — Revalidate ATA device

Synopsis

```
int ata_dev_revalidate (struct ata_device * dev, unsigned int new_class,
unsigned int readid_flags);
```

Arguments

dev	device to revalidate
new_class	new class code
readid_flags	read ID flags

Description

Re-read IDENTIFY page, make sure *dev* is still attached to the port and reconfigure it according to the new IDENTIFY page.

LOCKING

Kernel thread context (may sleep)

RETURNS

0 on success, negative errno otherwise

Name

ata_is_40wire — check drive side detection

Synopsis

```
int ata_is_40wire (struct ata_device * dev);
```

Arguments

dev device

Description

Perform drive side detection decoding, allowing for device vendors who can't follow the documentation.

Name

cable_is_40wire — 40/80/SATA decider

Synopsis

```
int cable_is_40wire (struct ata_port * ap);
```

Arguments

ap port to consider

Description

This function encapsulates the policy for speed management in one place. At the moment we don't cache the result but there is a good case for setting ap->cbl to the result when we are called with unknown cables (and figuring out if it impacts hotplug at all).

Return 1 if the cable appears to be 40 wire.

Name

ata_dev_xfermask — Compute supported xfermask of the given device

Synopsis

```
void ata_dev_xfermask (struct ata_device * dev);
```

Arguments

dev Device to compute xfermask for

Description

Compute supported xfermask of *dev* and store it in dev->*_mask. This function is responsible for applying all known limits including host controller limits, device blacklist, etc...

LOCKING

None.

Name

ata_dev_set_xfermode — Issue SET FEATURES - XFER MODE command

Synopsis

```
unsigned int ata_dev_set_xfermode (struct ata_device * dev);
```

Arguments

dev Device to which command will be sent

Description

Issue SET FEATURES - XFER MODE command to device *dev* on port *ap*.

LOCKING

PCI/etc. bus probe sem.

RETURNS

0 on success, AC_ERR_* mask otherwise.

Name

ata_dev_init_params — Issue INIT DEV PARAMS command

Synopsis

```
unsigned int ata_dev_init_params (struct ata_device * dev, u16 heads,
u16 sectors);
```

Arguments

dev Device to which command will be sent

heads Number of heads (taskfile parameter)

sectors Number of sectors (taskfile parameter)

LOCKING

Kernel thread context (may sleep)

RETURNS

0 on success, AC_ERR_* mask otherwise.

Name

ata_sg_clean — Unmap DMA memory associated with command

Synopsis

```
void ata_sg_clean (struct ata_queued_cmd * qc);
```

Arguments

qc Command containing DMA memory to be released

Description

Unmap all mapped DMA memory associated with this command.

LOCKING

spin_lock_irqsave(host lock)

Name

atapi_check_dma — Check whether ATAPI DMA can be supported

Synopsis

```
int atapi_check_dma (struct ata_queued_cmd * qc);
```

Arguments

qc Metadata associated with taskfile to check

Description

Allow low-level driver to filter ATA PACKET commands, returning a status indicating whether or not it is OK to use DMA for the supplied PACKET command.

LOCKING

spin_lock_irqsave(host lock)

RETURNS

0 when ATAPI DMA can be used nonzero otherwise

Name

ata_sg_setup — DMA-map the scatter-gather table associated with a command.

Synopsis

```
int ata_sg_setup (struct ata_queued_cmd * qc);
```

Arguments

qc Command with scatter-gather table to be mapped.

Description

DMA-map the scatter-gather table associated with queued_cmd *qc*.

LOCKING

spin_lock_irqsave(host lock)

RETURNS

Zero on success, negative on error.

Name

swap_buf_le16 — swap halves of 16-bit words in place

Synopsis

```
void swap_buf_le16 (u16 * buf, unsigned int buf_words);
```

Arguments

buf Buffer to swap

buf_words Number of 16-bit words in buffer.

Description

Swap halves of 16-bit words if needed to convert from little-endian byte order to native cpu byte order, or vice-versa.

LOCKING

Inherited from caller.

Name

ata_qc_new_init — Request an available ATA command, and initialize it

Synopsis

```
struct ata_queued_cmd * ata_qc_new_init (struct ata_device * dev, int tag);
```

Arguments

dev Device from whom we request an available command structure

tag tag

LOCKING

None.

Name

ata_qc_free — free unused ata_queued_cmd

Synopsis

```
void ata_qc_free (struct ata_queued_cmd * qc);
```

Arguments

qc Command to complete

Description

Designed to free unused ata_queued_cmd object in case something prevents using it.

LOCKING

spin_lock_irqsave(host lock)

Name

ata_qc_issue — issue taskfile to device

Synopsis

```
void ata_qc_issue (struct ata_queued_cmd * qc);
```

Arguments

qc command to issue to device

Description

Prepare an ATA command to submission to device. This includes mapping the data into a DMA-able area, filling in the S/G table, and finally writing the taskfile to hardware, starting the command.

LOCKING

spin_lock_irqsave(host lock)

Name

ata_phys_link_online — test whether the given link is online

Synopsis

```
bool ata_phys_link_online (struct ata_link * link);
```

Arguments

link ATA link to test

Description

Test whether *link* is online. Note that this function returns 0 if online status of *link* cannot be obtained, so ata_link_online(link) != !ata_link_offline(link).

LOCKING

None.

RETURNS

True if the port online status is available and online.

Name

ata_phys_link_offline — test whether the given link is offline

Synopsis

```
bool ata_phys_link_offline (struct ata_link * link);
```

Arguments

link ATA link to test

Description

Test whether *link* is offline. Note that this function returns 0 if offline status of *link* cannot be obtained, so ata_link_online(link) != !ata_link_offline(link).

LOCKING

None.

RETURNS

True if the port offline status is available and offline.

Name

ata_dev_init — Initialize an ata_device structure

Synopsis

```
void ata_dev_init (struct ata_device * dev);
```

Arguments

dev Device structure to initialize

Description

Initialize *dev* in preparation for probing.

LOCKING

Inherited from caller.

Name

ata_link_init — Initialize an ata_link structure

Synopsis

```
void ata_link_init (struct ata_port * ap, struct ata_link * link, int pmp);
```

Arguments

ap ATA port link is attached to

link Link structure to initialize

pmp Port multiplier port number

Description

Initialize *link*.

LOCKING

Kernel thread context (may sleep)

Name

sata_link_init_spd — Initialize link->sata_spd_limit

Synopsis

```
int sata_link_init_spd (struct ata_link * link);
```

Arguments

link Link to configure sata_spd_limit for

Description

Initialize *link*->[hw_]sata_spd_limit to the currently configured value.

LOCKING

Kernel thread context (may sleep).

RETURNS

0 on success, -errno on failure.

Name

ata_port_alloc — allocate and initialize basic ATA port resources

Synopsis

```
struct ata_port * ata_port_alloc (struct ata_host * host);
```

Arguments

host ATA host this allocated port belongs to

Description

Allocate and initialize basic ATA port resources.

