PCIe® Server Validation

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Topics

- Servers
- Areas of Testing
- Approaches
  - ✓ Validation Areas
  - ✓ The Matrix
  - ✓ RAS
- Recommendations

Server

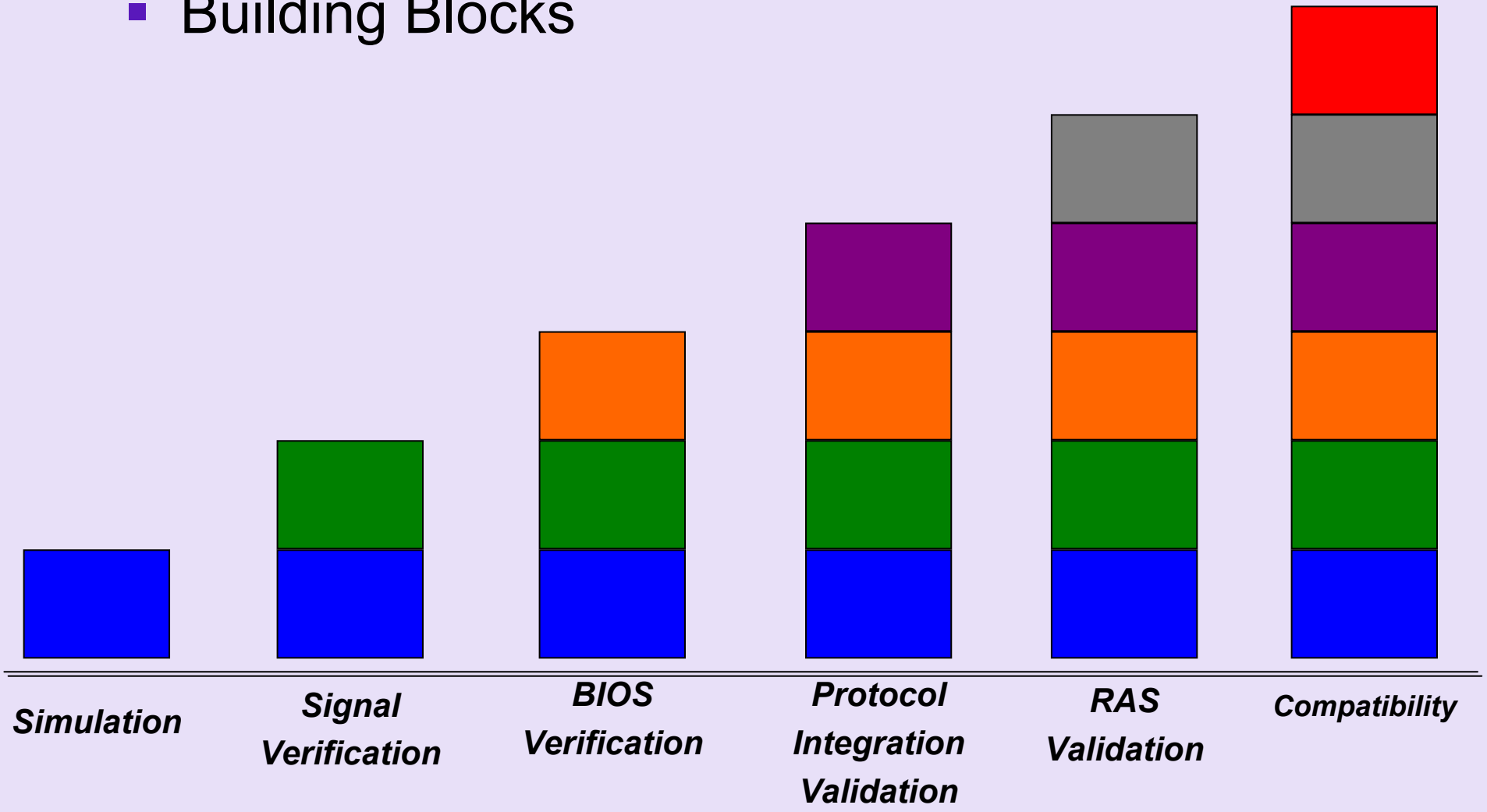
Server?

Servers

- A server is a pool of high-end resources (memory, disk, processor, I/O, etc..) for clients / customers
- Servers range from uni-processor to 32-processor Multi-Node NUMA (Non Uniform Memory Addressing) scaleable servers
- Requires High RAS (Reliability, Availability, & Serviceability)
  - ✓ Low tolerance for persistent recoverable and non recoverable events
- All servers need high performance I/O enablement
  - ✓ Compatibility and compliance are key!

