

FICON 101

Live Webcast
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Today's Presenters



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Agenda

- World of the Mainframe
 - Introduction
- The Mainframe IS FASTER
 - Characteristics
- FICON Protocol
 - System and Link Architecture Overview
- Q&A

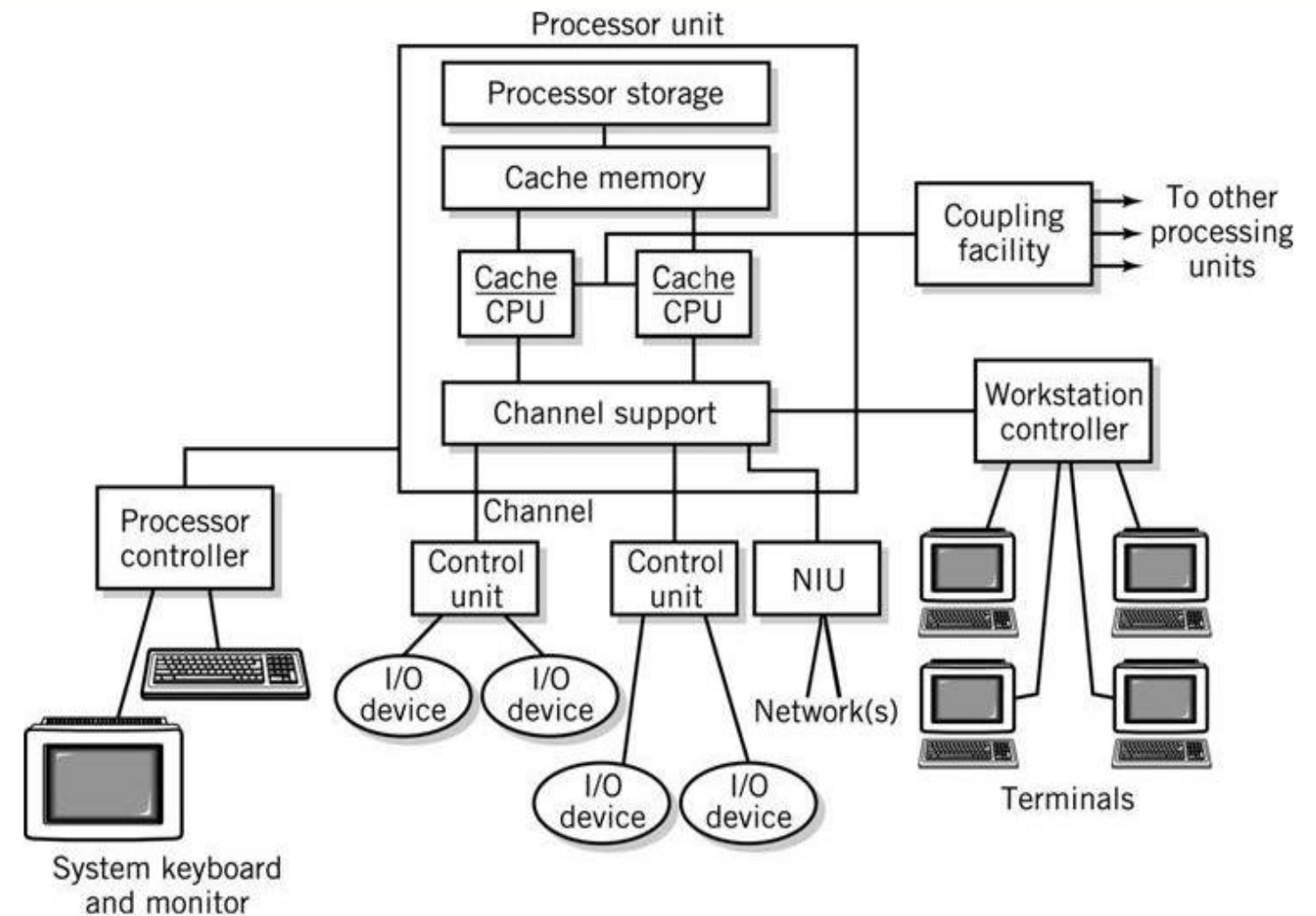
Introduction

World of the Mainframe

- *Mainframe* describes a **style** of operation, applications, and operating system facilities

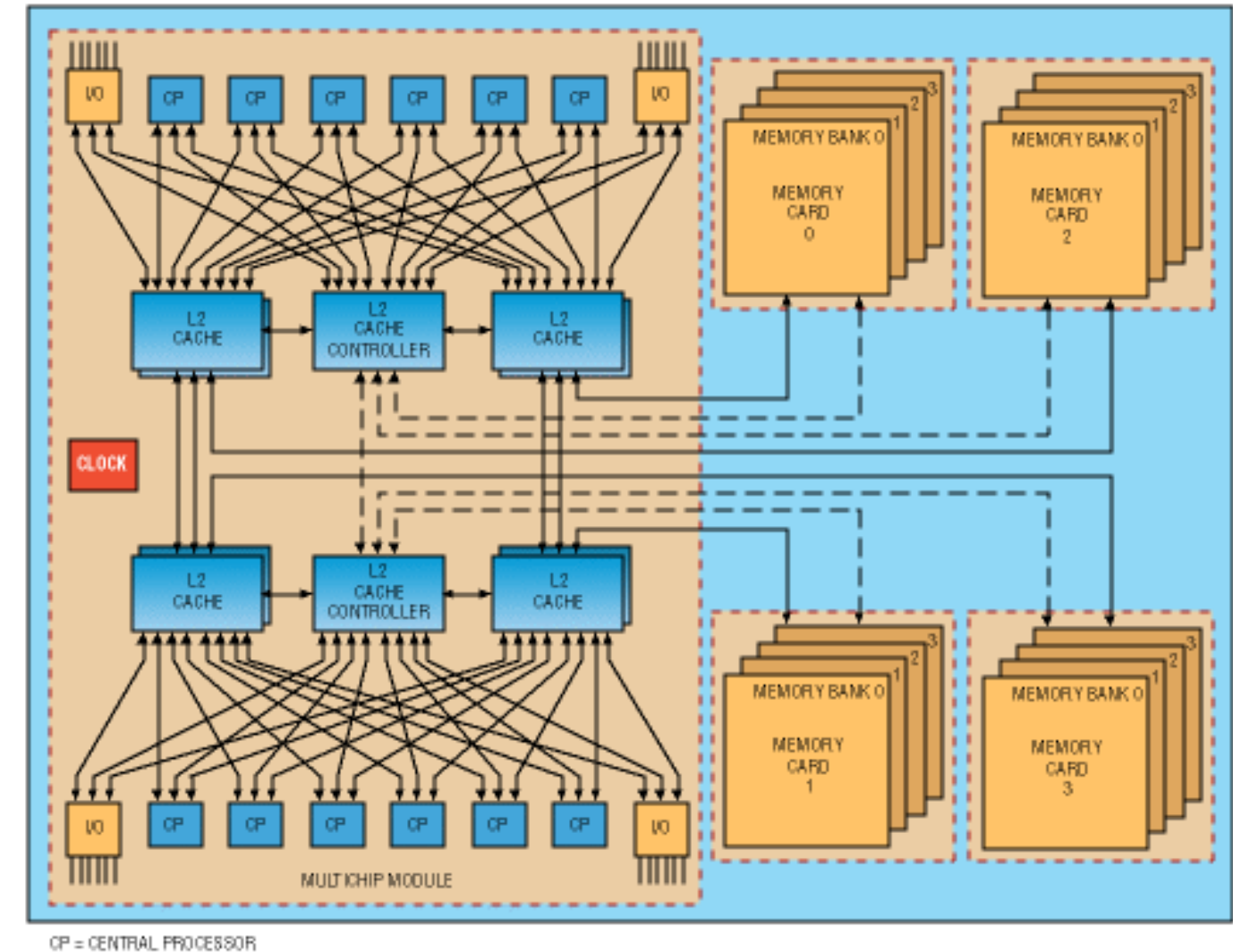
Did you know?

The mainframe was the first to exploit widespread use of fiber optic interfaces, Storage Area Networks (SAN), and virtualized (i.e. shared) adapters.



Purpose of the Mainframe

- *A mainframe:*
 - Host commercial databases
 - Drive transaction servers
 - Secure and available applications

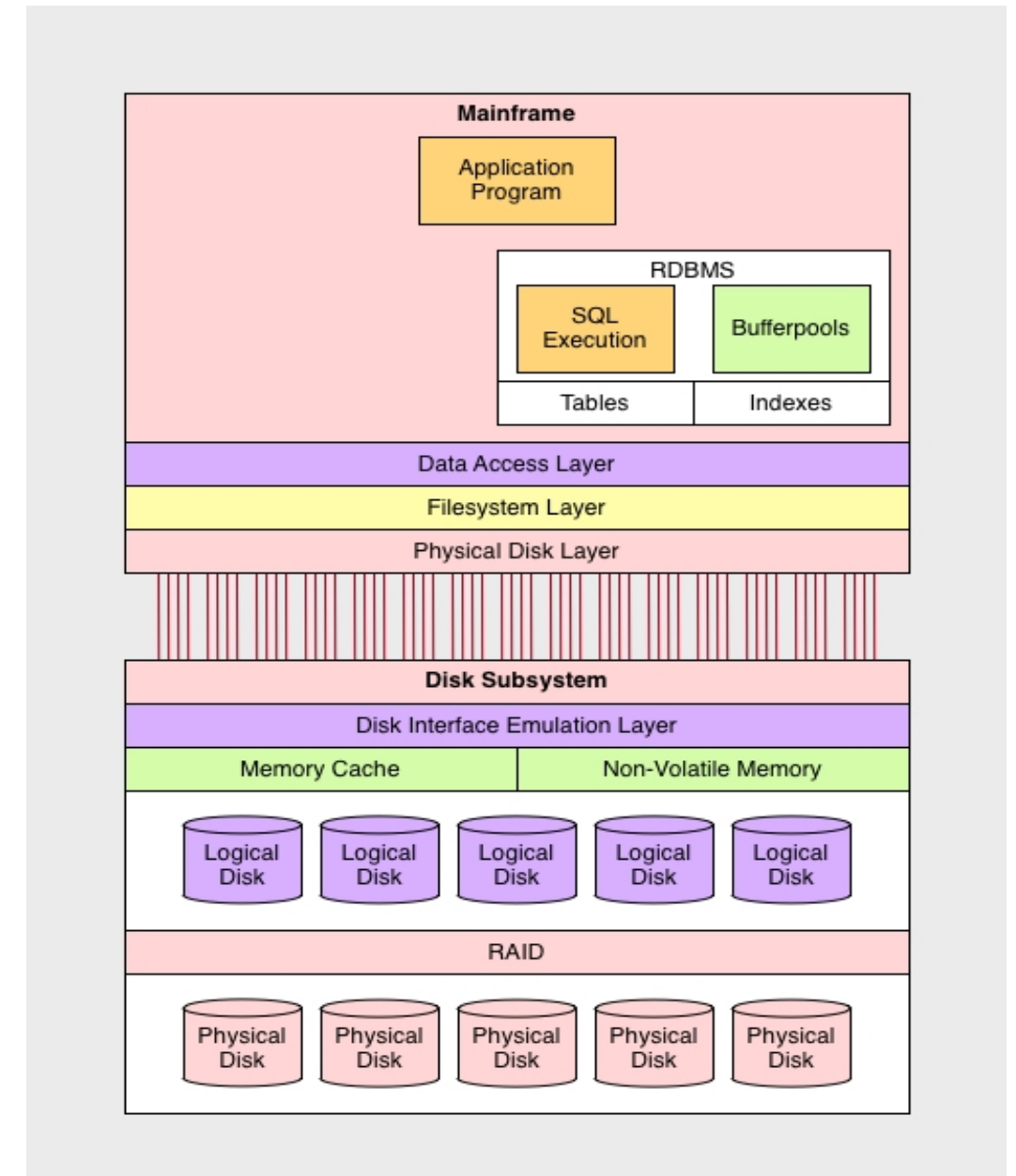


Activities of the Mainframe

- Transactional processing
 - Mobility and the Internet of Things
 - 80% of the world's data and transactions
 - Volumes of data exchanged
 - High transfer rates with high compute performance