RETURNS

Allocate ATA port on success, NULL on failure.

LOCKING

Inherited from calling layer (may sleep).

Name

ata_finalize_port_ops — finalize ata_port_operations

Synopsis

```
void ata_finalize_port_ops (struct ata_port_operations * ops);
```

Arguments

ops ata_port_operations to finalize

Description

An ata_port_operations can inherit from another ops and that ops can again inherit from another. This can go on as many times as necessary as long as there is no loop in the inheritance chain.

Ops tables are finalized when the host is started. NULL or unspecified entries are inherited from the closet ancestor which has the method and the entry is populated with it. After finalization, the ops table directly points to all the methods and ->inherits is no longer necessary and cleared.

Using ATA_OP_NULL, inheriting ops can force a method to NULL.

LOCKING

None.

Name

ata_port_detach — Detach ATA port in prepration of device removal

Synopsis

```
void ata_port_detach (struct ata_port * ap);
```

Arguments

ap ATA port to be detached

Description

Detach all ATA devices and the associated SCSI devices of *ap*; then, remove the associated SCSI host. *ap* is guaranteed to be quiescent on return from this function.

LOCKING

Kernel thread context (may sleep).

Chapter 6. libata SCSI translation/ emulation

Name

ata_std_bios_param — generic bios head/sector/cylinder calculator used by sd.

Synopsis

```
int ata_std_bios_param (struct scsi_device * sdev, struct block_device
* bdev, sector_t capacity, int geom[]);
```

Arguments

sdev	SCSI device for which BIOS geometry is to be determined
bdev	block device associated with *sdev*
capacity	capacity of SCSI device
geom[]	location to which geometry will be output

Description

Generic bios head/sector/cylinder calculator used by sd. Most BIOSes nowadays expect a XXX/255/16 (CHS) mapping. Some situations may arise where the disk is not bootable if this is not used.

LOCKING

Defined by the SCSI layer. We don't really care.

RETURNS

Zero.

Name

ata_scsi_unlock_native_capacity — unlock native capacity

Synopsis

```
void ata_scsi_unlock_native_capacity (struct scsi_device * sdev);
```

Arguments

sdev SCSI device to adjust device capacity for

Description

This function is called if a partition on *sdev* extends beyond the end of the device. It requests EH to unlock HPA.

LOCKING

Defined by the SCSI layer. Might sleep.

Name

ata_scsi_slave_config — Set SCSI device attributes

Synopsis

```
int ata_scsi_slave_config (struct scsi_device * sdev);
```

Arguments

sdev SCSI device to examine

Description

This is called before we actually start reading and writing to the device, to configure certain SCSI mid-layer behaviors.

LOCKING

Defined by SCSI layer. We don't really care.

Name

ata_scsi_slave_destroy — SCSI device is about to be destroyed

Synopsis

```
void ata_scsi_slave_destroy (struct scsi_device * sdev);
```

Arguments

sdev SCSI device to be destroyed

Description

sdev is about to be destroyed for hot/warm unplugging. If this unplugging was initiated by libata as indicated by NULL dev->sdev, this function doesn't have to do anything. Otherwise, SCSI layer initiated warm-unplug is in progress. Clear dev->sdev, schedule the device for ATA detach and invoke EH.

LOCKING

Defined by SCSI layer. We don't really care.

Name

__ata_change_queue_depth — helper for ata_scsi_change_queue_depth

Synopsis

```
int __ata_change_queue_depth (struct ata_port * ap, struct scsi_device
* sdev, int queue_depth);
```

Arguments

ap	ATA port to which the device change the queue depth
sdev	SCSI device to configure queue depth for
queue_depth	new queue depth

Description

libsas and libata have different approaches for associating a sdev to its ata_port.

Name

ata_scsi_change_queue_depth — SCSI callback for queue depth config

Synopsis

```
int ata_scsi_change_queue_depth (struct scsi_device * sdev, int queue_depth);
```

Arguments

sdev	SCSI device to configure queue depth for
queue_depth	new queue depth

Description

This is libata standard hostt->change_queue_depth callback. SCSI will call into this callback when user tries to set queue depth via sysfs.

LOCKING

SCSI layer (we don't care)

RETURNS

Newly configured queue depth.

Name

ata_scsi_queuecmd — Issue SCSI cdb to libata-managed device

Synopsis

```
int ata_scsi_queuecmd (struct Scsi_Host * shost, struct scsi_cmnd * cmd);
```

Arguments

shost SCSI host of command to be sent

cmd SCSI command to be sent

Description

In some cases, this function translates SCSI commands into ATA taskfiles, and queues the taskfiles to be sent to hardware. In other cases, this function simulates a SCSI device by evaluating and responding to certain SCSI commands. This creates the overall effect of ATA and ATAPI devices appearing as SCSI devices.

LOCKING

ATA host lock

RETURNS

Return value from `__ata_scsi_queuecmd` if *cmd* can be queued, 0 otherwise.

Name

ata_scsi_simulate — simulate SCSI command on ATA device

Synopsis

```
void ata_scsi_simulate (struct ata_device * dev, struct scsi_cmnd *
cmd);
```

Arguments

dev the target device

cmd SCSI command being sent to device.

Description

Interprets and directly executes a select list of SCSI commands that can be handled internally.

LOCKING

spin_lock_irqsave(host lock)

Name

ata_sas_port_alloc — Allocate port for a SAS attached SATA device

Synopsis

```
struct ata_port * ata_sas_port_alloc (struct ata_host * host, struct
ata_port_info * port_info, struct Scsi_Host * shost);
```

Arguments

host	ATA host container for all SAS ports
port_info	Information from low-level host driver
shost	SCSI host that the scsi device is attached to

LOCKING

PCI/etc. bus probe sem.

RETURNS

ata_port pointer on success / NULL on failure.

Name

ata_sas_port_start — Set port up for dma.

Synopsis

```
int ata_sas_port_start (struct ata_port * ap);
```

Arguments

ap Port to initialize

Description

Called just after data structures for each port are initialized.

May be used as the `port_start` entry in ata_port_operations.

LOCKING

Inherited from caller.

Name

ata_sas_port_stop — Undo `ata_sas_port_start`

Synopsis

```
void ata_sas_port_stop (struct ata_port * ap);
```

Arguments

ap Port to shut down

Description

May be used as the `port_stop` entry in ata_port_operations.

LOCKING

Inherited from caller.

Name

ata_sas_async_probe — simply schedule probing and return

Synopsis

```
void ata_sas_async_probe (struct ata_port * ap);
```

Arguments

ap Port to probe

Description

For batch scheduling of probe for sas attached ata devices, assumes the port has already been through `ata_sas_port_init`

Name

ata_sas_port_init — Initialize a SATA device

Synopsis

```
int ata_sas_port_init (struct ata_port * ap);
```

Arguments

ap SATA port to initialize

LOCKING

PCI/etc. bus probe sem.

