System z

Introduction to Virtualization

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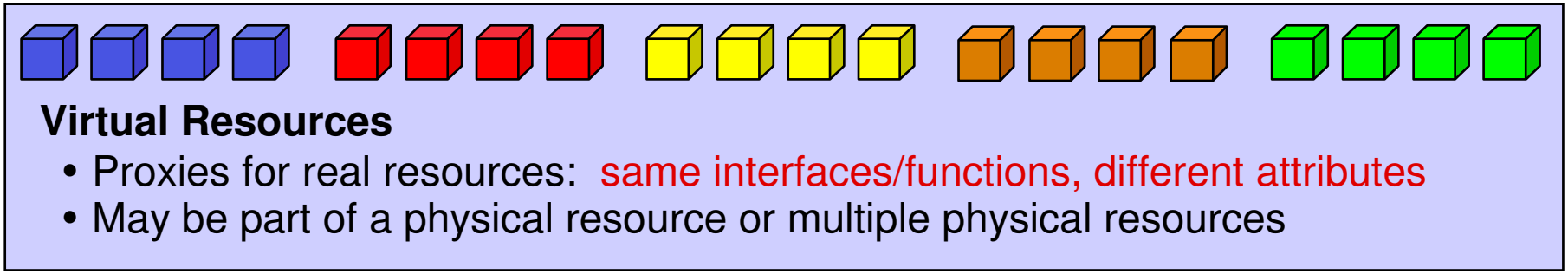
System z Architecture and Technology

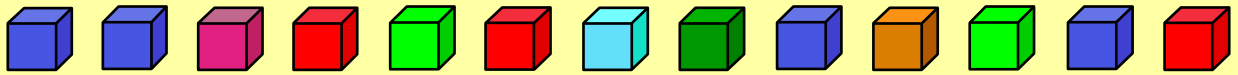
- **Introduction to Virtualization**
  - Concept
  - Server Virtualization Approaches
  - Hypervisor Implementation Methods
  - Why Virtualization Matters
- **Virtualization on System z**
  - Logical Partitions
  - Virtual Machines



Virtual Resources
- Proxies for real resources: same interfaces/functions, different attributes
- May be part of a physical resource or multiple physical resources

Virtualization
- Creates virtual resources and "maps" them to real resources
- Primarily accomplished with software or firmware

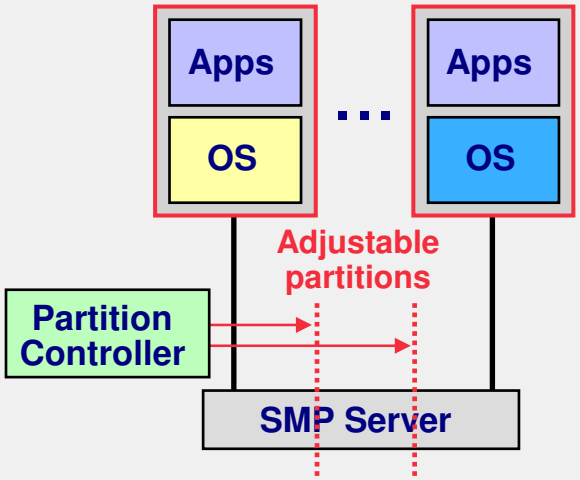
Resources
- Components with architecturally-defined interfaces/functions
- May be centralized or distributed - usually physical
- Examples: memory, disk drives, networks, servers



- **Separates presentation of resources to users from actual resources**
- **Aggregates pools of resources for allocation to users as virtual resources**

Server Virtualization Approaches

Hardware Partitioning

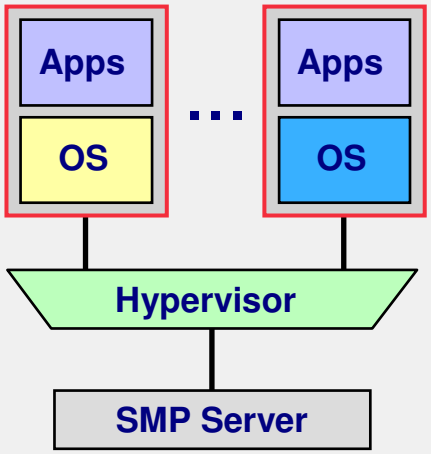


Server is subdivided into fractions each of which can run an OS

Physical partitioning
- S/370™ SI-to-PP and PP-to-SI
- Sun Domains, HP nPartitions

Logical partitioning
- IBM eServer™ pSeries® LPAR
- HP vPartitions

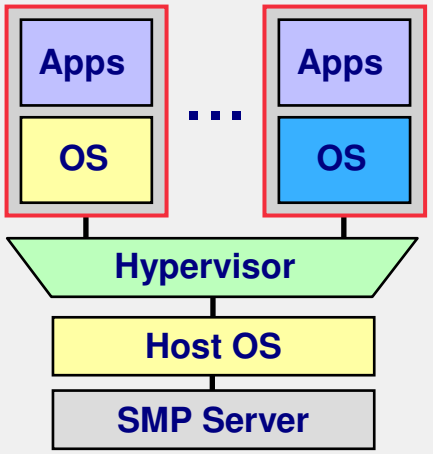
Bare-metal Hypervisor



Hypervisor provides fine-grained timesharing of all resources

Hypervisor software/firmware runs directly on server
- System z LPAR and z/VM®
- POWER™ Hypervisor
- VMware ESX Server
- Xen Hypervisor

Hosted Hypervisor



Hypervisor uses OS services to do timesharing of all resources

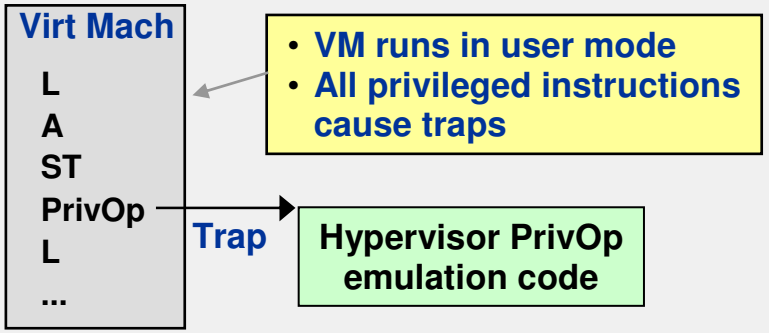
Hypervisor software runs on a host operating system
- VMware GSX
- Microsoft® Virtual Server
- HP Integrity VM
- KVM

Characteristics:

- Bare-metal hypervisors offer high efficiency and availability
- Hosted hypervisors are useful for clients where host OS integration is important
- Hardware partitioning is less flexible than hypervisor-based solutions

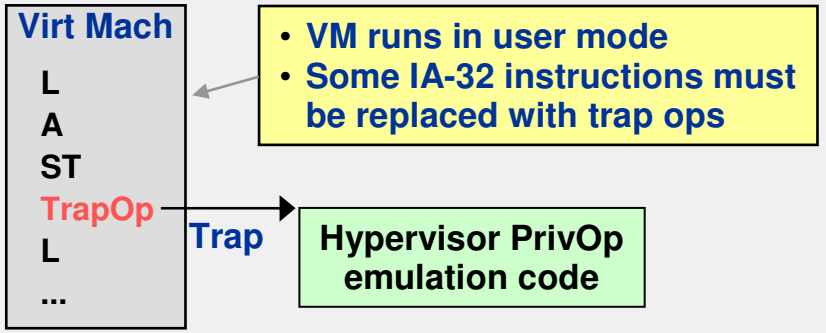
Hypervisor Implementation Methods

Trap and Emulate



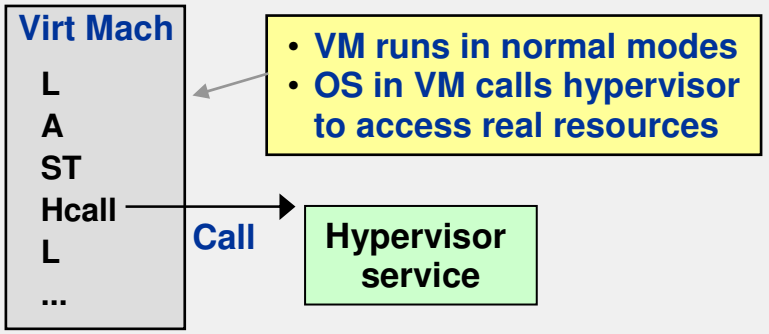
Examples: CP-67, VM/370
Benefits: Runs unmodified OS
Issues: Substantial overhead