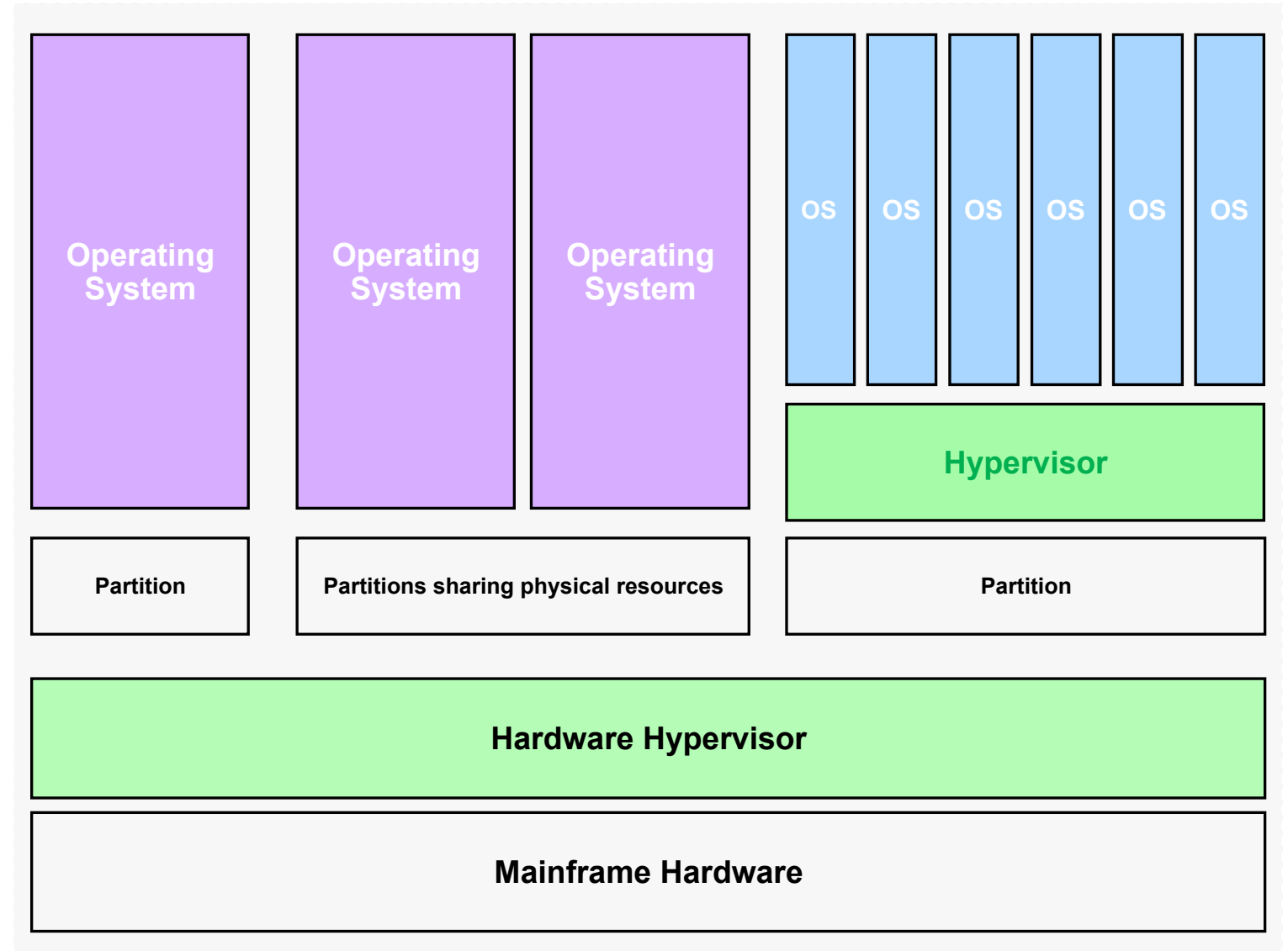
Did you know?

1.3 million CICS (a mainframe Online Transaction Processing service) transactions are processed every second, every day. In comparison, there are 68,542 Google searches every second globally



Characteristics of the Mainframe

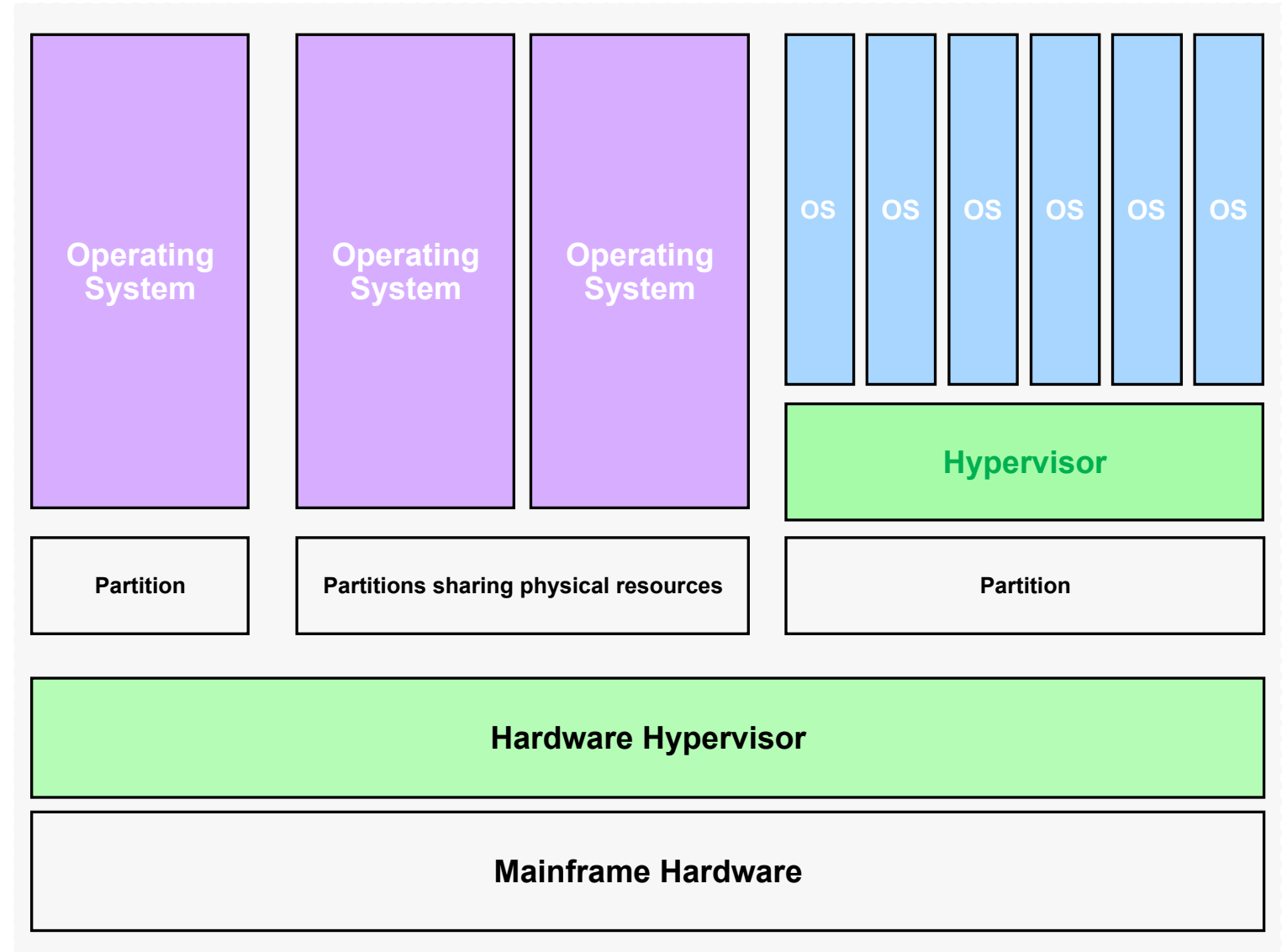
- Integrity
- Security
- Flexibility
- Availability
- Serviceability
- Transactions
- Efficiency
- Reliability



Characteristics

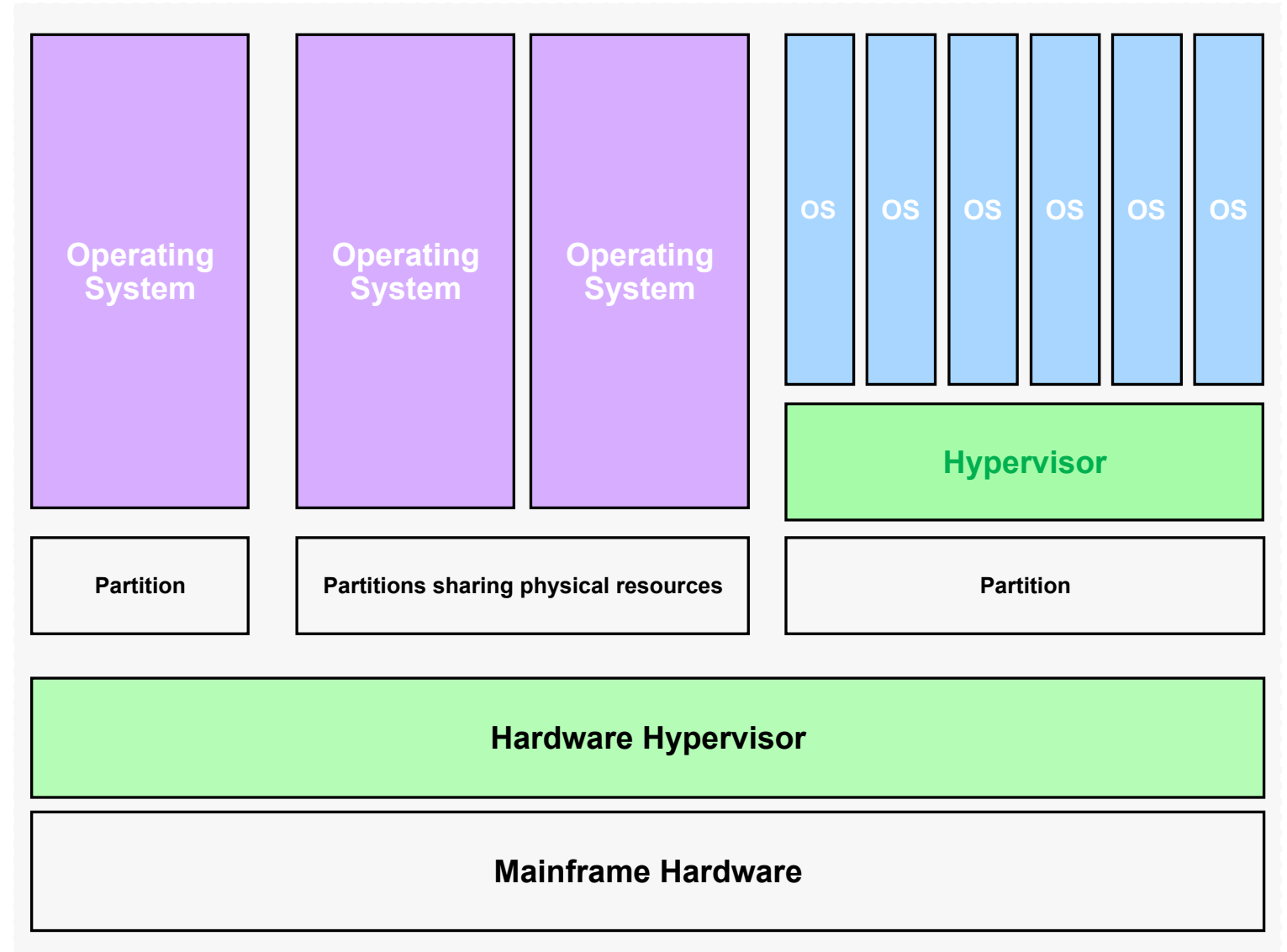
Integrity

- Accuracy of information
 - Errors do not result in data corruption



Security

- Logical isolation
 - Provided by virtualization
 - Shared hardware resources
 - Provide extreme scale
- Controlled fabric configuration