RETURNS

Zero on success, non-zero on error.

Name

ata_sas_port_destroy — Destroy a SATA port allocated by ata_sas_port_alloc

Synopsis

```
void ata_sas_port_destroy (struct ata_port * ap);
```

Arguments

ap SATA port to destroy

Name

ata_sas_slave_configure — Default slave_config routine for libata devices

Synopsis

```
int ata_sas_slave_configure (struct scsi_device * sdev, struct ata_port
* ap);
```

Arguments

sdev SCSI device to configure

ap ATA port to which SCSI device is attached

RETURNS

Zero.

Name

ata_sas_queuecmd — Issue SCSI cdb to libata-managed device

Synopsis

```
int ata_sas_queuecmd (struct scsi_cmnd * cmd, struct ata_port * ap);
```

Arguments

cmd SCSI command to be sent

ap ATA port to which the command is being sent

RETURNS

Return value from `__ata_scsi_queuecmd` if *cmd* can be queued, 0 otherwise.

Name

ata_get_identity — Handler for HDIO_GET_IDENTITY ioctl

Synopsis

```
int ata_get_identity (struct ata_port * ap, struct scsi_device * sdev,
void __user * arg);
```

Arguments

ap target port

sdev SCSI device to get identify data for

arg User buffer area for identify data

LOCKING

Defined by the SCSI layer. We don't really care.

RETURNS

Zero on success, negative errno on error.

Name

ata_cmd_ioctl — Handler for HDIO_DRIVE_CMD ioctl

Synopsis

```
int ata_cmd_ioctl (struct scsi_device * scsidev, void __user * arg);
```

Arguments

scsidev Device to which we are issuing command

arg User provided data for issuing command

LOCKING

Defined by the SCSI layer. We don't really care.

RETURNS

Zero on success, negative errno on error.

Name

ata_task_ioctl — Handler for HDIO_DRIVE_TASK ioctl

Synopsis

```
int ata_task_ioctl (struct scsi_device * scsidev, void __user * arg);
```

Arguments

scsidev Device to which we are issuing command

arg User provided data for issuing command

LOCKING

Defined by the SCSI layer. We don't really care.

RETURNS

Zero on success, negative errno on error.

Name

ata_scsi_qc_new — acquire new ata_queued_cmd reference

Synopsis

```
struct ata_queued_cmd * ata_scsi_qc_new (struct ata_device * dev, struct
scsi_cmnd * cmd);
```

Arguments

dev ATA device to which the new command is attached

cmd SCSI command that originated this ATA command

Description

Obtain a reference to an unused ata_queued_cmd structure, which is the basic libata structure representing a single ATA command sent to the hardware.

If a command was available, fill in the SCSI-specific portions of the structure with information on the current command.

LOCKING

spin_lock_irqsave(host lock)

RETURNS

Command allocated, or NULL if none available.

Name

ata_dump_status — user friendly display of error info

Synopsis

```
void ata_dump_status (unsigned id, struct ata_taskfile * tf);
```

Arguments

id id of the port in question

tf ptr to filled out taskfile

Description

Decode and dump the ATA error/status registers for the user so that they have some idea what really happened at the non make-believe layer.

LOCKING

inherited from caller

Name

ata_to_sense_error — convert ATA error to SCSI error

Synopsis

```
void ata_to_sense_error (unsigned id, u8 drv_stat, u8 drv_err, u8 * sk,
u8 * asc, u8 * ascq, int verbose);
```

Arguments

id	ATA device number
drv_stat	value contained in ATA status register
drv_err	value contained in ATA error register
sk	the sense key we'll fill out
asc	the additional sense code we'll fill out
ascq	the additional sense code qualifier we'll fill out
verbose	be verbose

Description

Converts an ATA error into a SCSI error. Fill out pointers to SK, ASC, and ASCQ bytes for later use in fixed or descriptor format sense blocks.

LOCKING

spin_lock_irqsave(host lock)

Name

ata_gen_ata_sense — generate a SCSI fixed sense block

Synopsis

```
void ata_gen_ata_sense (struct ata_queued_cmd * qc);
```

Arguments

qc Command that we are erroring out

Description

Generate sense block for a failed ATA command *qc*. Descriptor format is used to accommodate LBA48 block address.

LOCKING

None.

Name

atapi_drain_needed — Check whether data transfer may overflow

Synopsis

```
int atapi_drain_needed (struct request * rq);
```

Arguments

rq request to be checked

Description

ATAPI commands which transfer variable length data to host might overflow due to application error or hardare bug. This function checks whether overflow should be drained and ignored for *request*.

LOCKING

None.

RETURNS

1 if ; otherwise, 0.

Name

ata_scsi_start_stop_xlat — Translate SCSI START STOP UNIT command

Synopsis

```
unsigned int ata_scsi_start_stop_xlat (struct ata_queued_cmd * qc);
```

Arguments

qc Storage for translated ATA taskfile

Description

Sets up an ATA taskfile to issue STANDBY (to stop) or READ VERIFY (to start). Perhaps these commands should be preceded by CHECK POWER MODE to see what power mode the device is already in. [See SAT revision 5 at www.t10.org]

LOCKING

spin_lock_irqsave(host lock)

RETURNS

Zero on success, non-zero on error.

Name

ata_scsi_flush_xlat — Translate SCSI SYNCHRONIZE CACHE command

Synopsis

```
unsigned int ata_scsi_flush_xlat (struct ata_queued_cmd * qc);
```

Arguments

qc Storage for translated ATA taskfile

Description

Sets up an ATA taskfile to issue FLUSH CACHE or FLUSH CACHE EXT.

LOCKING

spin_lock_irqsave(host lock)

RETURNS

Zero on success, non-zero on error.

Name

scsi_6_lba_len — Get LBA and transfer length

Synopsis

```
void scsi_6_lba_len (const u8 * cdb, u64 * plba, u32 * plen);
```

Arguments

cdb SCSI command to translate

plba the LBA

plen the transfer length

Description

Calculate LBA and transfer length for 6-byte commands.

Name

scsi_10_lba_len — Get LBA and transfer length

Synopsis

```
void scsi_10_lba_len (const u8 * cdb, u64 * plba, u32 * plen);
```

Arguments

cdb SCSI command to translate

plba the LBA

plen the transfer length

Description

Calculate LBA and transfer length for 10-byte commands.

Name

scsi_16_lba_len — Get LBA and transfer length

Synopsis

```
void scsi_16_lba_len (const u8 * cdb, u64 * plba, u32 * plen);
```

Arguments

cdb SCSI command to translate

plba the LBA

plen the transfer length

Description

Calculate LBA and transfer length for 16-byte commands.

Name

ata_scsi_verify_xlat — Translate SCSI VERIFY command into an ATA one

Synopsis

```
unsigned int ata_scsi_verify_xlat (struct ata_queued_cmd * qc);
```

Arguments

qc Storage for translated ATA taskfile

Description

Converts SCSI VERIFY command to an ATA READ VERIFY command.

