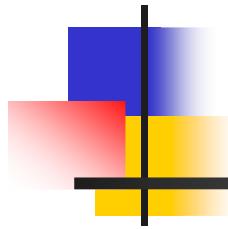


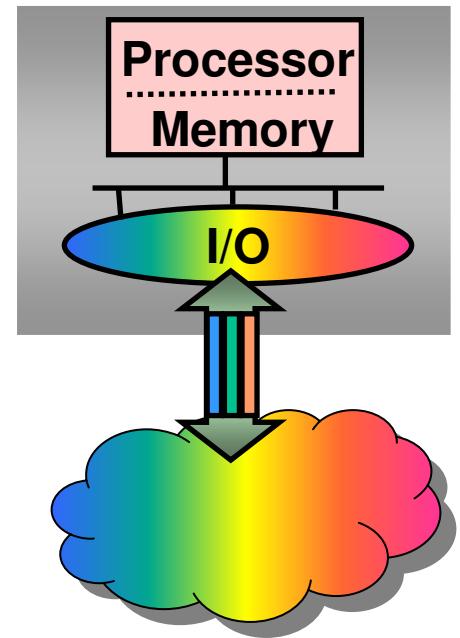
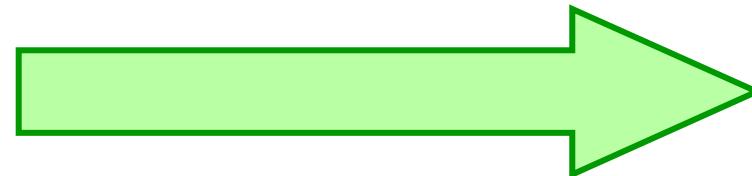
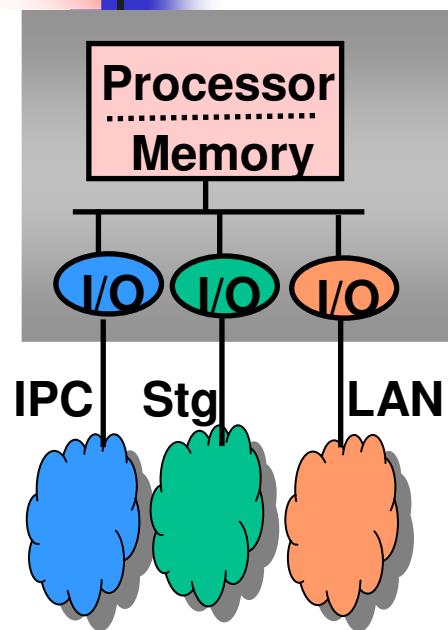
Fabric Convergence from a Storage Perspective



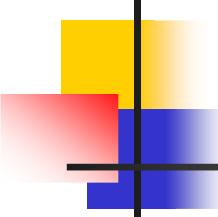
Mike Ko, IBM
Manoj Wadekar, Intel
Davide Bergamasco, Cisco
Joe Pelissier, Brocade

May 29, 2007

I/O Consolidation in the Datacenter

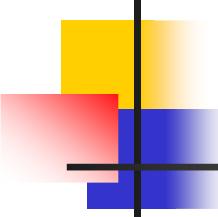


- Enhancing Ethernet to enable I/O consolidation in the datacenter has been discussed in 802 meetings since 2004
- Proposals on congestion management are currently being debated in 802.1Qau working group



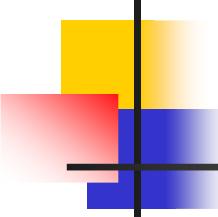
Key Enablers for Storage Convergence

- For I/O consolidation onto a single enhanced Ethernet link
 - Storage will be sharing the link with other classes of applications such as IPC and LAN
- There are 3 key areas that need to be considered:
 - Priority processing and packet scheduling
 - Per priority flow control (e.g. PAUSE)
 - Discovery and capability exchange protocol
- This will be crucial for new emerging storage protocols
 - Discussions are underway at T11 for layering Fibre Channel directly over Ethernet



