

1394 Open HCI Systems

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Product Development

Mixed Signal PCIbus Solutions

Texas Instruments, Inc.

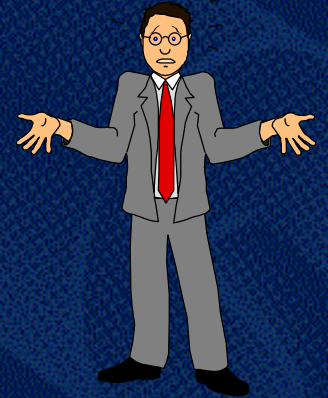
Presentation Overview

1394 Open HCI systems

- ◆ What, Where, Why of 1394 Open HCI
- ◆ OHCI hardware choices
 - ◆ What to look for in Open HCI devices
 - ◆ A look at Open HCI power management
- ◆ 1394 PC system design issues
 - ◆ Cable power management
 - ◆ PHY and link layout
 - ◆ PC 98/99 and 1394 systems

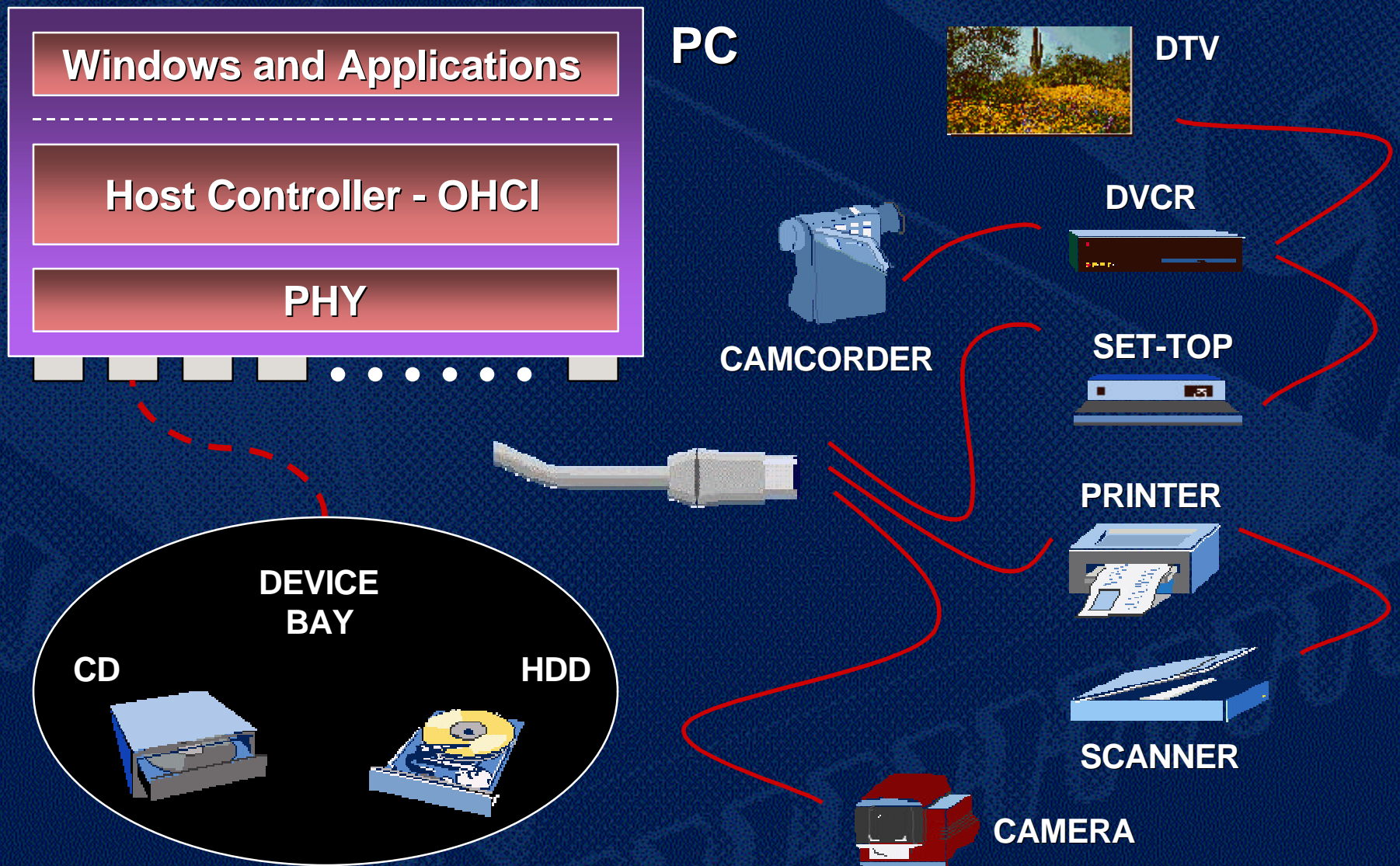
What Is IEEE1394 OHCI?

