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Host Bus Error Handling/Recovery

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Host Bus Errors

- Split transaction time-out
- ECC/parity error on data
- ECC/parity error on address
- Bad address (e.g., memory not present)
- Bad operation (e.g., write to read-only memory)
- Protection violation (e.g., access not allowed)
- etc.

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Open HCI Perspective of Host Bus Errors

- All host bus errors have a single classification -- access didn’t work
- Error handling is unit/mode dependent

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DMA Units

- Self ID Buffer
- Physical Read Request
- Asynchronous Request Transmit
- Asynchronous Response Transmit
- Isochronous Transmit
- Asynchronous Request Receive
- Asynchronous Response Receive
- Isochronous Receive
- Physical Write Request

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Self ID Buffer

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Self ID Buffer

- **Errors that are detected by HC**
  - **memory write error (can't write)**
  - **buffer overflow (tried to write too much)**
  - **FIFO overflow (can't write fast enough)**
- **In all cases:**
  - **set SelfIDCount.*selfIDerror***
  - **drop remaining self ID packets**

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Self ID Buffer (cont.)

- In the case of an error, IntEvent.*selfIDcomplete* is not set until end of self ID process
- It is not an error if self ID process starts and HCControl.*rcvSelfID* is not set

Physical Read Requests

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Physical Read Request

- Read from address in first 4GB from a node that is enabled in PhysDMAEnable and AsynchronousRequestFilter
- If memory read error at start of packet, before header sent, send response with resp_data_error.

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Physical Read Request (cont.)

- If memory error after packet starts
  - truncate packet
  - if requester responds with ack_data_error, then re-arbitrate and send response with response code of resp_data_error
  - if requester response with anything else, drop the response

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Physical Read Request (cont.)

- If FIFO underrun after packet starts
  - truncate packet
  - if requester responds with ack_data_error, then re-arbitrate and try to re-send
  - if requester responds with anything else, drop the response

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Physical Read Request (cont.)

- On error, no interrupt event is generated and there is no logging of interrupt for statistics gathering.

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DMA Units with Standard Context

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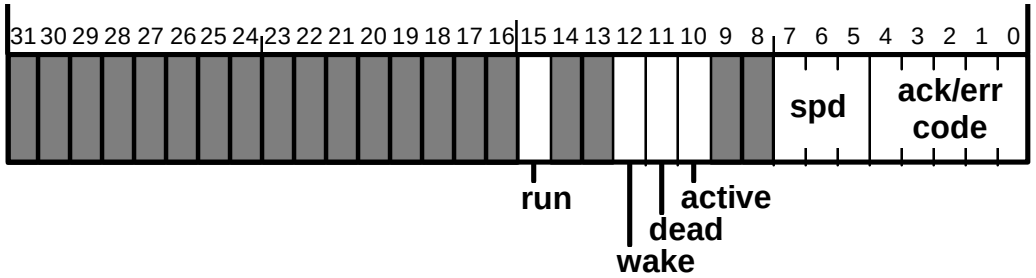
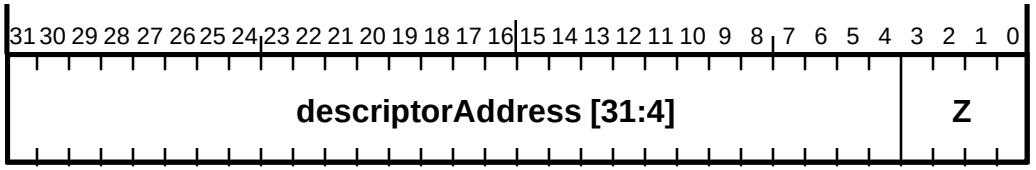
Standard Context



ContextControl



CommandPtr

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Units Using Standard Context

- Asynchronous Request Transmit
- Asynchronous Response Transmit
- Isochronous Transmit
- Asynchronous Request Receive
- Asynchronous Response Receive
- Isochronous Receive

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‘Standard’ Failures

- **Descriptor Read**
  - **host bus error**
- **Data Read**
  - **host bus error**
  - **FIFO underrun**
  - **invalid tCode**

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‘Standard’ Failures (cont.)

- **Data Write**
  - **host bus error**
  - **FIFO overrun**
  - **buffer overrun**
- **Descriptor Status Update**
  - **host bus error**

Descriptor Read Error

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Descriptor Read Error

- **All standard contexts have same behavior**
  - **truncate packet transmit**
  - **set ContextControl.*dead***
  - **set IntEvent.*unrecoverableError***
  - **set ContextControl.*ack* to evt_descriptor_read**
  - **CommandPtr.*descriptorAddress* points to a descriptor within the failed descriptor block**

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Descriptor Read Error (cont.)

- Failure behavior is the same if descriptor block read in parts or as a whole
- In case of multiple errors, descriptor read error error takes precedence

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Descriptor Read Error (cont.)

- **Do not:**
  - **set the ‘normal’ interrupt for the context in IntEvent**
  - **update xferStatus, resCount or timeStamp**

Status Update Error

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Status Update Error

- Occurs when there is a host bus error in writing to the xferStatus and resCount/timeStamp in a descriptor
- Writing status quadlet to input buffer is <u>not</u> considered a status update error. It is a ‘data write’ for error purposes.

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Status Update Error (cont.)