Translate, Trap, and Emulate



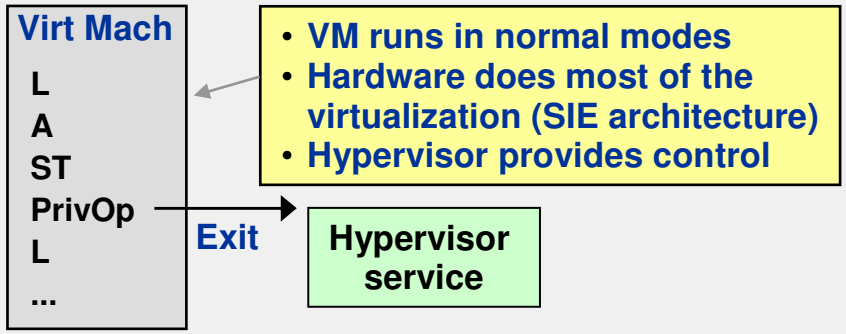
Examples: VMware, Microsoft VS
Benefits: Runs unmodified, translated OS
Issues: Substantial overhead

Hypervisor Calls ("Paravirtualization")



Examples: POWER Hypervisor, Xen
Benefits: High efficiency
Issues: OS must be modified to issue Hcalls

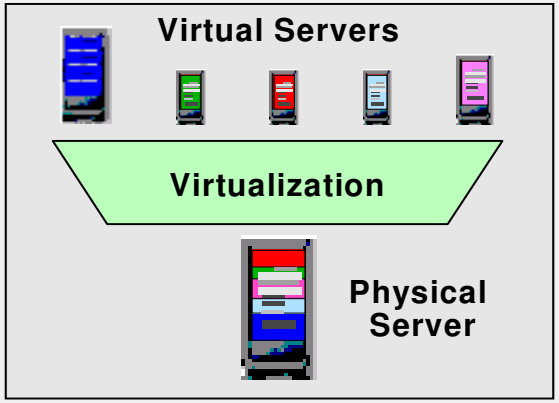
Direct Hardware Virtualization



Examples: System z LPAR, z/VM, Xen
Benefits: High efficiency, runs unmodified OS
Issues: Requires underlying hardware support

Server Virtualization Business Value

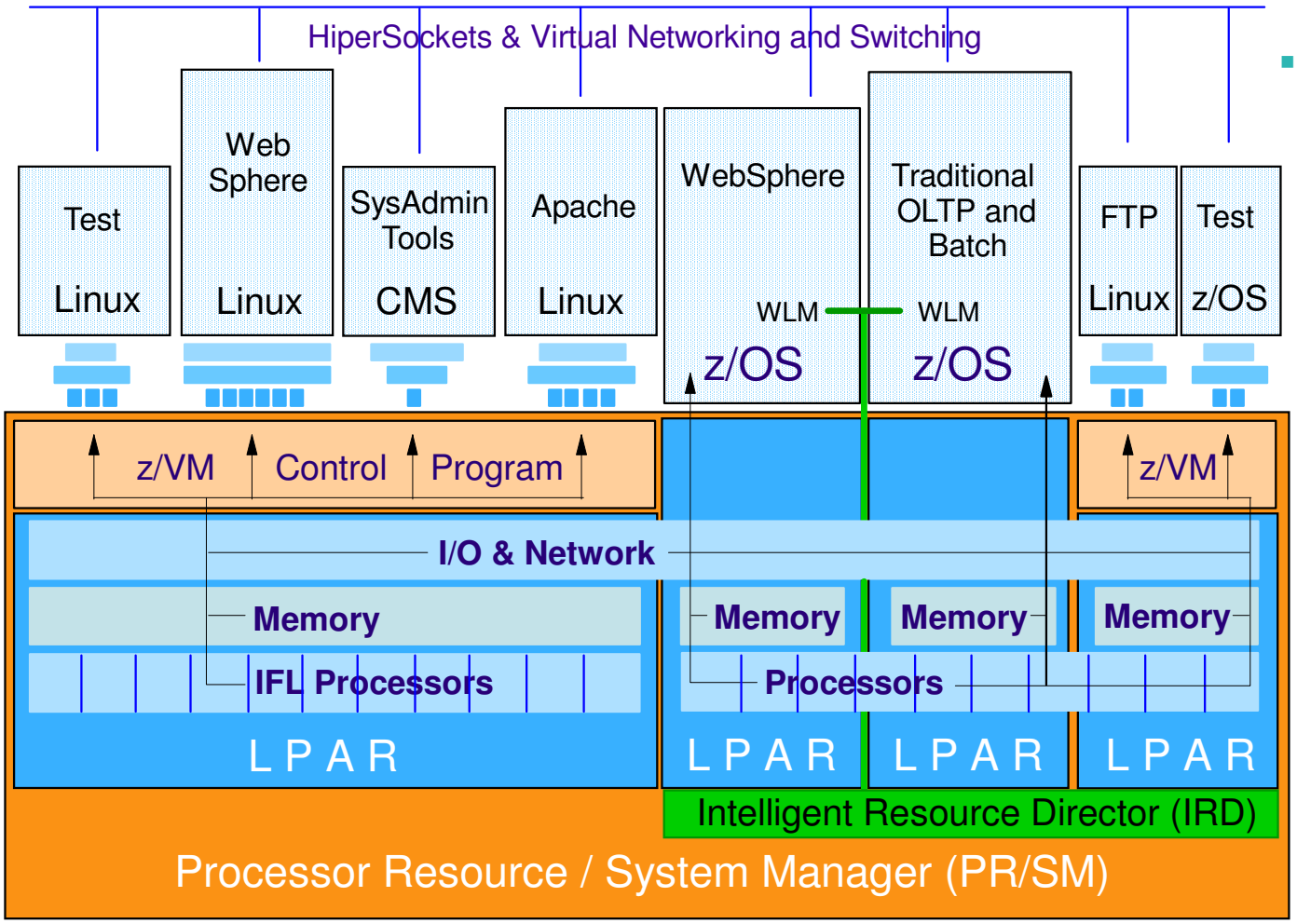
Roles:
- Consolidations
- Dynamic provisioning/hosting
- Workload management
- Workload isolation
- Software release migration
- Mixed production and test
- Mixed OS types/releases
- Reconfigurable clusters
- Low-cost backup servers



Possible Benefits:
- High resource utilization
- Great usage flexibility
- Enhanced workload QoS
- High availability / security
- Low cost of availability
- Low management costs
- Enhanced interoperability
- Legacy compatibility
- Investment protection

Virtualization can fill many roles and provide many benefits
In the final analysis, its potential benefits take three forms:

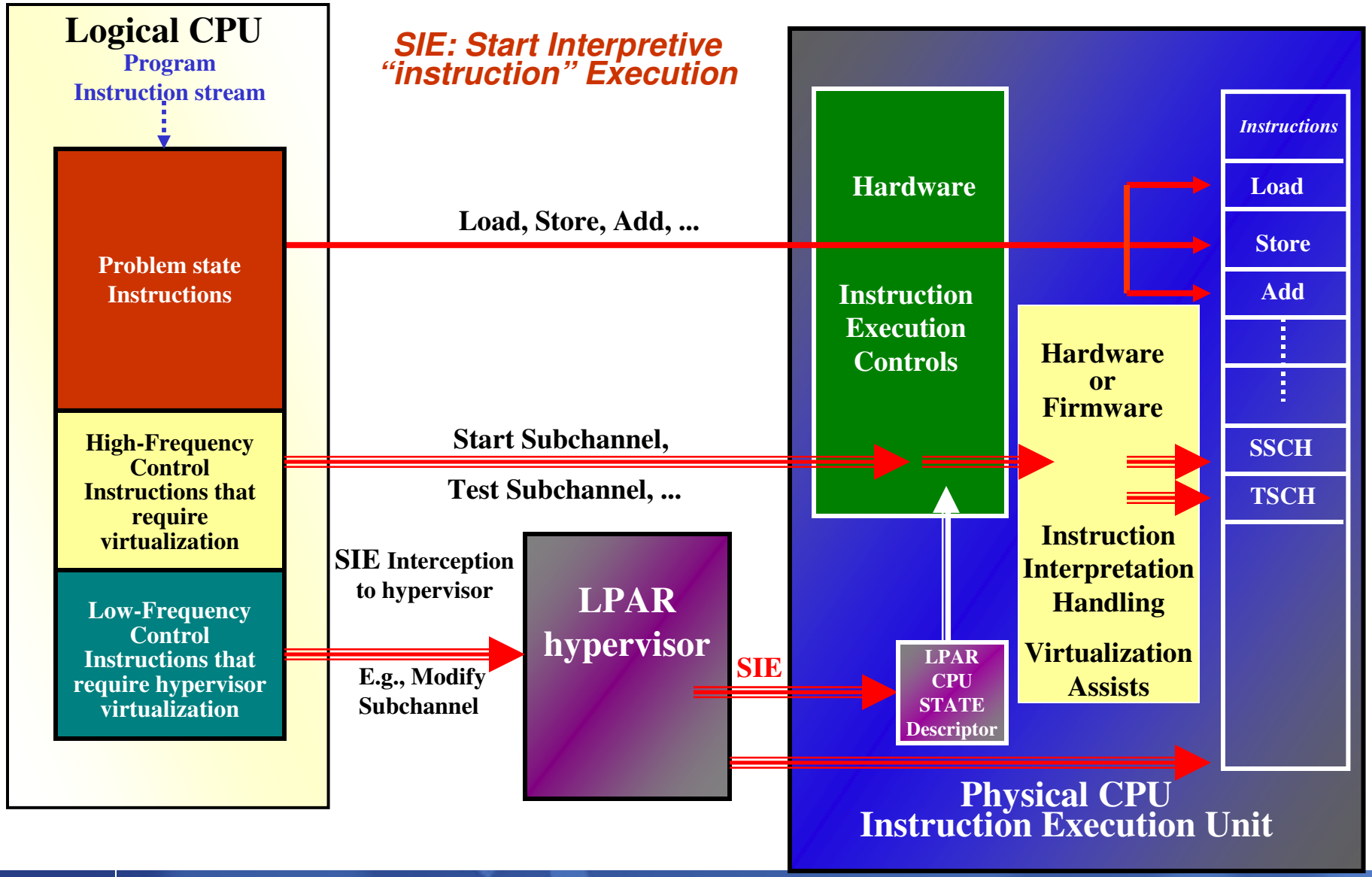
- **Help reduce hardware costs**
  - Help increase physical resource utilization
  - Small footprints
- **Can improve flexibility and responsiveness**
  - Virtual resources can be adjusted dynamically to meet new or changing needs and to optimize service level achievement
  - Virtualization is a key enabler of on demand operating environments such as cloud
- **Can reduce management costs**
  - Fewer physical servers to manage
  - Many common management tasks become much easier



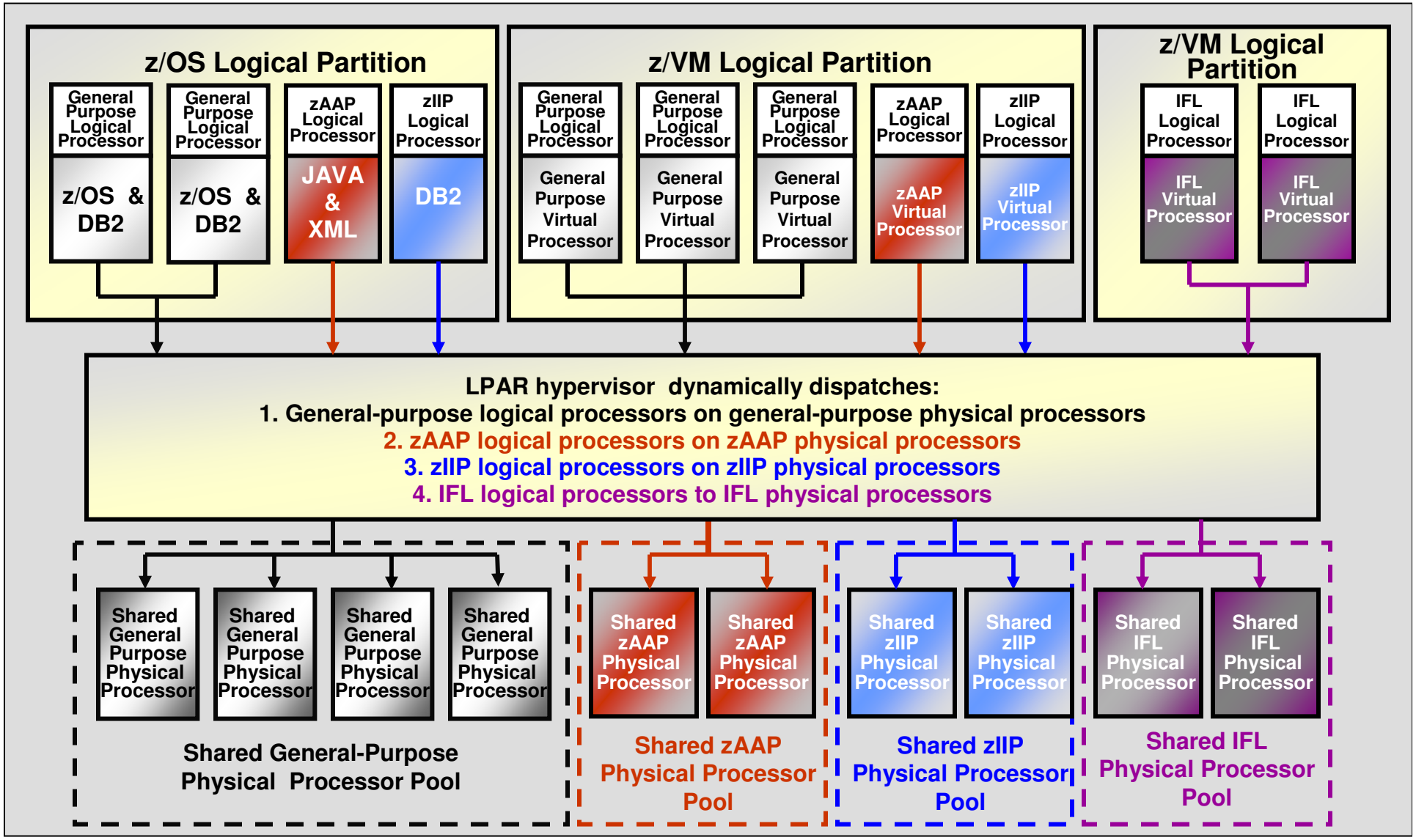
- **Multi-dimensional virtualization technology**
  - System z provides logical (LPAR) and software (z/VM) partitioning
  - PR/SM enables highly scalable virtual server hosting for LPAR *and* z/VM virtual machine environments
  - IRD coordinates allocation of CPU and I/O resources among z/OS and non-z/OS® LPARs*

