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STORAGE NETWORKING INDUSTRY ASSOCIATION

EDUCATION

Networking for Storage Professionals

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Networking for Storage Professionals

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- **Objectives:**
  - **Identify what networking is and how it relates to storage**
  - **Examine storage *networking* technology similarities and differences**
  - **Clarify and explain the language of networking: Terminology**

- **Topics**
  - **Network Vs. Storage**
  - **DAS, NAS, SAN**
  - **Introduction to Networks**
  - **Fundamental Concepts**
  - **Semantic "ANALyst"**
  - **Names & Addresses**
  - **OSI, IPS (TCP/IP) and Fibre Channel**
  - **Traditional FC SAN, Traditional NAS, iSCSI SAN**
  - **Futures**

Network Vs. Storage

Network Considerations	Storage Considerations
Information movement	Information repository
Data over Distance	Data over Time
Configuring and segmenting network topologies	Formatting and partitioning hard disks
Hubs, bridges, switches, routers, gateways	JBOD, RAID, Tape Controllers
Client/Server Applications	Initiator / Target - LUN Functions
Email, Web Browsing, File Mgt Network Interface	Backup, Archive, Mirror, Block Mgt I/O Interfaces

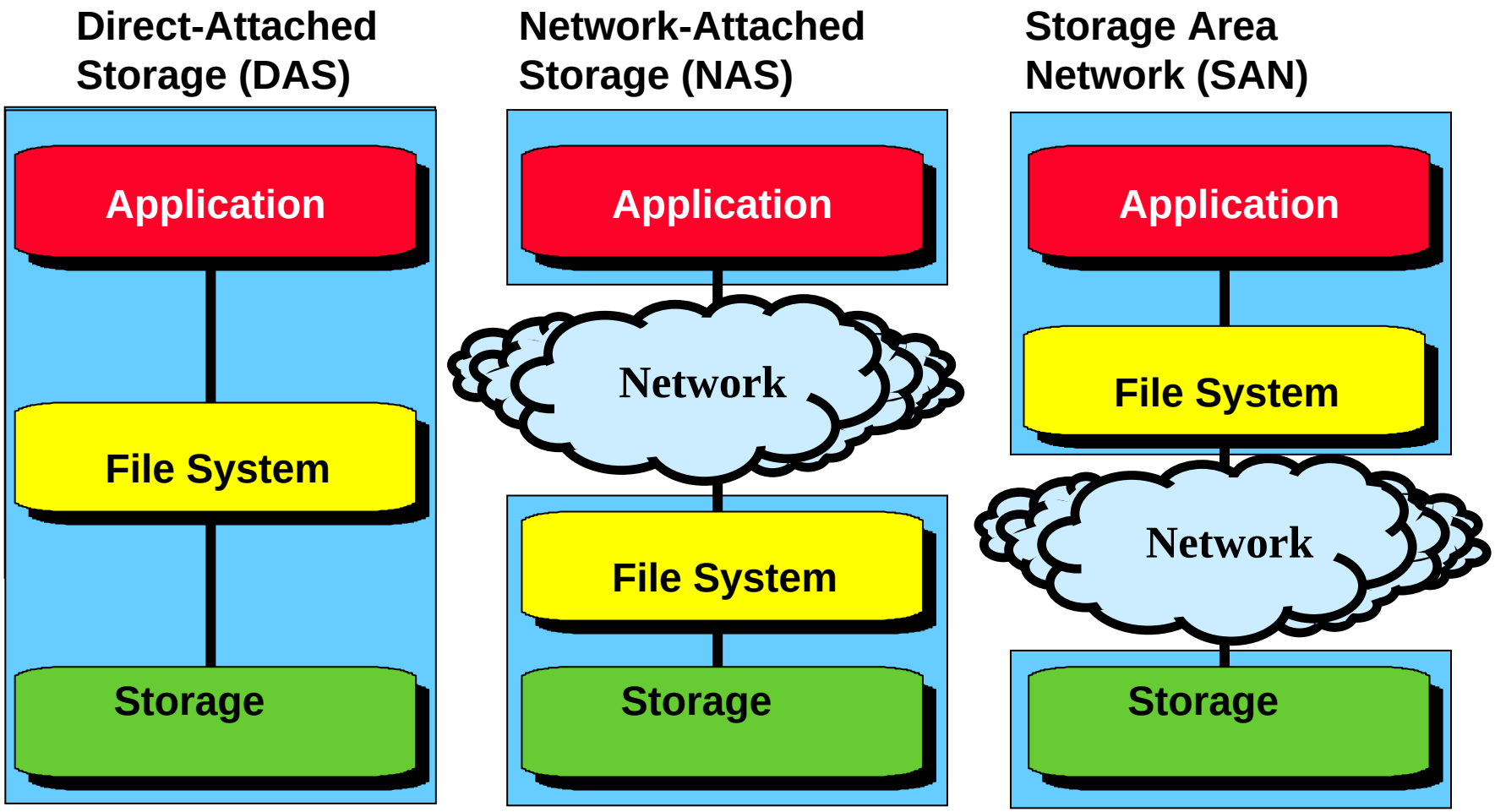
Network Vs. Storage

Network Considerations	Storage Considerations
Speed, Solid-State	Capacity, Mechanical Movement
Media – Copper, Fiber, Wireless	Media – Disk, Tape, Paper
Bits in Frames, CRC error checks every frame	Bytes in Blocks, Parity check every byte
Buffers and Link transfer rates – Kbps, Mbps, Gbps	Cache and Disk/Tape I/O interface transfer rates - MBps
Interconnectivity network and device latencies - bottlenecks	Disk/Tape seek times and latencies – ms, us, ns
Applications – HTTP, NFS, SMTP Transport Protocols – (TCP/IP/Ethernet) , Fibre Channel	Logical Device Protocols – SCSI, ESCON, IDE/ATA Physical Protocols – Parallel SCSI

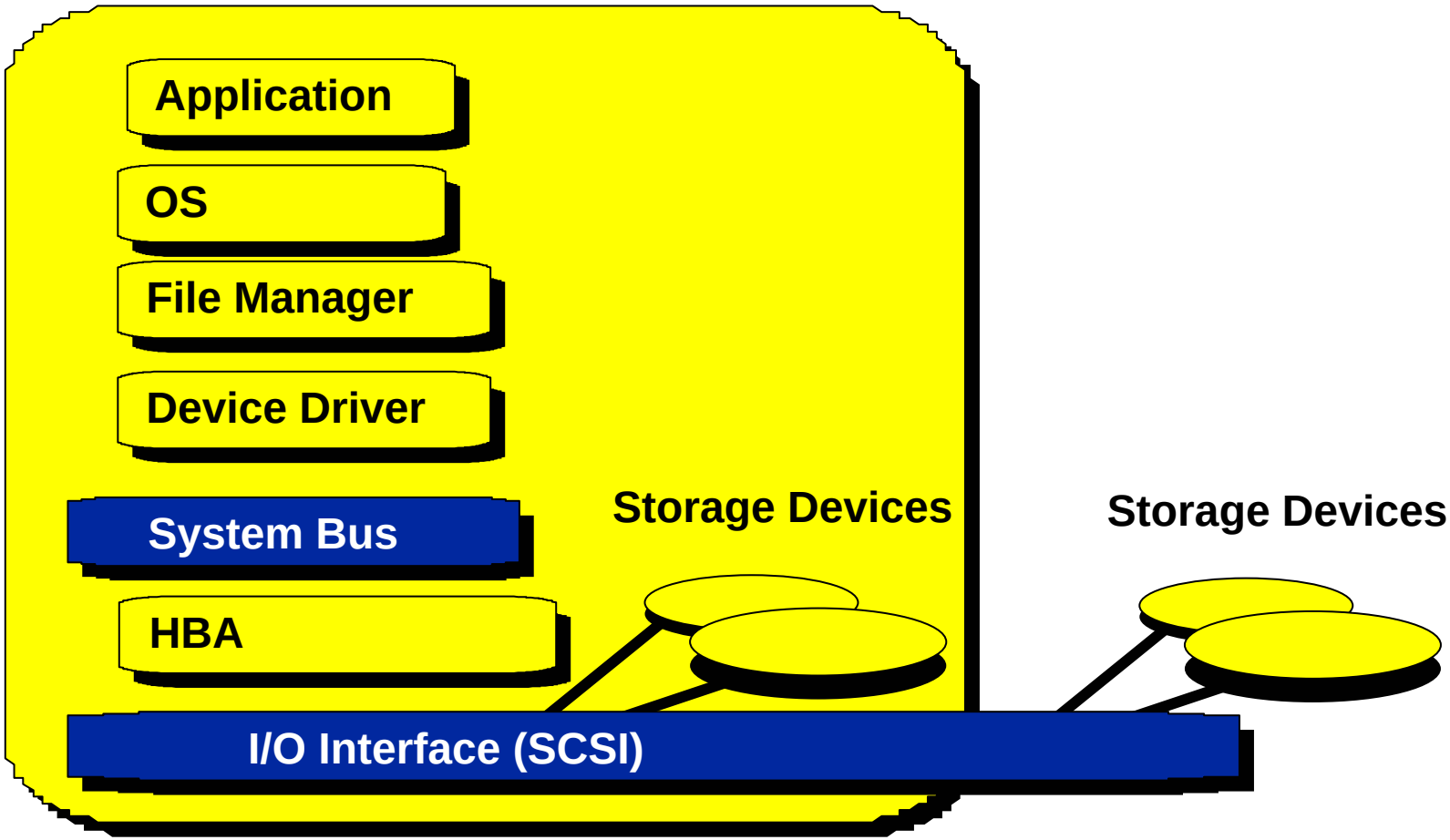
Network & Storage

Network Considerations	Storage Considerations
ESCON, FICON	ESCON
P-SCSI, FCP, SSA, IEEE 1394 Firewire, iSCSI, SAS	SCSI
P-ATA, SATA, SAS(STP), USB	IDE, EIDE, ATA,
PCI, PCIX, Infiniband	System

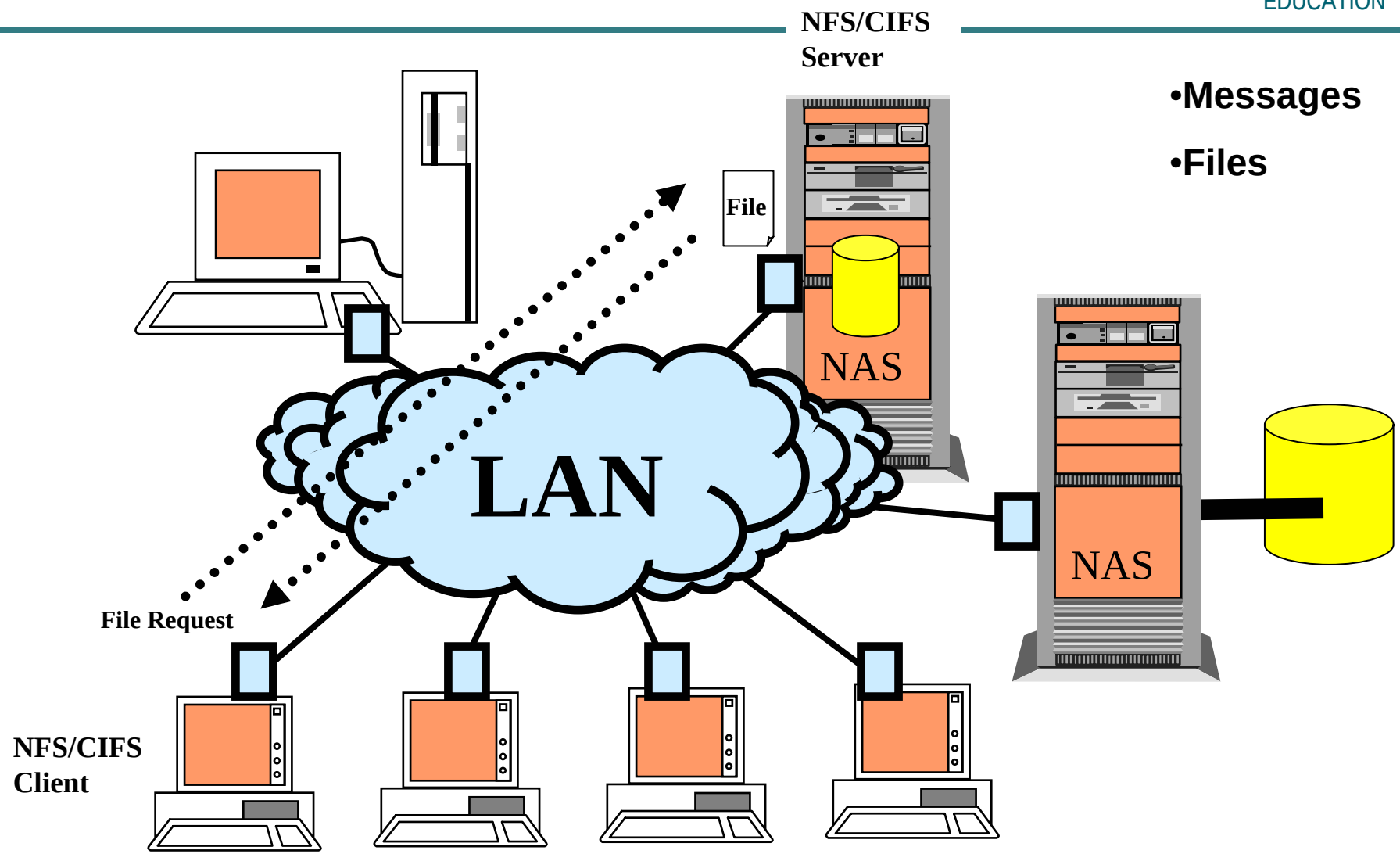
Basic Storage Network Technology



Direct Attached Storage



Network Attached Storage



What is a SAN?