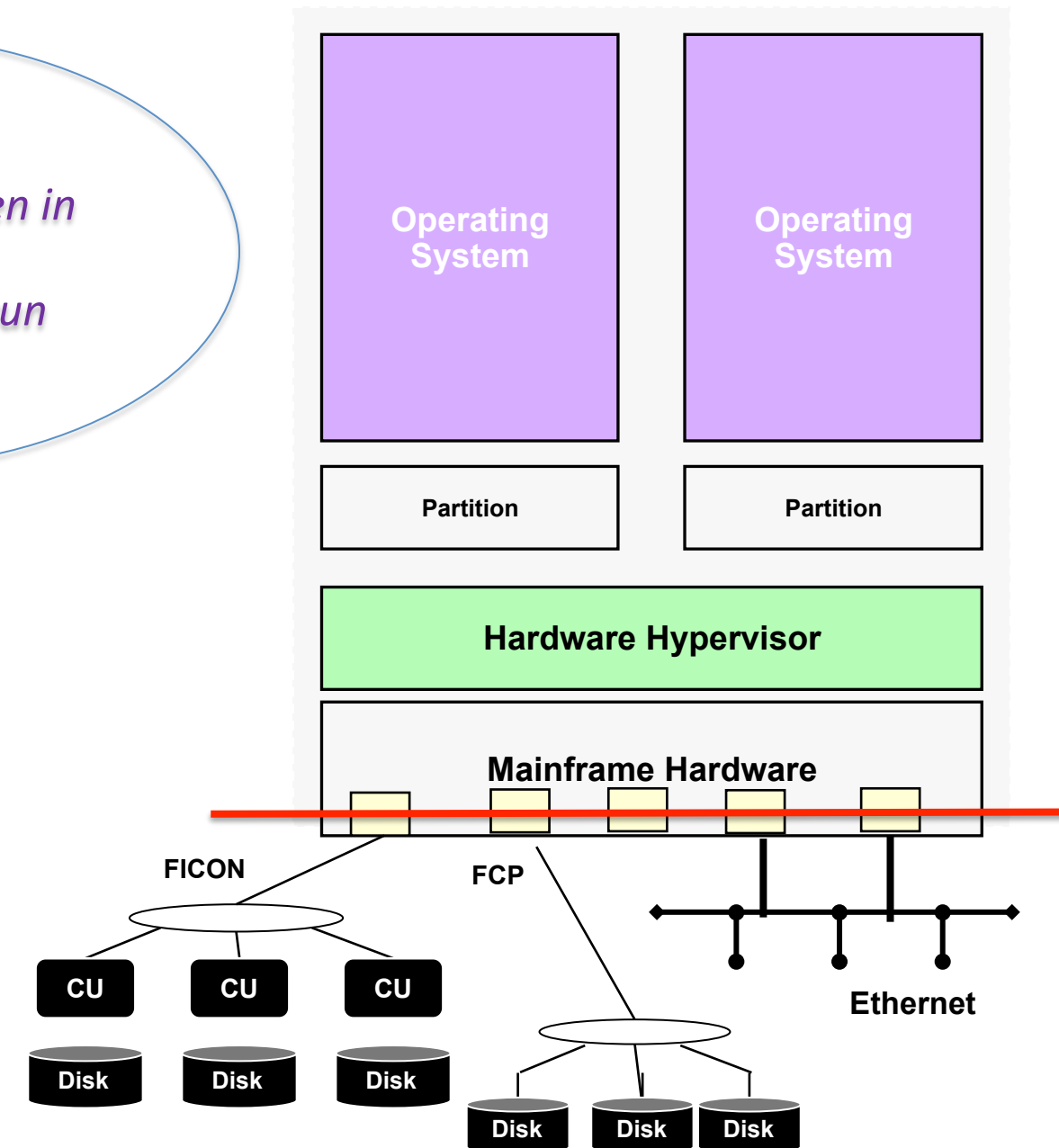


Flexibility

- “The old stuff has to run!”
 - ‘Principles of Operation’ (POP)
- Architecture is the bedrock
 - Architecture is evolutionary
 - Underlying technologies are disruptive
- Application foundation
 - Migrate across models/systems
 - Accommodate new advances
- Integrated interconnections
 - “Purpose built”

Did you know?

An application written in 1964 to run on a mainframe will still run today!



Availability

*Cost of 1 hour of downtime
during core business hours*

- Mainframe I/O designed for Resiliency => Availability
 - Identification and elimination of single points of failure
 - Detection and identification of problems
 - Isolated recovery from a failed component
 - Automatic hardware sparing or internal 'rerouting'
 - Software error recovery provided by the operating system
 - Non-disruptive management, configuration, & service actions
- Every hour of outage is costly
 - 92 of the top 100 of the world's banks
 - 10 out of 10 of the world's largest insurers

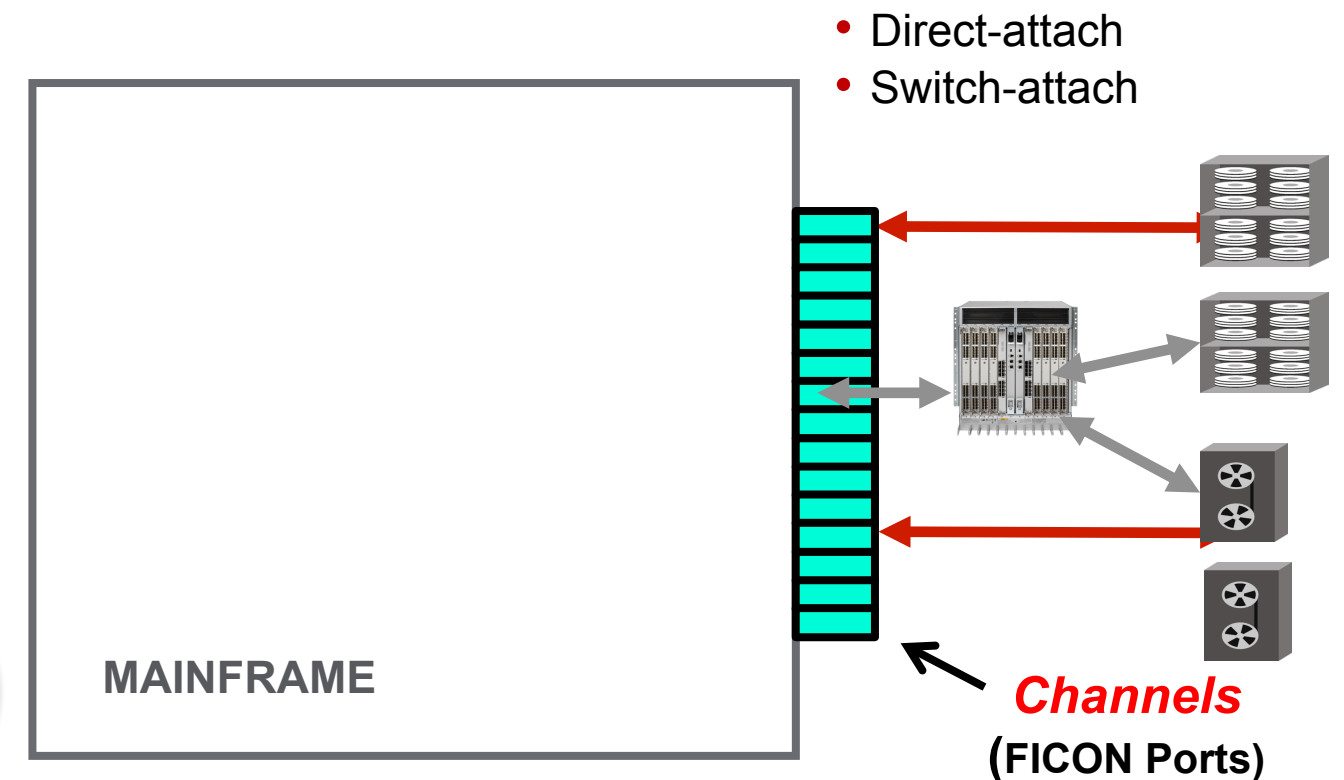
Cost of Downtime by Industry	
Industry Sector	Loss per Hour
Financial	\$8,213,470
Telecommunications	\$4,611,604
Information Technology	\$3,316,058
Insurance	\$2,582,382
Pharmaceuticals	\$2,058,710
Energy	\$1,468,798
Transportation	\$1,463,128
Banking	\$1,145,129
Chemicals	\$1,071,404
Consumer Products	\$989,795
Source: Robert Frances Group 2006, "Picking up the value of PKI: Leveraging z/OS for Improving Manageability, Reliability, and Total Cost of Ownership of PKI and Digital Certificates."	