Open Host Controller Interface

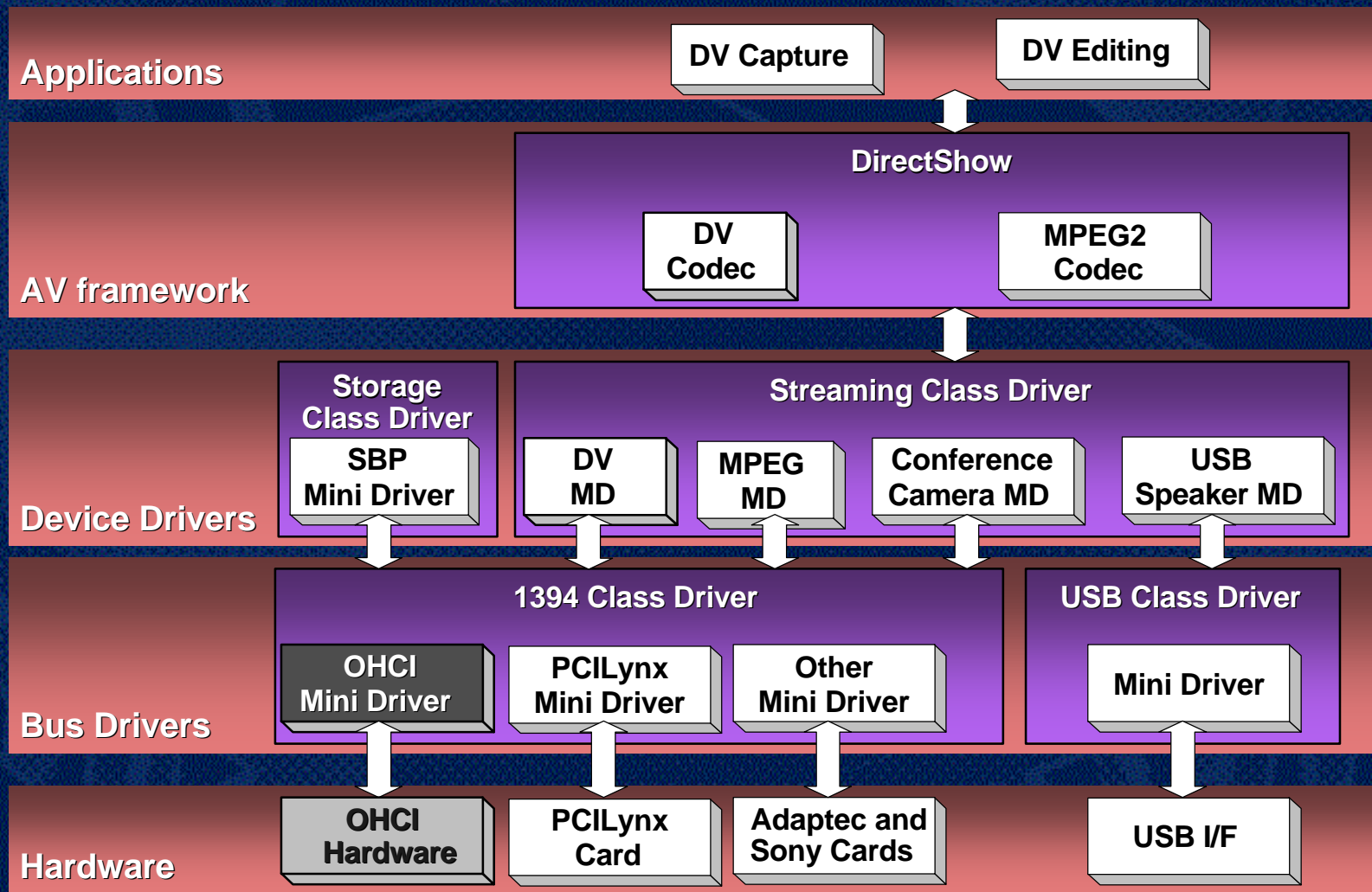


- ◆ A 1394 link layer implementation
 - ◆ Asynchronous and isochronous
 - ◆ Defines high-performance DMA engines
- ◆ Release 1.00 October 20, 1997
- ◆ 1394 Open HCI promoters as of 10/97
 - ◆ Apple, Compaq, Intel, Microsoft, National Semiconductor, Sun, Texas Instruments
 - ◆ austin.ibm.com/pub/chrptech/1394ohci