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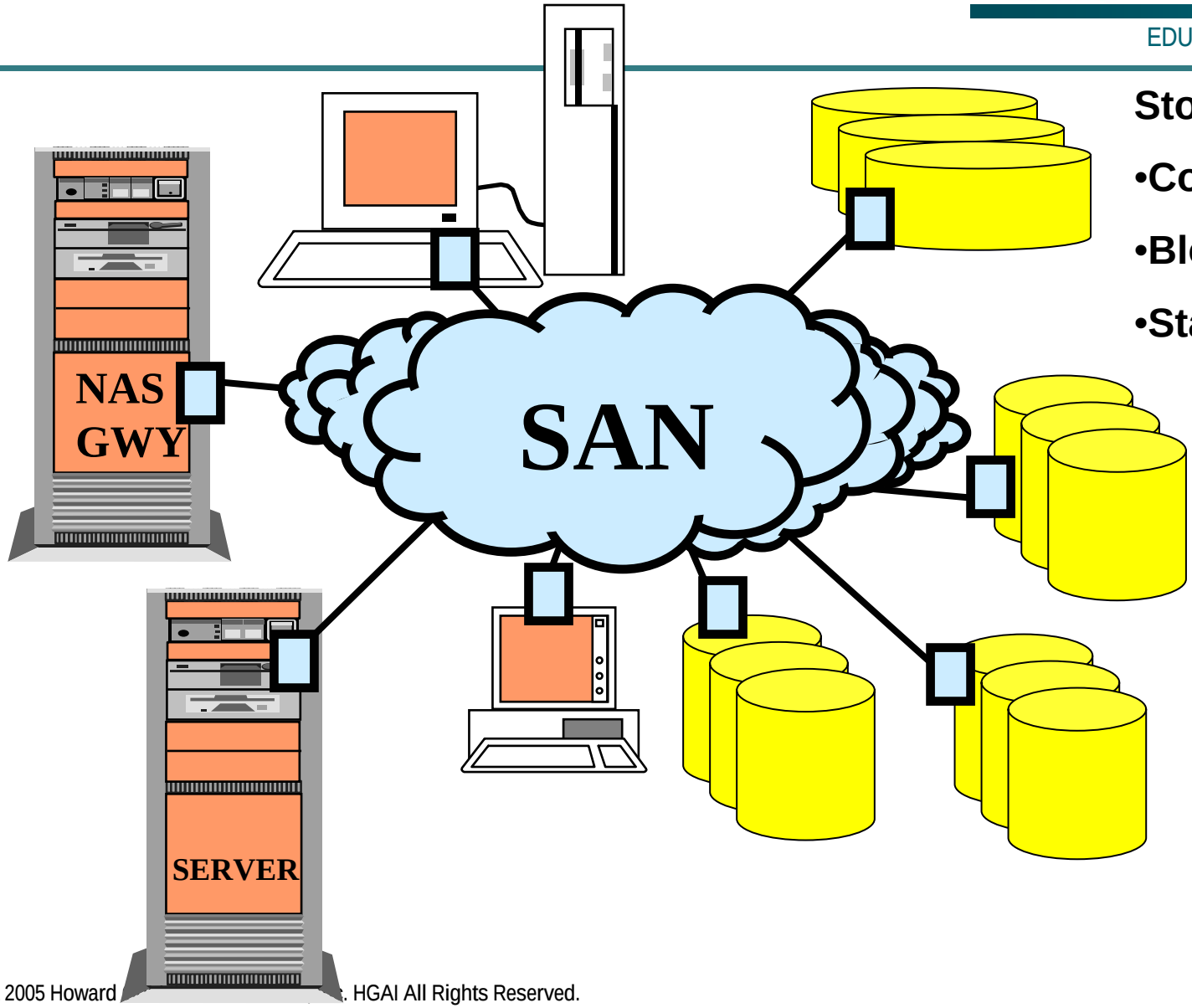
- Storage Area Network
- Server Area Network
- System Area Network
- The latest thing to sell!

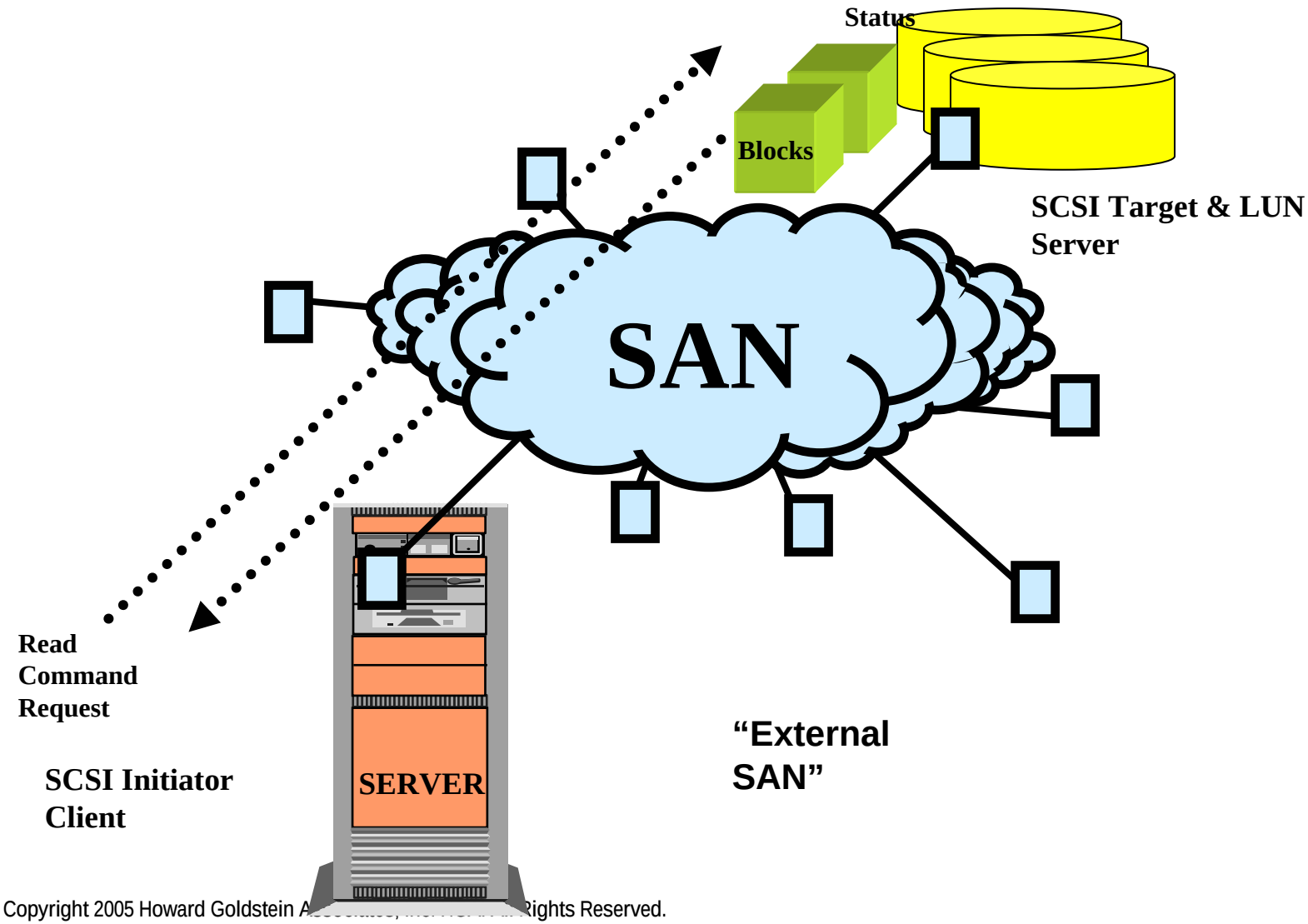
Storage Area Network



Storage

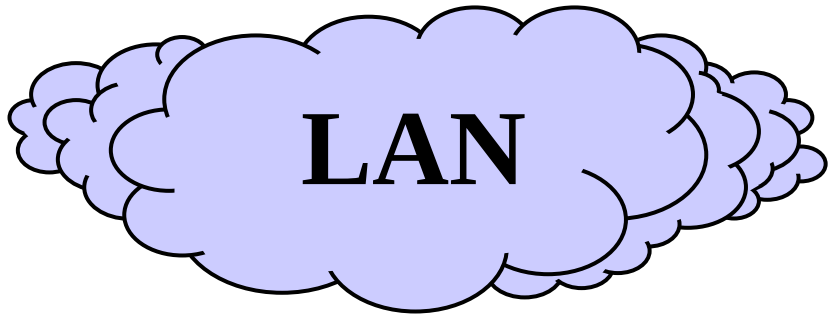
- **Commands**
- **Blocks**
- **Status**

Storage Area Network – "External SAN"



LAN/SAN Benefits

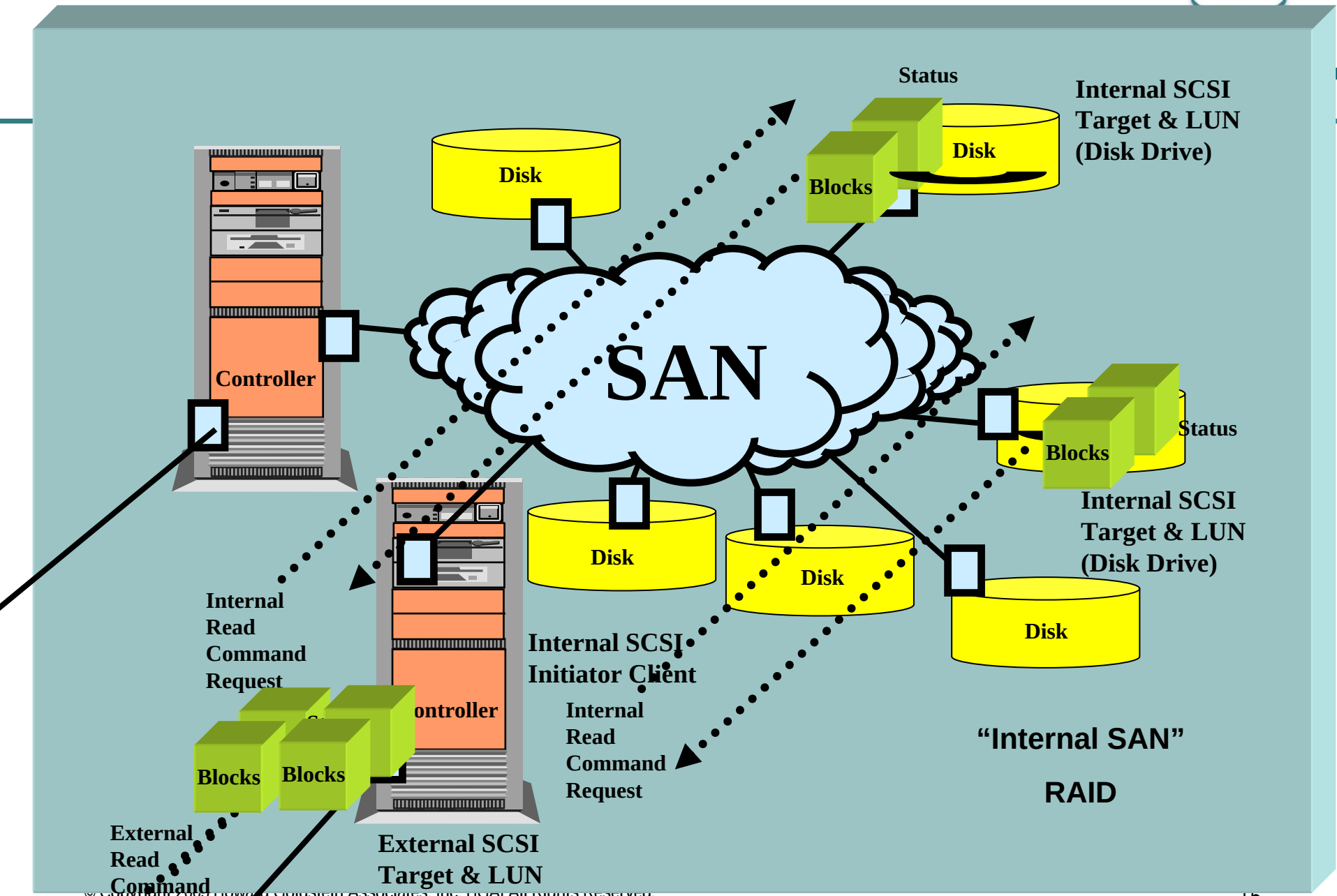
- Expanded connectivity
- Port consolidation
- Extended distance
- Higher bandwidth
- Potential performance improvement