LOCKING

spin_lock_irqsave(host lock)

RETURNS

Zero on success, non-zero on error.

Name

ata_scsi_rw_xlat — Translate SCSI r/w command into an ATA one

Synopsis

```
unsigned int ata_scsi_rw_xlat (struct ata_queued_cmd * qc);
```

Arguments

qc Storage for translated ATA taskfile

Description

Converts any of six SCSI read/write commands into the ATA counterpart, including starting sector (LBA), sector count, and taking into account the device's LBA48 support.

Commands `READ_6`, `READ_10`, `READ_16`, `WRITE_6`, `WRITE_10`, and `WRITE_16` are currently supported.

LOCKING

spin_lock_irqsave(host lock)

RETURNS

Zero on success, non-zero on error.

Name

ata_scsi_translate — Translate then issue SCSI command to ATA device

Synopsis

```
int ata_scsi_translate (struct ata_device * dev, struct scsi_cmnd * cmd,
ata_xlat_func_t xlat_func);
```

Arguments

dev ATA device to which the command is addressed

cmd SCSI command to execute

xlat_func Actor which translates *cmd* to an ATA taskfile

Description

Our ->queuecommand function has decided that the SCSI command issued can be directly translated into an ATA command, rather than handled internally.

This function sets up an ata_queued_cmd structure for the SCSI command, and sends that ata_queued_cmd to the hardware.

The xlat_func argument (actor) returns 0 if ready to execute ATA command, else 1 to finish translation. If 1 is returned then cmd->result (and possibly cmd->sense_buffer) are assumed to be set reflecting an error condition or clean (early) termination.

LOCKING

spin_lock_irqsave(host lock)

RETURNS

0 on success, SCSI_ML_QUEUE_DEVICE_BUSY if the command needs to be deferred.

Name

ata_scsi_rbuf_get — Map response buffer.

Synopsis

```
void * ata_scsi_rbuf_get (struct scsi_cmnd * cmd, bool copy_in, unsigned
long * flags);
```

Arguments

cmd	SCSI command containing buffer to be mapped.
copy_in	copy in from user buffer
flags	unsigned long variable to store irq enable status

Description

Prepare buffer for simulated SCSI commands.

LOCKING

spin_lock_irqsave(ata_scsi_rbuf_lock) on success

RETURNS

Pointer to response buffer.

Name

ata_scsi_rbuf_put — Unmap response buffer.

Synopsis

```
void ata_scsi_rbuf_put (struct scsi_cmnd * cmd, bool copy_out, unsigned long * flags);
```

Arguments

cmd	SCSI command containing buffer to be unmapped.
copy_out	copy out result
flags	*flags* passed to ata_scsi_rbuf_get

Description

Returns rbuf buffer. The result is copied to *cmd*'s buffer if *copy_back* is true.

LOCKING

Unlocks ata_scsi_rbuf_lock.

Name

ata_scsi_rbuf_fill — wrapper for SCSI command simulators

Synopsis

```
void ata_scsi_rbuf_fill (struct ata_scsi_args * args, unsigned int (*actor) (struct ata_scsi_args *args, u8 *rbuf));
```

Arguments

args device IDENTIFY data / SCSI command of interest.

actor Callback hook for desired SCSI command simulator

Description

Takes care of the hard work of simulating a SCSI command... Mapping the response buffer, calling the command's handler, and handling the handler's return value. This return value indicates whether the handler wishes the SCSI command to be completed successfully (0), or not (in which case cmd->result and sense buffer are assumed to be set).

LOCKING

spin_lock_irqsave(host lock)

Name

ata_scsiop_inq_std — Simulate INQUIRY command

Synopsis

```
unsigned int ata_scsiop_inq_std (struct ata_scsi_args * args, u8 * rbuf);
```

Arguments

args device IDENTIFY data / SCSI command of interest.

rbuf Response buffer, to which simulated SCSI cmd output is sent.

Description

Returns standard device identification data associated with non-VPD INQUIRY command output.

LOCKING

spin_lock_irqsave(host lock)

Name

ata_scsiop_inq_00 — Simulate INQUIRY VPD page 0, list of pages

Synopsis

```
unsigned int ata_scsiop_inq_00 (struct ata_scsi_args * args, u8 * rbuf);
```

Arguments

args device IDENTIFY data / SCSI command of interest.

rbuf Response buffer, to which simulated SCSI cmd output is sent.

Description

Returns list of inquiry VPD pages available.

LOCKING

spin_lock_irqsave(host lock)

Name

ata_scsiop_inq_80 — Simulate INQUIRY VPD page 80, device serial number

Synopsis

```
unsigned int ata_scsiop_inq_80 (struct ata_scsi_args * args, u8 * rbuf);
```

Arguments

args device IDENTIFY data / SCSI command of interest.

rbuf Response buffer, to which simulated SCSI cmd output is sent.

Description

Returns ATA device serial number.

LOCKING

spin_lock_irqsave(host lock)

Name

ata_scsiop_inq_83 — Simulate INQUIRY VPD page 83, device identity

Synopsis

```
unsigned int ata_scsiop_inq_83 (struct ata_scsi_args * args, u8 * rbuf);
```

Arguments

args device IDENTIFY data / SCSI command of interest.

rbuf Response buffer, to which simulated SCSI cmd output is sent.

Yields two logical unit device identification designators

- vendor specific ASCII containing the ATA serial number - SAT defined “t10 vendor id based” containing ASCII vendor name (“ATA ”), model and serial numbers.

LOCKING

spin_lock_irqsave(host lock)

Name

ata_scsiop_inq_89 — Simulate INQUIRY VPD page 89, ATA info

Synopsis

```
unsigned int ata_scsiop_inq_89 (struct ata_scsi_args * args, u8 * rbuf);
```

Arguments

args device IDENTIFY data / SCSI command of interest.

rbuf Response buffer, to which simulated SCSI cmd output is sent.

Description

Yields SAT-specified ATA VPD page.

LOCKING

spin_lock_irqsave(host lock)

Name

ata_scsiop_noop — Command handler that simply returns success.

Synopsis

```
unsigned int ata_scsiop_noop (struct ata_scsi_args * args, u8 * rbuf);
```

Arguments

args device IDENTIFY data / SCSI command of interest.

rbuf Response buffer, to which simulated SCSI cmd output is sent.

Description

No operation. Simply returns success to caller, to indicate that the caller should successfully complete this SCSI command.

LOCKING

spin_lock_irqsave(host lock)

Name

modecpy — Prepare response for MODE SENSE

Synopsis

```
void modecpy (u8 * dest, const u8 * src, int n, bool changeable);
```

Arguments

dest	output buffer
src	data being copied
n	length of mode page
changeable	whether changeable parameters are requested

Description

Generate a generic MODE SENSE page for either current or changeable parameters.

LOCKING

None.