OHCI And The 1394 System

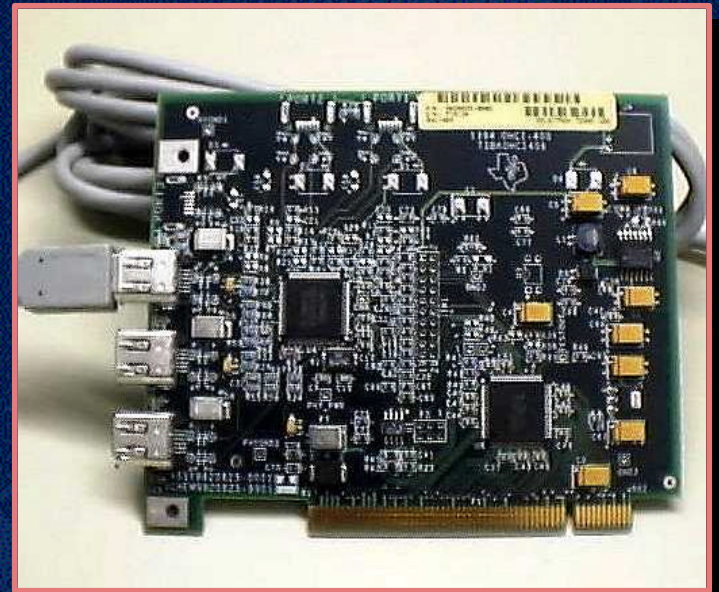


Microsoft WDM 1394 Stack



Open HCI Implementations

- ◆ Stand alone and integrated solutions for motherboards
 - ◆ Core logic integration
 - ◆ Desktop and notebook computers
 - ◆ Palmtops
- ◆ Expansion solutions
 - ◆ PCI option cards
 - ◆ CardBus designs



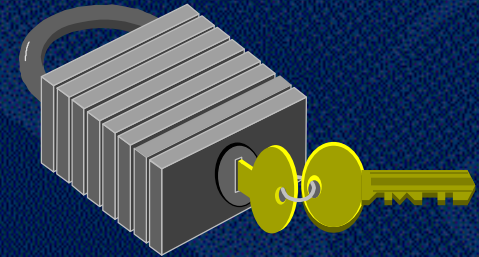
Benefits Of 1394 Open HCI

- ◆ **Common WDM driver interface**
 - ◆ Windows 98 and Windows NT 5.0
- ◆ **High performance and robustness**
 - ◆ Outperforming earlier 1394 HC designs
 - ◆ Higher tolerance of excessive latencies
 - ◆ Improved error handling
- ◆ **Dedicated committee with wide industry participation**
- ◆ **Security improvements**

The OHCI logo is a black ribbon banner with the text "OHCI" in white. It is positioned to the right of the list of benefits.