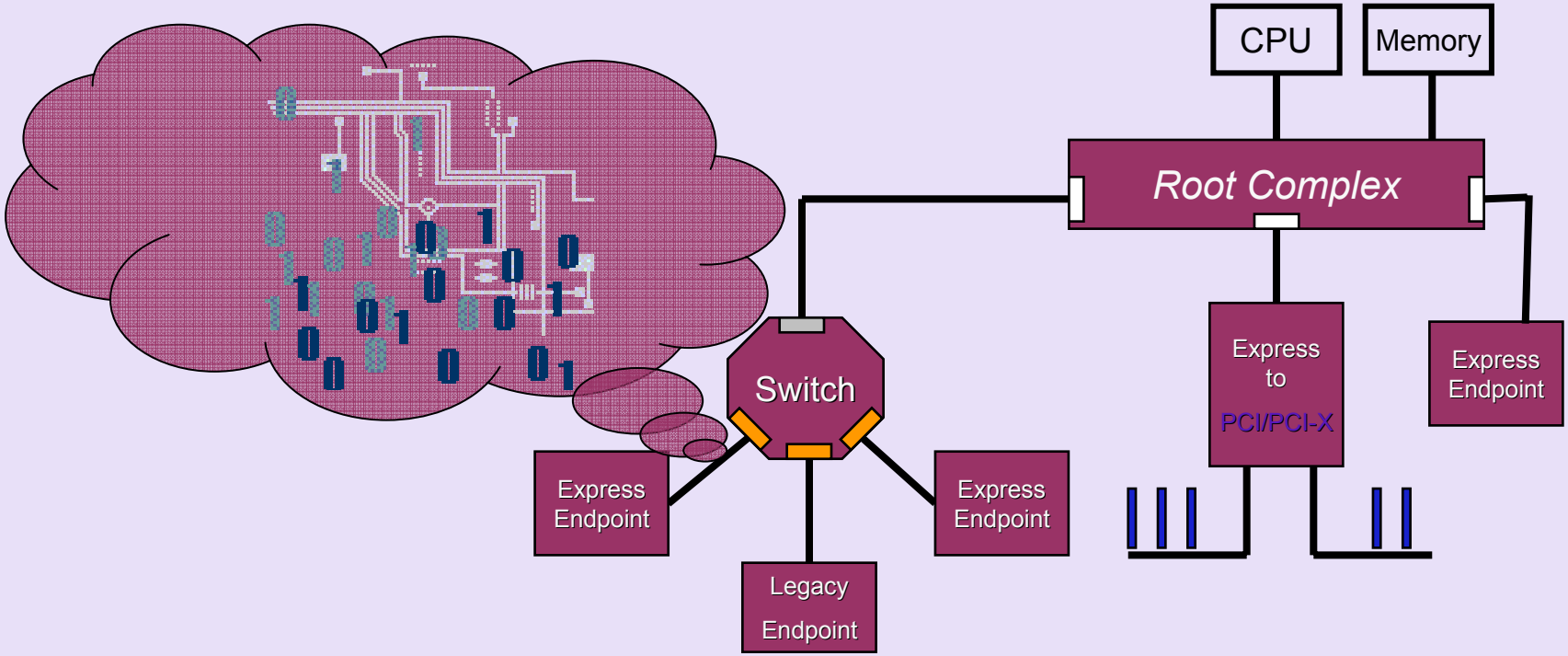
Areas of Testing

- Building Blocks



Areas of Testing

- Simulation
  - ✓ Pre-Hardware / Logic testing
  - ✓ Can be for hardware or Testing Tools



Areas of Testing

Signal Verification

- Physical Bring-up
- Signal integrity measured
  - ✓ Methods
    - PCI-SIG - PCI Express® Electrical Test Fixtures (eye diagrams)
      - Compliance Load Board (CLB)
      - Compliance Base Board (CBB)
    - Custom Analysis Tools
      - Create soft Insertion points for verification
      - Allows check point verifications