Serviceability

- Determine why a failure occurred
- Replacement of hardware/software elements
 - Impacting operational system as little as possible
- Well-defined units of replacement
 - Hardware or software

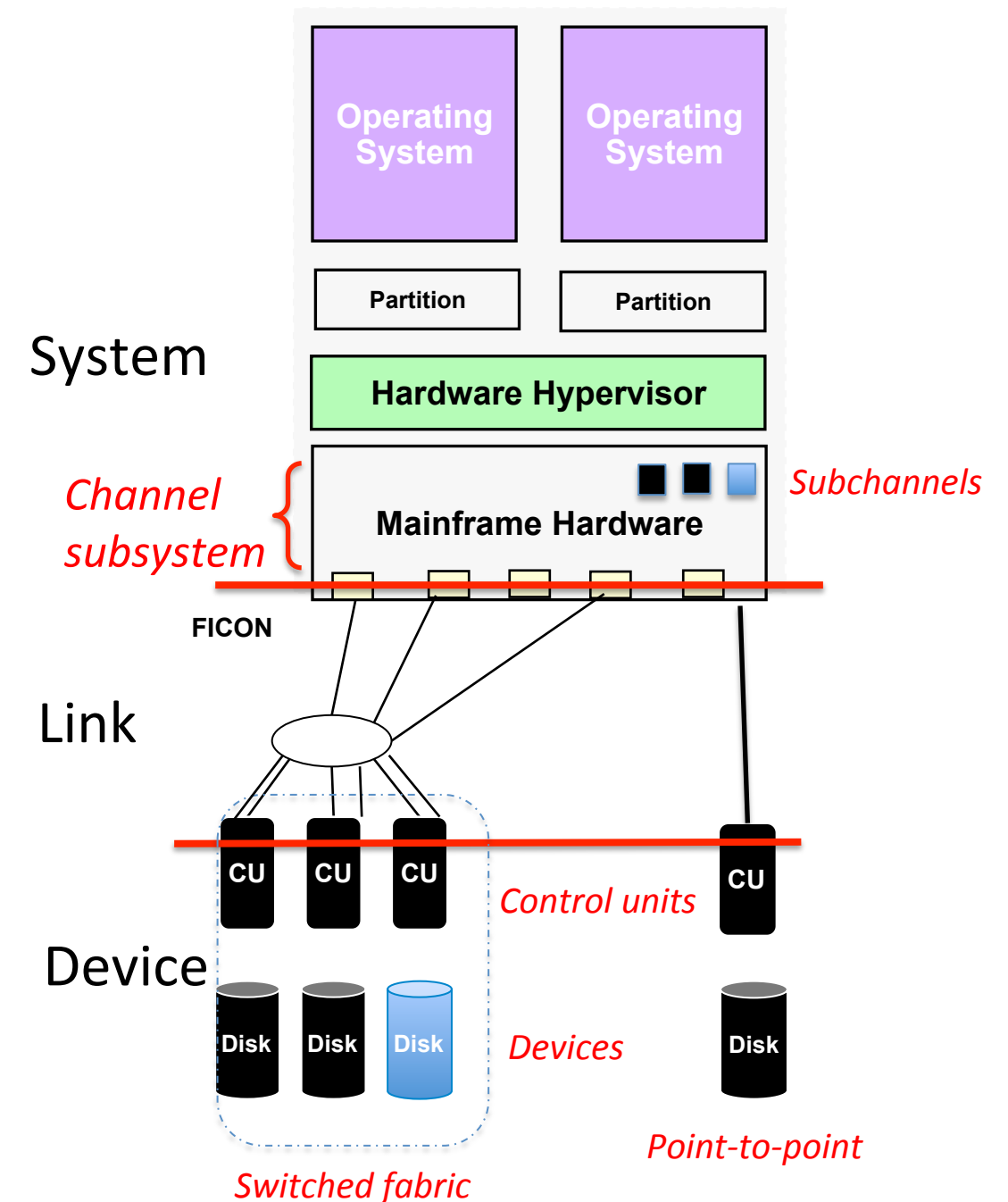
Mr. Obvious says,

"Once mainframes filled large rooms and ran on vacuum tubes that consumed large amounts of electricity, now they're smaller but still sizable. You mean, it used to fill my basement, now it's the size of my refrigerator."



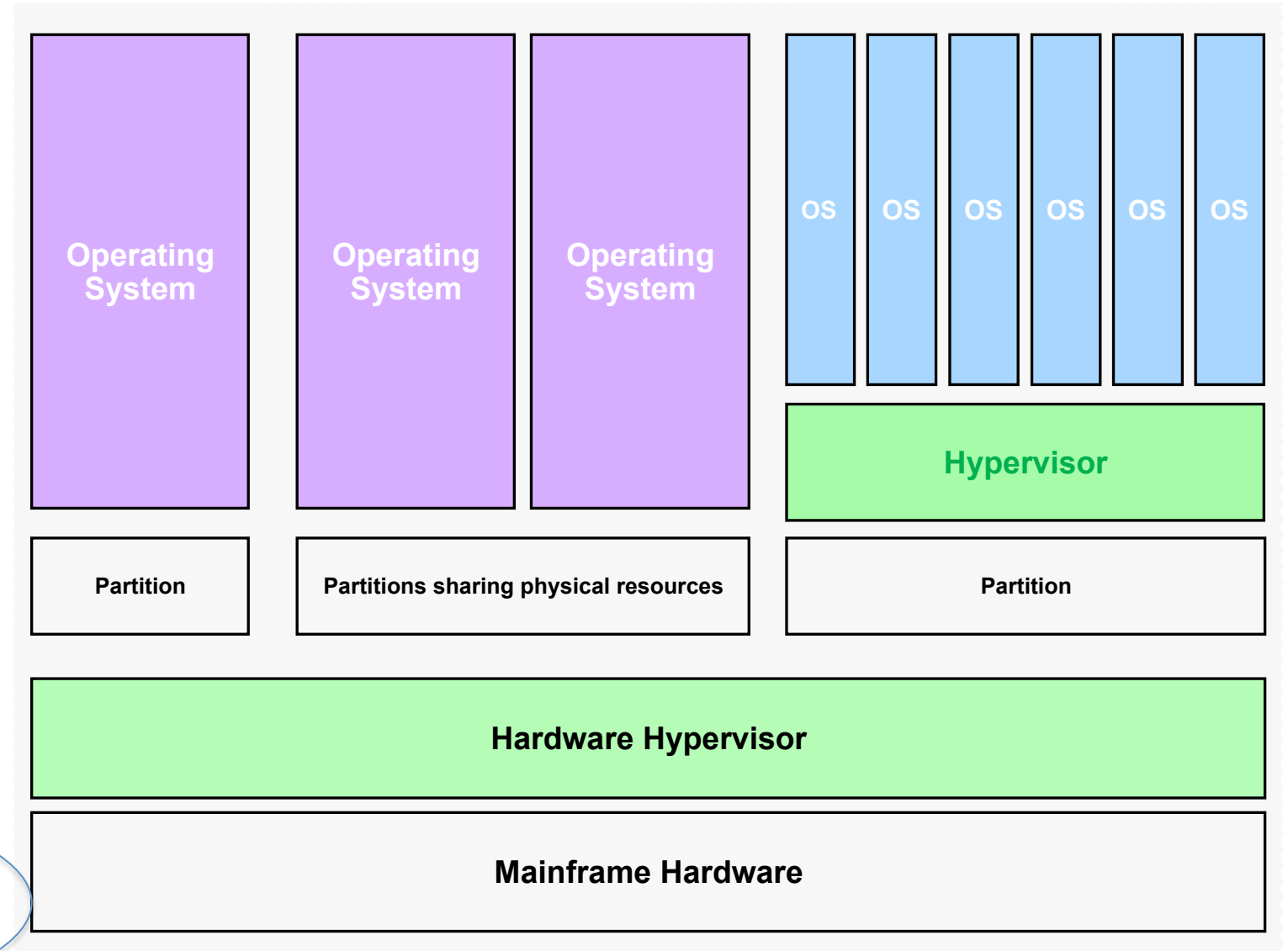
Transactions

- Transactional Processing/Performance
 - Multiple commands and data in one I/O operation
- Efficient use of I/O resources
 - IT analytics, WLM
- Efficient handling of shared devices
 - Sharing devices across multiple instances
- Flow control
 - At multiple layers (i.e. “IU Pacing”)



Efficiency

- Multiple operating systems
- Hardware/firmware virtualization
- Hypervisor virtualization
- Shared or dedicated resources
 - Processors and I/O adapters
 - Dedicated to one image
 - Shared across a set

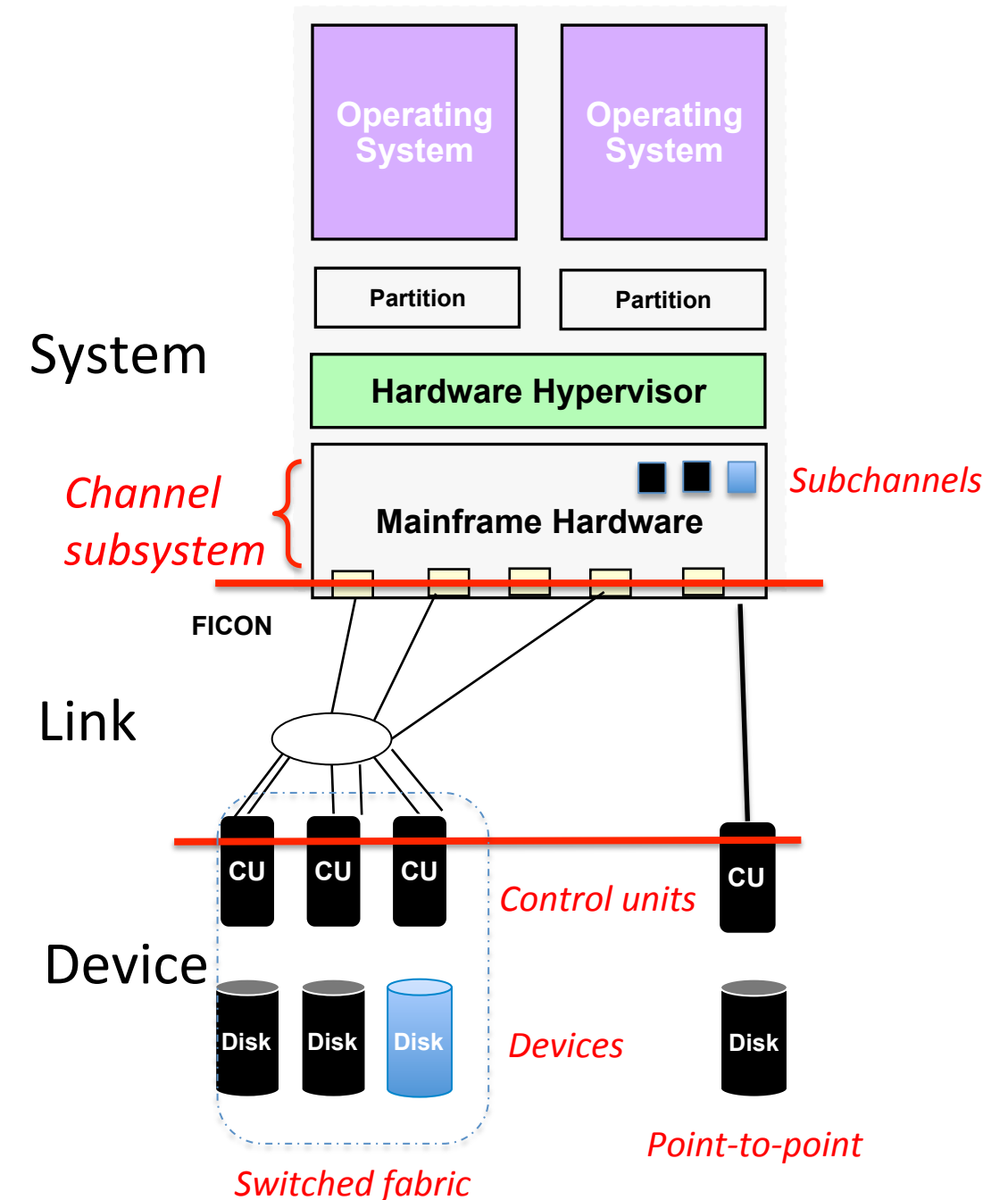


Did you know?