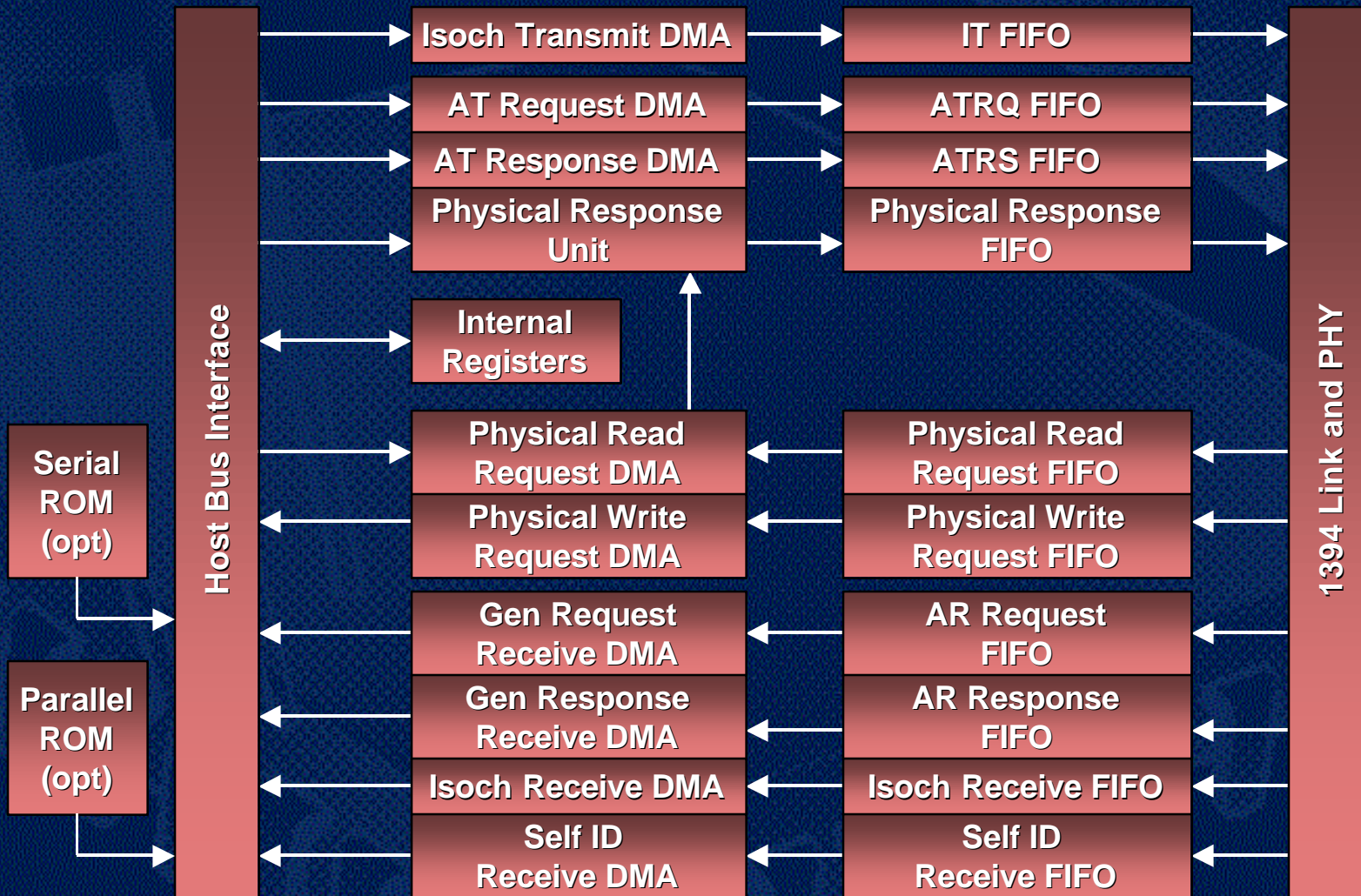
OHCI

Security Improvements



- ◆ Security requires both software and hardware
 - ◆ OHCI does not in itself provide security
- ◆ Hardware filters used for security
 - ◆ Asynchronous request filter
 - ◆ Physical request filter
 - ◆ Tag filter for isoch copy protection
- ◆ OHCI protected GUID
- ◆ OHCI does not support bus snooping

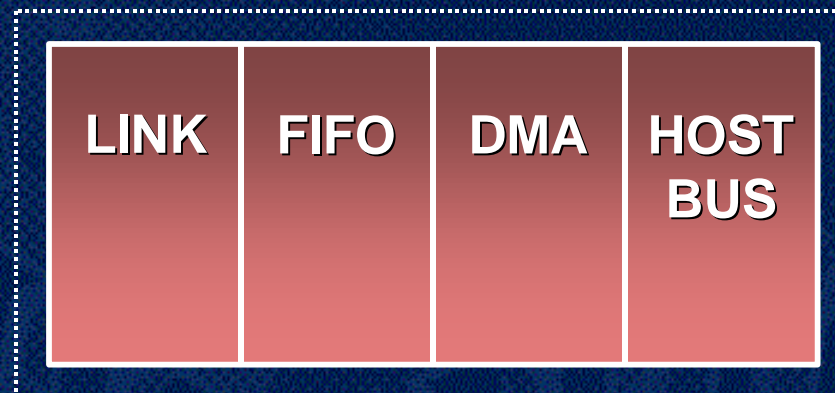
Conceptual Block Diagram



Logical Open HCI Blocks

- ◆ Four major blocks of Open HCI
 - ◆ Link interfaces with physical layer
 - ◆ FIFO buffers 1394 packet data
 - ◆ DMA controls transfers to/from memory
 - ◆ Host Bus interfaces with host I/O bus

Open HCI



Link Layer Block

Open HCI fundamentals



- ◆ Link compatible with both 1394-1995 and 1394A PHYs
- ◆ IEEE 1394A considerations
 - ◆ Standardized PHY/Link interface
 - ◆ 1394 bus snoop mode not allowed
 - ◆ Supports asynchronous streams
 - ◆ Ping timer implemented in Link
 - ◆ PHY/Link turn around idle insertion

Link Layer Block

More Open HCI fundamentals

- ◆ **CYCLE_TIME cannot move backwards**
- ◆ **Extensive async and isoch filtering**
- ◆ **Improvements to existing controllers**
 - ◆ **Bus manager registers in Link**
 - ◆ **Bus_info_block implemented in Link**
 - ◆ **GUID protected with one-time-write**
 - ◆ **Software reset is clearly defined**
 - ◆ **Improved PHY register access**