Areas of Testing

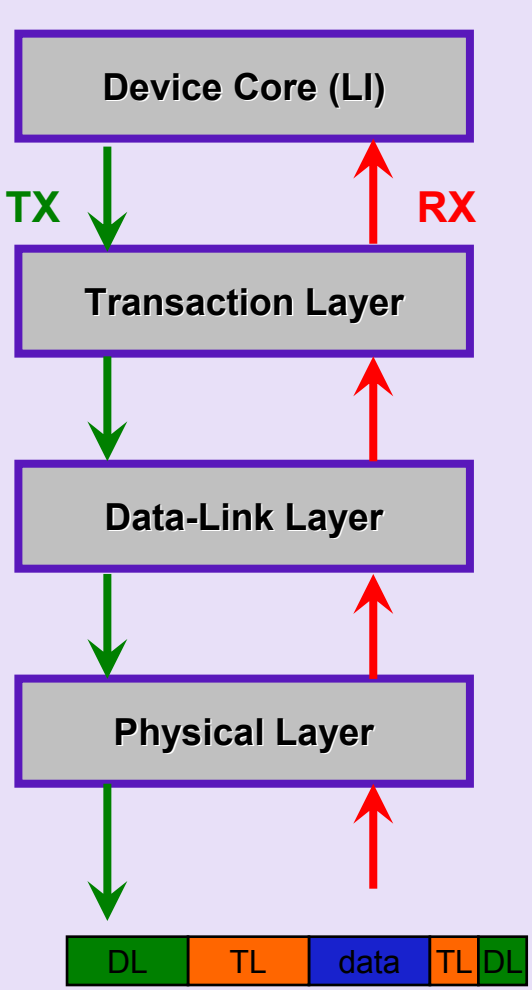
BIOS

- System / Device Initialization
  - ✓ Methods
    - PCI-SIG - PCI Express Platform BIOS test
      - Uses Protocol Test Card + External Software
      - Simulates various devices
        - Good events
        - Bad events
    - Custom Tools
      - Specific BIOS call testing
        - Software
      - Specific BIOS handling
        - Hardware

Areas of Testing

Protocol

- System / Device Interaction
  - ✓ Methods
    - – Custom Tools
      - Software / Hardware
      - Extended verification
  - ✓ Different Levels of the Protocol
    - – Several layers for validation
  - ✓ Compatibility / Add in-cards
    - – Several approaches

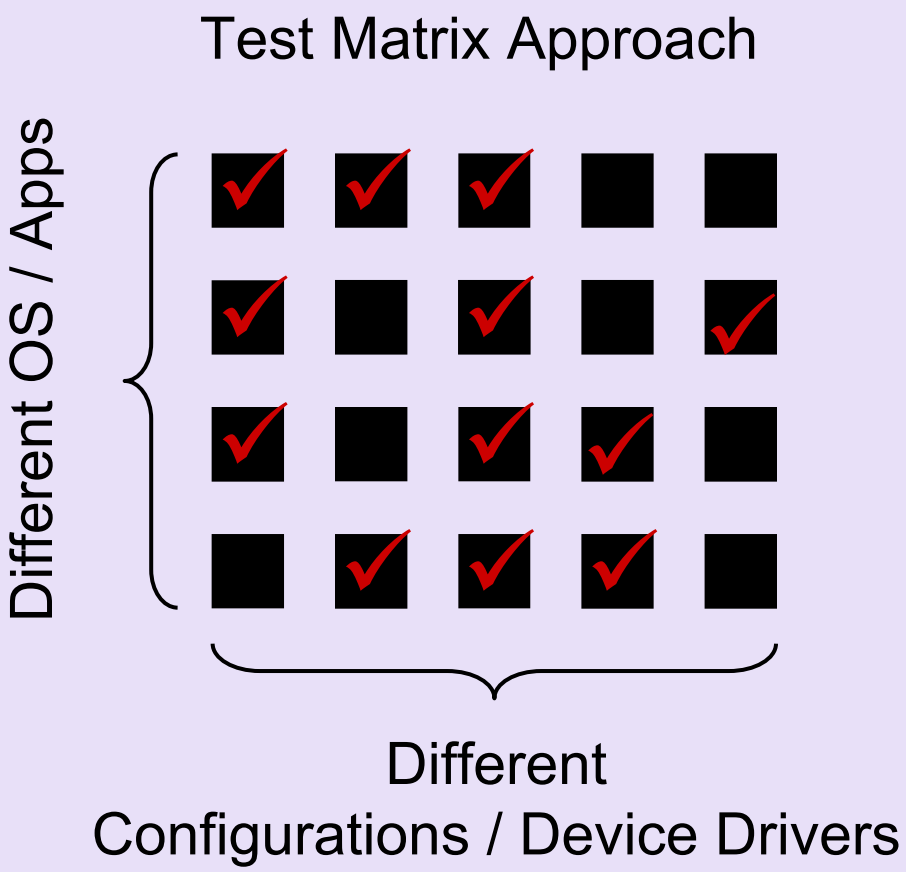


Areas of Testing

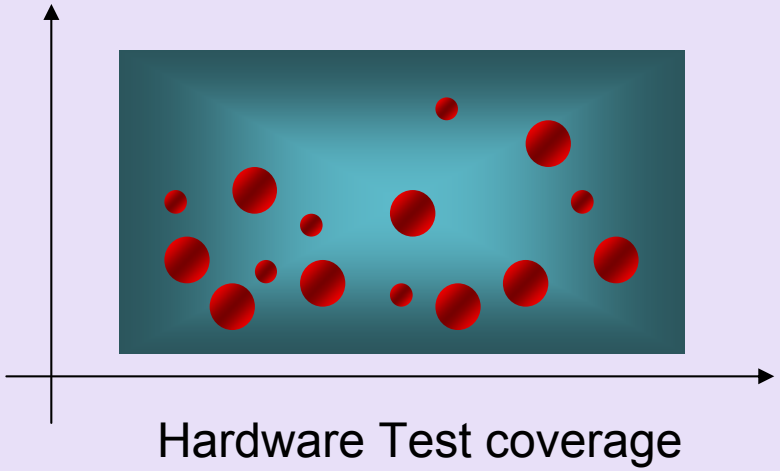
The Matrix Approach

- Use Add-in cards as “configuration validation”
  - ✓ Customize your configuration
- OS(s) used as the hardware enabler
  - ✓ Applications used to drive / load system
  - ✓ Specific to Add-in Card selected
- Time and Coverage NOT directly related
  - ✓ Devices are not designed to do ALL transaction types
    - – Size of the devices queue?
    - – What are the expected transactions?
    - – Does it support….