SAN Applications

- High performance storage and workgroups
- Large data bases
- Data warehouse
- Storage backup and recovery
- Server clusters
- Network based storage
- Campus backbones
- Digital audio/visual networks

Storage Area Network – “Internal SAN”



Storage Network Physical Transport Choices

"Very Small"

"Very Skinny"

- Integrated Device Electronics (IDE)
- Small Computer Systems Interface (SCSI) Bus
- Enterprise System Connectivity (ESCON)
- Serial ATA SATA, Serial Attached SCSI SAS
- Fibre Channel

Fibre Channel

- IP Storage
  - internet SCSI (iSCSI)
  - internet Fibre Channel Protocol (iFCP)
  - Fibre Channel Internet Protocol (FCIP)
  - internet Storage Name Service (iSNS)

IP Storage

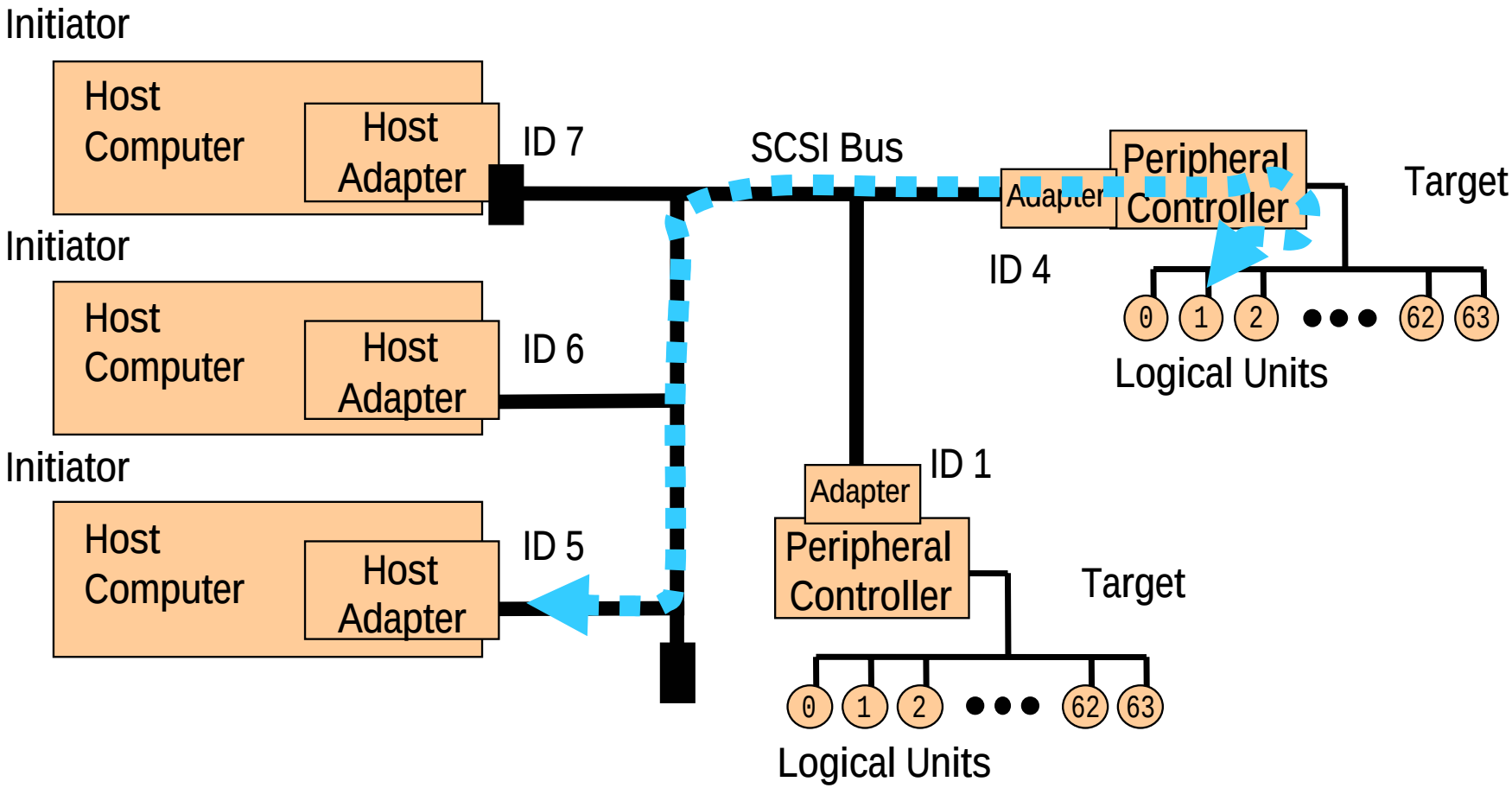
- TCP/IP
  - Transmission Control Protocol (TCP)
  - Internet Protocol (IP)
  - Gigabit Ethernet (GE), SONET/SDH, DWDM

TCP/IP/GE

- Infiniband

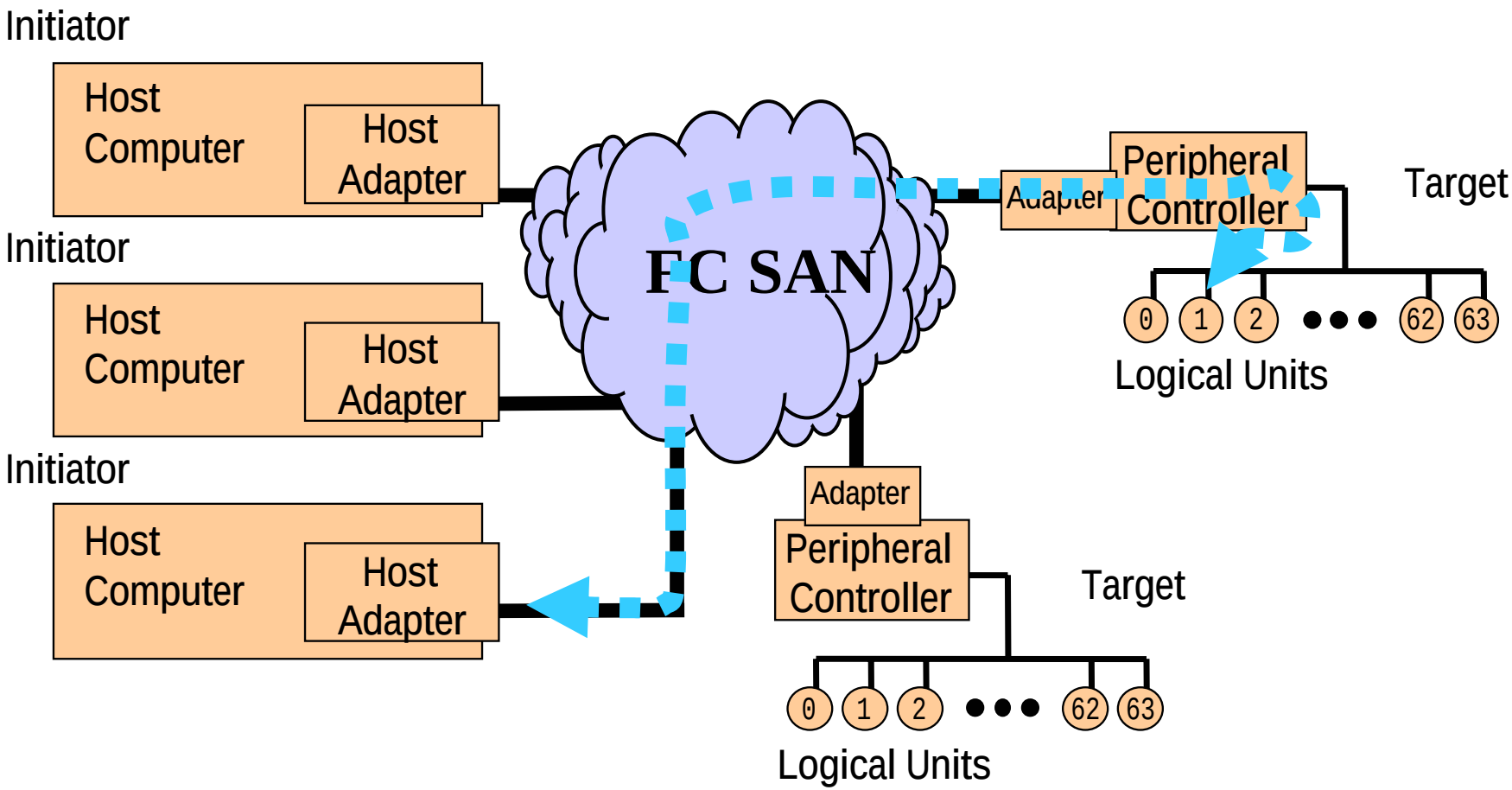
Infiniband

Virtual SCSI Cables on SCSI Bus



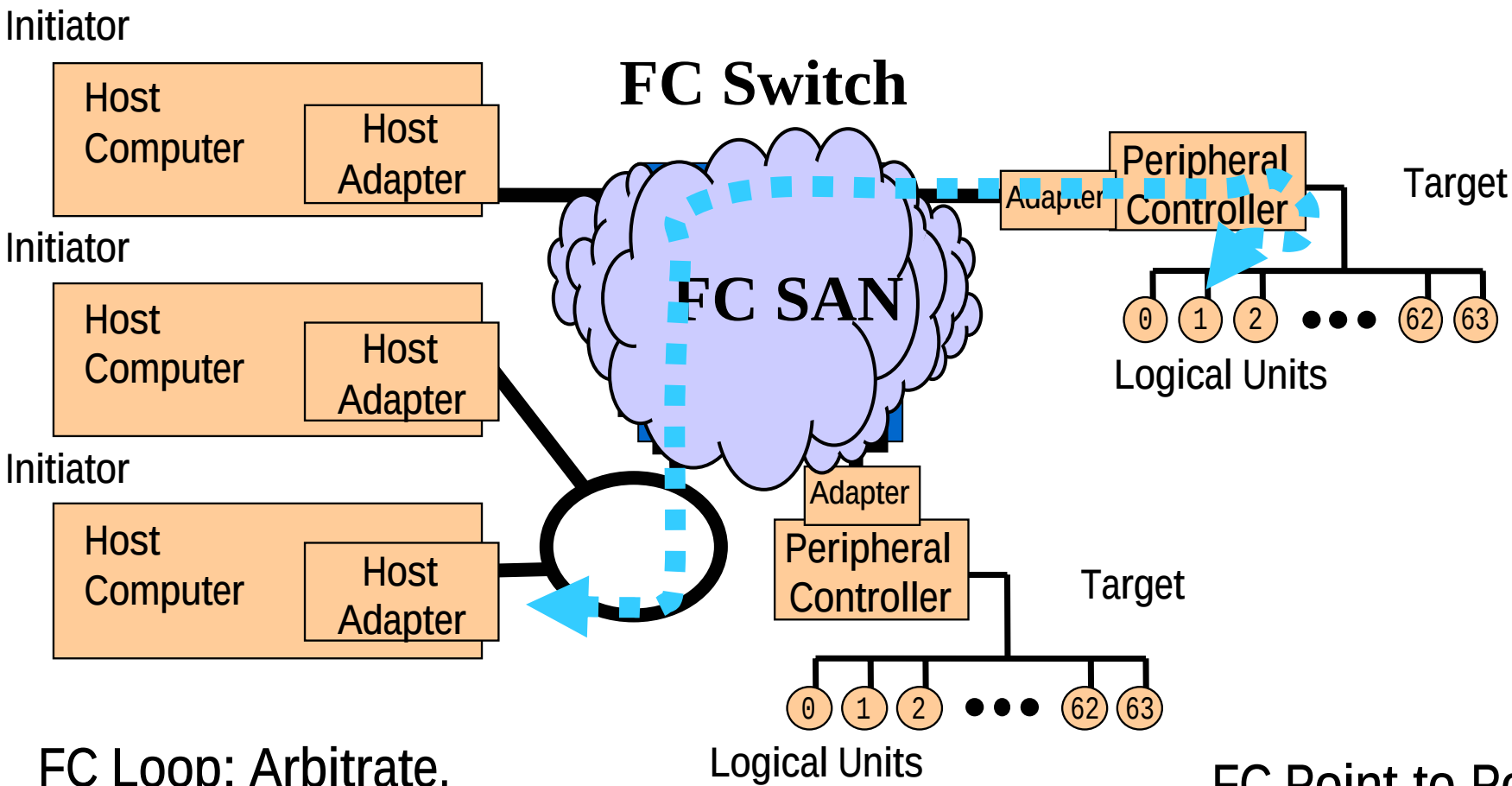
SCSI Bus: Arbitrate ID, Select ID, Identify LUN