* Excluding non-shared resources like Integrated Facility for Linux processors

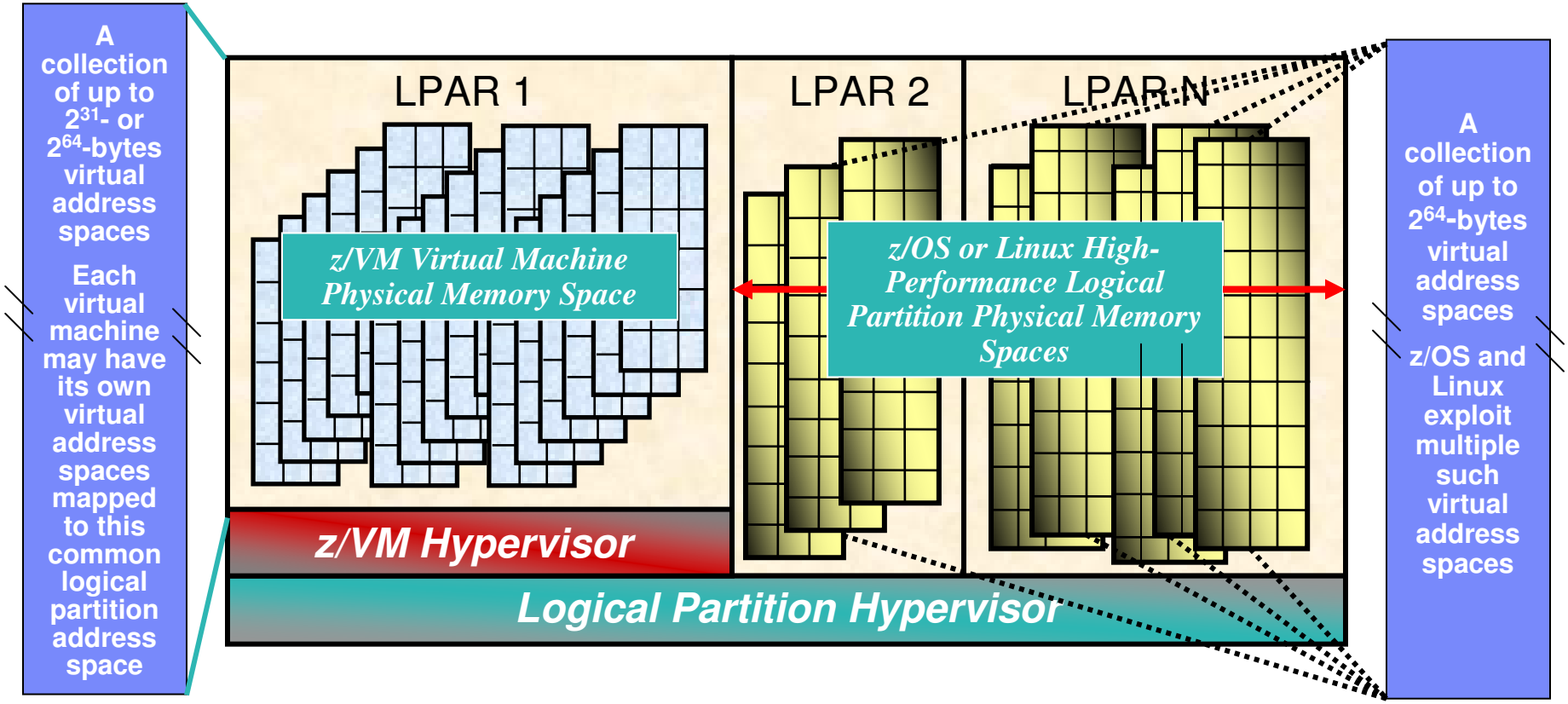
LPAR Logical CPU Dispatching and Execution Control