Areas of Testing



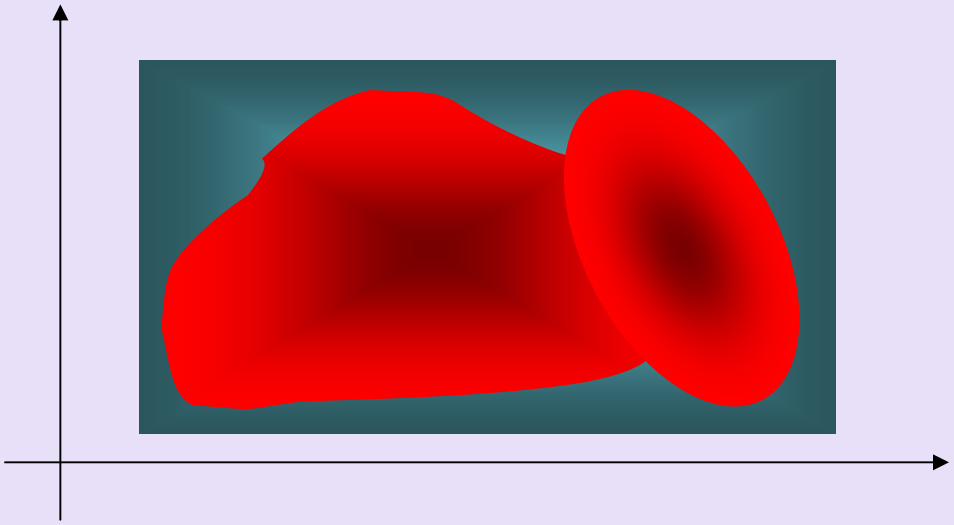
- More hardware coverage using more hardware configurations
- Very time consuming
- Test holes can only be found and verified by knowing the *true* interaction of the device driver with OS.
- OS has direction impact
  - ✓ Access to processors, memory, etc…



Areas of Testing

Hardware direct testing

- Use ***"Hardware Test Vehicles"*** (HTV)
  - ✓ Protocol Exercisers and Analyzers
- Emulate / Access any system devices directly
- Interact with system components
  - ✓ Memory
  - ✓ CPU
  - ✓ Cache
  - ✓ Other PCI / PCI-X® / PCIe
  - ✓ Interrupts
  - ✓ NUMA (Non Uniform Memory Addressing) Nodes
- Increase integration test coverage
- Focus on subsystem Interactions and coverage
- OS limitation minimized



Hardware Test coverage

Areas of Testing

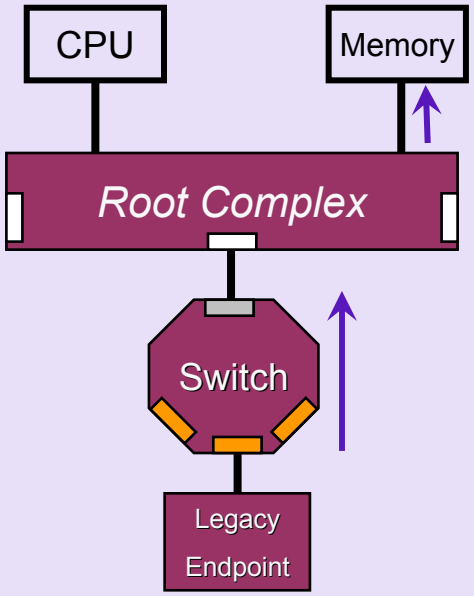
- Many market available for ***HTV***
  - ✓ FPGA base and ASIC based
    - Both have advantages and disadvantages
- Allows direct control - Deterministic
  - ✓ To device (Completer)
    - Responses
    - Behavior
    - Timing
    - Etc…
  - ✓ From device (Initiator)
    - System devices targeted
- OS limitations removed
  - ✓ OS Control put in the “back ground”
- Analyzer / Counters
  - ✓ Verify
  - ✓ Debug
- Not a silver bullet
  - ✓ Will not find compatibility issues

Areas of Testing

Method Matters

Memory Target

- …0000 0001
- …0000 0010
  - ✓ Stress test
    - Pattern written and Read in burst
  - ✓ Performance test
    - Written once and read back many
  - ✓ Protocol test
    - Pattern written and read back many
      - Changing payload, start at various boundaries, Byte Enables, etc
  - ✓ Positive RAS test
    - Receiver Errors, Bad TLP, Replay Time-out, Replay Number Rollover, etc..
  - ✓ Link retraining