Virtual SCSI Cables Fibre Channel



FC: Fabric Login, N_Port Login, FC-4 Login

Virtual SCSI Cables Fibre Channel

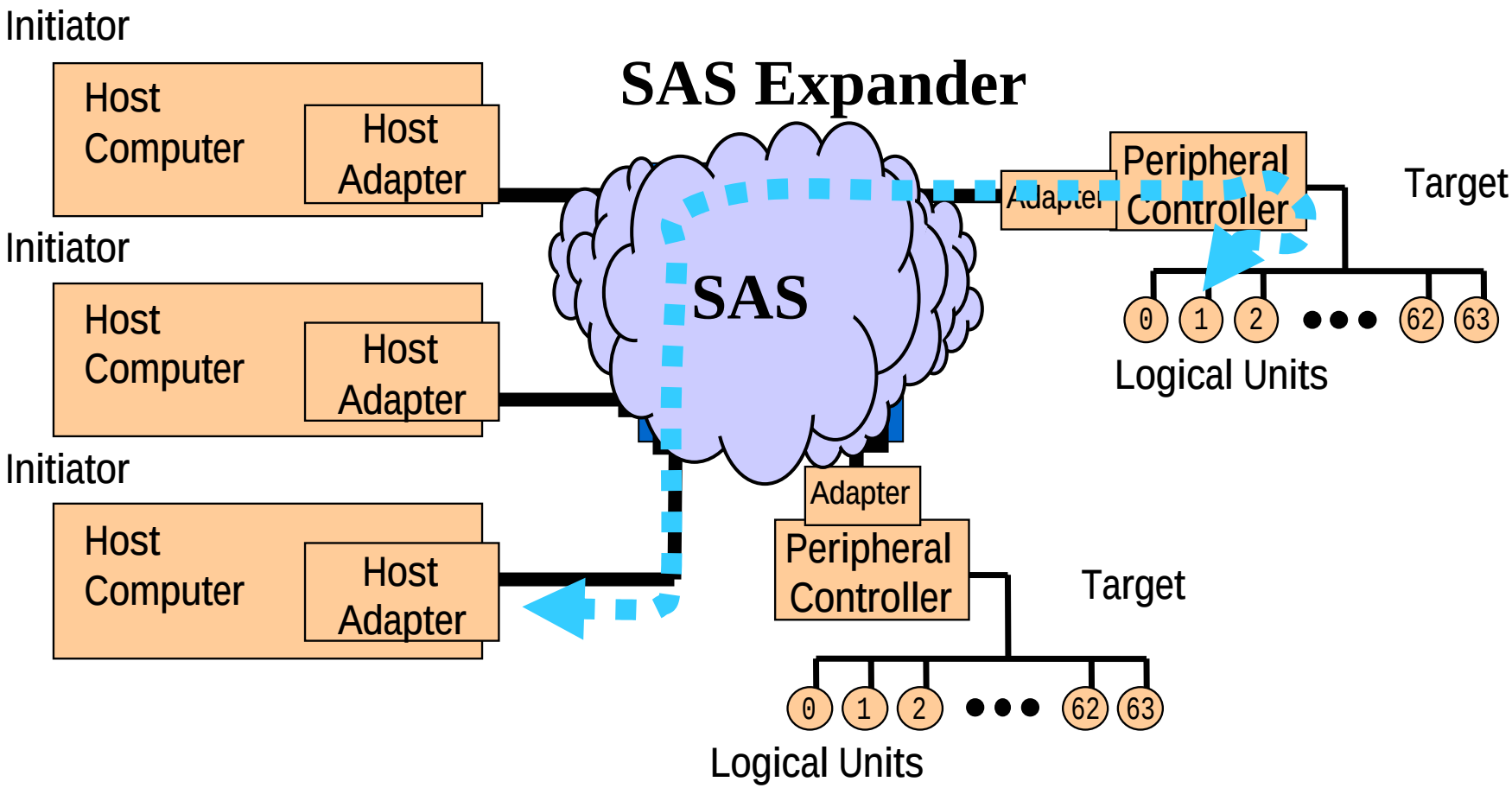


FC Loop: Arbitrate, Open Loop Circuit

FC Fabric: Switch Routing

FC Point-to-Point: Direct Routing

Virtual SCSI Cables SAS

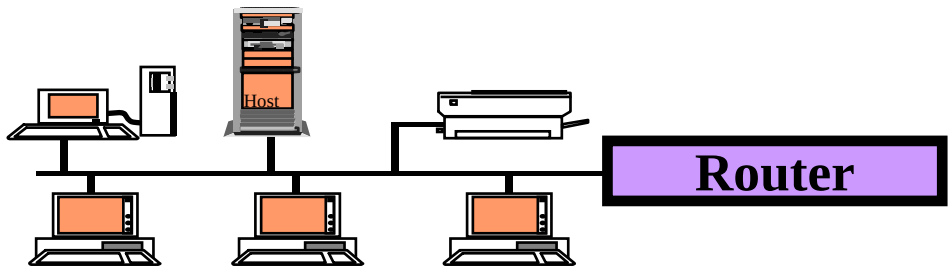


Serial Attached SCSI Bus: Open, Information, Close

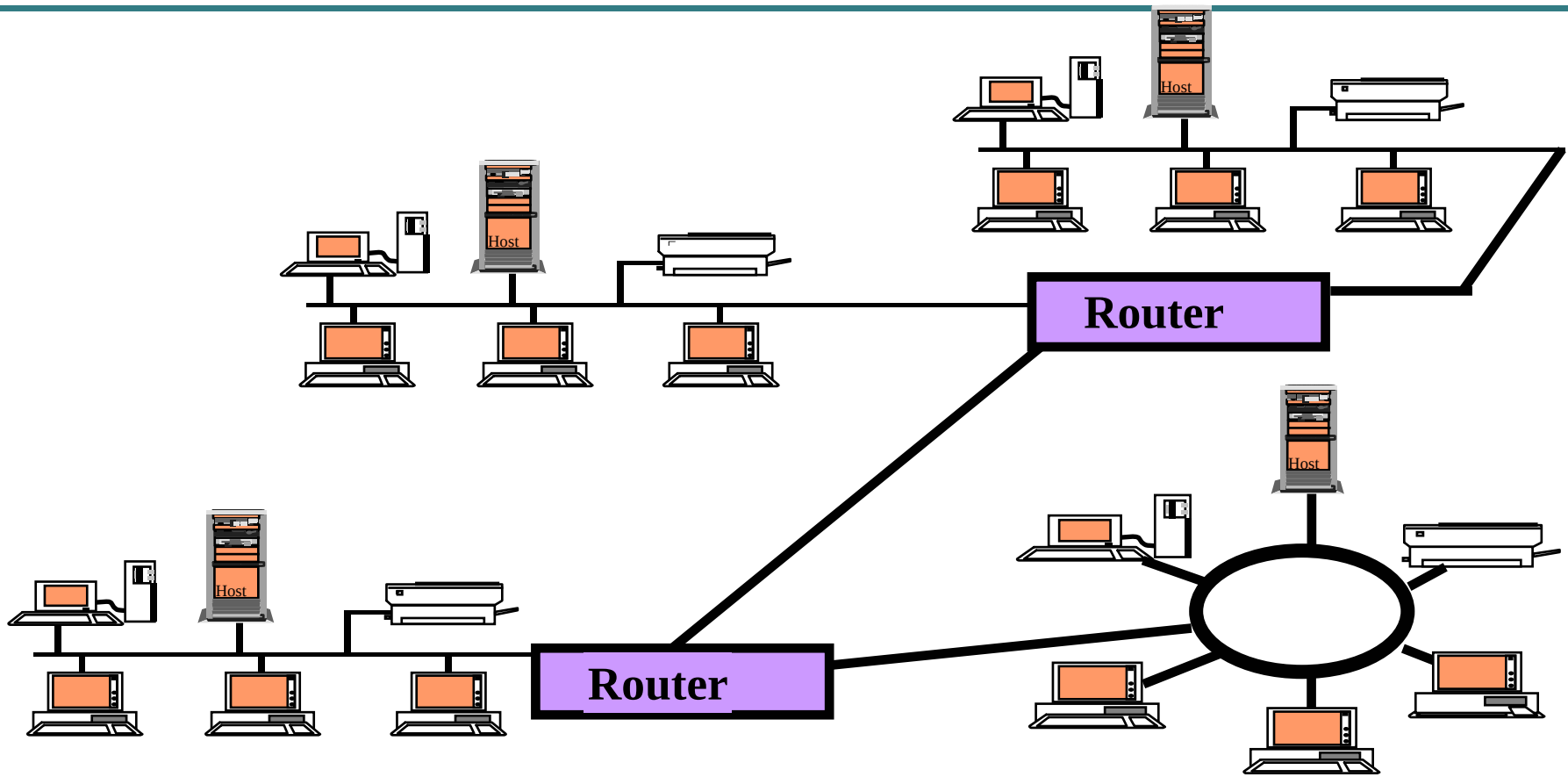
Plumbing is Beautiful

What is a Physical Transport Network?