LPAR Logical Processor Dispatching



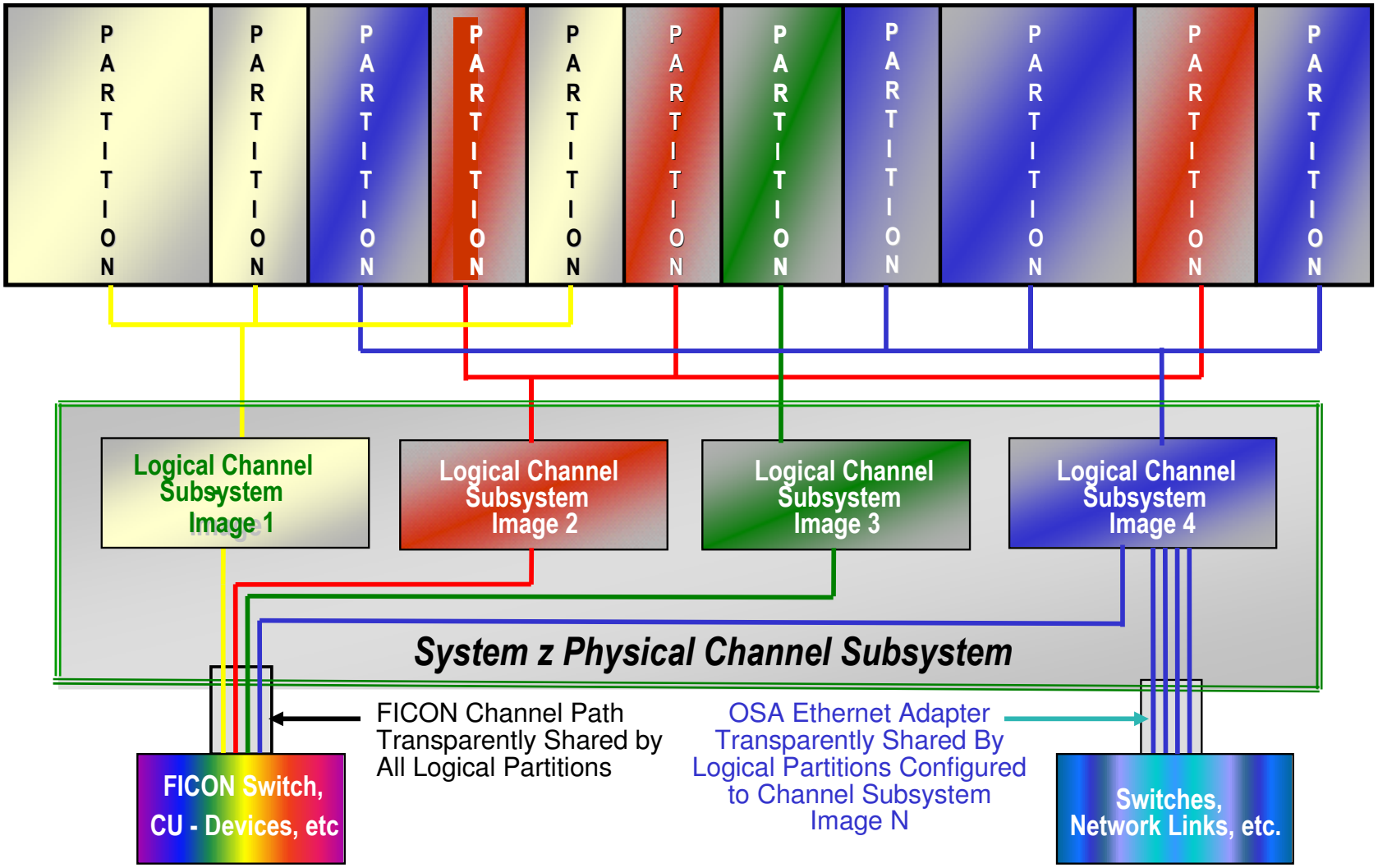
LPAR Memory Partitioning



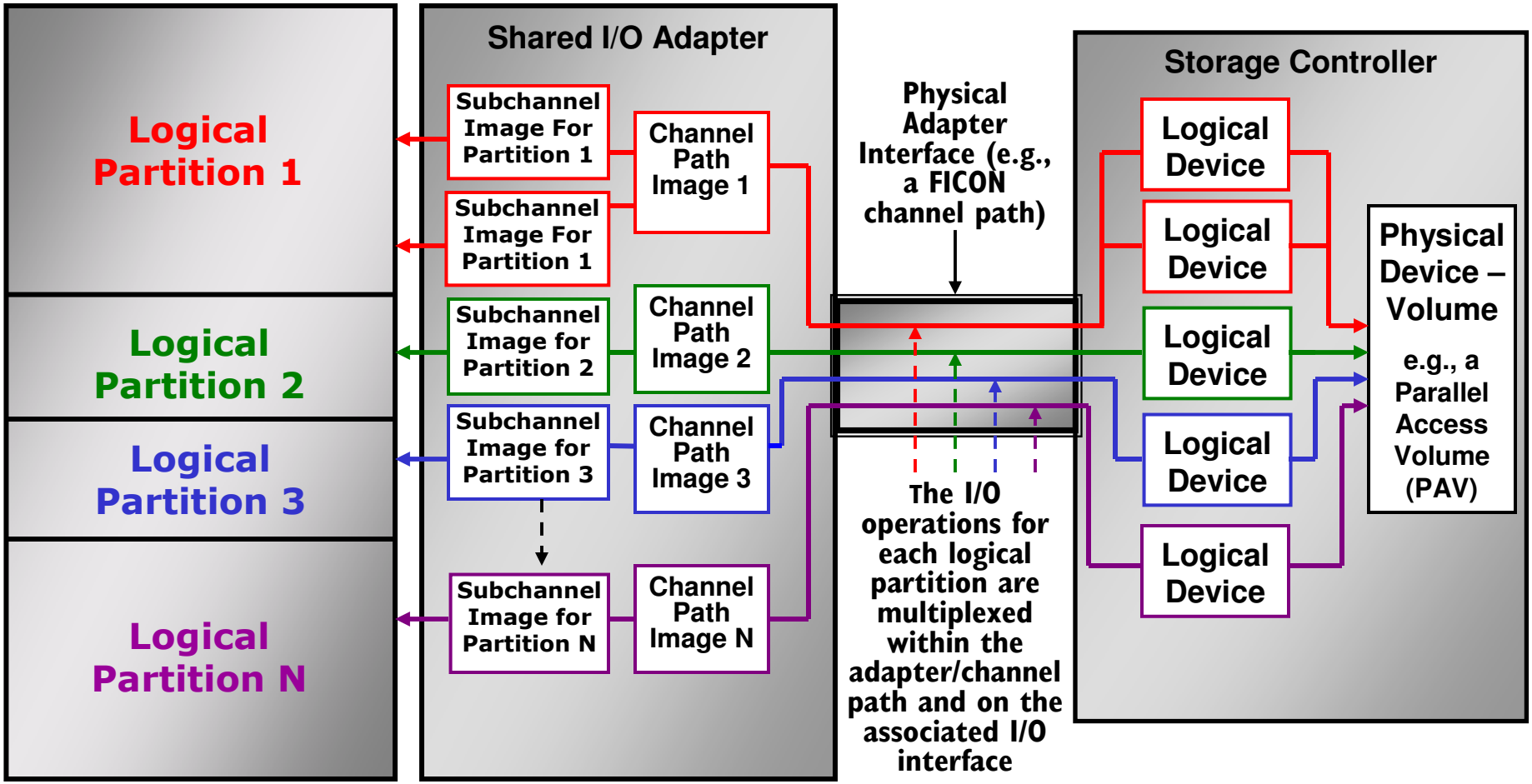
= the real partition memory pages associated with a virtual address space; that is, the sets of dynamically-allocated physical memory pages necessary to run a z/OS task or a Linux process

= the real partition memory pages associated with a virtual machine; that is, the sets of dynamically-allocated physical memory pages necessary to run a guest operating system in a virtual machine

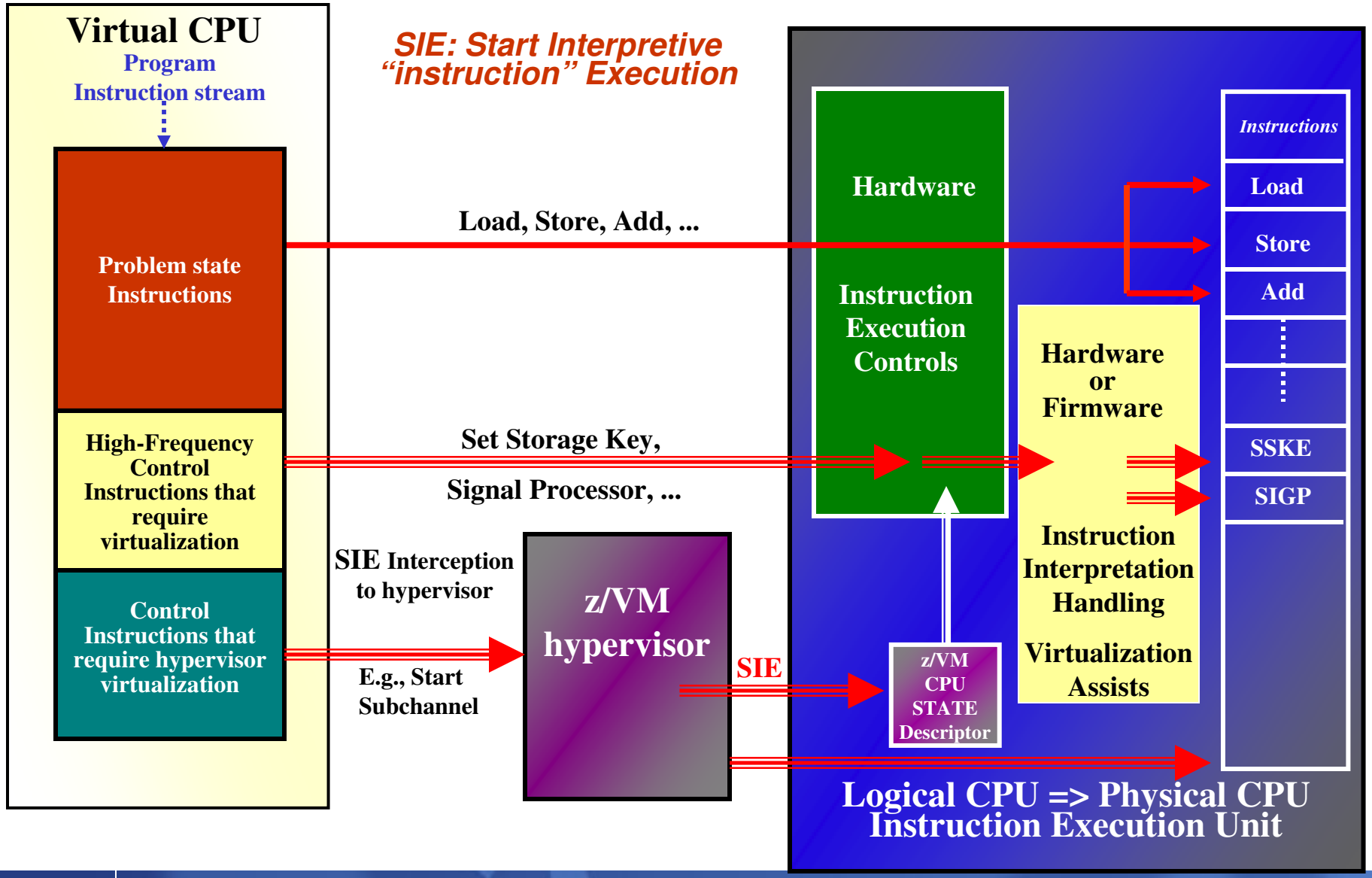
LPAR Multiple Logical Channel Subsystems