Name

ata_msense_caching — Simulate MODE SENSE caching info page

Synopsis

```
unsigned int ata_msense_caching (u16 * id, u8 * buf, bool changeable);
```

Arguments

id	device IDENTIFY data
buf	output buffer
changeable	whether changeable parameters are requested

Description

Generate a caching info page, which conditionally indicates write caching to the SCSI layer, depending on device capabilities.

LOCKING

None.

Name

ata_msense_control — Simulate MODE SENSE control mode page

Synopsis

```
unsigned int ata_msense_control (struct ata_device * dev, u8 * buf,
bool changeable);
```

Arguments

dev	ATA device of interest
buf	output buffer
changeable	whether changeable parameters are requested

Description

Generate a generic MODE SENSE control mode page.

LOCKING

None.

Name

ata_msense_rw_recovery — Simulate MODE SENSE r/w error recovery page

Synopsis

```
unsigned int ata_msense_rw_recovery (u8 * buf, bool changeable);
```

Arguments

buf output buffer

changeable whether changeable parameters are requested

Description

Generate a generic MODE SENSE r/w error recovery page.

LOCKING

None.

Name

ata_scsiop_mode_sense — Simulate MODE SENSE 6, 10 commands

Synopsis

```
unsigned int ata_scsiop_mode_sense (struct ata_scsi_args * args, u8 *
rbuf);
```

Arguments

args device IDENTIFY data / SCSI command of interest.

rbuf Response buffer, to which simulated SCSI cmd output is sent.

Description

Simulate MODE SENSE commands. Assume this is invoked for direct access devices (e.g. disks) only. There should be no block descriptor for other device types.

LOCKING

spin_lock_irqsave(host lock)

Name

ata_scsiop_read_cap — Simulate READ CAPACITY[16] commands

Synopsis

```
unsigned int ata_scsiop_read_cap (struct ata_scsi_args * args, u8 *
rbuf);
```

Arguments

args device IDENTIFY data / SCSI command of interest.

rbuf Response buffer, to which simulated SCSI cmd output is sent.

Description

Simulate READ CAPACITY commands.

LOCKING

None.

Name

ata_scsiop_report_luns — Simulate REPORT LUNS command

Synopsis

```
unsigned int ata_scsiop_report_luns (struct ata_scsi_args * args, u8
* rbuf);
```

Arguments

args device IDENTIFY data / SCSI command of interest.

rbuf Response buffer, to which simulated SCSI cmd output is sent.

Description

Simulate REPORT LUNS command.

LOCKING

spin_lock_irqsave(host lock)

Name

atapi_xlat — Initialize PACKET taskfile

Synopsis

```
unsigned int atapi_xlat (struct ata_queued_cmd * qc);
```

Arguments

qc command structure to be initialized

LOCKING

spin_lock_irqsave(host lock)

RETURNS

Zero on success, non-zero on failure.

Name

ata_scsi_find_dev — lookup ata_device from scsi_cmnd

Synopsis

```
struct ata_device * ata_scsi_find_dev (struct ata_port * ap, const
struct scsi_device * scsidev);
```

Arguments

ap ATA port to which the device is attached

scsidev SCSI device from which we derive the ATA device

Description

Given various information provided in struct scsi_cmnd, map that onto an ATA bus, and using that mapping determine which ata_device is associated with the SCSI command to be sent.

LOCKING

spin_lock_irqsave(host lock)

RETURNS

Associated ATA device, or `NULL` if not found.

Name

ata_scsi_pass_thru — convert ATA pass-thru CDB to taskfile

Synopsis

```
unsigned int ata_scsi_pass_thru (struct ata_queued_cmd * qc);
```

Arguments

qc command structure to be initialized

Description

Handles either 12 or 16-byte versions of the CDB.

RETURNS

Zero on success, non-zero on failure.

Name

ata_format_dsm_trim_descr — SATL Write Same to DSM Trim

Synopsis

```
size_t ata_format_dsm_trim_descr (struct scsi_cmnd * cmd, u32 trmax,
u64 sector, u32 count);
```

Arguments

cmd SCSI command being translated

trmax Maximum number of entries that will fit in sector_size bytes.

sector Starting sector

count Total Range of request in logical sectors

Description

Rewrite the WRITE SAME descriptor to be a DSM TRIM little-endian formatted descriptor.

63

48 Range Length

47

0 LBA

Range Length of 0 is ignored. LBA's should be sorted order and not overlap.

NOTE

this is the same format as ADD LBA(S) TO NV CACHE PINNED SET

Return

Number of bytes copied into sglist.

Name

ata_format_sct_write_same — SATL Write Same to ATA SCT Write Same

Synopsis

```
size_t ata_format_sct_write_same (struct scsi_cmnd * cmd, u64 lba, u64 num);
```

Arguments

cmd SCSI command being translated

lba Starting sector

num Number of sectors to be zero'd.

Description

Rewrite the WRITE SAME payload to be an SCT Write Same formatted descriptor.

NOTE

Writes a pattern (0's) in the foreground.

Return

Number of bytes copied into sglist.

Name

ata_scsi_write_same_xlat — SATL Write Same to ATA SCT Write Same

Synopsis

```
unsigned int ata_scsi_write_same_xlat (struct ata_queued_cmd * qc);
```

Arguments

qc Command to be translated

Description

Translate a SCSI WRITE SAME command to be either a DSM TRIM command or an SCT Write Same command. Based on WRITE SAME has the UNMAP flag When set translate to DSM TRIM When clear translate to SCT Write Same

Name

ata_scsiop_maint_in — Simulate a subset of MAINTENANCE_IN

Synopsis

```
unsigned int ata_scsiop_maint_in (struct ata_scsi_args * args, u8 *
rbuf);
```

Arguments

args device MAINTENANCE_IN data / SCSI command of interest.

rbuf Response buffer, to which simulated SCSI cmd output is sent.

Description

Yields a subset to satisfy `scsi_report_opcode`

LOCKING

spin_lock_irqsave(host lock)

Name

ata_scsi_report_zones_complete — convert ATA output

Synopsis

```
void ata_scsi_report_zones_complete (struct ata_queued_cmd * qc);
```

Arguments

qc command structure returning the data

Description

Convert T-13 little-endian field representation into T-10 big-endian field representation. What a mess.

Name

ata_mselect_caching — Simulate MODE SELECT for caching info page

Synopsis

```
int ata_mselect_caching (struct ata_queued_cmd * qc, const u8 * buf,
int len, u16 * fp);
```

Arguments

qc Storage for translated ATA taskfile

buf input buffer

len number of valid bytes in the input buffer

fp out parameter for the failed field on error

Description

Prepare a taskfile to modify caching information for the device.

LOCKING

None.

Name

ata_mselect_control — Simulate MODE SELECT for control page

Synopsis

```
int ata_mselect_control (struct ata_queued_cmd * qc, const u8 * buf,
int len, u16 * fp);
```

Arguments

qc Storage for translated ATA taskfile

buf input buffer

len number of valid bytes in the input buffer

fp out parameter for the failed field on error

Description

Prepare a taskfile to modify caching information for the device.