- A group of connected systems - at least two!
  - Host, Node, Computer, Server, Workstation, Printer, Router, Storage Device
    - Network Interface Cards (NICs), Host Bus Adapters (HBAs), Storage Adapters (SAs)
- A medium or the “appearance of” a connection medium
  - Unshielded Twisted Pair(s) (UTP), Coaxial Cable(s), Multi-Mode Fiber(s), Leased Line(s), RF
- A connection protocol or method
  - Ethernet, Token Ring, PPP, Frame Relay, ATM, Fibre Channel, SAS, SATA, SONET/SDH, DWDM



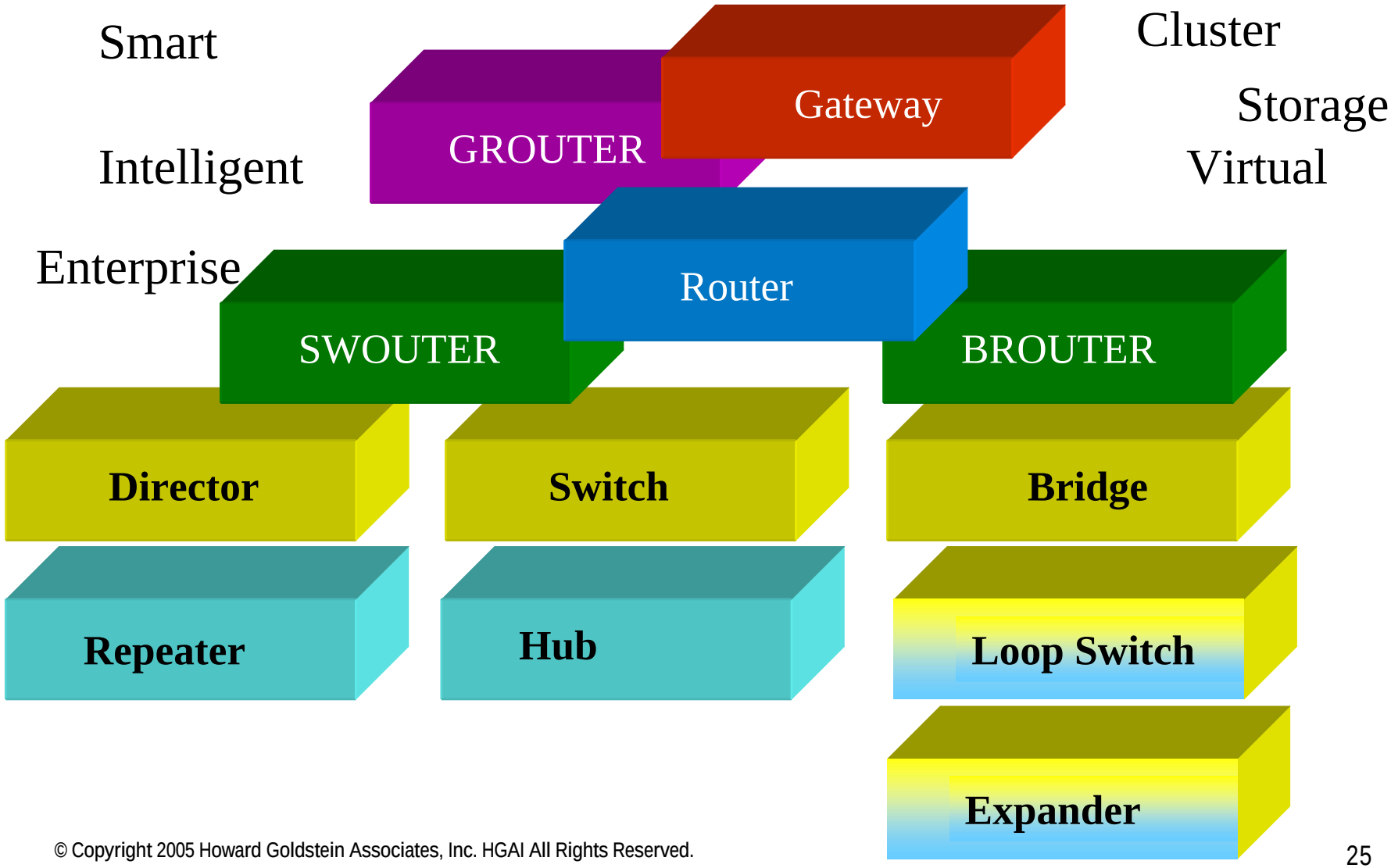
Internetworking



Network Components

- Network Topologies
  - Point-to-Point, Bus, Ring, Arbitrated Loop, Switched, Fabric, Hybrids
- Network Types
  - Local Area, Metropolitan Area, Wide Area, Storage Area, Backbone Networks
- Network Interconnectivity
  - Repeaters, Hubs, Bridges, Switches, Routers, Gateways
  - Expanders, Port Multipliers, Routing Switching Multiplexers

Beware of Semantics



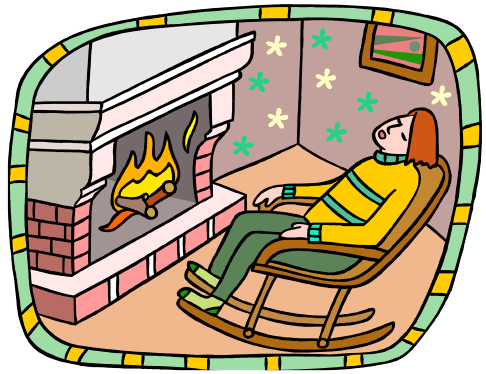
Fundamental Concepts

- Connection-oriented versus Connectionless Systems
- Circuit Switch – Packet Switch
- Flow control and congestion management
  - TCP Sliding Window
  - Credit-Based Fibre Channel
- User payload integrity management
- Layered protocols and Protocol Data Units (PDU)
- Addressing and Identification schemes
- Routing
  - Switch frame “steering” across one “appearance of media”
  - Router packet “forwarding” across many “appearances of media”
- Segmentation, Convergence and Reassembly
- Discovery
- Hardware Offload for Performance Acceleration

Server to Storage Information Flow Requirements

- Applications have no way to qualify information flow requirements to storage
- Operating Systems have few interfaces to request special network services such as QoS
- In many ways, the Operating Systems are the most primitive network requesters in computer systems
- Traditional approach requires as fast as possible interfaces
  - Low Latency, High Bandwidth

Name, Address & Route



Name

Address

Route

Name, Address & Route

- Name is a specific identification
  - Machine, User, Application - Unique target for data
    - Internet
      - Fully Qualified Domain Names WWW.HGAI.COM
      - Media Access Control MAC ID – Physical Port Identifier
    - Storage
      - World Wide Node Names WWNN (Fibre Channel)
      - World Wide Port Names WWPN (Fibre Channel)
      - Enterprise Unique Identifier EUI (iSCSI)
      - iSCSI Qualified Name IQN (iSCSI)
- Address identifies where the target is located
  - Hardware, Network, Port, Socket
      - Port ID FCID (Fibre Channel)
      - IP Address
- Route identifies path to get to the destination

Transport Addressing Ports

- Ports are used to deliver information to relevant application services
- Well-known and “Not-so-well-known” Transient

Port	Name	Description
20	FTP-3DATA	File Transfer (Data Channel)
21	FTP	File Transfer (Control Channel)
22	TELNET	Telnet
25	SMTP	Simple Mail Transfer
53	DNS	Domain Name Services
3260	ISCSI	Internet SCSI

- Comparable to Well known FCID Port ID Addresses
  - FFFFFC Name Server
  - FFFFFD Fabric Controller

Hierarchical, Routable Addressing

- IP addresses can be divided into three parts
  - **Network Address (NETID)**
  - **Subnetwork Address using (Subnetwork Mask 255.255.255.0)**
  - **Host IP Address**
    - **Example 172.16.2.6**
      - **Network 172.16.0.0, Subnetwork 172.16.2.0, Host IP Address 172.16.2.6**
- FC addresses can be divided into three parts
  - **Domain (Domain ID)**
  - **Area (Area ID)**
  - **Device (Device ID)**
    - **Example 0102EF**
      - **Domain 01 (Switch 01), Area 02 (Port 02 on the Switch), Device EF (ALPA of Loop Device)**

SATA Address Comparison – 1 Gram

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- **SATA Point-to-Point $2^0 = 1$**

- **SATA II "Port Multiplier" $2^4 = 15$**

SAS Address Comparison – 1 Gram

- **SAS "Expanders" 2^{10} = 128 x 128 = 16,384**

FC Address Comparison – 1 Gram

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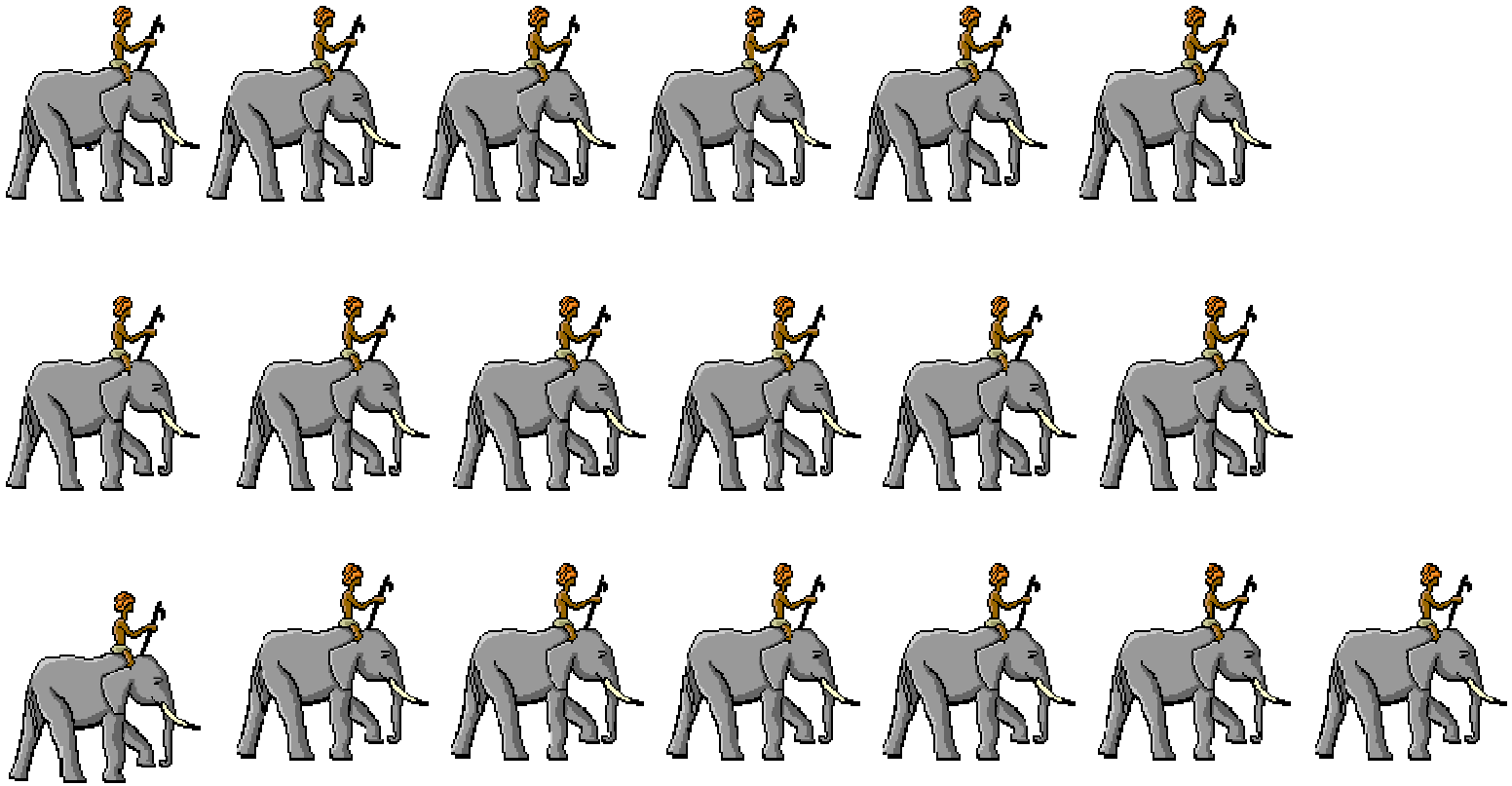
- **All Fibre Channel 2^{24} = 16,777,214**



IP Address Comparison – 1 Gram

- All IPv4 – 2^{32} = 4,294,967,292

- All IPv6 – 2^{128} = **340,282,366,920,938,463,463,374,607,431,768,211,456**

X 56

Address Assignment

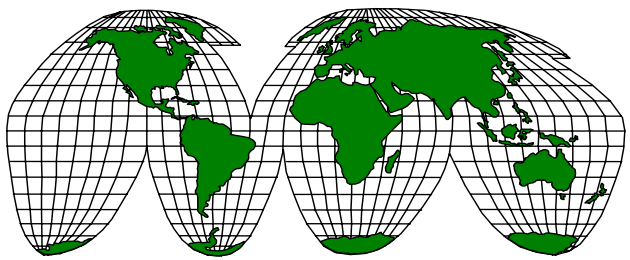
- DHCP Mechanism for allocating and assigning IP addresses to clients
  - Automatic: Host requesting an address are provided with a permanent IP address
  - Dynamic: Hosts requesting an address are provided with a temporary address
  - Manual: Host IP addresses are manually configured and DHCP just delivers these assignments
- Fibre Channel
  - Loop Initialization LISM, LIFA, FIPA, LIHA, LISA, LIRP, LILP
    - Select Master, Fabric Assigned, Hard Assigned, Soft Assigned, Report Position, List Position
  - Fabric Login Controller
  - Point-to-Point - Lowest World Wide Port Name (WWPN) Assigns

