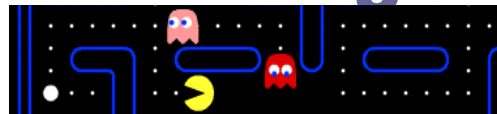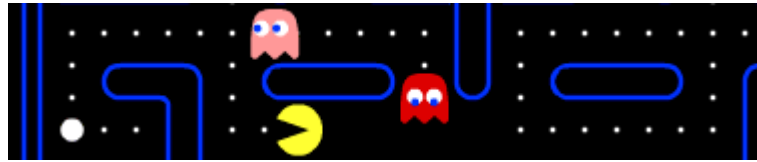# Ethernet or EtherNot:
Ethernet the PacMan of Network Technologies

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Hot Interconnects

Stanford University, Stanford CA

19 August 2005

SIGNAL LAKE

13th Annual IEEE
Symposium on
High Performance Interconnects

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Ethernet as PacMan

- **Ethernet continually evolves:**
  - Adds functionality from high-end protocols
  - Drives prices for this functionality way down (driven by Ethernet's huge scale and open source cost advantages)
  - Makes the once high-end protocols obsolete and/or scrambling to establish the next high-end standard

- **It's happened since 1970s**
  - 20+ Project 802 Subcommittees
  - 8 Currently Active 802.3 Subcommittees!
  - Tens of thousands of staff years of time
  - Hundreds of millions of dollars

- **It will happen again!**

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Ethernet Version 1.0
September 1980
Digital Equipment, Intel, Xerox

- **Serial digital transmission**
  - High reliability: earlier approaches were parallel digital
  - Takes advantage of Moore's law
- **High speed**
  - 1 mbps-20 mbps
  - 3 mbps in 1980 was cost effective->10 mbps in 1985
- **Local**
  - Up to three segments each five hundred meters maximum extent
  - Slot time tied to electromagnetic propagation time
- **PHY (Physical Layer)**
  - Physical Medium: Six Shield Orange Coaxial Cable
  - Limited Coaxial Cable Availability: drive for new media!
- **Layer One**
  - Electrical: Manchester Encoding to insure collision detection
- **Layer Two**
  - Distributed state: Collision Detection and Binary Backoff
  - Media Access Control: 48 bytes

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High-End Protocols, Circa 1980

- ## Token Ring
  - Star shaped ring: low cost management
  - Predictable performance
  - High reliability/availability
  - Performance scales with semiconductor technology advancement

- ## Token Bus
  - Predictable performance
  - High reliability/availability
  - Performance scales with semiconductor technology advancement

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IEEE Computer Society Local Network Standards Committee Project 802—Founded Feb 1980 Open Networking Before Open Software!

- **802.1-Higher Level Interface (HLI)**
- **802.2-Logical Link Control (Dormant)—B.W.Stuck Member**
- **802.3-Carrier Sense Multiple Access/Collision Detection Bus**
- **802.4-Token Passing Bus (Disbanded)—B.W.Stuck Member**
- **802.5-Token Passing Ring (Dormant)**
- **802.6-Metropolitan Area Network (Disbanded)**
- **802.7-Broadband Technical Advisory Group (Disbanded)**
- **802.8-Fiber Optics Technical Advisory Group (Disbanded)**
- **802.9-Integrated Services LAN (ISLAN) (Disbanded)**
- **802.10-Standard for Interoperable LAN Security (SILS) (Disbanded)**
- **802.11-Wireless Local Area Network (WLAN)**
- **802.12-Demand Priority (Dormant)**
- **802.14-Cable-TV Based Broadband Communication Network (Disbanded)**
- **802.15-Wireless Personal Area Network (WPAN)**
- **802.16-Broadband Wireless Access (BWA)**
- **802.17-Resilient Packet Ring (RPR)**
- **802.18-Radio Regulatory Technical Advisory Group**
- **802.19-Coexistence Technical Advisory Group**
- **802.20-Mobile Wireless Access**
- **802.21-Media Independent Handover**

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Ethernet Enhancements: 1980->2005

Attribute	1980 Ethernet	2005 Ethernet
Bit Rate	10Mbps	10Gbps
Physical Media	Coax	Coax, copper wire, optical fiber, microwave
Topology	Bus	Switch/star
Quality of Service (QoS)	Binary Backoff	Multiple priorities, QoS per flow, lossless switch
Distance	1500 meters	Thousands of kilometers

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So What Are the Challenges Today?