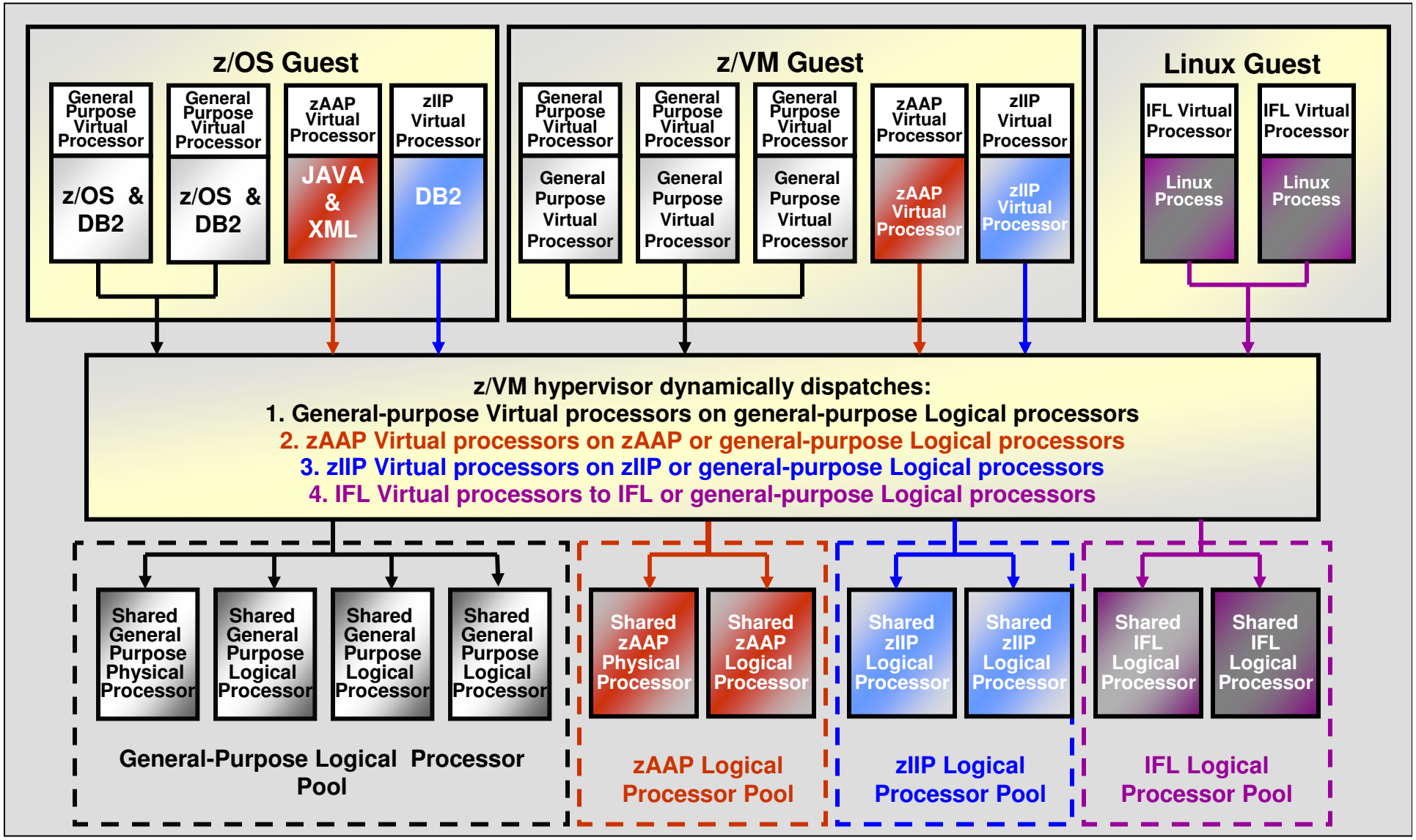
LPAR High-Performance I/O Sharing



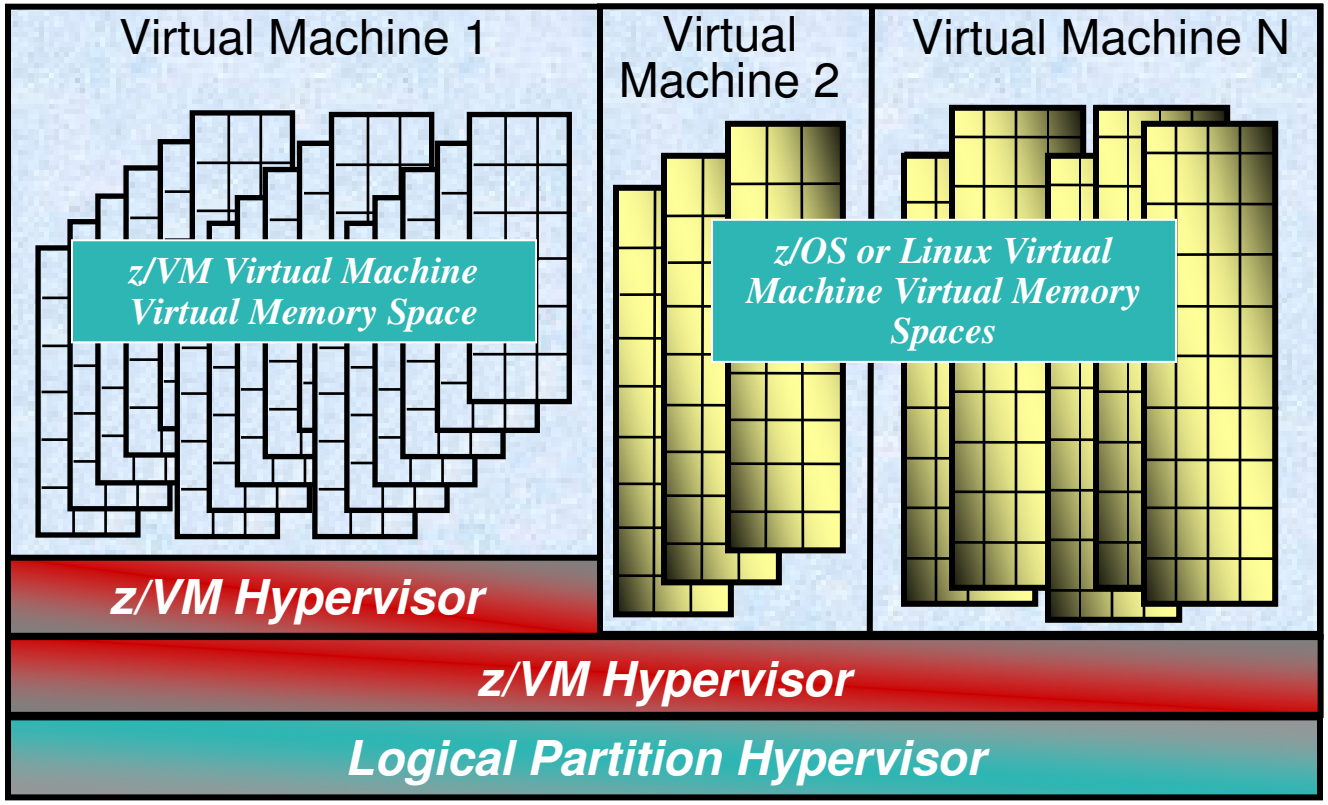
- The I/O infrastructure (adapters/channels, their transmission links, and attached I/O resources are shared by LPARs at native speeds (without hypervisor involvement)
  - I/O requests, their associated data transfers , and I/O interruptions flow between each OS instance and the shared I/O components, just as if the I/O components were physically dedicated to a single OS instance