- 1) *Linux runs on the mainframe.*
- 2) *Applications for the mainframe can be written in virtually any programming language, such as Python or Java or R.*

Reliability

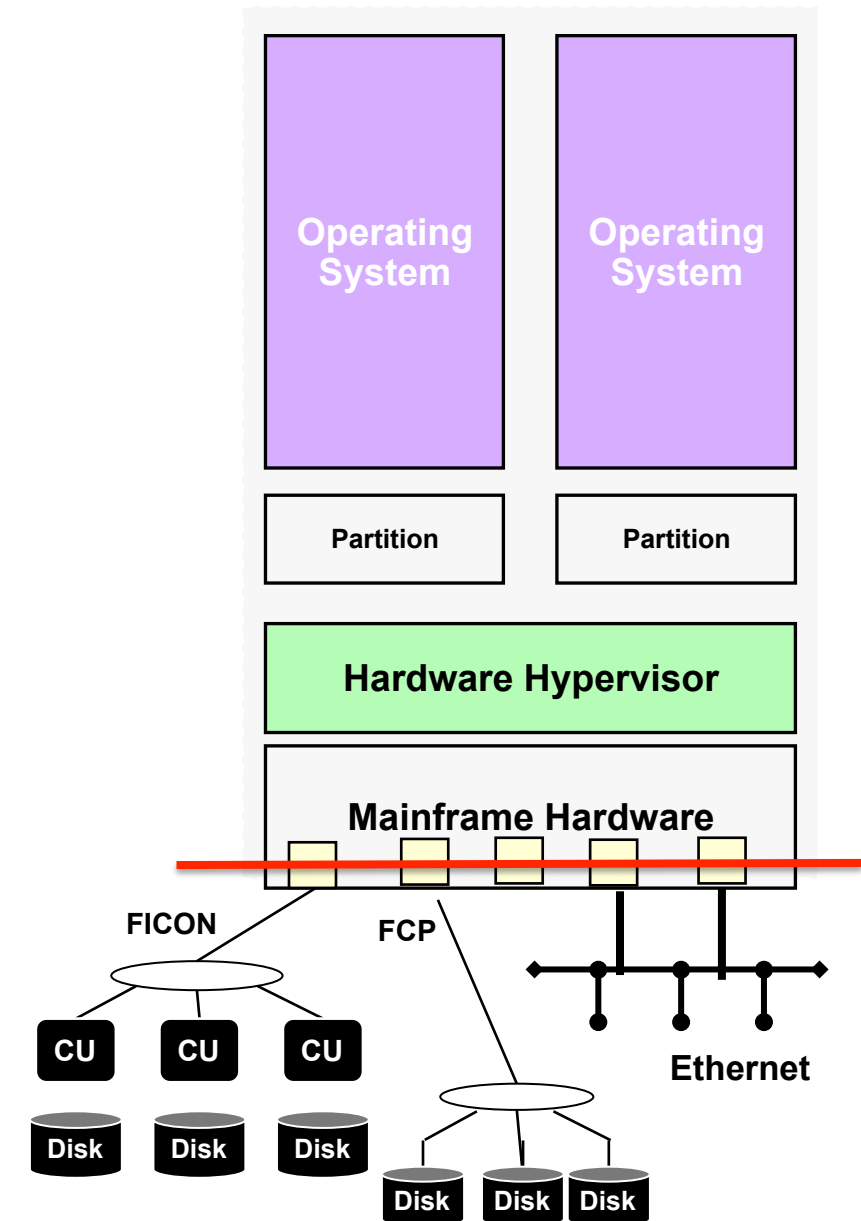
- Hardware components
 - Self-checking and self-recovery
 - Ensure accurate, repeatable operations
- Software reliability
 - Extensive testing
 - Quick updates for detected problems



FICON Protocol Overview

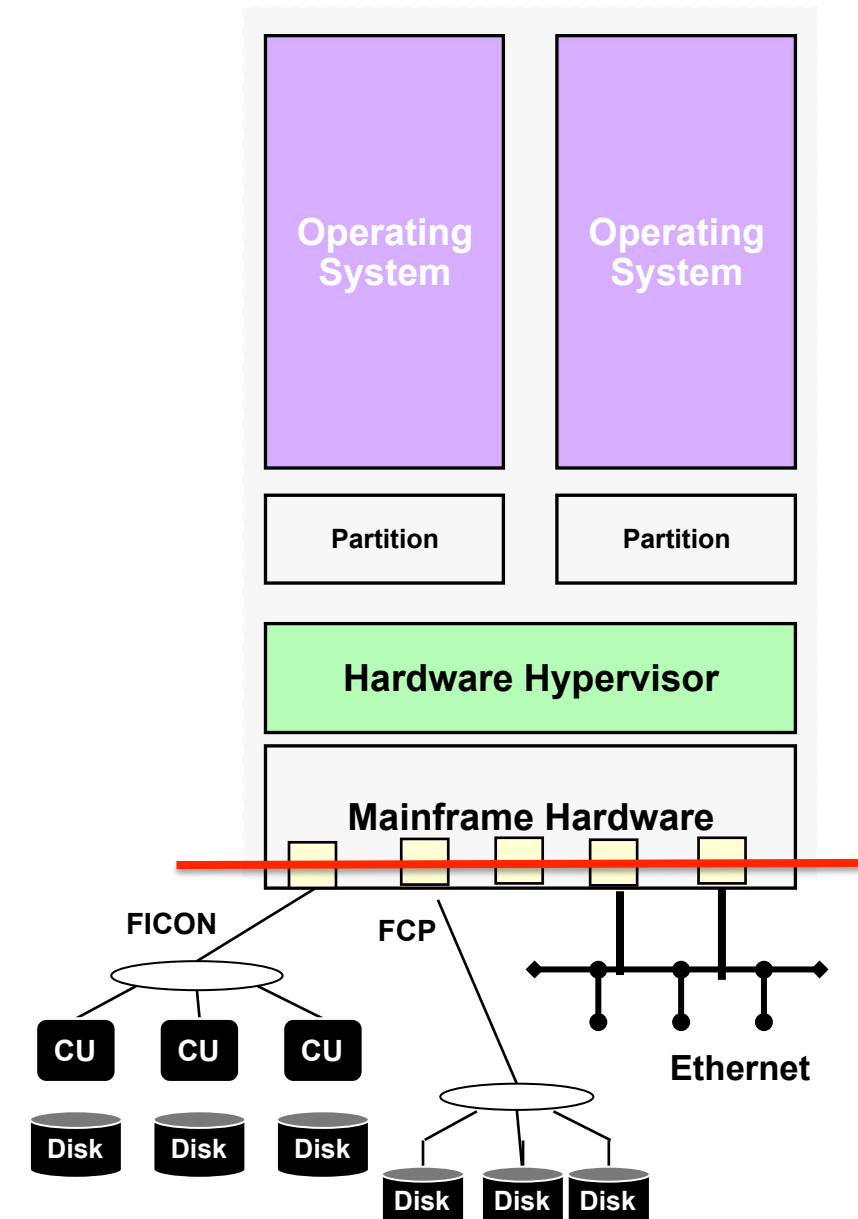
FICON - A Tale of Two Architectures

- System Architecture
 - API for I/O operations
 - Golden Rule: “The old stuff has to run!”
 - Preserves years (and \$) of client investment
 - Major value proposition for mainframes
 - ‘Principles of Operations’ (POPs)

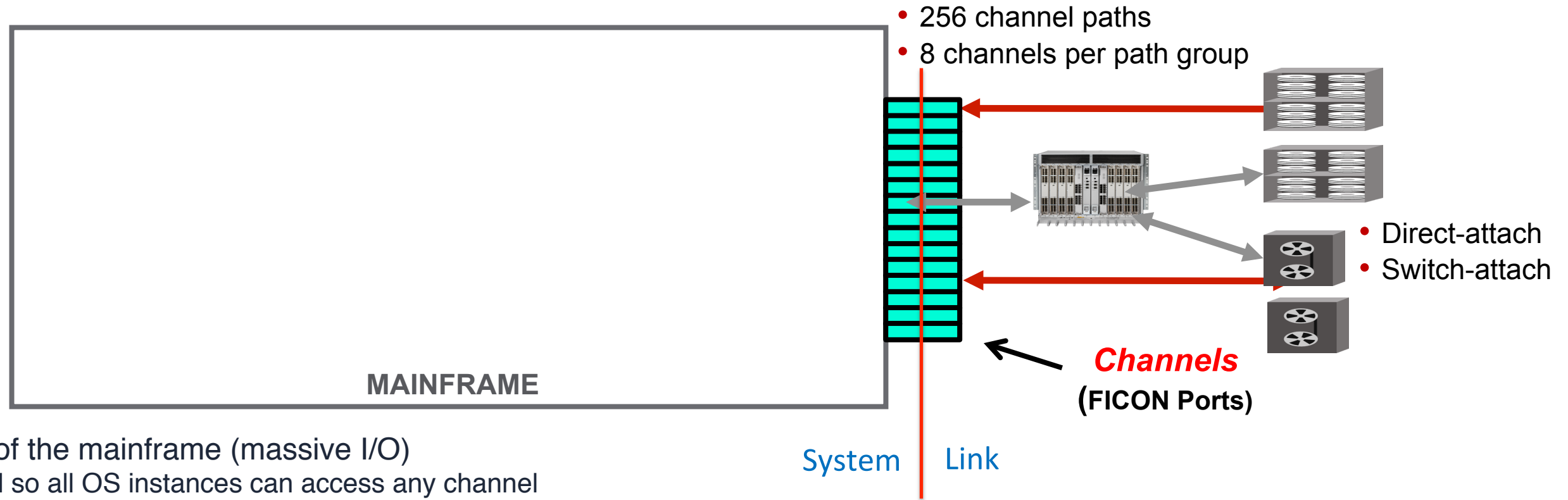


FICON - A Tale of Two Architectures

- 'Link' Architecture
 - Physical/ protocols for channel and controller
 - Changed drastically over the years
 - 1964 Parallel
 - 1990 ESCON
 - 2000 FICON
 - 'Need for speed'
 - Increasing system MIPS requires faster I/O
 - Industry competitiveness
 - ANSI Standards