Link Layer Block

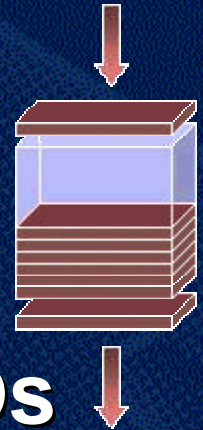
Recommendations



- ◆ Support IEEE 1394A arbitration enhancements
- ◆ **PRIORITY_BUDGET** is optional
 - ◆ Issue priority LREQs for all response and PHY packets
- ◆ Implement bus holders for isolation
- ◆ Cycle starts sent with a minimum offset to account for PHY jitter and drift

FIFO RAM Block

Open HCI fundamentals



- ◆ No requirement on number of FIFOs
- ◆ No requirement on FIFO sizes
- ◆ Rules for combining FIFOs
 - ◆ Response not blocked by busied request
 - ◆ Receive contexts proceed independently
- ◆ Open HCI allows for big-endian and little-endian host environments

FIFO RAM Block

Sizing guidelines



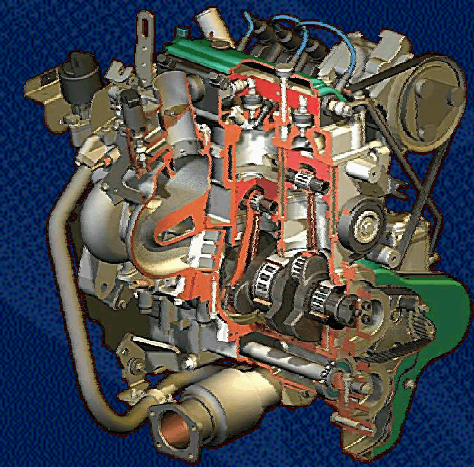
- ◆ Recommend ~ 2K per FIFO that handles the entire 1394 throughput
 - ◆ For 32bit/33MHz PCI based Open HCI

- ◆ FIFO size dependent upon

- | | |
|--------------------------------|----------|
| ◆ Host bus b/w and latency | HOST |
| ◆ Host bus b/w utilization | OHCI |
| ◆ Internal arbitration latency | OHCI |
| ◆ 1394 throughput | 400 Mbps |

OHCI DMA Engines

Open HCI fundamentals



- ◆ All DMA engines are host bus contenders
- ◆ Requires minimum of 4 isoch receive and 4 isoch transmit DMA engines
- ◆ Isochronous transmit
 - ◆ Prefetch up to two periods ahead
 - ◆ Designed to accommodate cycle skips
- ◆ DMA engines have robust error reporting to the host

OHCI DMA Engines

More Open HCI fundamentals

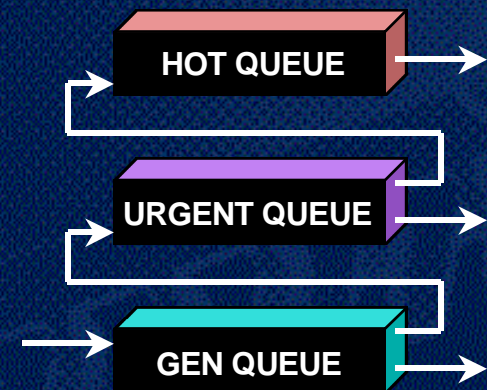
- ◆ **Physical DMA engine**
 - ◆ **Handles 1394 configuration ROM access**
 - ◆ **Gives nodes direct host memory access**
 - ◆ **Supports write posting up to the number of error reporting reporting**
 - ◆ **Can post as many write requests as error reporting registers**
- ◆ **ARRQ synthesized bus reset packets**
 - ◆ **Pair requests with bus reset generation**

OHCI DMA Engines

Recommendations



- ◆ Allow physical DMA to make forward progress while responses are queued
- ◆ Implement at least three physical posted write error reporting registers
- ◆ Implement priority internal arbitration
 - ◆ Limits access latency to a critical FIFO