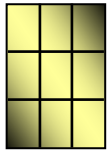


z/VM Virtual Processor Dispatching

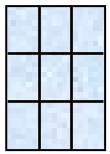


z/VM Memory Virtualization



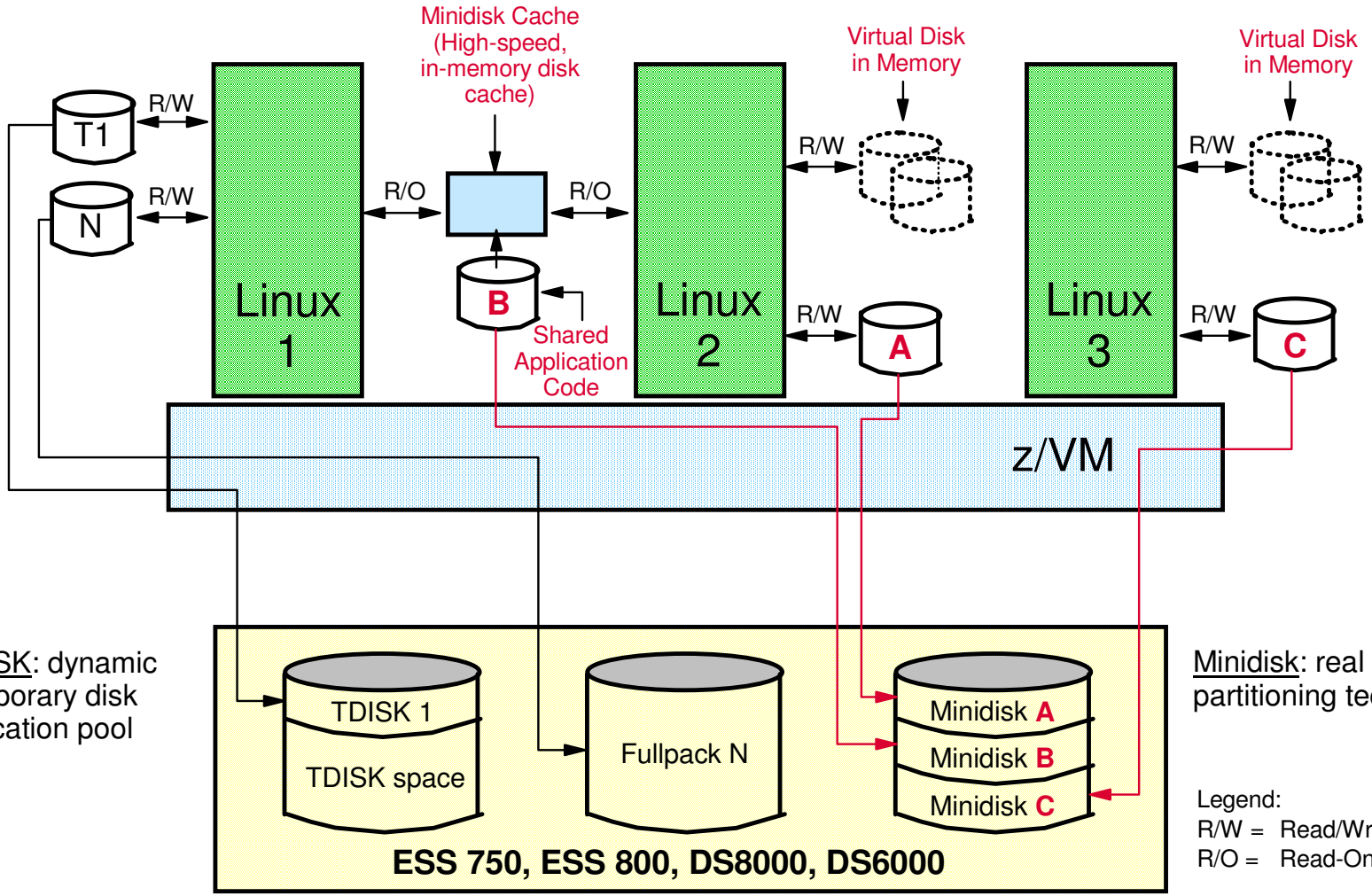


= the guest real memory pages associated with a virtual address space; that is, the sets of dynamically-allocated host virtual memory pages necessary to run a z/OS task or a Linux process



= the guest real memory pages associated with a virtual machine; that is, the sets of dynamically-allocated host virtual memory pages necessary to run a guest operating system in a virtual machine