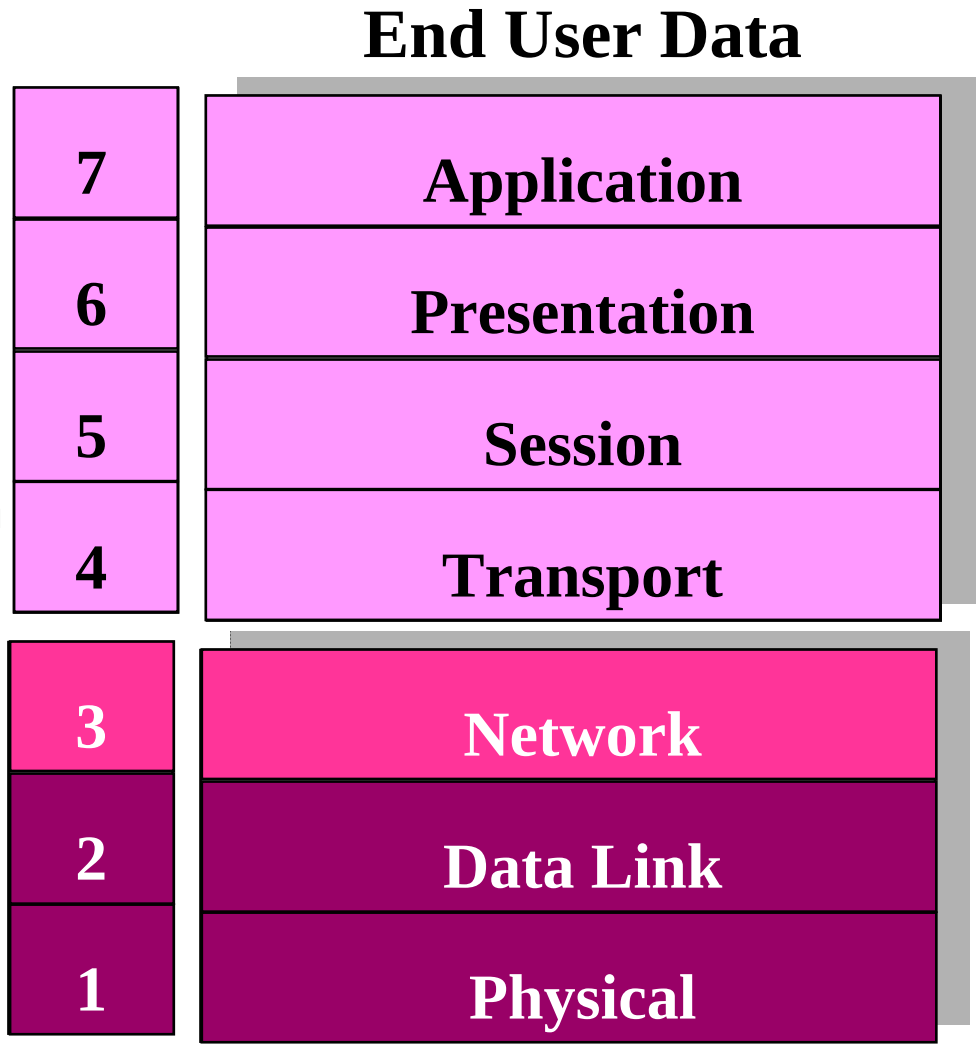
Name Service

- Off-load the Name to Address resolution to a directory service
- Internet
  - Domain Name Services for IP
    - Fully Qualified Domain Name FQDN to IP Address
    - Running on distributed servers
- Storage
  - Name Services for Fibre Channel
    - WWPN to Fibre Channel Identifier FCID, Fabric service running in the Switch
  - iSNS Storage Name Service (iSNS) for iSCSI

What is OSI?

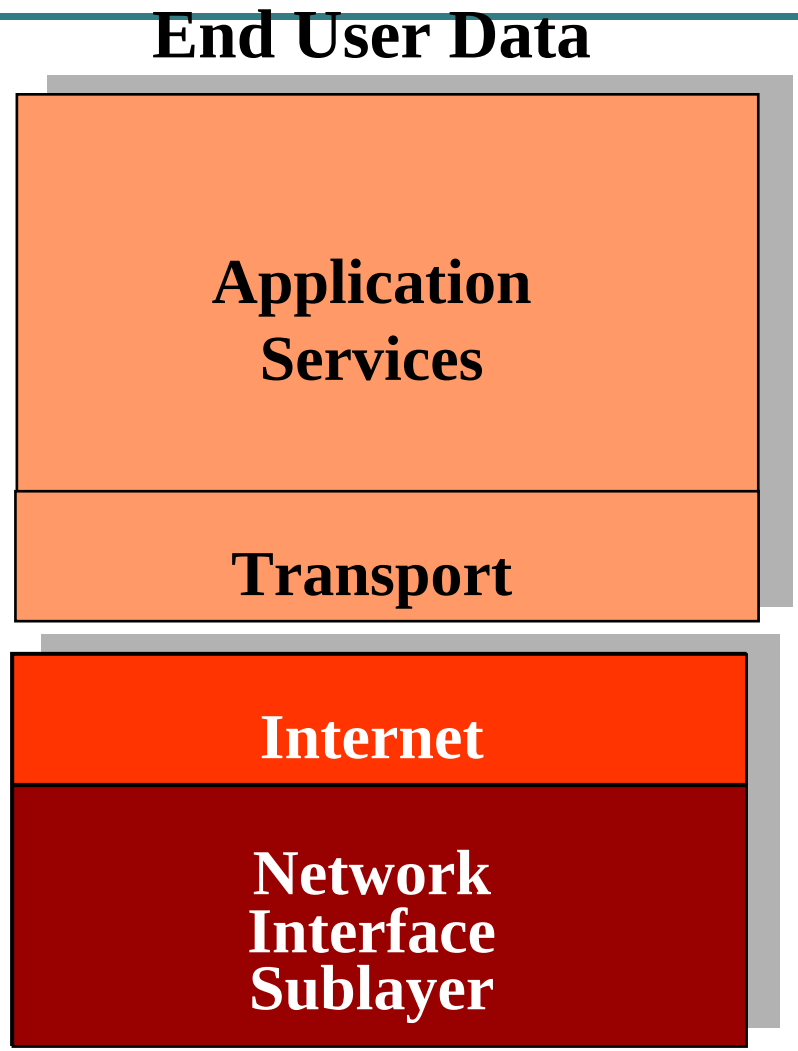
- Open Systems Interconnection
- International Organization for Standardization (ISO)
- 145 member countries
- Enables interoperability across multiple vendors
- 7 layer model
- Began in the early 70's along with TCP/IP, SNA, DECNet
- Eliminates de-facto standards?



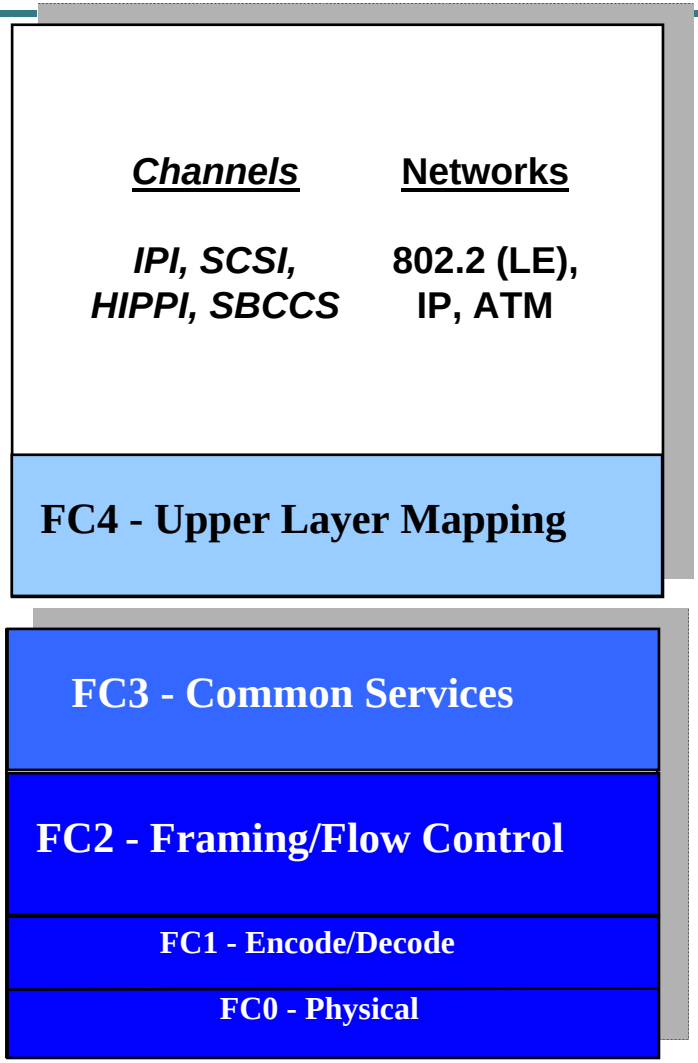


The Internet Protocol Suite - TCP/IP

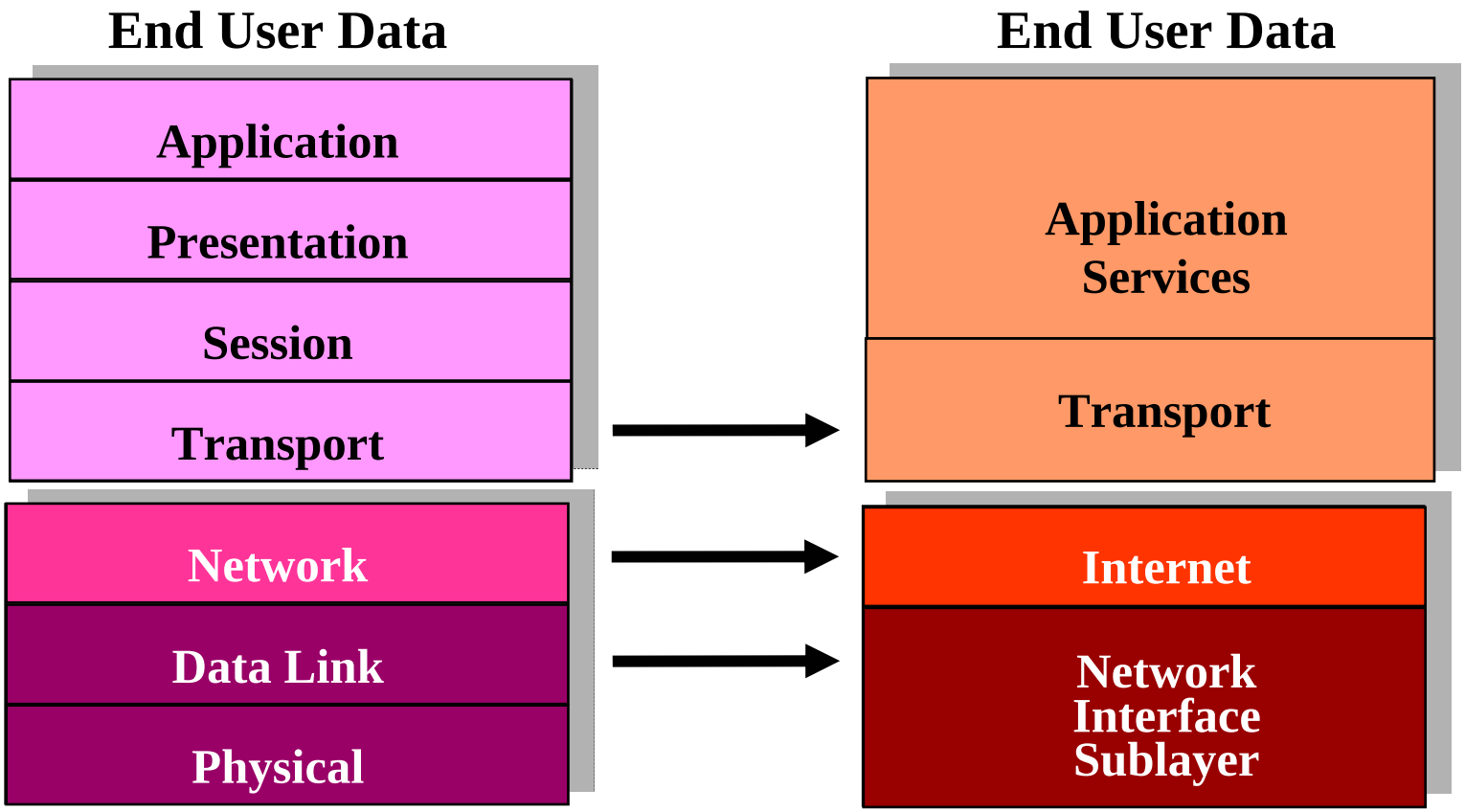
- **Began with Defense Advanced Research Projects Agency DARPA in the 1960s**
  - **Move data across the network even if nuclear war disrupted parts of the network**
  - **Bolt, Beranek & Newman, Inc. (BBN) built first network ARPANET**
- **4 Layer Model**