- For all units with the ‘standard’ context the behavior is the same
  - set ContextControl.*dead*
  - retain ContextControl.*ack* and ContextControl.*spd* for completed packet
  - set IntEvent.*unrecoverableError*
  - Do <u>not</u> optionally set the context’s ‘normal’ IntEvent

Asynchronous Transmit Request and Response

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Data Read Errors

- Data read error can only occur on block write request, lock request, block read response or lock response
- Three types of errors
  - host bus read error
  - FIFO underrun
  - invalid tCode

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Host Bus Read Error

- Truncate packet and advance to last in descriptor block (OUTPUT_LAST*)
- Wait for response (unless broadcast)
- If response is ack_data_error then change ContextControl.*ack* to evt_data_read
  - else save response code as returned

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Host Bus Read Error (cont.)

- Conditionally update status in OUTPUT_LAST*
- Conditionally set context event bit in IntEvent

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FIFO Underflow

- **Behavior same as data read error except the replacement *ack/error code* is evt_underrun**

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tCode Error

- Means that tCode not appropriate for context (tCode ‘A’ in async context)
- tCode error also means that header length doesn’t match tCode
- Don’t put header into output FIFO -- don’t start packet
- Set ContextControl.*ack* to evt_tcode_err
- Conditionally save ContextControl in xferStatus of OUTPUT_LAST* and conditionally generate interrupt

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Isochronous Transmit

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Data Access Errors

- **Data read**
  - **host bus read error**
  - **FIFO underrun**
  - **invalid tCode**
- **Data write**
  - **Host bus write error during STORE_VALUE**

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Host Bus Read Error

- Truncate packet and advance to last in descriptor block (OUTPUT_LAST*)
- Set ContextControl.*ack* to evt_data_read
- Conditionally update status in descriptor containing OUTPUT_LAST and conditionally set IntEvent
- Continue

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FIFO Underflow

- **Behavior same as host bus read error except ContextControl.*ack* set to evt_underrun**

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tCode Error

- Means that tCode not appropriate for context (not iso tCode)
- tCode error also means that header length doesn't match tCode
- Don't put header into output FIFO -- don't start packet
- Set ContextControl.*ack* to evt_tcode_err
- Conditionally save ContextControl in xferStatus of OUTPUT_LAST* and conditionally generate interrupt

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Data Write

- Set ContextControl.ack to evt_data_write
- Skip to OUTPUT_LAST*
- Conditionally update xferStatus and set IntEvent

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A diversion...

Input FIFOs

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Input FIFOs

- Want to minimize number of input FIFOs
- Can combine things that never block into same FIFO
- Error strategy is to prevent any input FIFO from blocking so that they can all be combined
- Other strategies are possible - e.g., have multiple FIFOs.

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AR Response

- Prevention of buffer overrun of AR response context is responsibility of software
- If AR response buffer fills, response packets are dropped
  - leads to split transaction time-outs

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AR Request

- Dealing with buffer overruns of AR request context is responsibility of HC
- When overrun occurs
  - Packets that were given ack_pending by link are dropped
    - can't return resp_conflict_error because output queue would be blocking resource
  - Packets that were given ack_complete are reported to software or dropped

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Posted Write Requests

- If link sent ack_complete on write request before data is written to memory, packet is ‘posted’
- <u>May</u> drop, and not report, if write to offset above physical memory limit (48’h0000_FFFF_FFFF)
  - writes to CSR space are <u>never</u> posted

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Posted Write Requests (cont.)

- If posted to physical memory, local offset and source node ID reported to software through PostedWriteAddress registers
- Can't post more write requests than can be reported

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Buffer Space Tracking

- Can reduce number of request packets that are dropped by keeping track of amount of space in AR request buffer
  - do, pre-fetch of descriptors to determine remaining space (reqCount)
  - each reqCount value given to link to increase available space
  - as link accepts packets it reduces the available space
  - when link runs out of space, it sends ack_busy

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Dead Contexts

- **When context is *dead* or *run* not set link will 'reject' packets for the context -- <u>no ack sent!</u>**

and now back to...

Asynchronous Receive

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Asynchronous Receive

- Asynchronous receive only runs in buffer-fill mode.
- When HC can't write to buffer due to host bus error, buffer can no longer be 'parsed' by software.
- Therefore, unlike transmit, when data transfer error occurs (other than buffer full), HC must stop context

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Asynchronous Receive Request/Response

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Data Write Error

- Set ContextControl.*dead* (link 'rejects' packets for context)
- Set ContextControl.*ack* to evt_data_write
- Set IntEvent.*unrecoverableError*
- Drop packets that reach host side of input FIFO (only if shared FIFO)
  - if posted write, report failure to software
- CommandPtr points to descriptor where failure occurred

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FIFO Overflow

- Link side of FIFO truncates packet going into receive FIFO and sends ack_busy on 1394 bus
- System side of FIFO sees truncated packet and does not update status
- This makes it look like packet never happened (packet is ‘backed out’ of the buffer)

Isochronous Receive

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Buffer-fill Mode

- On FIFO/buffer overrun, back packet out of buffer
- On write error:
  - set *dead*
  - set *ack/error code* to evt_data_write
  - set *unrecoverableError* interrupt event
  - discard all packets for context

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Packet/buffer Mode

- **On data write error**
  - **set *ack/error code* to evt_data_write**
  - **conditionally update xferStatus in descriptor in which error occurred**
  - **continue as if packet was received correctly**

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