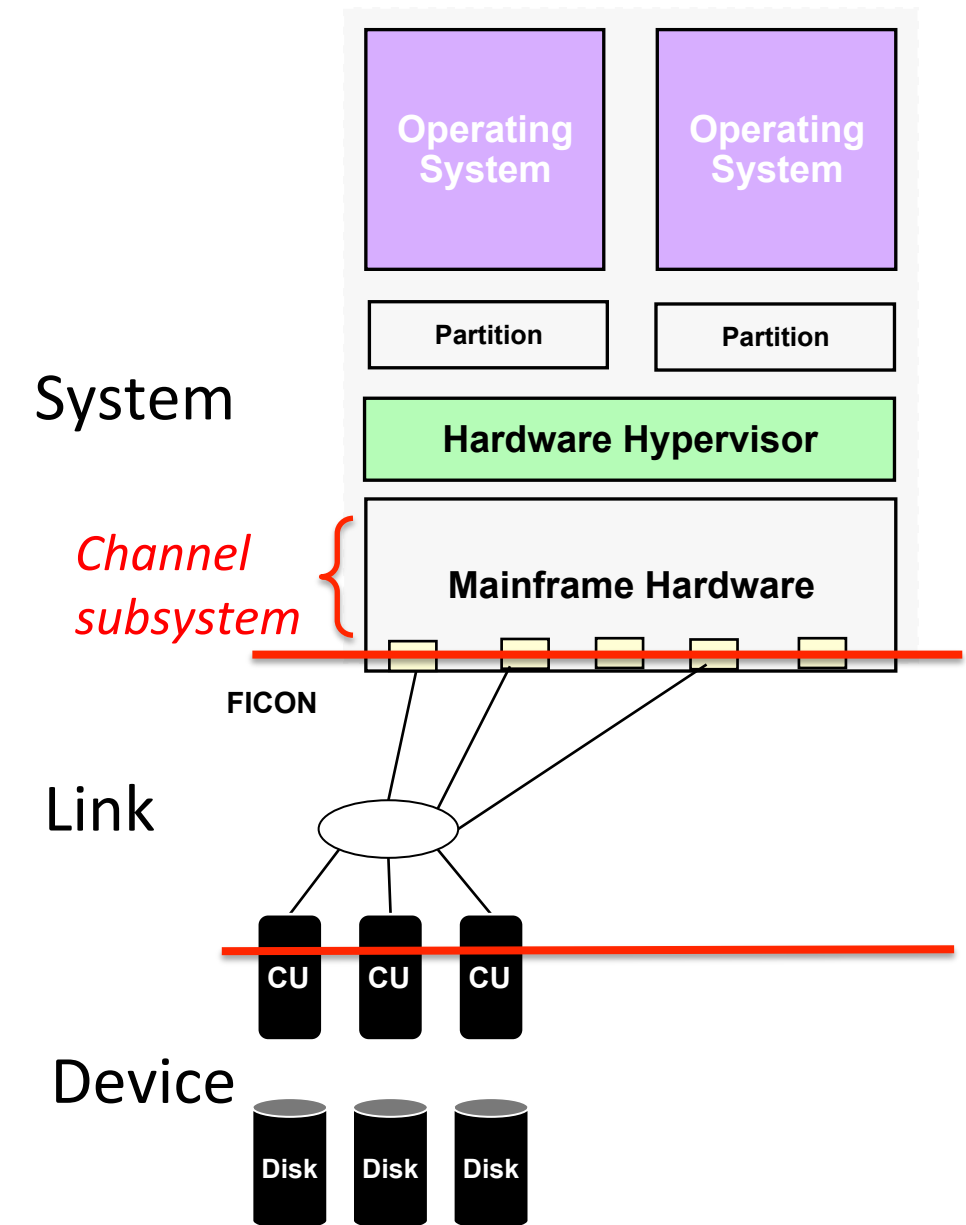
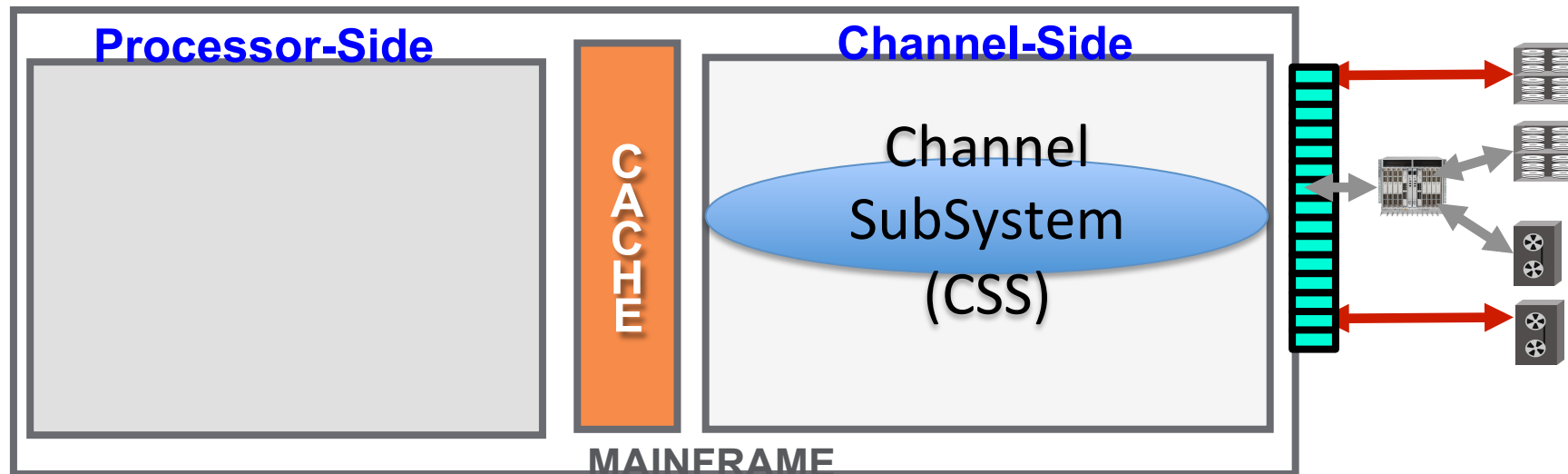
System Architecture - Channels



- Key strength of the mainframe (massive I/O)
 - Virtualized so all OS instances can access any channel
- **Channels** (or **channel paths**) are the communication paths from the host to the I/O devices
 - Channels are assigned a **channel path ID** (CHPID)
- Analogous to a PCI bus
 - Connects one or more “controllers”
 - Controls one or more “devices” (e.g. disk drive, tape drive, terminal, etc)
- Channels convert from **System** Architecture to **Link** Architecture
 - FICON channels convert from System Architecture to a Fibre Channel transport

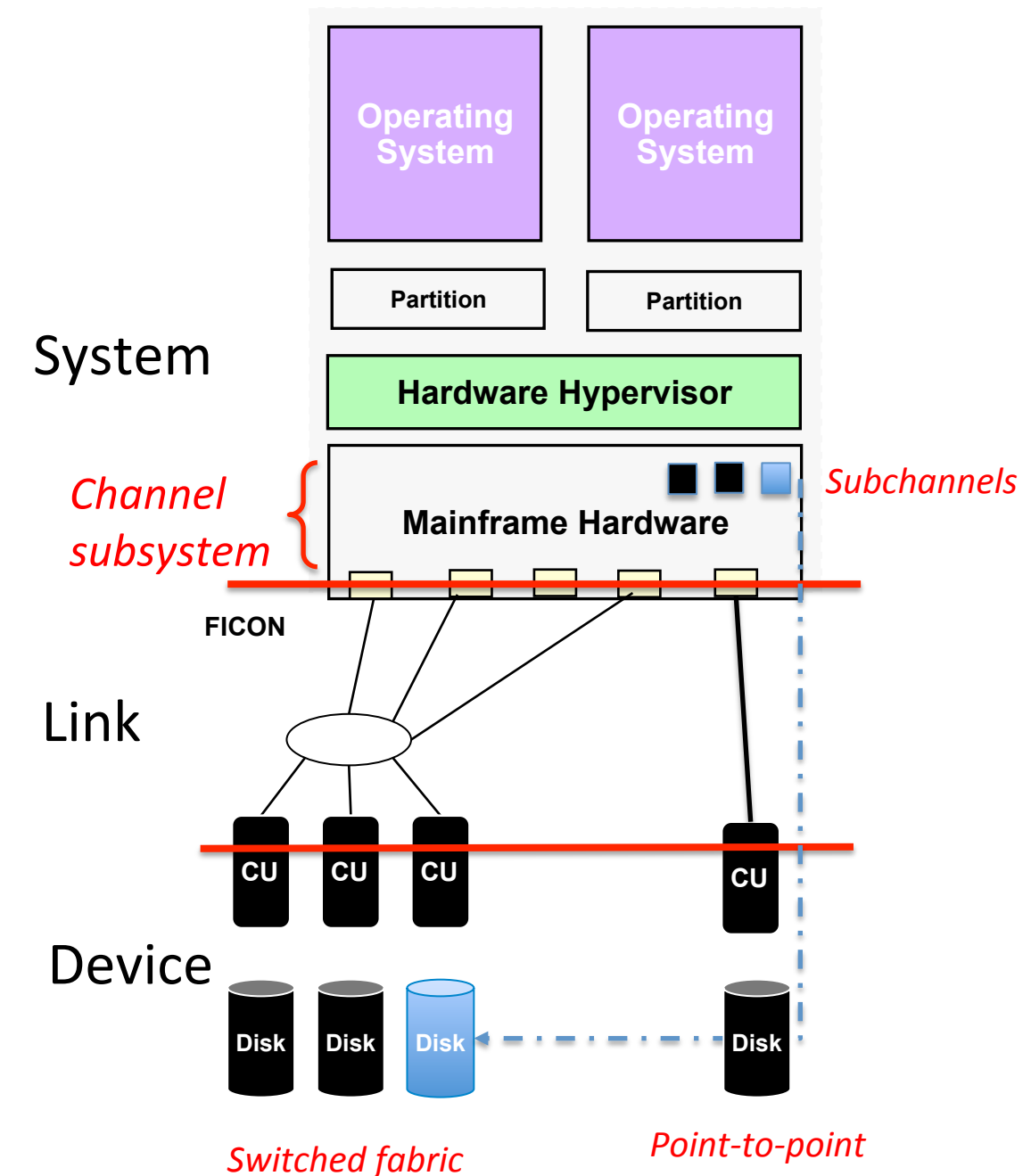
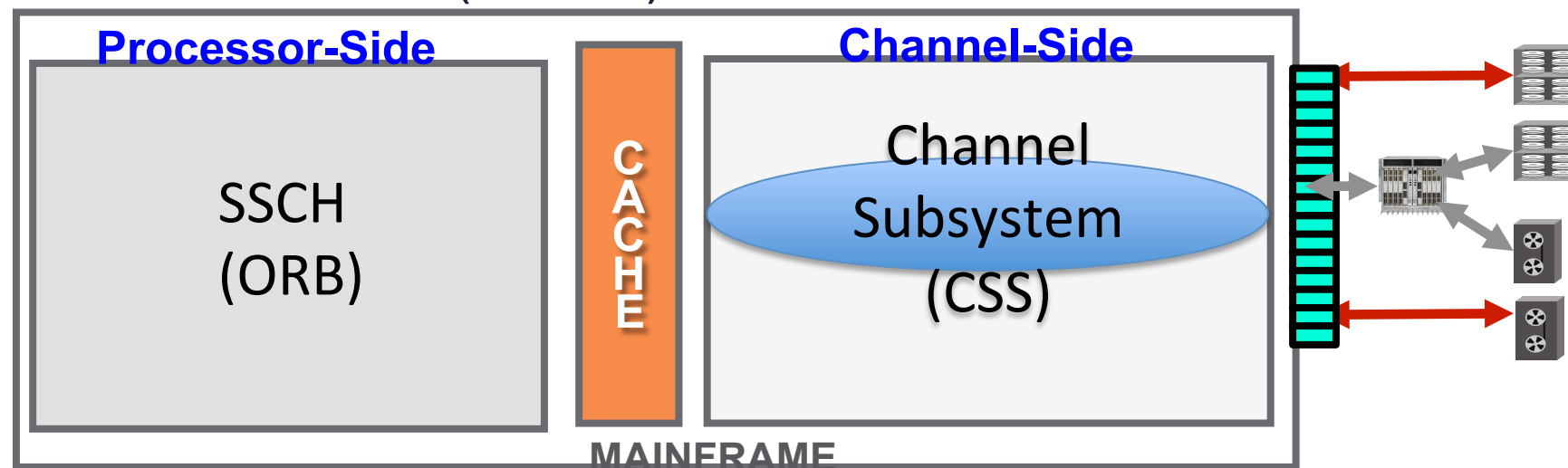
System Architecture – The Channel Subsystem

- The *Channel Subsystem* disconnects instruction processing from IO
 - Information stored in control blocks
 - Interrupt result of the operation
- Relieves host from path selection and I/O devices communication
 - Application processing proceeds concurrently with I/O processing