Features	Infiniband	Myrinet	Fiber Channel
Latency	5 µsec HCA	3 µsec NIC	7 µsec HBA
Throughput	1-25 Gbps	1-20 Gbps	1-8 Gbps
QoS	Four priority levels with 16 channels	Proprietary	Credit based flow control
Interoperability	Common Drivers	Proprietary	Vendor Specific
Topology	Star/switch	Bus	Star/switch

8 Currently Active 802.3 Subcommittees

- IEEE 802.3, Residential Ethernet Study Group.

- IEEE 802.3, Power over Ethernet plus Study Group.

- IEEE P802.3REVam, Maintenance #8 (Revision).

- IEEE P802.3an, 10GBASE-T Task Force.

- IEEE P802.3ap, Backplane Ethernet Task Force.

- IEEE P802.3aq, 10GBASE-LRM Task Force.

- IEEE P802.3ar, Congestion Management Task Force.
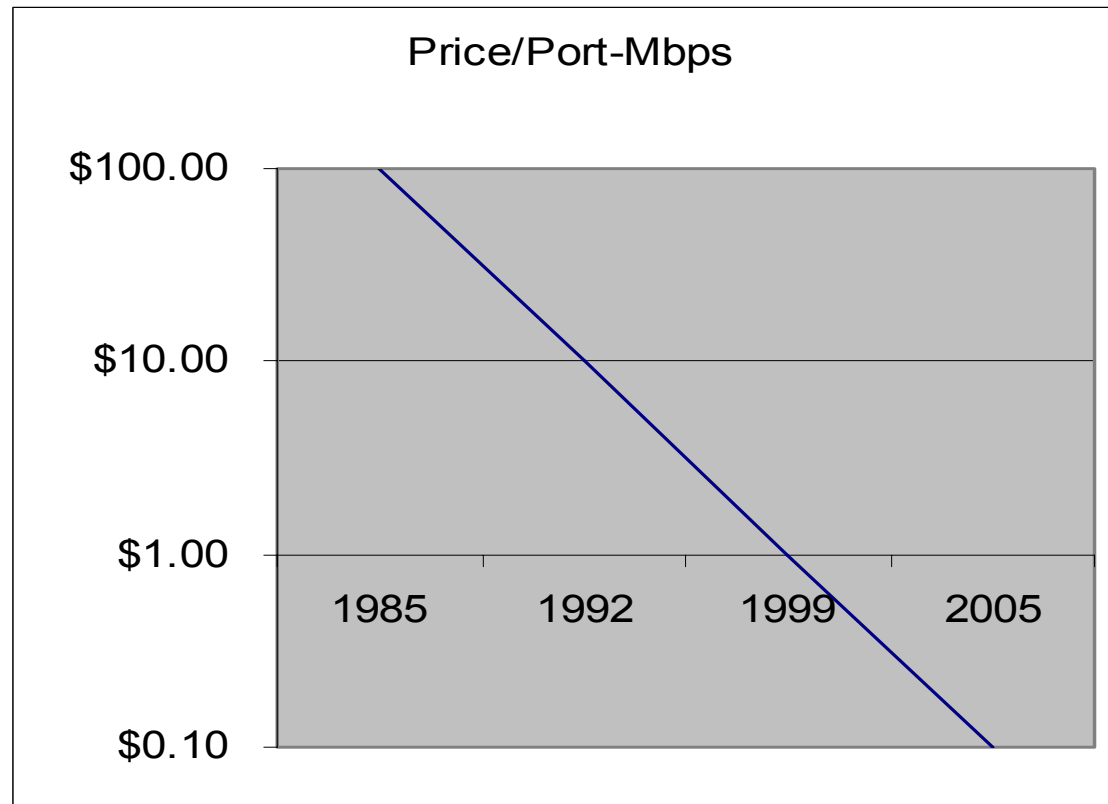
- IEEE P802.3as, Frame Expansion Task Force.

So What Are the Challenges Today?

Features	Infiniband	Myrinet	Fibre Channel	ETHERNET
Latency	5 μsec	3 μsec	7 μsec	3 μsec
Throughput	1-25 Gbps	1-20 Gbps	1-8 Gbps	1-40 Gbps
QoS	Four priority levels with 16 channels	Proprietary	Credit based flow control	Thousands of flow based priority levels; lossless switch
Interoperability	Common Drivers	Proprietary	Vendor Specific	YES
Topology	Switch/star	Bus	Switch/star	Switch/star

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Ethernet Historical Price Trends: Lowest Total Cost of Ownership

Price/Port-Mbps

$100.00			
$10.00			
$1.00	1985	1992	1999	2005
$0.10			

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Conclusion

- The question is when, not if

- 'When' is sooner than many people think

- There will always be room for higher-end extensions

- Ethernet will adopt the best of these new extensions: the lifetime of extensions are limited by the inevitable onslaught of Ethernet.

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