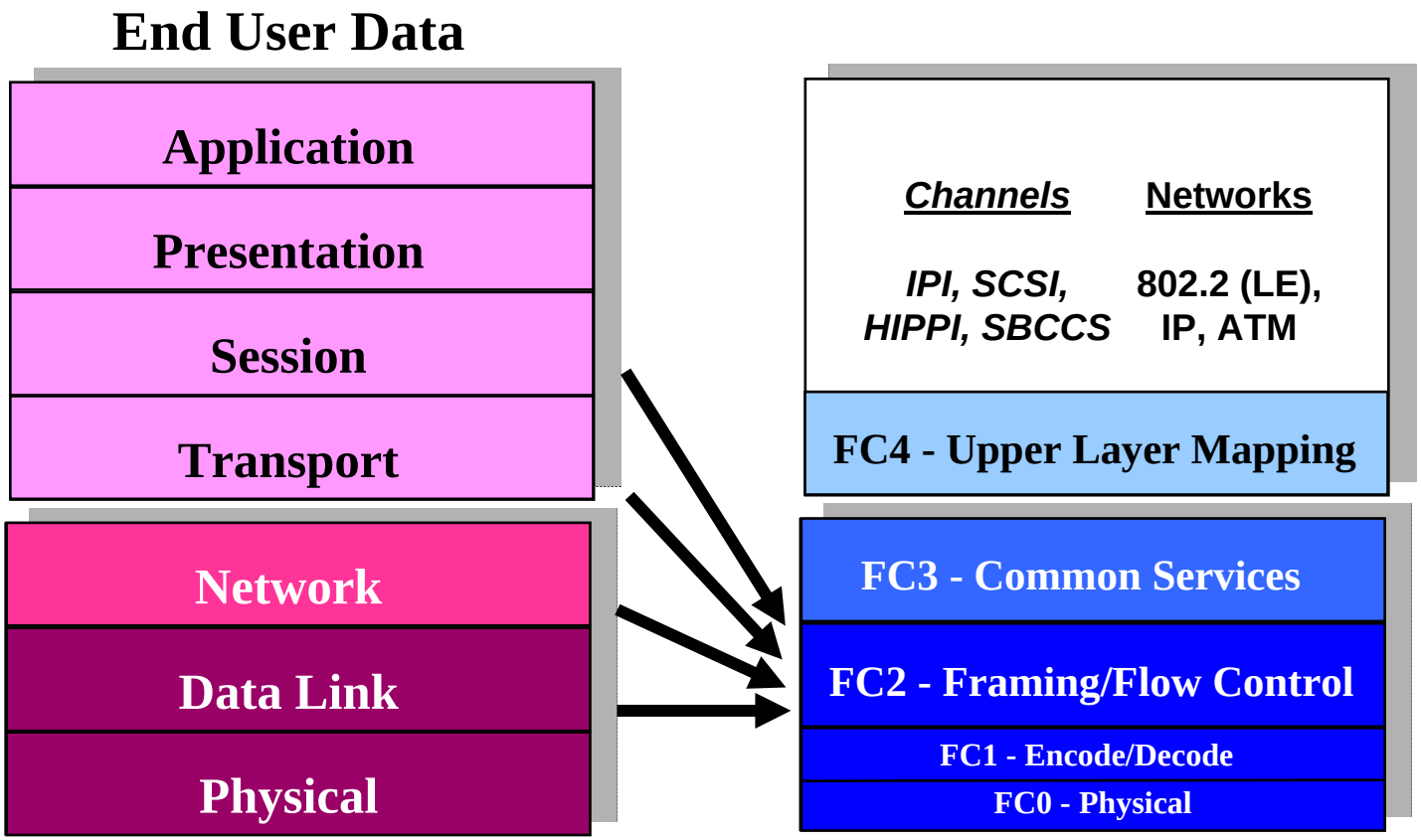
What is Fibre Channel?



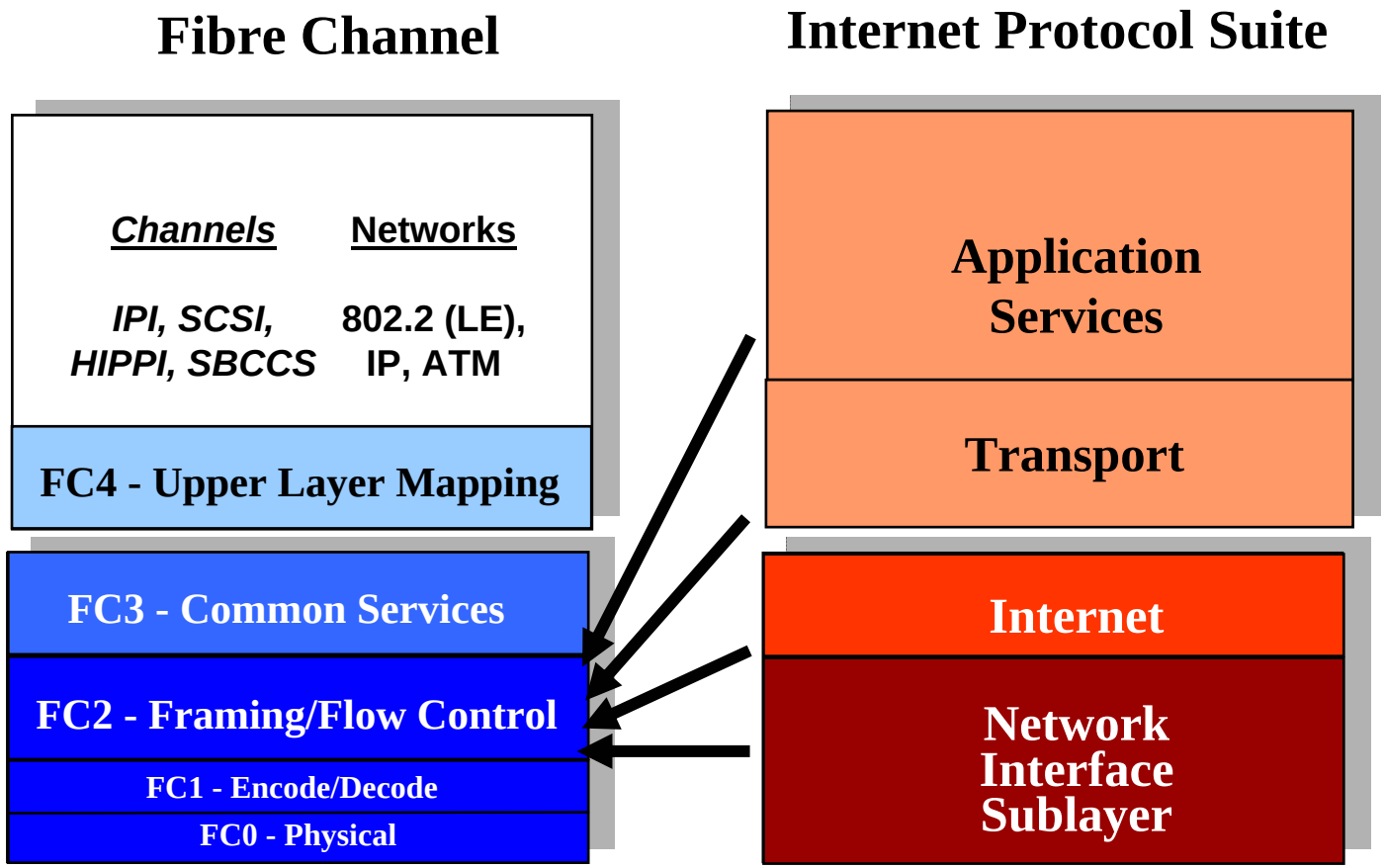
OSI & IPS (TCP/IP)