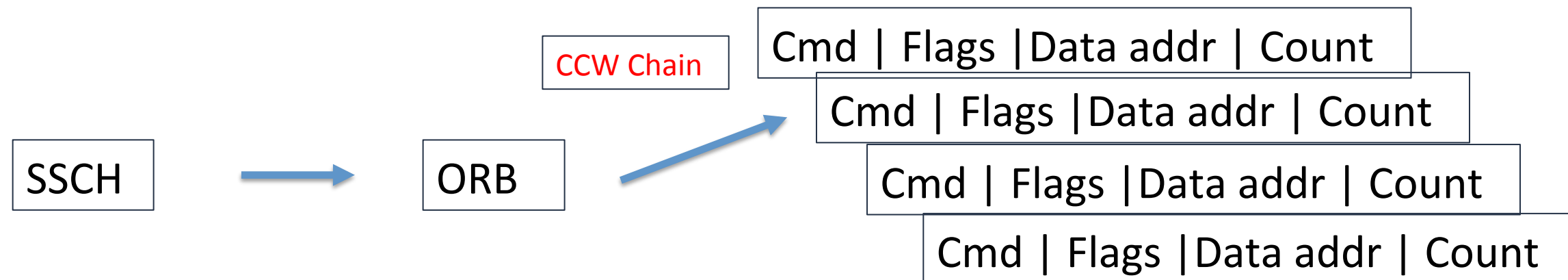
System Architecture – The I/O Operation

- Target device is called a *subchannel*
- A *subchannel* can have up to 8 paths to a device
 - Channel Subsystem selects the path
 - Path identification
 - “Point-to-point” - host channel path
 - Switched fabric - host channel path and egress switch port
- An I/O operation is initiated by the **Start Subchannel** instruction (**SSCH**)



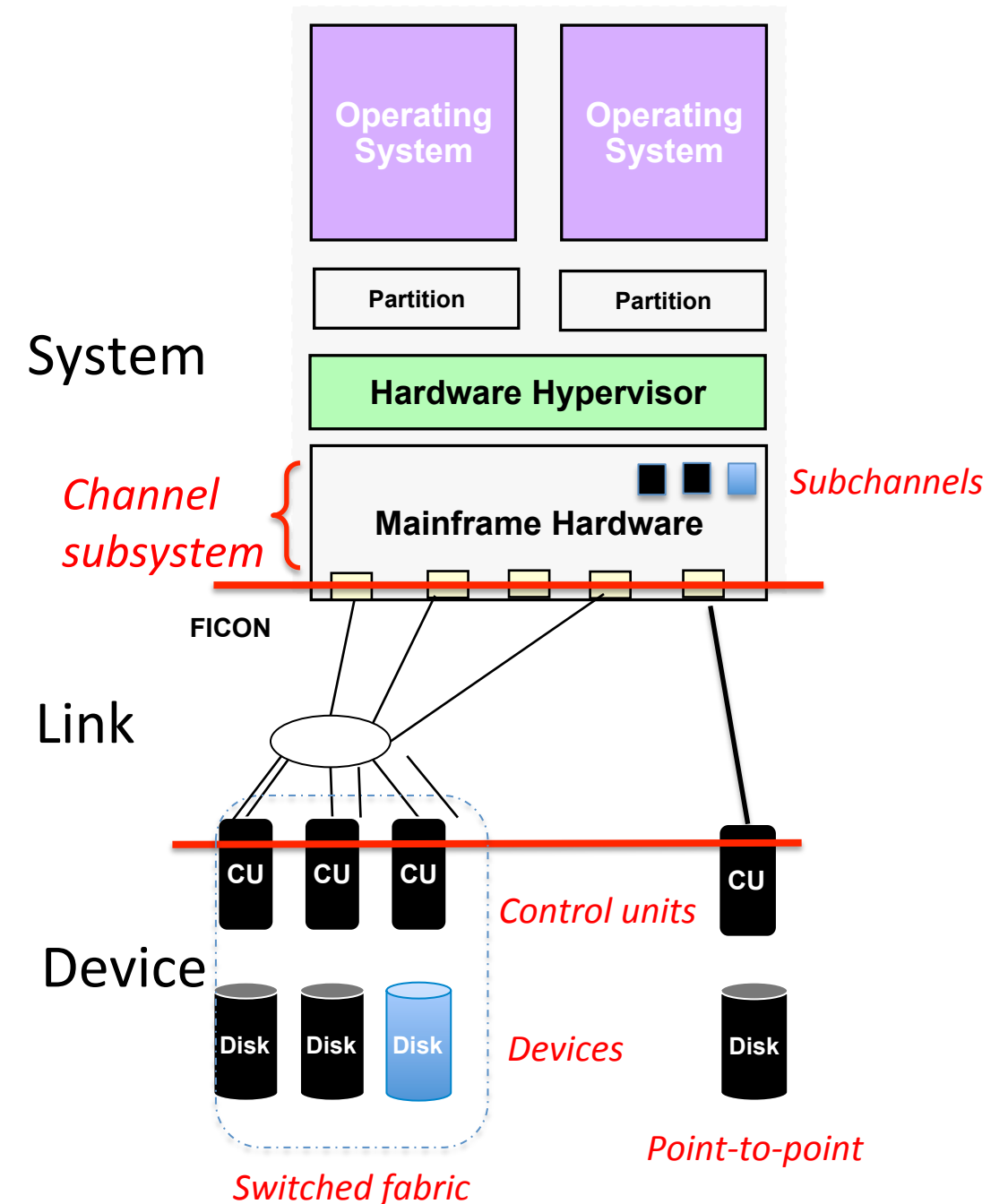
System Architecture – The I/O Operation

- Start Subchannel parameters:
 - Subchannel number => target device
 - Pointer to an **Operation Request Block (ORB)**
 - Pointer to sequence of **Channel Command Words (CCWs)**
 - Command
 - Data address
 - Quantity of data
 - Control conditions (flags)
 - » e.g. command chaining, conditional execution, and the ability to construct a command chain in discontinuous storage



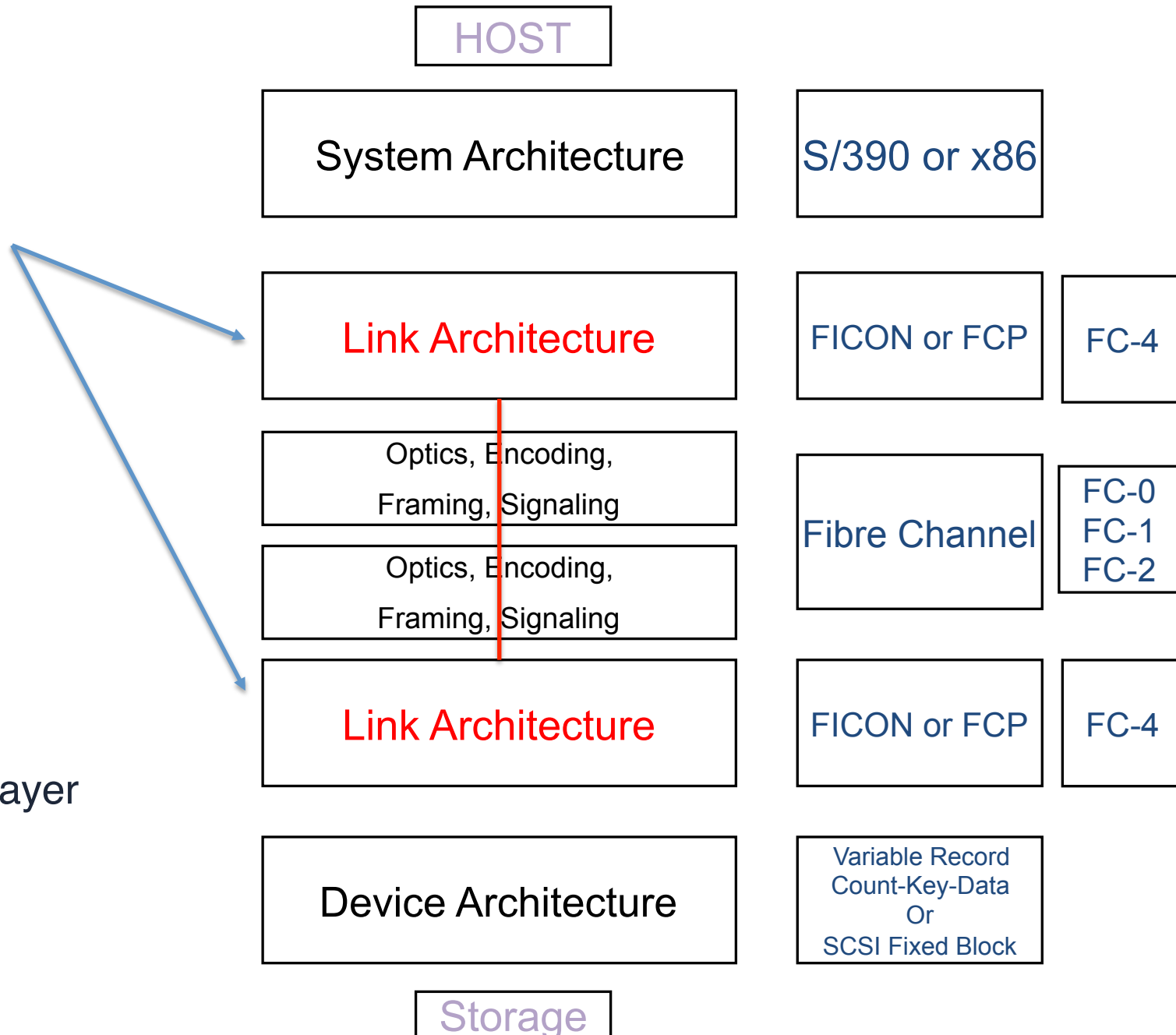
System Architecture - Control Units and Devices

- Storage controllers receive commands and data from the host
- Virtualized as **Logical Control Units (LCUs)** i.e. 'control units'
- Control units contain I/O **devices**
 - Similar to a SCSI LUN of multiple types (e.g. disk, tape, printer, etc)
- Control units convert between **link** and **device** architecture constructs
 - FICON control units convert between Fibre Channel transport constructs and Extended Count Key Data (ECKD) device architecture