Host Bus Interface

Open HCI fundamentals



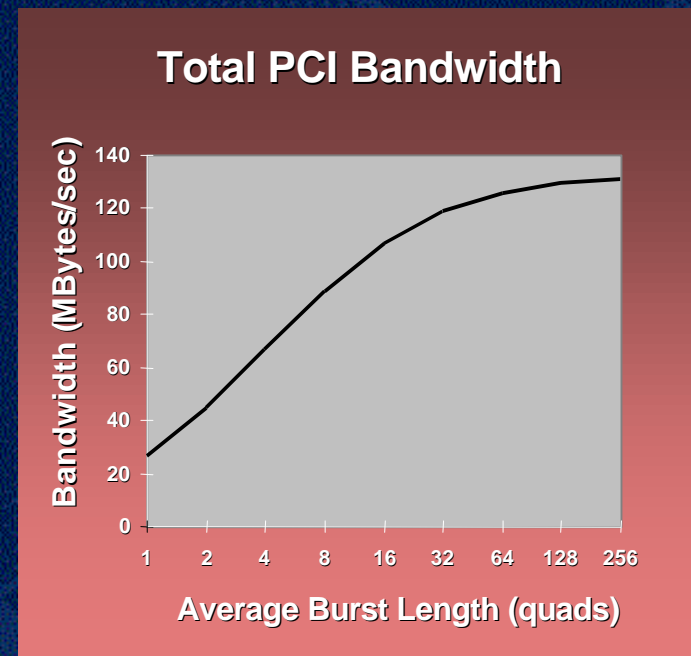
- ◆ OHCI Annex A addresses PCI configuration space
 - ◆ Includes PCI global byte swap bit
- ◆ PCI b/w required to implement OHCI
 - ◆ 50 MB/s for 1394 data throughput
 - ◆ Plus ~ 10 MB/s DMA engine overhead

PCI Interface Block

Recommendations



- ◆ Design for multiple cacheline bursting
- ◆ Use appropriate PCI commands
 - ◆ MRL, MRM, MWI
- ◆ Truncate bursting to prevent starvation
- ◆ Implement PCI Power Management



OHCI Power Management

PCI Power Management

- ◆ **1394 HC Device Class Power Management**
 - ◆ Addressed in Open HCI 1.1 committee
 - ◆ Microsoft is ready to support D0 and D3
- ◆ **D0: On. Fully operational**
- ◆ **D3: Off. PCI clock may stop**
 - ◆ OHCI software is responsible for LPS
 - ◆ Wake event supported from D3
 - ◆ D3 - D0 transition requires internal reset retaining the PME# context

OHCI Power Management

Suspend / Resume

- ◆ **Link Power Status (LPS) is required**
 - ◆ OHCI software controls the LPS signal
 - ◆ PHY drives SCLK when LPS is asserted
 - ◆ PHY may save power when de-asserted
- ◆ **LinkOn is an optional OHCI input**
 - ◆ Wakes up host when LPS is de-asserted
 - ◆ Indicates LinkOn packet received
 - ◆ Indicates port connection change

OHCI Power Management

Mobile considerations

- ◆ Consider D3_{COLD} device power state
 - ◆ May need auxiliary power supply
 - ◆ May require separate reset to initialize the PCI Power Management registers
- ◆ Unlikely standard power provider
- ◆ Implement CLKRUN#
- ◆ Need high performance CardBus controllers for OHCI PC Cards



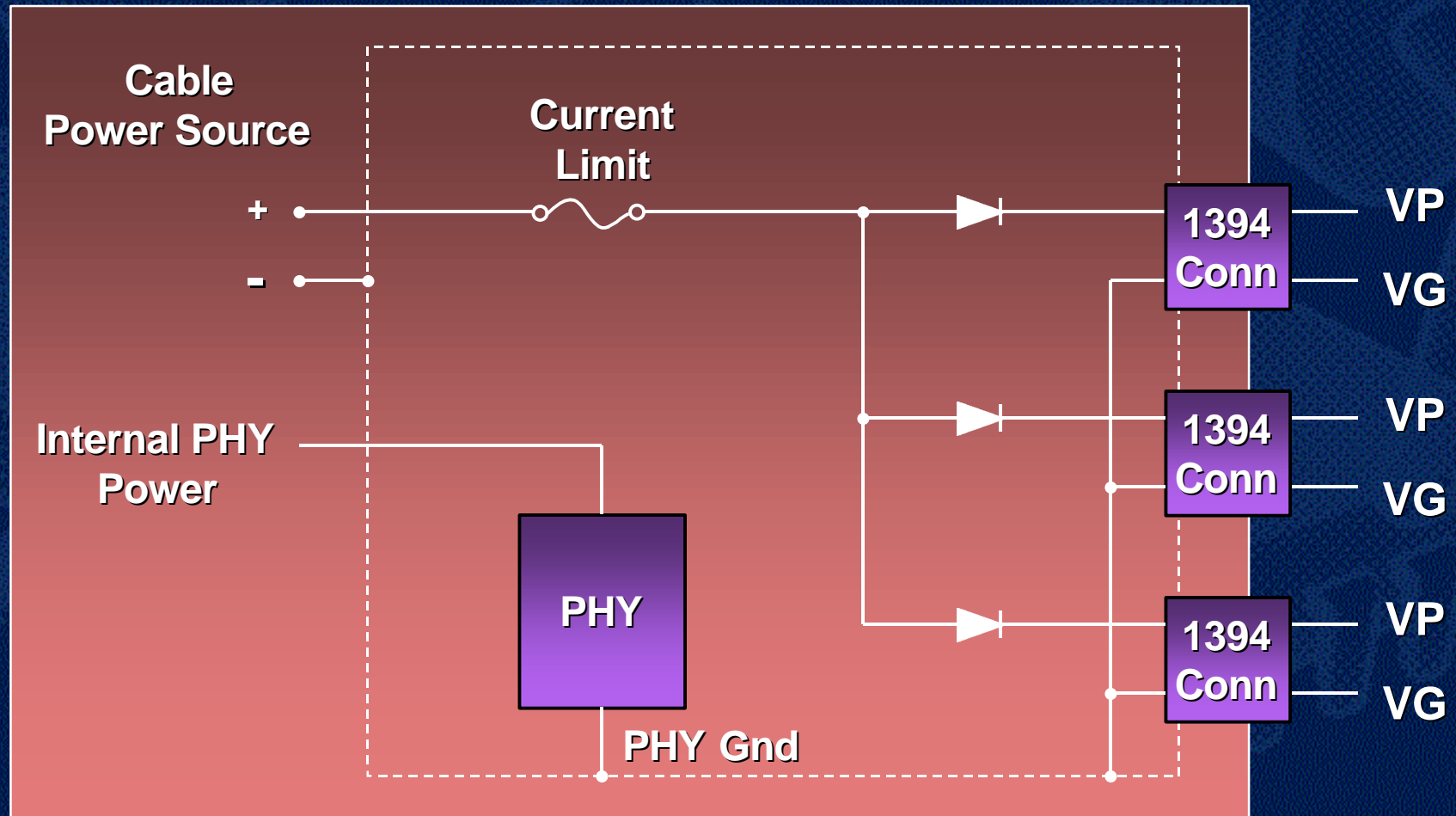
Cable Power Management

Self ID POWER_CLASS options

POWER_CLASS	Node Description
3'b000	Does not need power and does not repeat power
3'b001	Self-powered and provides a min of 15W to the bus
3'b010	Self-powered and provides a min of 30W to the bus
3'b011	Self-powered and provides a min of 45W to the bus
3'b100	May be powered from the bus and is using up to 3W
3'b101	Node is bus powered, and is using up to 3W No additional power is needed to enable the Link
3'b110	Node is bus powered, and is using up to 3W An additional 3W is needed to enable the Link
3'b111	Node is bus powered, and is using up to 3W An additional 7W is needed to enable the Link