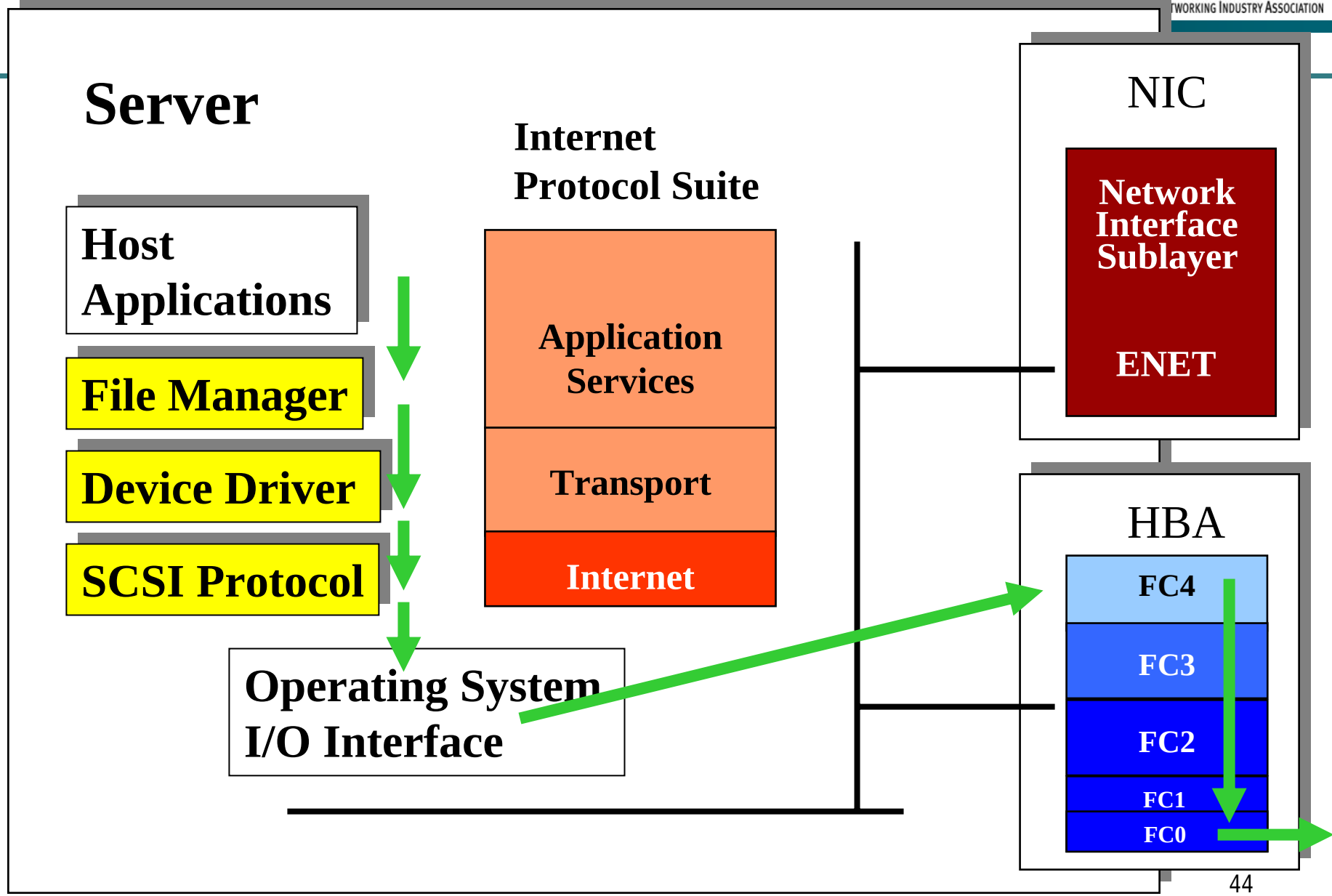
OSI & Fibre Channel Architecture



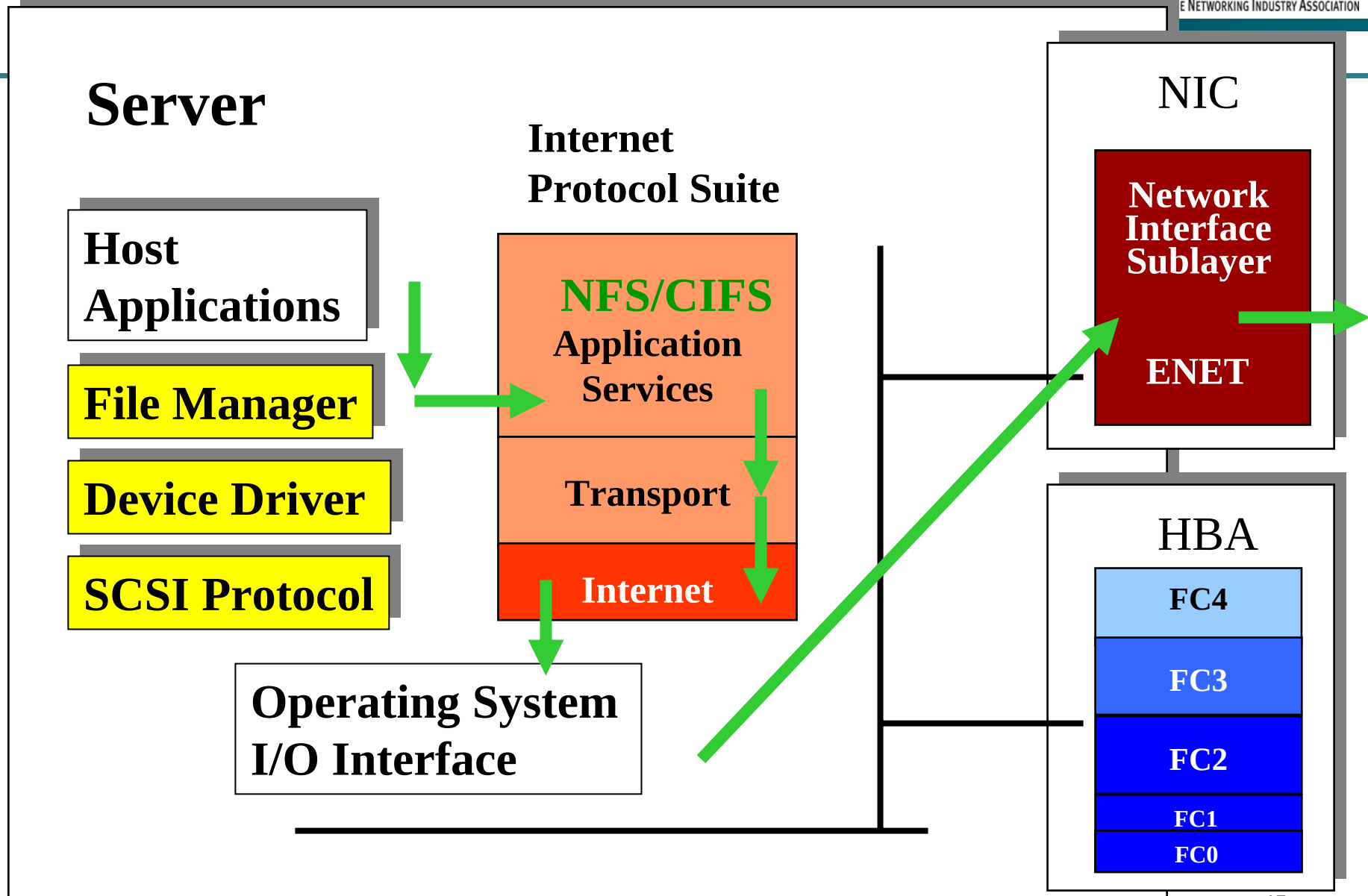
Fibre Channel and IPS



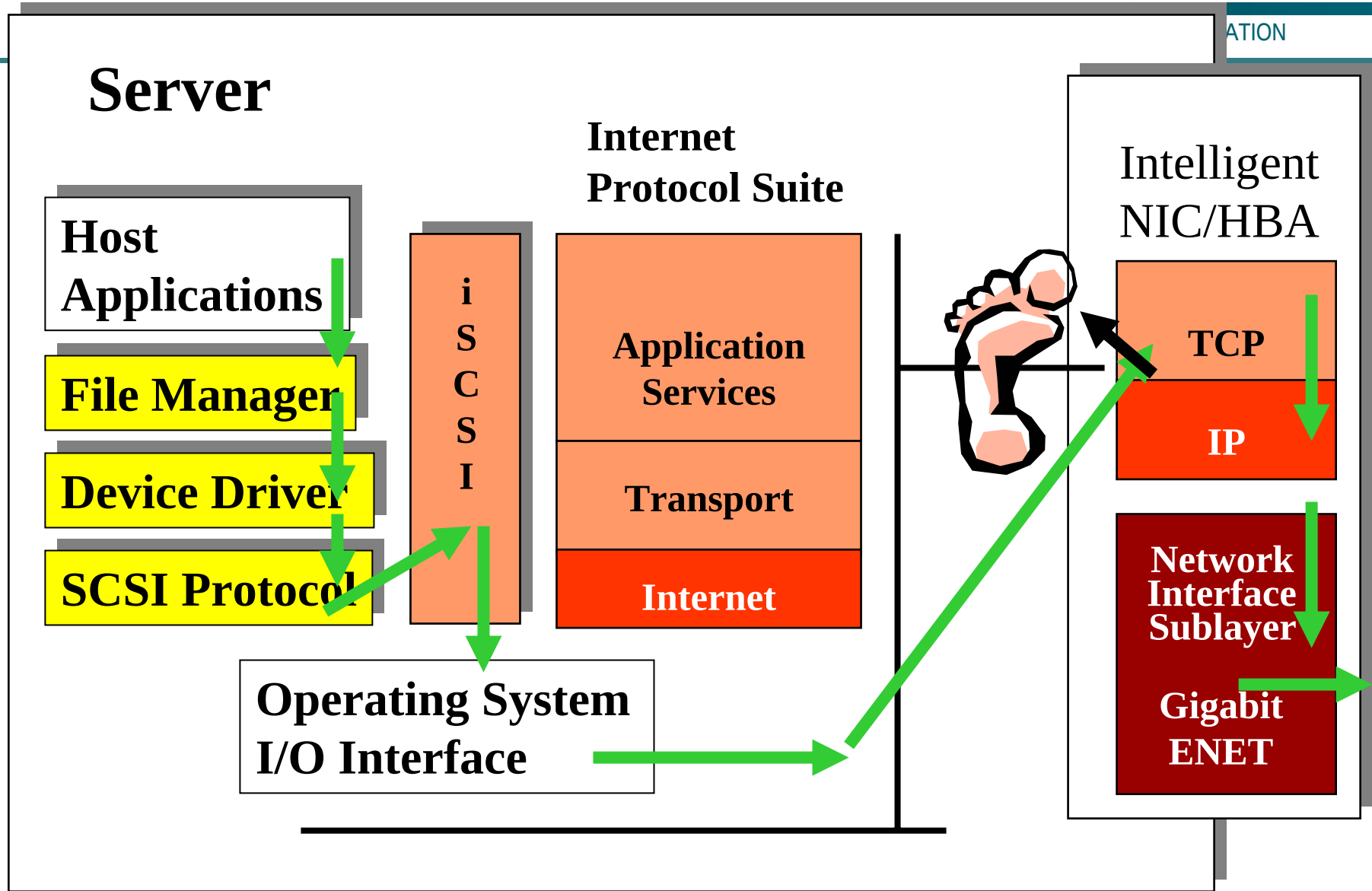
Traditional SAN



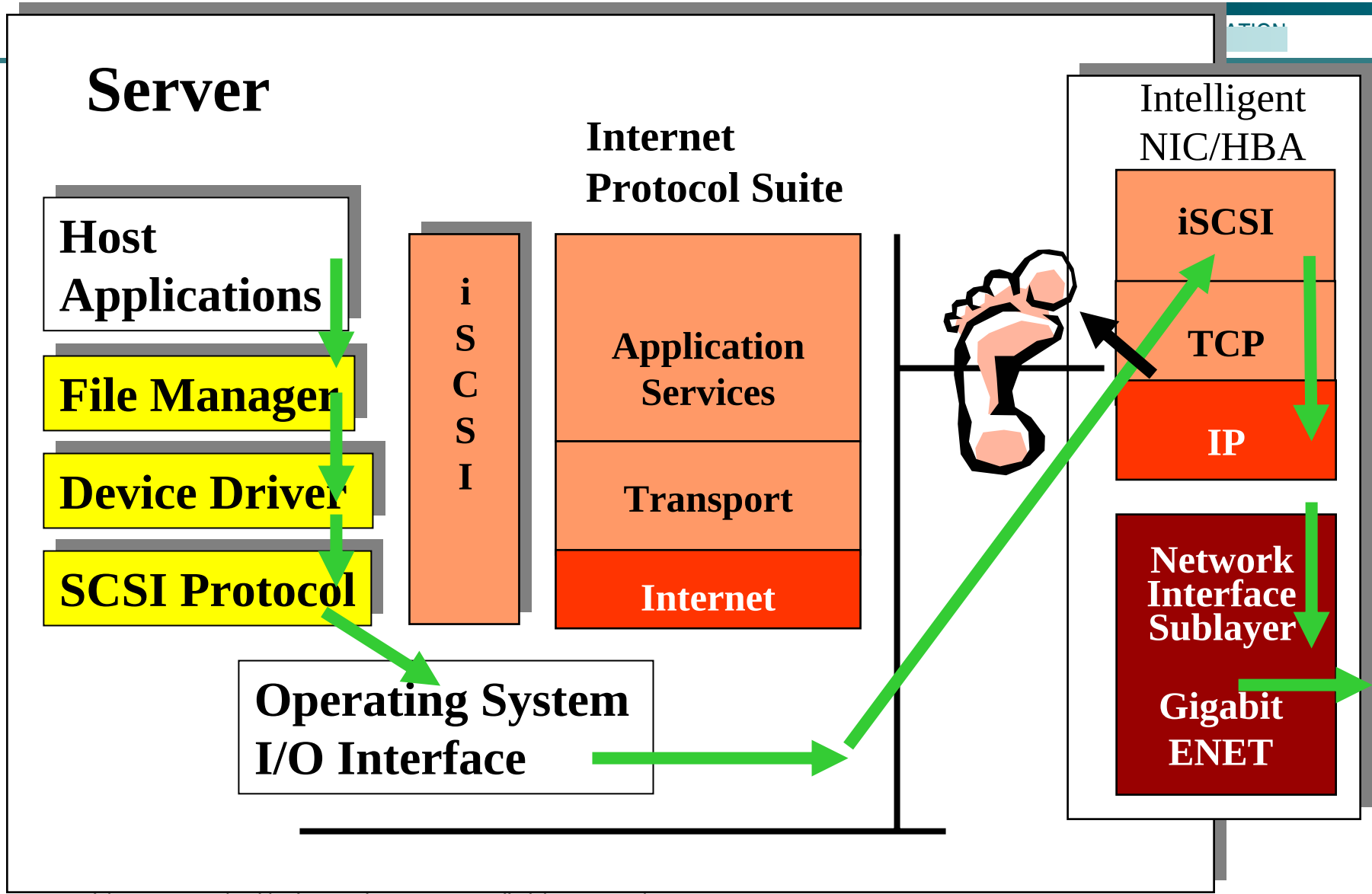
Traditional NAS



iSCSI – TCP/IP Offload



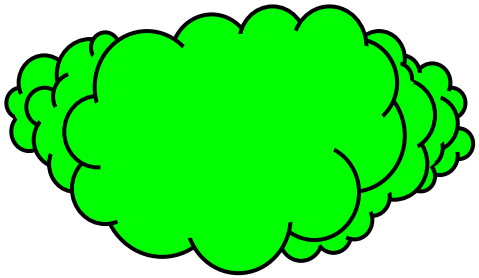
iSCSI – Full Offload



Storage Networking Futures

- Upper layer protocol changes
  - Lazy and Hyper reads and writes
  - System SAN awareness, Dynamic discovery
- Higher bandwidth rates for aggregation and higher speed processors for servers, storage and adapters
- External SANs with Fibre Channel and iSCSI/TCP/IP/GE
- Internal SANs with SAS and SATA
- NAS & SAN integration

Networking for Storage Professionals



This concludes

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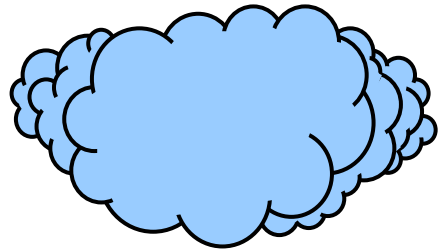

Thanks for attending and hope to see you again

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Good Luck!