LOCKING

None.

Name

ata_scsi_mode_select_xlat — Simulate MODE SELECT 6, 10 commands

Synopsis

```
unsigned int ata_scsi_mode_select_xlat (struct ata_queued_cmd * qc);
```

Arguments

qc Storage for translated ATA taskfile

Description

Converts a MODE SELECT command to an ATA SET FEATURES taskfile. Assume this is invoked for direct access devices (e.g. disks) only. There should be no block descriptor for other device types.

LOCKING

spin_lock_irqsave(host lock)

Name

ata_get_xlat_func — check if SCSI to ATA translation is possible

Synopsis

```
ata_xlat_func_t ata_get_xlat_func (struct ata_device * dev, u8 cmd);
```

Arguments

dev ATA device

cmd SCSI command opcode to consider

Description

Look up the SCSI command given, and determine whether the SCSI command is to be translated or simulated.

RETURNS

Pointer to translation function if possible, NULL if not.

Name

ata_scsi_dump_cdb — dump SCSI command contents to dmesg

Synopsis

```
void ata_scsi_dump_cdb (struct ata_port * ap, struct scsi_cmnd * cmd);
```

Arguments

ap ATA port to which the command was being sent

cmd SCSI command to dump

Description

Prints the contents of a SCSI command via `printk`.

Name

ata_scsi_offline_dev — offline attached SCSI device

Synopsis

```
int ata_scsi_offline_dev (struct ata_device * dev);
```

Arguments

dev ATA device to offline attached SCSI device for

Description

This function is called from `ata_eh_hotplug` and responsible for taking the SCSI device attached to *dev* offline. This function is called with host lock which protects dev->sdev against clearing.

LOCKING

spin_lock_irqsave(host lock)

RETURNS

1 if attached SCSI device exists, 0 otherwise.

Name

ata_scsi_remove_dev — remove attached SCSI device

Synopsis

```
void ata_scsi_remove_dev (struct ata_device * dev);
```

Arguments

dev ATA device to remove attached SCSI device for

Description

This function is called from `ata_eh_scsi_hotplug` and responsible for removing the SCSI device attached to *dev*.

LOCKING

Kernel thread context (may sleep).

Name

ata_scsi_media_change_notify — send media change event

Synopsis

```
void ata_scsi_media_change_notify (struct ata_device * dev);
```

Arguments

dev Pointer to the disk device with media change event

Description

Tell the block layer to send a media change notification event.

LOCKING

spin_lock_irqsave(host lock)

Name

ata_scsi_hotplug — SCSI part of hotplug

Synopsis

```
void ata_scsi_hotplug (struct work_struct * work);
```

Arguments

work Pointer to ATA port to perform SCSI hotplug on

Description

Perform SCSI part of hotplug. It's executed from a separate workqueue after EH completes. This is necessary because SCSI hot plugging requires working EH and hot unplugging is synchronized with hot plugging with a mutex.

LOCKING

Kernel thread context (may sleep).

Name

ata_scsi_user_scan — indication for user-initiated bus scan

Synopsis

```
int ata_scsi_user_scan (struct Scsi_Host * shost, unsigned int channel,
unsigned int id, u64 lun);
```

Arguments

shost	SCSI host to scan
channel	Channel to scan
id	ID to scan
lun	LUN to scan

Description

This function is called when user explicitly requests bus scan. Set probe pending flag and invoke EH.

LOCKING

SCSI layer (we don't care)

RETURNS

Zero.

Name

ata_scsi_dev_rescan — initiate `scsi_rescan_device`

Synopsis

```
void ata_scsi_dev_rescan (struct work_struct * work);
```

Arguments

`work` Pointer to ATA port to perform `scsi_rescan_device`

Description

After ATA pass thru (SAT) commands are executed successfully, libata need to propagate the changes to SCSI layer.

LOCKING

Kernel thread context (may sleep).

Chapter 7. ATA errors and exceptions

This chapter tries to identify what error/exception conditions exist for ATA/ATAPI devices and describe how they should be handled in implementation-neutral way.

The term 'error' is used to describe conditions where either an explicit error condition is reported from device or a command has timed out.

The term 'exception' is either used to describe exceptional conditions which are not errors (say, power or hotplug events), or to describe both errors and non-error exceptional conditions. Where explicit distinction between error and exception is necessary, the term 'non-error exception' is used.

Exception categories

Exceptions are described primarily with respect to legacy taskfile + bus master IDE interface. If a controller provides other better mechanism for error reporting, mapping those into categories described below shouldn't be difficult.

In the following sections, two recovery actions - reset and reconfiguring transport - are mentioned. These are described further in the section called “EH recovery actions”.

HSM violation

This error is indicated when STATUS value doesn't match HSM requirement during issuing or execution any ATA/ATAPI command.

Examples

- ATA_STATUS doesn't contain !BSY && DRDY && !DRQ while trying to issue a command.
- !BSY && !DRQ during PIO data transfer.
- DRQ on command completion.
- !BSY && ERR after CDB transfer starts but before the last byte of CDB is transferred. ATA/ATAPI standard states that "The device shall not terminate the PACKET command with an error before the last byte of the command packet has been written" in the error outputs description of PACKET command and the state diagram doesn't include such transitions.

In these cases, HSM is violated and not much information regarding the error can be acquired from STATUS or ERROR register. IOW, this error can be anything - driver bug, faulty device, controller and/or cable.

As HSM is violated, reset is necessary to restore known state. Reconfiguring transport for lower speed might be helpful too as transmission errors sometimes cause this kind of errors.

ATA/ATAPI device error (non-NCQ / non-CHECK CONDITION)

These are errors detected and reported by ATA/ATAPI devices indicating device problems. For this type of errors, STATUS and ERROR register values are valid and describe error condition. Note that some of ATA bus errors are detected by ATA/ATAPI devices and reported using the same mechanism as device errors. Those cases are described later in this section.

For ATA commands, this type of errors are indicated by !BSY && ERR during command execution and on completion.

For ATAPI commands,

- !BSY && ERR && ABRT right after issuing PACKET indicates that PACKET command is not supported and falls in this category.
- !BSY && ERR(==CHK) && !ABRT after the last byte of CDB is transferred indicates CHECK CONDITION and doesn't fall in this category.
- !BSY && ERR(==CHK) && ABRT after the last byte of CDB is transferred *probably* indicates CHECK CONDITION and doesn't fall in this category.

Of errors detected as above, the followings are not ATA/ATAPI device errors but ATA bus errors and should be handled according to the section called “ATA bus error”.

CRC error during data transfer
: This is indicated by ICRC bit in the ERROR register and means that corruption occurred during data transfer. Up to ATA/ATAPI-7, the standard specifies that this bit is only applicable to UDMA transfers but ATA/ATAPI-8 draft revision 1f says that the bit may be applicable to multiword DMA and PIO.