z/VM Disk Virtualization

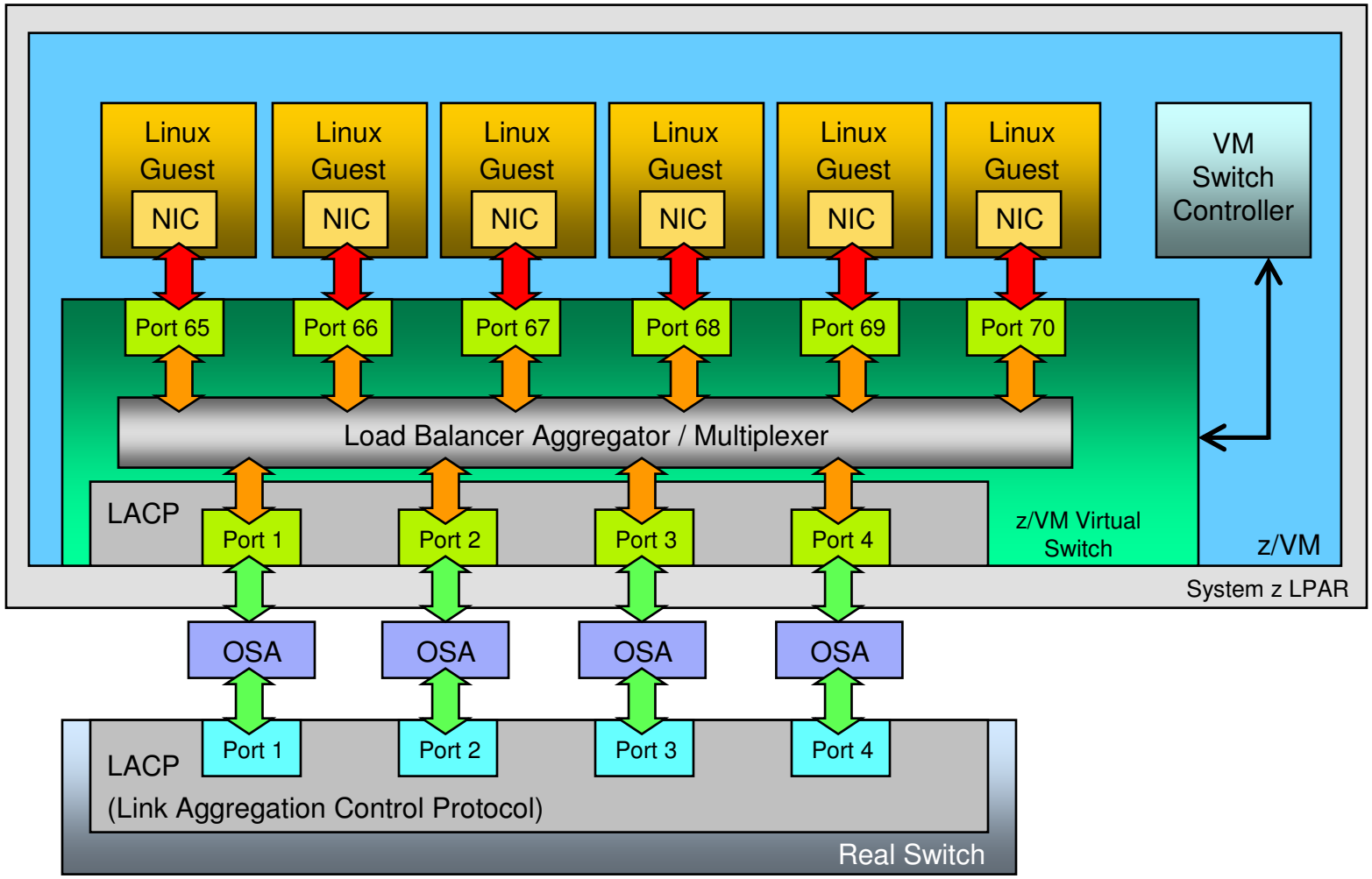


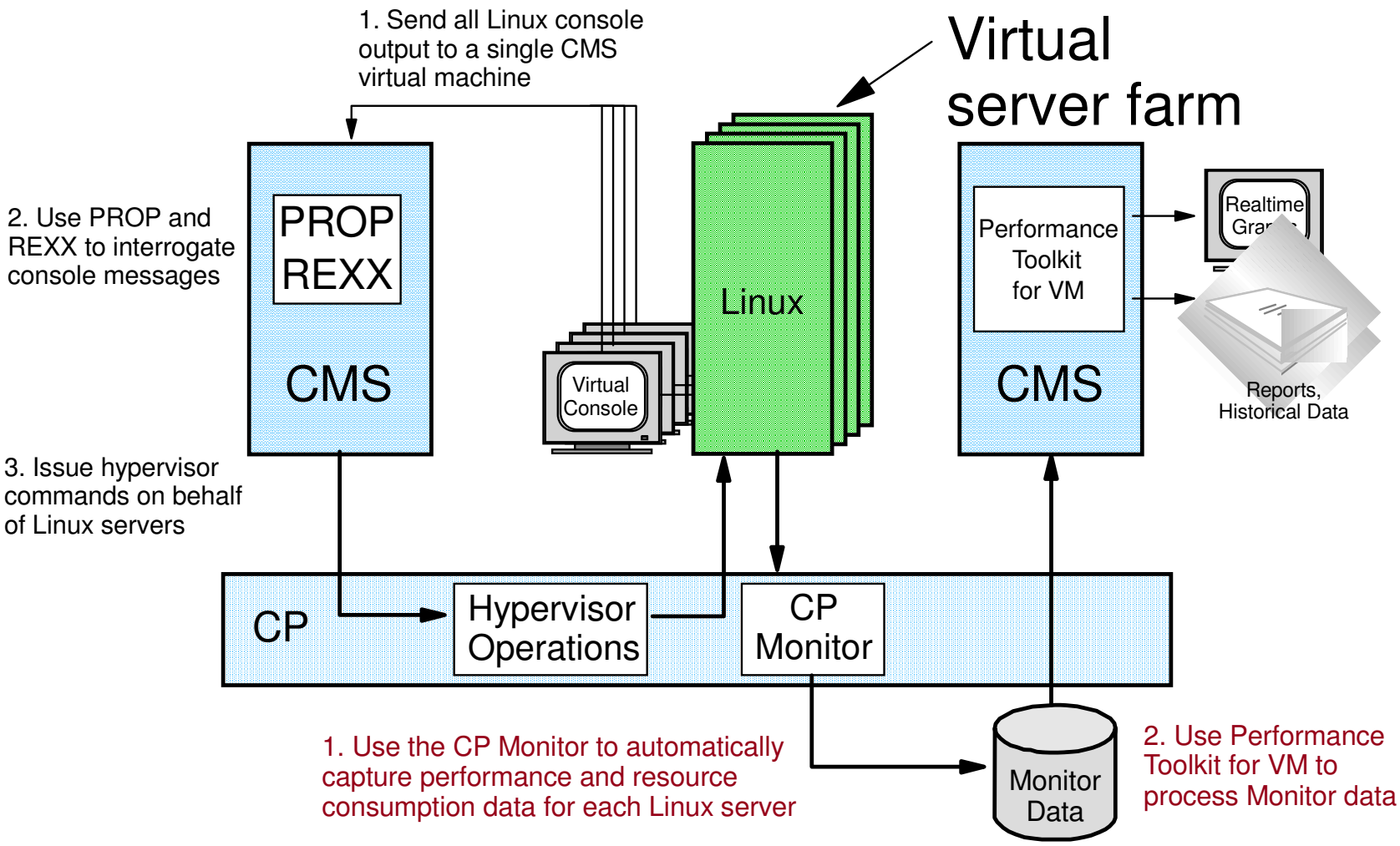
TDISK: dynamic temporary disk allocation pool

Minidisk: real disk partitioning technology

Legend:
R/W = Read/Write
R/O = Read-Only

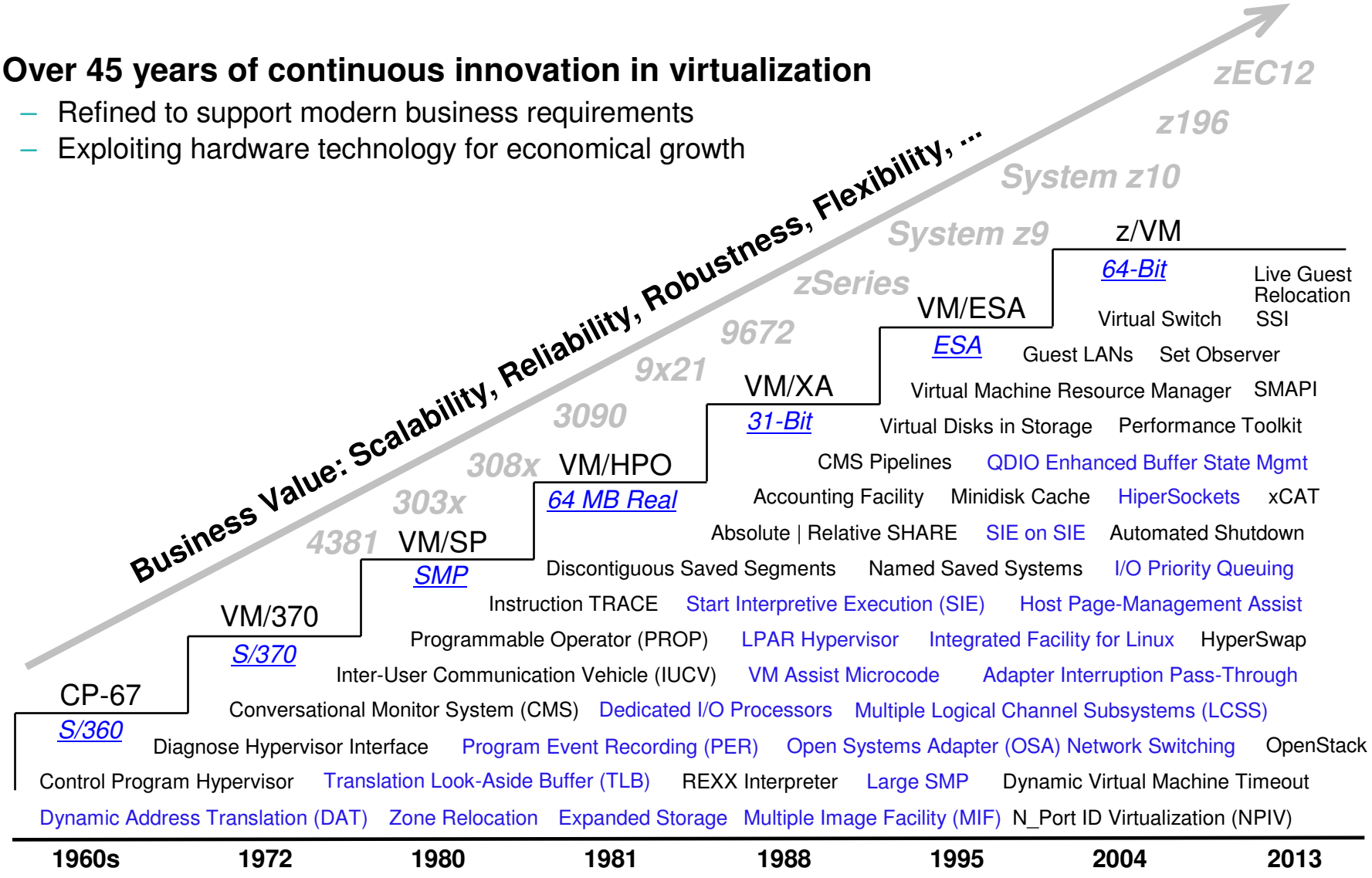
z/VM LAN and Switch Virtualization





Over 45 years of continuous innovation in virtualization

- Refined to support modern business requirements
- Exploiting hardware technology for economical growth



IBM System z – a comprehensive and sophisticated suite of virtualization function