Cable Power Management

Standard power provider



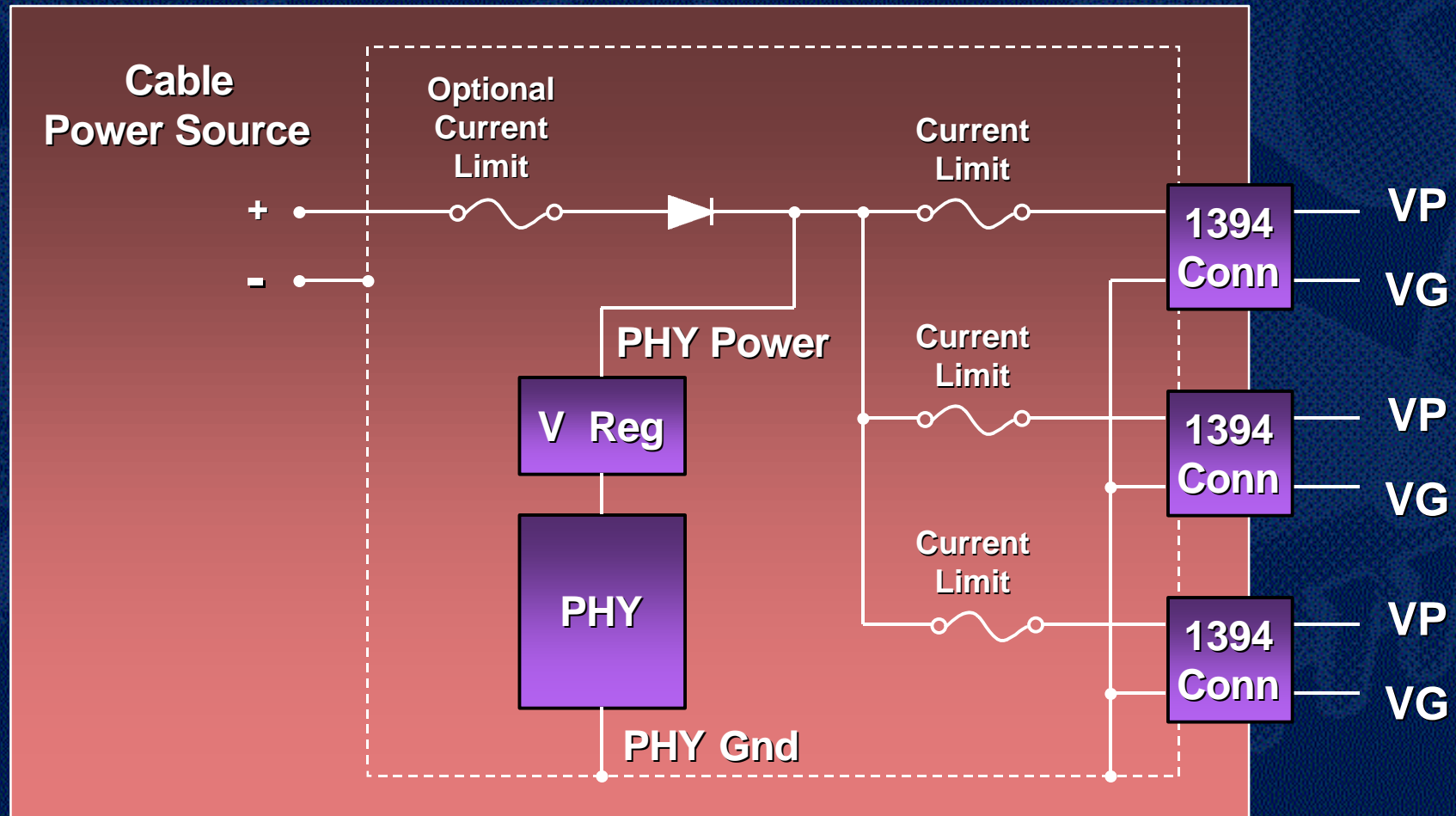
Cable Power Management

Standard power provider summary

- ◆ Creates power domains for better power distribution management
- ◆ Launch voltage of 20 to 33 volts
- ◆ Never consume cable power
- ◆ Per port diode isolation is required
- ◆ Will not pass 1394 bus power
- ◆ Provides current limited to less than or equal to 1.5 A per port

Cable Power Management

Alternate power provider



Cable Power Management

Alternate power provider summary

- ◆ Power class 4 may use cable power
- ◆ May pass 1394 bus power
- ◆ Current limit for 1.5 A peak per port
 - ◆ Protection from V_p short circuits
- ◆ Launch voltage of 8 - 33 Volts
 - ◆ Per port diode isolation required for launch voltage of 20V or greater

Open HCI System Layout

Cable / PHY interface

- ◆ Minimize distance differential signals must propagate etch
 - ◆ PHY as close as possible to connectors
- ◆ Match etch impedance to cable and termination network
 - ◆ Match differential signal etch lengths
- ◆ Locate differential signal termination resistors as close as possible to PHY

Open HCI System Layout

More PHY layout recommendations

- ◆ Keep crystal close to PHY
- ◆ Keep cable power regulator (if used) far away from PHY
 - ◆ Especially crystal and differential signals
- ◆ Keep PHY-Link interface short
 - ◆ Signals should have same trace length
- ◆ Texas Instruments 1394 app notes
 - ◆ www.ti.com/sc/docs/psheets/app_mixed_signal_and_analog.htm

Microsoft PC 98 Guidelines

IEEE 1394 bus design

- ◆ Controllers are OHCI, S400 capable
- ◆ Config ROM provides GUID
 - ◆ Other configuration ROM requirements
- ◆ PCs use standard 6-pin connectors
 - ◆ Recommend 3 ports minimum
- ◆ PCs source cable power
 - ◆ Recommend minimum of 20V at 15W
 - ◆ Comply with Cable Power Distribution

Microsoft PC 99 Guidelines

IEEE 1394 bus design

- ◆ PC 99 requirements are not closed
- ◆ Mandatory 1394A features are required
- ◆ All devices provide at least two ports
- ◆ All host controller ports that are externally accessible should support the 6-pin connector
- ◆ PC 99 includes recommended use of Device Bay connector

Call To Action

- ◆ **Test hardware to existing Windows driver stack**
- ◆ **OHCI and IEEE 1394A compliance**
 - ◆ austin.ibm.com/pub/chrptech/1394ohci
 - ◆ symbios.com/pub/standards/io/1394/P1394a
- ◆ **Build PC 98/99 compliant systems**
- ◆ **Submit OHCI hardware to Windows 98 team for testing**
 - ◆ E-mail nmdriver@microsoft.com