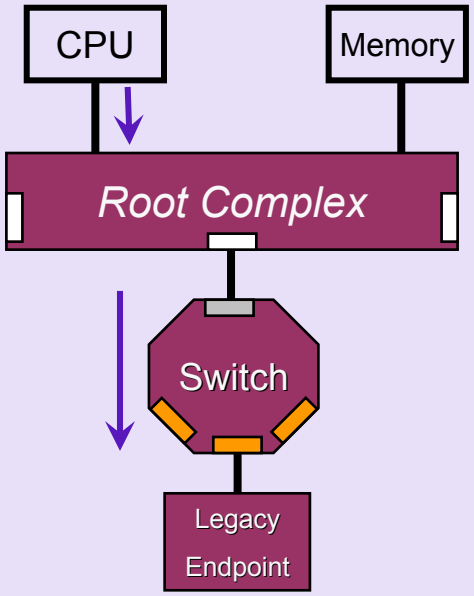


Areas of Testing

Method Matters

Device Target

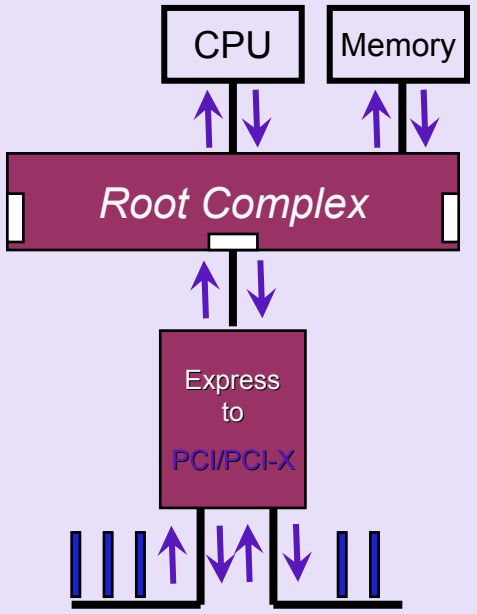
- …0000 0001
- …0000 0010
- Behavior and Reponses controlled
  - ✓ Stress test
    - Pattern written and Read in burst
  - ✓ Performance test
    - Written once and read back many
  - ✓ Protocol test
    - Pattern written and read back many
      - Changing flow control, Interrupts, Message passing,
  - ✓ Positive RAS test
    - Receiver Errors, Bad TLP, Replay Time-out, Replay Number Rollover, etc..
    - Make part as your standard tests
  - ✓ Link retraining



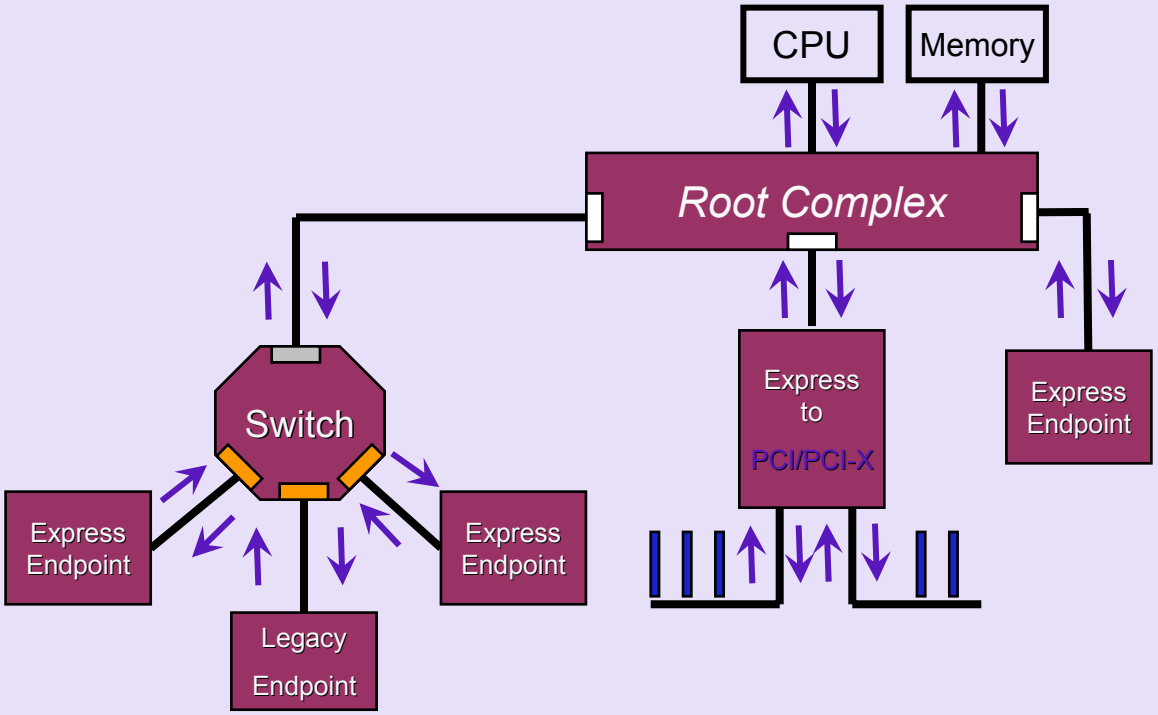
Areas of Testing

- Don’t forget about Legacy Buses!
  - ✓ Traffic loading
  - ✓ Compatibility
  - ✓ Starving?