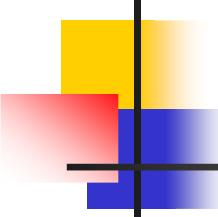
Priority Processing and Packet Scheduling

- For each class of applications that will now use the same consolidated layer 2 transport
 - Queuing requirements for different traffic classes are needed to allow for different resource allocation
- Different traffic classes need to be managed separately
 - LAN
 - Large number of flows, not very sensitive to latency
 - E.g. dominant traffic type in Front End Servers
 - SAN
 - Large packet sizes, sensitive to packet drops
 - E.g. Middle Tier and Back End Servers
 - IPC:
 - Mix of large and small messages
 - Small messages are latency sensitive
 - E.g. Back End Servers, HPC Applications



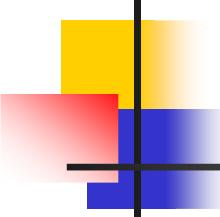
Use of Queuing Requirements in Storage

- Priority groups allow storage traffic to be managed as a group with configurable QOS guarantees
 - Ensures that storage traffic will get its fair share of resources
 - Allows the scheduling mechanism to apply different disciplines
 - Provide minimal latency for delay sensitive traffic in other bandwidth groups
- If necessary, different queues can be set up within the storage traffic class group with different QOS allocation



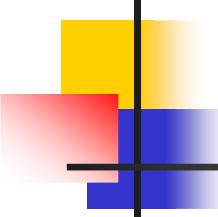
Proposals on Priority Processing and Packet Scheduling

- We need to start developing a list of requirements/objectives for priority processing and packet scheduling
- Proposals made in the following presentations can be used as a basis for the draft:
 - “Improved Transmission Selection” by Wadekar et al, May ‘06
 - new_cm_wadekar_transmission_selection-0506-01
 - “Proposal for Traffic Differentiation in Ethernet Networks” by Wadekar et al, March ‘05
 - new-wadekar-virtual-links-0305
 - “Congestion Management in Datacenter Networks” by Wadekar, May ‘05
 - new-wadekar-congestion-management-framework-0505
 - “Proposal to improve expedited forwarding” by Congdon, May ‘05
 - new-congdon-improved-queuing-0505
 - “Proposal to improve expedited forwarding (...continued...)” by Congdon, July ‘05
 - new-congdon-improved-queuing-0705



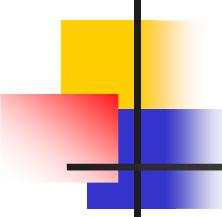
Per Priority Flow Control and Storage

- Scheduling mechanism allows storage traffic to share the same link with non storage traffic
 - But to achieve the no packet drop behavior required by some storage protocols, per priority flow control (e.g., PAUSE) will be needed
- Per Priority PAUSE extends the granularity of 802.3x PAUSE mechanism to accommodate different priority classes
 - Selective pausing avoids impacts to high priority and delay sensitive traffic
 - For storage protocols layered over TCP/IP, per priority flow control enables service differentiation at the link layer (vs at the IP layer)



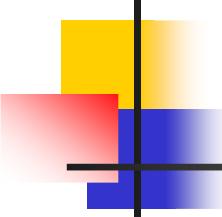
Impact of Dropped Packets in Storage

- For storage traffic that uses TCP/IP as the transport, e.g., iSCSI, iSER, etc.
 - Besides retransmission delay, TCP/IP also exhibits additive-increase-multiplicative-decrease (AIMD) behavior in response to packet drops
 - Hurts throughput and latency
 - Alternatives with different congestion avoidance algorithms include FastTCP, HighSpeed TCP, BIC-TCP, H-TCP, XCP, etc.
- For storage traffic that does not use a transport layer, e.g., Fibre Channel over Ethernet
 - Detection at the SCSI level is in the order of 10s of seconds
 - Detection time is in the order of seconds if Read Exchange Concise (REC) extended link service is supported
 - Recovery is at the SCSI command level
 - Severely hurts throughput and latency
 - May cause severe system malfunction (e.g., unexpected server reboots)