ABRT error during data transfer or on completion
: Up to ATA/ATAPI-7, the standard specifies that ABRT could be set on ICRC errors and on cases where a device is not able to complete a command. Combined with the fact that MWDMA and PIO transfer errors aren't allowed to use ICRC bit up to ATA/ATAPI-7, it seems to imply that ABRT bit alone could indicate transfer errors.

  However, ATA/ATAPI-8 draft revision 1f removes the part that ICRC errors can turn on ABRT. So, this is kind of gray area. Some heuristics are needed here.

ATA/ATAPI device errors can be further categorized as follows.

Media errors
: This is indicated by UNC bit in the ERROR register. ATA devices reports UNC error only after certain number of retries cannot recover the data, so there's nothing much else to do other than notifying upper layer.

  READ and WRITE commands report CHS or LBA of the first failed sector but ATA/ATAPI standard specifies that the amount of transferred data on error completion is indeterminate, so we cannot assume that sectors preceding the failed sector have been transferred and thus cannot complete those sectors successfully as SCSI does.

Media changed / media change requested error
: <<TODO: fill here>>

Address error
: This is indicated by IDNF bit in the ERROR register. Report to upper layer.

Other errors
: This can be invalid command or parameter indicated by ABRT ERROR bit or some other error condition. Note that ABRT bit can indicate a lot of things including ICRC and Address errors. Heuristics needed.

Depending on commands, not all STATUS/ERROR bits are applicable. These non-applicable bits are marked with "na" in the output descriptions but up to ATA/ATAPI-7 no definition of "na" can be found. However, ATA/ATAPI-8 draft revision 1f describes "N/A" as follows.

> 3.2.3.3a N/A — A keyword the indicates a field has no defined value in this standard and should not be checked by the host or device. N/A fields should be cleared to zero.

So, it seems reasonable to assume that "na" bits are cleared to zero by devices and thus need no explicit masking.

ATAPI device CHECK CONDITION

ATAPI device CHECK CONDITION error is indicated by set CHK bit (ERR bit) in the STATUS register after the last byte of CDB is transferred for a PACKET command. For this kind of errors, sense data should be acquired to gather information regarding the errors. REQUEST SENSE packet command should be used to acquire sense data.

Once sense data is acquired, this type of errors can be handled similarly to other SCSI errors. Note that sense data may indicate ATA bus error (e.g. Sense Key 04h HARDWARE ERROR && ASC/ASCQ 47h/00h SCSI PARITY ERROR). In such cases, the error should be considered as an ATA bus error and handled according to the section called “ATA bus error”.

ATA device error (NCQ)

NCQ command error is indicated by cleared BSY and set ERR bit during NCQ command phase (one or more NCQ commands outstanding). Although STATUS and ERROR registers will contain valid values describing the error, READ LOG EXT is required to clear the error condition, determine which command has failed and acquire more information.

READ LOG EXT Log Page 10h reports which tag has failed and taskfile register values describing the error. With this information the failed command can be handled as a normal ATA command error as in the section called “ATA/ATAPI device error (non-NCQ / non-CHECK CONDITION)” and all other in-flight commands must be retried. Note that this retry should not be counted - it's likely that commands retried this way would have completed normally if it were not for the failed command.

Note that ATA bus errors can be reported as ATA device NCQ errors. This should be handled as described in the section called “ATA bus error”.

If READ LOG EXT Log Page 10h fails or reports NQ, we're thoroughly screwed. This condition should be treated according to the section called “HSM violation”.

ATA bus error

ATA bus error means that data corruption occurred during transmission over ATA bus (SATA or PATA). This type of errors can be indicated by

- ICRC or ABRT error as described in the section called “ATA/ATAPI device error (non-NCQ / non-CHECK CONDITION)”.
- Controller-specific error completion with error information indicating transmission error.
- On some controllers, command timeout. In this case, there may be a mechanism to determine that the timeout is due to transmission error.

- Unknown/random errors, timeouts and all sorts of weirdities.

As described above, transmission errors can cause wide variety of symptoms ranging from device ICRC error to random device lockup, and, for many cases, there is no way to tell if an error condition is due to transmission error or not; therefore, it's necessary to employ some kind of heuristic when dealing with errors and timeouts. For example, encountering repetitive ABRT errors for known supported command is likely to indicate ATA bus error.

Once it's determined that ATA bus errors have possibly occurred, lowering ATA bus transmission speed is one of actions which may alleviate the problem. See the section called “Reconfigure transport” for more information.

PCI bus error

Data corruption or other failures during transmission over PCI (or other system bus). For standard BMDMA, this is indicated by Error bit in the BMDMA Status register. This type of errors must be logged as it indicates something is very wrong with the system. Resetting host controller is recommended.

Late completion

This occurs when timeout occurs and the timeout handler finds out that the timed out command has completed successfully or with error. This is usually caused by lost interrupts. This type of errors must be logged. Resetting host controller is recommended.

Unknown error (timeout)

This is when timeout occurs and the command is still processing or the host and device are in unknown state. When this occurs, HSM could be in any valid or invalid state. To bring the device to known state and make it forget about the timed out command, resetting is necessary. The timed out command may be retried.

Timeouts can also be caused by transmission errors. Refer to the section called “ATA bus error” for more details.

Hotplug and power management exceptions

<<TODO: fill here>>

EH recovery actions

This section discusses several important recovery actions.

Clearing error condition

Many controllers require its error registers to be cleared by error handler. Different controllers may have different requirements.

For SATA, it's strongly recommended to clear at least SError register during error handling.

Reset

During EH, resetting is necessary in the following cases.

- HSM is in unknown or invalid state
- HBA is in unknown or invalid state
- EH needs to make HBA/device forget about in-flight commands
- HBA/device behaves weirdly

Resetting during EH might be a good idea regardless of error condition to improve EH robustness. Whether to reset both or either one of HBA and device depends on situation but the following scheme is recommended.

- When it's known that HBA is in ready state but ATA/ATAPI device is in unknown state, reset only device.
- If HBA is in unknown state, reset both HBA and device.

HBA resetting is implementation specific. For a controller complying to taskfile/BMDMA PCI IDE, stopping active DMA transaction may be sufficient iff BMDMA state is the only HBA context. But even mostly taskfile/BMDMA PCI IDE complying controllers may have implementation specific requirements and mechanism to reset themselves. This must be addressed by specific drivers.

OTOH, ATA/ATAPI standard describes in detail ways to reset ATA/ATAPI devices.

PATA hardware reset	This is hardware initiated device reset signalled with asserted PATA RESET- signal. There is no standard way to initiate hardware reset from software although some hardware provides registers that allow driver to directly tweak the RESET- signal.
Software reset	This is achieved by turning CONTROL SRST bit on for at least 5us. Both PATA and SATA support it but, in case of SATA, this may require controller-specific support as the second Register FIS to clear SRST should be transmitted while BSY bit is still set. Note that on PATA, this resets both master and slave devices on a channel.
EXECUTE DEVICE DIAGNOSTIC command	Although ATA/ATAPI standard doesn't describe exactly, EDD implies some level of resetting, possibly similar level with software reset. Host-side EDD protocol can be handled with normal command processing and most SATA controllers should be able to handle EDD's just like other commands. As in software reset, EDD affects both devices on a PATA bus. Although EDD does reset devices, this doesn't suit error handling as EDD cannot be issued while BSY is set and it's unclear how it will act when device is in unknown/weird state.
ATAPI DEVICE RESET command	This is very similar to software reset except that reset can be restricted to the selected device without affecting the other device sharing the cable.
SATA phy reset	This is the preferred way of resetting a SATA device. In effect, it's identical to PATA hardware reset. Note that this can be done with the standard SCR Control register. As such, it's usually easier to implement than software reset.

One more thing to consider when resetting devices is that resetting clears certain configuration parameters and they need to be set to their previous or newly adjusted values after reset.

Parameters affected are.

- CHS set up with INITIALIZE DEVICE PARAMETERS (seldom used)
- Parameters set with SET FEATURES including transfer mode setting
- Block count set with SET MULTIPLE MODE
- Other parameters (SET MAX, MEDIA LOCK...)

ATA/ATAPI standard specifies that some parameters must be maintained across hardware or software reset, but doesn't strictly specify all of them. Always reconfiguring needed parameters after reset is required for robustness. Note that this also applies when resuming from deep sleep (power-off).

Also, ATA/ATAPI standard requires that IDENTIFY DEVICE / IDENTIFY PACKET DEVICE is issued after any configuration parameter is updated or a hardware reset and the result used for further operation. OS driver is required to implement revalidation mechanism to support this.

Reconfigure transport

For both PATA and SATA, a lot of corners are cut for cheap connectors, cables or controllers and it's quite common to see high transmission error rate. This can be mitigated by lowering transmission speed.

The following is a possible scheme Jeff Garzik suggested.

> If more than $N (3?) transmission errors happen in 15 minutes,
>
> - if SATA, decrease SATA PHY speed. if speed cannot be decreased,
> - decrease UDMA xfer speed. if at UDMA0, switch to PIO4,
> - decrease PIO xfer speed. if at PIO3, complain, but continue

Chapter 8. ata_piix Internals

Name

ich_pata_cable_detect — Probe host controller cable detect info

Synopsis

```
int ich_pata_cable_detect (struct ata_port * ap);
```

Arguments

ap Port for which cable detect info is desired

Description

Read 80c cable indicator from ATA PCI device's PCI config register. This register is normally set by firmware (BIOS).

LOCKING

None (inherited from caller).

Name

piix_pata_prereset — prereset for PATA host controller

Synopsis

```
int piix_pata_prereset (struct ata_link * link, unsigned long deadline);
```

Arguments

link Target link

deadline deadline jiffies for the operation

LOCKING

None (inherited from caller).

Name

piix_set_piomode — Initialize host controller PATA PIO timings

Synopsis

```
void piix_set_piomode (struct ata_port * ap, struct ata_device * adev);
```

Arguments

ap Port whose timings we are configuring

adev Drive in question

Description

Set PIO mode for device, in host controller PCI config space.

LOCKING

None (inherited from caller).

Name

do_pata_set_dmamode — Initialize host controller PATA PIO timings

Synopsis

```
void do_pata_set_dmamode (struct ata_port * ap, struct ata_device *
adev, int isich);
```

Arguments

ap Port whose timings we are configuring

adev Drive in question

isich set if the chip is an ICH device

Description

Set UDMA mode for device, in host controller PCI config space.

LOCKING

None (inherited from caller).

Name

piix_set_dmamode — Initialize host controller PATA DMA timings

Synopsis

```
void piix_set_dmamode (struct ata_port * ap, struct ata_device * adev);
```

Arguments

ap Port whose timings we are configuring

adev um

Description

Set MW/UDMA mode for device, in host controller PCI config space.

LOCKING

None (inherited from caller).

Name

ich_set_dmamode — Initialize host controller PATA DMA timings

Synopsis

```
void ich_set_dmamode (struct ata_port * ap, struct ata_device * adev);
```

Arguments

ap Port whose timings we are configuring

adev um

Description

Set MW/UDMA mode for device, in host controller PCI config space.

LOCKING

None (inherited from caller).

Name

piix_check_450nx_errata — Check for problem 450NX setup

Synopsis

```
int piix_check_450nx_errata (struct pci_dev * ata_dev);
```

Arguments

ata_dev the PCI device to check

Description

Check for the present of 450NX errata #19 and errata #25. If they are found return an error code so we can turn off DMA

Name

piix_init_one — Register PIIX ATA PCI device with kernel services

Synopsis

```
int piix_init_one (struct pci_dev * pdev, const struct pci_device_id
* ent);
```

Arguments

pdev PCI device to register

ent Entry in piix_pci_tbl matching with *pdev*

Description

Called from kernel PCI layer. We probe for combined mode (sigh), and then hand over control to libata, for it to do the rest.

LOCKING

Inherited from PCI layer (may sleep).

RETURNS

Zero on success, or -ERRNO value.

Chapter 9. sata_sil Internals

Name

sil_set_mode — wrap set_mode functions

Synopsis

```
int sil_set_mode (struct ata_link * link, struct ata_device ** r_failed);
```

Arguments

link link to set up

r_failed returned device when we fail

Description

Wrap the libata method for device setup as after the setup we need to inspect the results and do some configuration work

Name

sil_dev_config — Apply device/host-specific errata fixups

Synopsis

```
void sil_dev_config (struct ata_device * dev);
```

Arguments

dev Device to be examined

Description

After the IDENTIFY [PACKET] DEVICE step is complete, and a device is known to be present, this function is called. We apply two errata fixups which are specific to Silicon Image, a Seagate and a Maxtor fixup.

For certain Seagate devices, we must limit the maximum sectors to under 8K.

For certain Maxtor devices, we must not program the drive beyond udma5.

Both fixups are unfairly pessimistic. As soon as I get more information on these errata, I will create a more exhaustive list, and apply the fixups to only the specific devices/hosts/firmwares that need it.

20040111 - Seagate drives affected by the Mod15Write bug are blacklisted The Maxtor quirk is in the blacklist, but I'm keeping the original pessimistic fix for the following reasons... - There seems to be less info on it, only one device gleaned off the Windows driver, maybe only one is affected. More info would be greatly appreciated. - But then again UDMA5 is hardly anything to complain about

Chapter 10. Thanks

The bulk of the ATA knowledge comes thanks to long conversations with Andre Hedrick (www.linux-ide.org), and long hours pondering the ATA and SCSI specifications.

Thanks to Alan Cox for pointing out similarities between SATA and SCSI, and in general for motivation to hack on libata.

libata's device detection method, ata_pio_devchk, and in general all the early probing was based on extensive study of Hale Landis's probe/reset code in his ATADRVR driver (www.ata-atapi.com).