Completed Picture?



Areas of Testing - All



RAS

Reliability, Availability, & Serviceability

RAS - New Challenges

Compare to Legacy

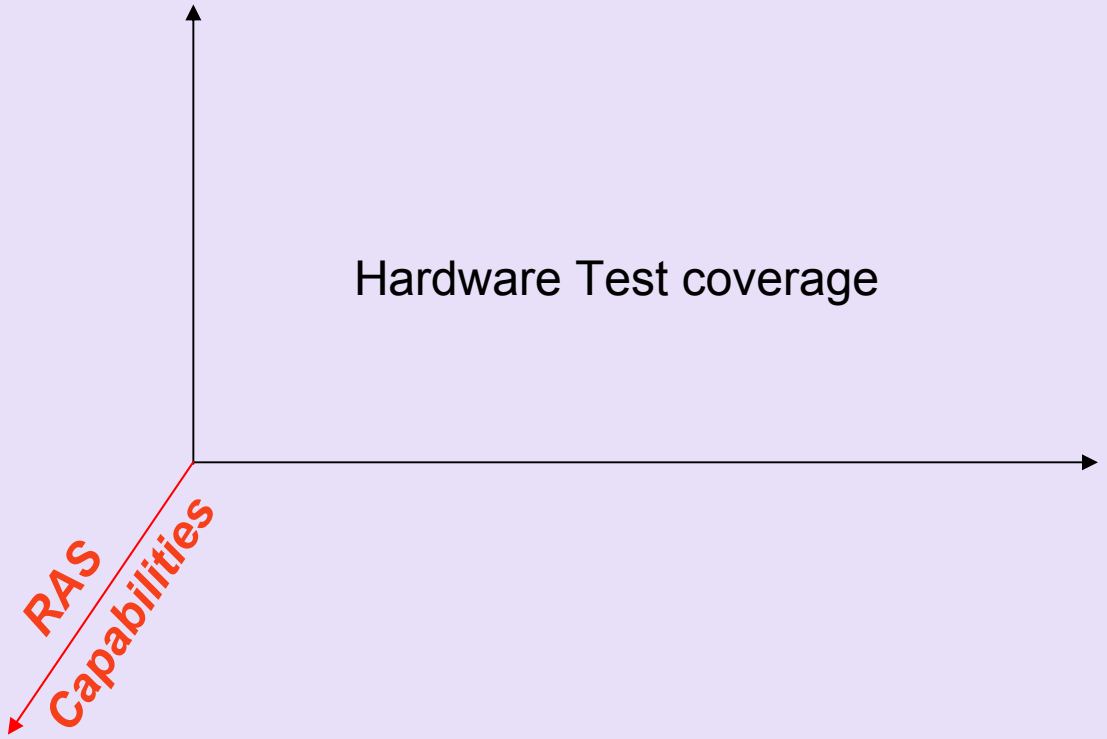
- PCI/PCI-X
  - ✓ Two main types
    - – Fatal
      - SERR
      - Parity
      - Master Abort (non config)
      - …
    - – Recoverable
      - Very limited support
        - Requires Device Driver support
      - Retry
      - …

***** Most errors in Servers are treated as Fatal *****

RAS - New Challenges

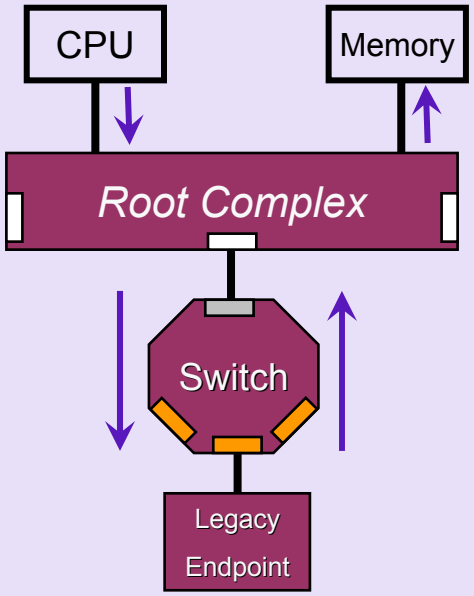
RAS Capabilities

- ✓ Error Generation
- ✓ Error Reporting
- ✓ Error Recovery
- ✓ Provisioning
- ✓ Optimization