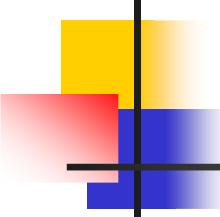
Proposals on Per Priority PAUSE

- We need to start developing a list of requirements/objectives for per priority flow control
- Proposals made in the following presentations can be used as a basis for the draft:
 - "Why Priority/Class Based PAUSE is Required" by Brunner et al, July '05
 - brunner_1_0507
 - "Priority Pause support for CN (e.g., BCN) Mechanism" by Hazarika et al, November '06
 - au-Brunner-Hazarika-Priority-Pause-considerations-111406
- Concerns about deadlocks with PAUSE were discussed in the following presentation but more work is needed to address all issues:
 - "Requirements Discussion of Link Level-Flow Control for Next Generation Ethernet" by Gusat et al, January '07
 - au-ZRL-Ethernet-LL-FC-requirements-r03



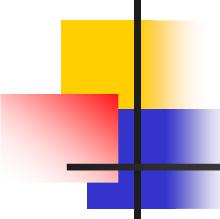
Discovery and Capability Exchange Protocol

- For the enhanced Ethernet, a mechanism is needed to discover the boundary of the enhanced Ethernet components and exchange capabilities
 - Determine capabilities:
 - priority class (such as bandwidth allocation),
 - congestion management support (optional),
 - per priority PAUSE support, etc.
 - Useful, but not essential, for storage protocols layered over TCP/IP such as iSCSI/iSER
 - Can always fall back to legacy Ethernet behavior
 - Critical for storage protocols directly layered over Ethernet such as Fibre Channel over Ethernet
 - Packet loss due to congestion can severely impact throughput and performance
- We need to start developing a list of requirements/objectives for the discovery and capability exchange protocol
- Previous discussion on this topic leverages LLDP
 - “CM Capability Exchange and Discovery” by Wadekar, January ‘07
 - au-wadekar-cm-discovery-protocol-needs-012407-v3



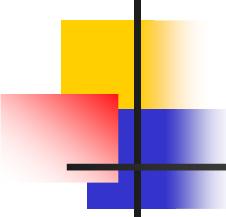
Summary

- Work on congestion management in 802.1Qau is a good first step
 - But not sufficient for the enhanced Ethernet to become the converged fabric in the datacenter
- We need to start developing a list of requirements/objectives on these other aspects:
 - Priority processing and packet scheduling
 - Per priority PAUSE
 - Discovery and capability exchange protocol



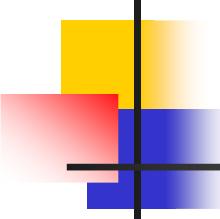
Straw Poll #1

- The CM task group should draft a PAR, 5 criteria and objectives for “transmission selection” for 802.1Q bridges and end nodes to provide priority grouping and per-group traffic class allocation, for review by IEEE 802.1 at the July plenary (22 present)
- Results:
 - Yes: 11
 - No: 0
 - Abstain: 9



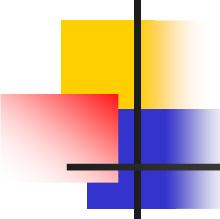
Straw Poll #2

- I intend to actively contribute to the development of a PAR, 5 criteria and objectives for the “priority grouping” work in 802.1Q spec
- Results:
 - Yes: 9
 - No:
 - Abstain:



Straw Poll #3

- The CM task group should draft a PAR, 5 criteria and objectives for granular (per priority) link level flow control for 802.1Q bridges for review by IEEE 802.1 at the July plenary
- Results:
 - Yes: 14
 - No: 2
 - Abstain: 4



Straw Poll #4

- I intend to actively contribute to development of a PAR, 5 criteria and objectives for the “per priority link flow control” work in 802.1Q spec
- Results:
 - Yes: 13
 - No:
 - Abstain: