Improving SAS for future generations

LSI Presentation to the SCSI Trade Association

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14-January-2008
Proposed Goals for SAS-3

• Forward and Backward Interoperability
  – Link Rate
    • 3 Physical Rate Generations: SAS-3 (12.0Gb), SAS-2 (6.0Gb), SAS-1.1 (3.0Gb)
    • 4 Connection Rate Generations (using rate matching for 1.5Gb)
  – Electrical
    • Backward
      – SAS-3 phys must function on SAS-2 interconnect
    • Forward
      – 6Gb SAS-2 phys must function on SAS-3 interconnect
  – Compatibility with future SATA specifications

• Performance
  – 2x bandwidth (1200MB/s)
  – Improve efficiency of the topology
  – Adopt enhanced method for bandwidth aggregation

• Improved cable reach
  – Active copper
  – Optical

• Power
  – Interface and Device power management mechanisms

• Robust
  – BER target $10^{-15}$
    • Based on S-parameter based simulations, as per SAS-2
Physical and Phy Layers

- Link Rate Alternatives for 1200MB/s bandwidth
  - 10Gb/s
    - Follow PCIe lead to double effective link rate
      - vs doubling of physical link rate
    - Encoding via 64b/66b or 64b/67b or scrambling with DC restoration
      - Longer run length increases ISI
      - Shift to different encoding scheme is 1 time fix only
    - Increased complexity
      - Have to replicate functionality of K characters
      - How to insure DC balance?
      - Clocking complications for non integrally related phy rates
      - Challenges for rate matching and multiplexing
  - 12Gb/s
    - Simpler compatibility model
    - 8b10b
      - Will require more advanced equalization techniques
  - LSI evaluating position
    - Starting to simulate channels at 12Gb/s

LSI Recommendation
- 12Gbps with 8b10b encoding
LSI 12Gb/s “Preview”

• Preliminary simulations against SAS-2 Channel Models
  – OIF-CEI-11G-LR compatible architecture at 12Gb
    • 3 TAP TX FIR
    • 8 TAP RX DFE
  – Voltage and timing noise sources
    • Inter-symbol interference (ISI)
    • Circuit noise (modeled as AWGN)
    • Random Jitter (RJ)
    • Duty-cycle distortion (DCD)
    • Crosstalk etc.

• Looked at horizontal and vertical eye margins for target BER of $10^{-15}$
• Preliminary observations – “Not slam dunk, but shows promise”
  – Good performance achievable over most SAS-2 channels at 12Gb/s with significant horizontal and vertical margin
  – Crosstalk in some cases (HP19, HP20, HP21) becomes prohibitively large resulting in eye closure or reduced margin
  – Large insertion loss at Nyquist observed on HP24-26 channels makes them challenging to handle
Desired cable/connector improvements for SAS

• Cheaper passive cables
• Longer cable length
  – Active cable
    • 20m minimum
    • Consider 50m-100m
• Cable recognition
  – I2C and serial EEPROM in cable
• Optical support
Concerns with QSFP
• Too long for a 2U short PCI card (MD2)
• InfiniBand-style pin ordering
Link Layer

- Link Aggregation methods
  - SAS multiplexing
  - Store/forward or switched
  - Virtual connections?
    - Priority
    - QoS

- Topology efficiency and scaling
  - Arbitration/Fairness improvements?
    - Congestion mitigation
  - Preferential pathway allocation?

SAS Multiplexing
- Expensive in controllers and expanders
- Does not play well with mixed speed devices
- Inflexible

SAS Expander Buffering
- Greatest opportunity to maximize:
  - Topology efficiency and utilization
  - System performance
- Accommodate mixed speed devices, flexibly

SAS has Virtual Phys
- Why not Virtual Connections?
Transport Layer

• Security/Authentication
  – What?
    • Authentication
      – Insure that the claimed sender is the actual sender
    • Integrity
      – Insure that no data has been created/modified/deleted between two devices
    • Confidentiality
      – Insure only intended recipients know what is being sent
  – How?
    • Don’t re-invent, rather leverage from IPsec/FC-SP/SCSI-IKEv2
  – Why?
    • Data security threat models for storage will evolve beyond data-at-rest
    • SAS usage models likely to include “small fabric”
    • Devices within SAS domain can easily incorporate “snoop” port capability
    • Peer and competing interfaces will have solutions

LSI Recommendation
• Pursue “SAS-SP” solution, perhaps address with separate SAS workgroup
Application Layer

• Improved management protocol
  – SMP originally defined for simple expanders
  – Scope of SAS has grown
    • Includes more complex configuration and reporting
    • Amount of management data has grown significantly
  – Likely continued increase in both complexity and data set size
    • Authentication and Security

→ Single frame, single connection SMP not best fit

LSI Recommendation
• Pursue standardization of either:
  • Enhanced SMP (disconnecting and multi-frame)
  • Encapsulation
    • SSP for in-band
    • ??? for out-of-band
Moving Ahead

- Close on SAS-2 ASAP (Q108)
- Constrain Scope of SAS-2.X to improve SAS-2 connectivity
- Resource SAS-3 once SAS-2.X is forwarded, if not before (Q408)
  - Many potential enhancements
  - Additional complexity will require a significant effort to close
- Strongly recommend NOT breaking SAS into multiple specifications
  - Slows approval cycles
  - Encourages feature creep
- STA to provide SAS-3 Marketing requirements Q2-Q3 2008.
Thank You