RAS - New Challenges

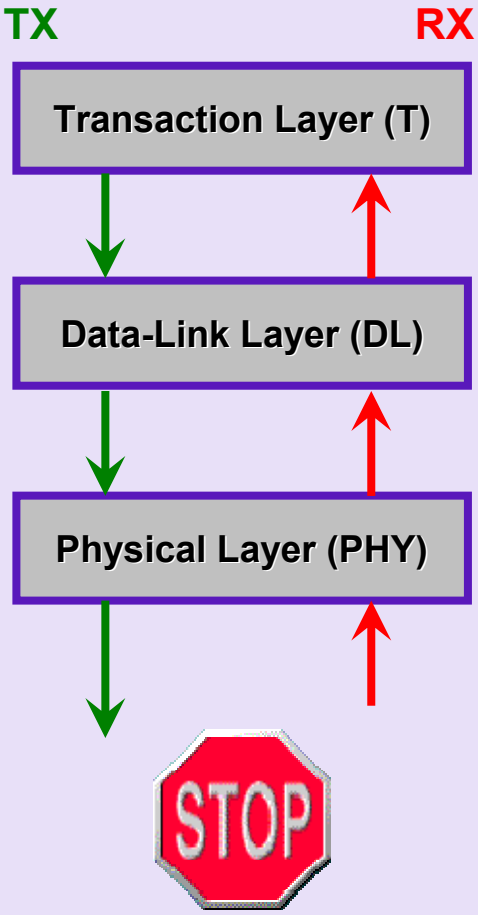
- RAS Capabilities
  - ✓ Negative Testing
    - – Uncorrectable Non-Fatal
      - Unexpected Completion
      - Unsupported Request
      - Completion Abort
      - Completion Time-out
      - Poisoned TLP Received
      - ECRC Failed



Transaction Layer

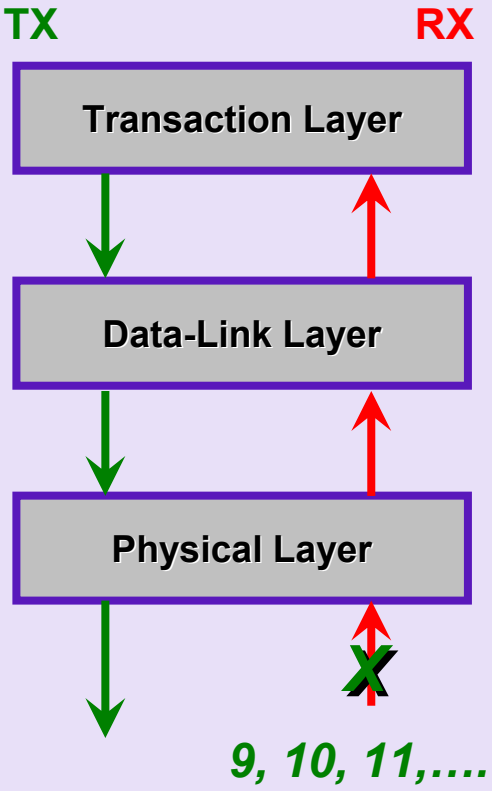
RAS - New Challenges

- RAS Capabilities
  - ✓ Negative Testing
    - – Uncorrectable Fatal
      - Flow Control Protocol Error (T)
      - Malformed TLP (T)
      - Training Error (PHY)
      - DLL Protocol Error (DL)
      - Receiver Overflow (T)



RAS - New Challenges

- RAS Capabilities
  - ✓ Thresholds
    - – Verify (exceed)
      - Non-Fatal / Correctable
    - – Action taken
      - i.e. Retraining?
    - – Reporting
      - Location and information
  - ✓ Systems Responses
    - – Take the system down
    - – Recovery



RAS - New Challenges

Must support Legacy and Express

- Insures Software and hardware compatibility
  - ✓ Legacy
- Is advanced error reporting on?
  - ✓ Not a requirement …

Areas of Testing

Compatibility

Areas of Testing

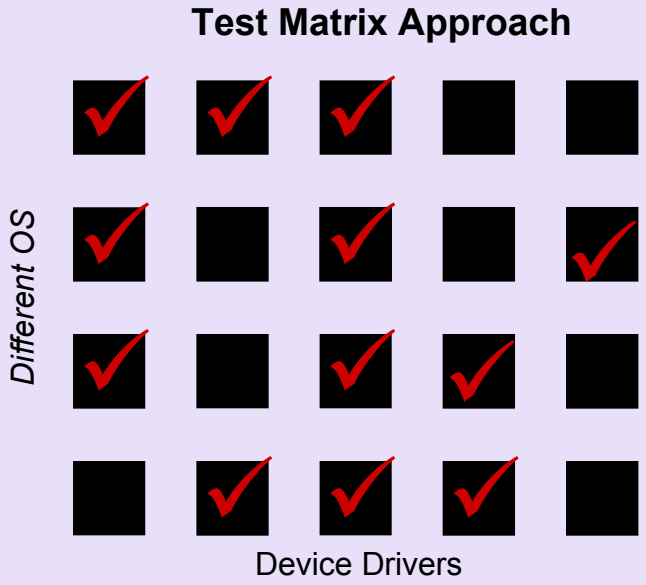
Device compatibility - Add-in adapters

- Verifying compatibility with ….
  - ✓ Your System
  - ✓ Your OS
  - ✓ Their Device
  - ✓ Their Device Driver
- Creating a solution
  - ✓ Integrated