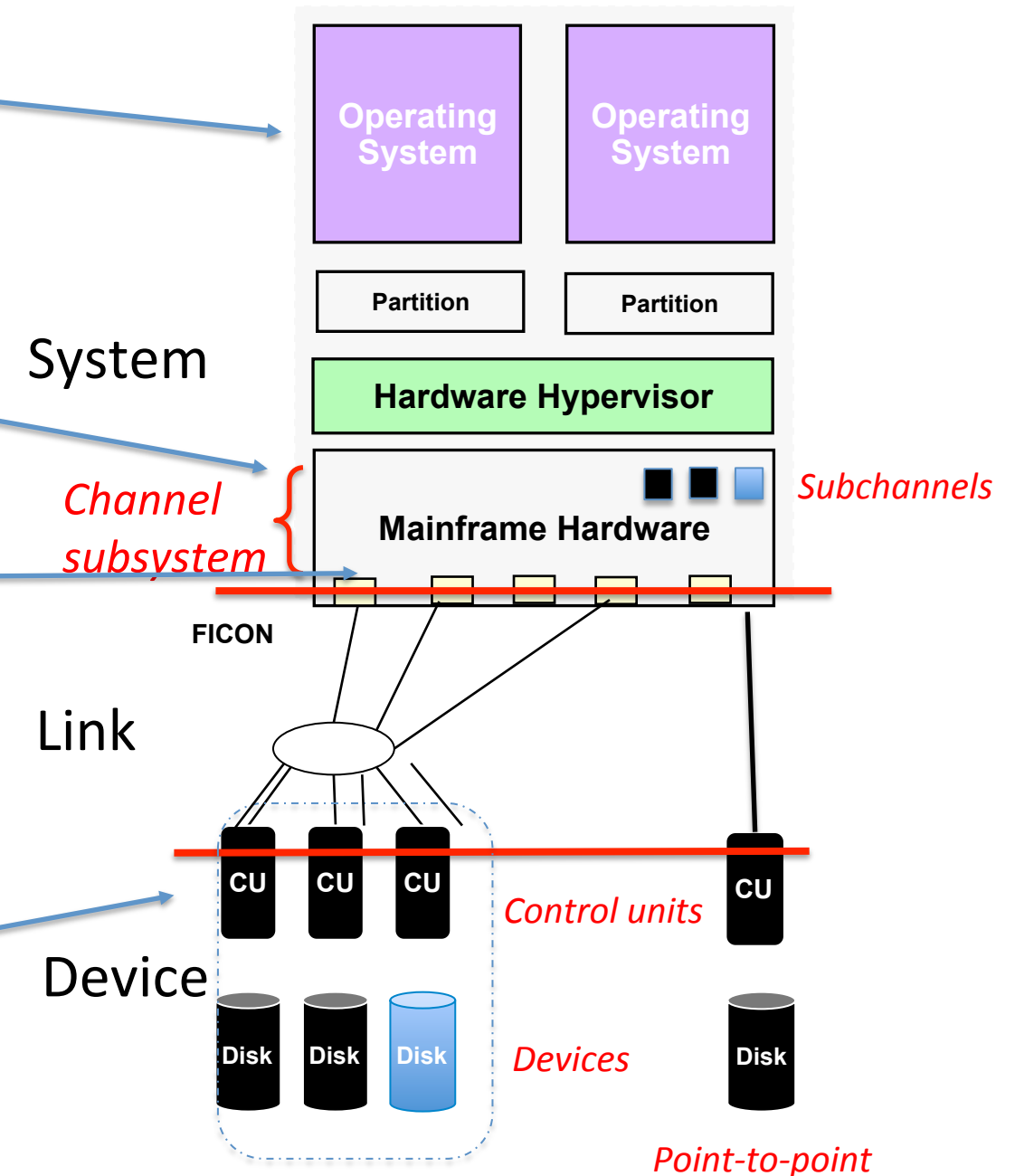
Link Architecture

- Exists on both the System and Device ends
- Translation
 - System/device architecture to link transport layer
- Describes behaviors required to execute I/O operations
 - Both host and storage ends of the link
- Describes :
 - Link Initialization process
 - Unique Link Level functions
 - How individual I/O operations are handled at this layer
 - Link level error detection
 - Link level recovery

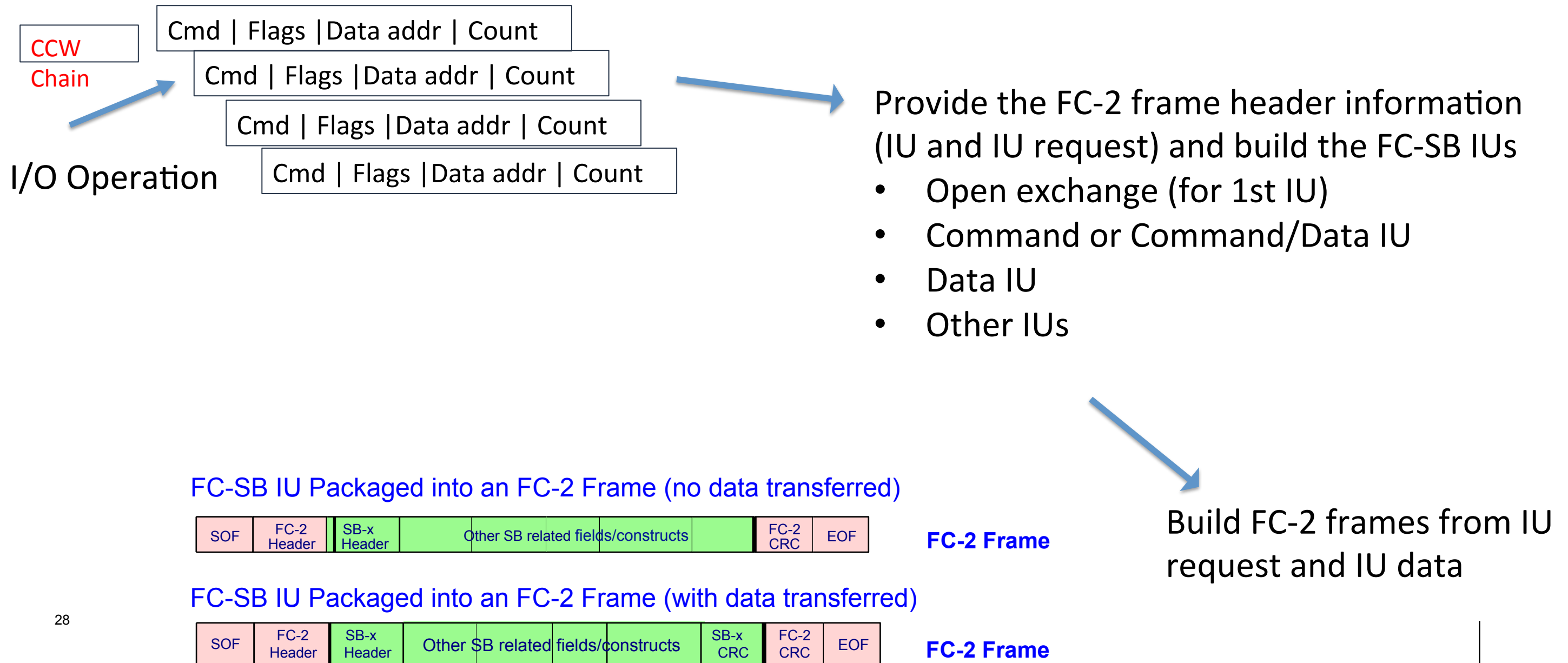


FICON Channel – I/O Request Sequence

- Start Subchannel (SSCH)
 - S/390 I/O Request (operation request block – ORB)
- Path selection
 - From set of defined and available paths
- FICON channel
 - Fetches and processes commands and data
 - CCW chain pointed to by the ORB
 - Packages commands and data into information units
 - FC-SB-x
 - Builds Fibre Channel frames from the IU request/data
- FICON Control Unit
 - Rebuilds the incoming Fibre Channel frames for an IU
 - Translates link layer IUs into Device Architecture

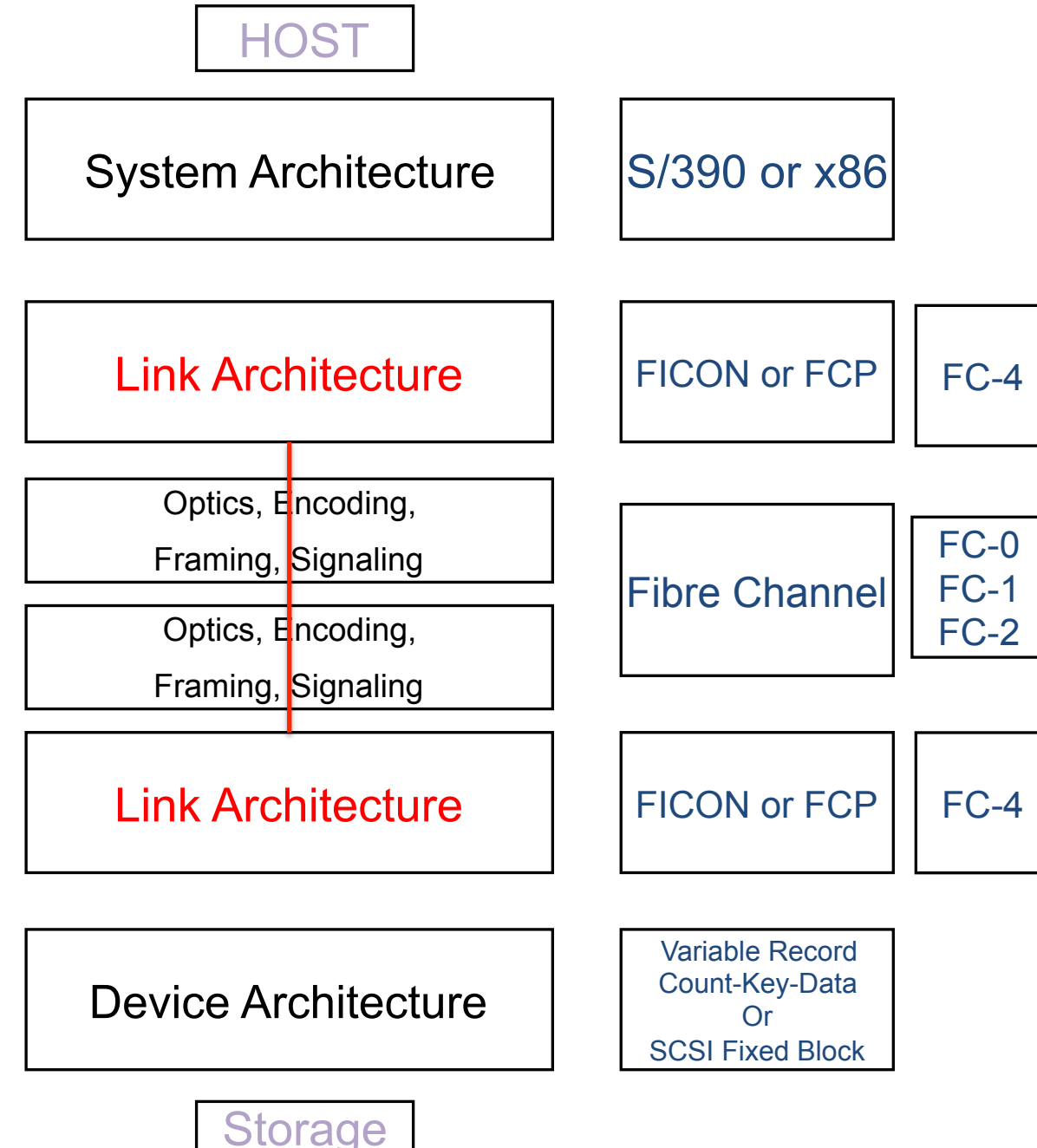


FICON – System to Link Architectures



Characteristics of FICON

- Integrity
 - End-to-End Cyclic Redundancy Check (CRC) for data integrity
- Security
 - High-integrity fabrics for secure SANs
- Flexibility
 - Simultaneous support for older and newer transport modes
- Availability
 - Logical paths and multi-pathing
- Serviceability
 - Automated gathering of local and remote data related to errors
- Transactions
 - Optimal utilization of IO resources enforces proficient transaction processing
- Efficiency
 - In band I/O instrumentation and metrics provide insight into workload operations
- 29 Reliability
 - Sequencing controls to ensure ordering



Q&A

Our Next FCIA Webcast:

Fibre Channel Interoperability

August 23, 2018

10:00 am PT

Register at:

<https://www.brighttalk.com/webcast/14967/327269>

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 - Fibre Channel Speedmap
 - FCIP (Extension): Data Protection and Business Continuity
 - Fibre Channel Performance
 - Fibre Channel Cabling

References

- https://www.ibm.com/support/knowledgecenter/zosbasics/com.ibm.zos.zmainframe/zconc_whatismainframe.htm
- <http://fibrechannell.org/webcasts>

Thank You