Areas of Testing

Device compatibility

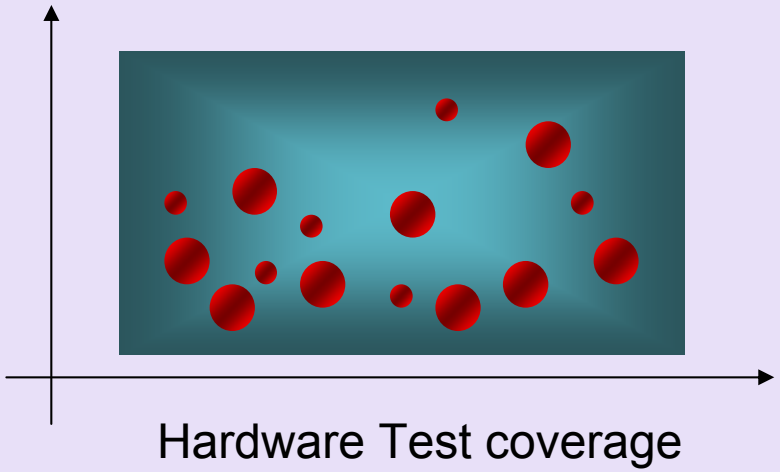
- System / Device Interaction
  - ✓ Methods
    - – Insure device is on the Integrator list
      - • Limits a number of issues
    - – OS(s)
      - • Signed Drivers
    - – Lane Width
    - – Advance Reporting
  - ✓ Reduced Testing Time



Areas of Testing

Device compatibility as “System Validation”

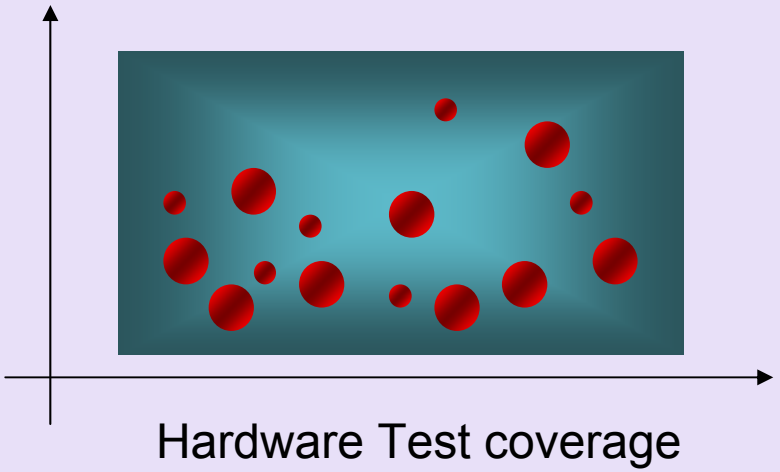
- Look at cross section of function and capability
  - ✓ Virtual channels?
  - ✓ Number of functions?
  - ✓ RAS?
  - ✓ OS Support
    - Device driver capabilities
    - Equal Support across?
- Lane width and bandwidth
  - ✓ Not an absolute
    - Types of transactions
- Closed System?
  - ✓ Know configuration



Areas of Testing

Device compatibility as “System Validation”

- Issue arise on
  - ✓ Lane width
    - Running in every slot?
      - x4 in a x8 slot?
  - ✓ Combinations of devices themselves
    - OS, Driver Version, Other devices
      - Similar, different
    - Application to drive the devices



Recommendations

- Recommendations
  - ✓ Signal Verification Feed your testing process
    - Most stressful patterns in different subsystem
  - ✓ Matrix is hard to manage
    - Look at devices testing as compatibility
  - ✓ Touch each layer of the protocol
    - But don't get lost in the combinations
  - ✓ Compatibility is a joint partnership
    - Out of the box testing
  - ✓ RAS is key to success
    - Detection is only one aspect
    - Positive and Negative testing insure overall quality

Recommendations

- Recommendations
  - ✓ No easy straight solution
    - Most solutions are a combination
  - ✓ Compliance allows a common measurement
    - Helps reduce chances of hardware churn
    - Early compatibility testing
  - ✓ Compare Hardware Test Vehicles
    - Many are on the market
      - All have + and –
    - Cost can be a barrier

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