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zEnterprise System – Network Architecture and Virtualization Overview (Part 1)

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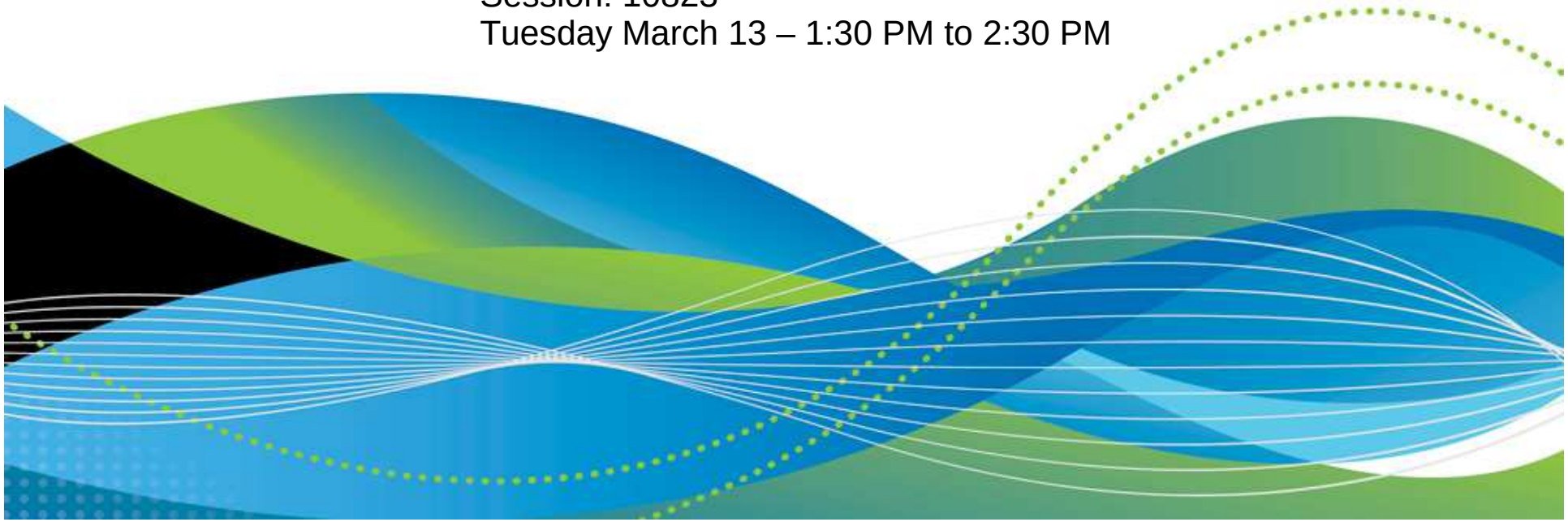
IBM Enterprise Networking Solutions
Raleigh, NC, USA

Session: 10823
Tuesday March 13 – 1:30 PM to 2:30 PM



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zEnterprise System - network architecture and virtualization overview (Part 1)

Session number:	10823
Date and time:	Tuesday, March 13th, 2011: 1:30 PM-2:30 PM
Location:	Hickory (Omni Hotel CNN Center)
Program:	Communications Infrastructure
Project:	Communications Server
Track:	Tracks: Network Support and Management
Classification:	Technical
Speaker:	Gus Kassimis, IBM
Abstract:	IBM's zEnterprise System provides the ability to consolidate multi tier and multi architecture workloads. This session will describe the networking architecture for the zEnterprise System, including an in depth review of the new Intra-Ensemble Data Network (IEDN) that provides the internal connectivity for this new system and how it relates to existing System z networking technologies. This session will also describe the IBM zEnterprise Unified Resource Manager advanced network virtualization functions that provide management of this network, including the ability to define multiple virtual networks for workload isolation.

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Related zEnterprise Networking Sessions

(10823): zEnterprise System - Network Architecture and Virtualization Overview (Part 1)	This session
(10824): zEnterprise System - z/OS IEDN network design and implementation (Part 2)	Tuesday, March 13, 2012: 3:00 PM-3:30 PM Hickory (Omni Hotel CNN Center Speakers: Gus Kassimis (IBM Corporation)
(10724): zEnterprise System - Secure Networking with the zEnterprise Ensemble – (Part 3)	Tuesday, August 9, 2011: 4:30 PM-5:30 PM Hickory (Omni Hotel CNN Center Speaker: Gwen Dente (IBM Corporation)
(10415): Connectivity to the zBX and Routing in the zEnterprise Ensemble	Thursday, March 15, 2012: 1:30 PM-2:30 PM Chestnut (Omni Hotel CNN Center) Speaker: Gwen Dente (IBM Corporation)
(10819): zEnterprise Networking Lessons Learned	Wednesday, March 14, 2012: 8:00 AM-9:00 AM Hickory (Omni Hotel CNN Center) Speaker: Tom Cosenza (IBM Corporation)

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Agenda

- Brief background
- zEnterprise Node Physical Infrastructure
- Communications within the Ensemble
- Network and OSA Types and Attributes
- External Network Access
- Network Virtualization Management
- Provisioning Virtual Networks
- Network Access Control and Security

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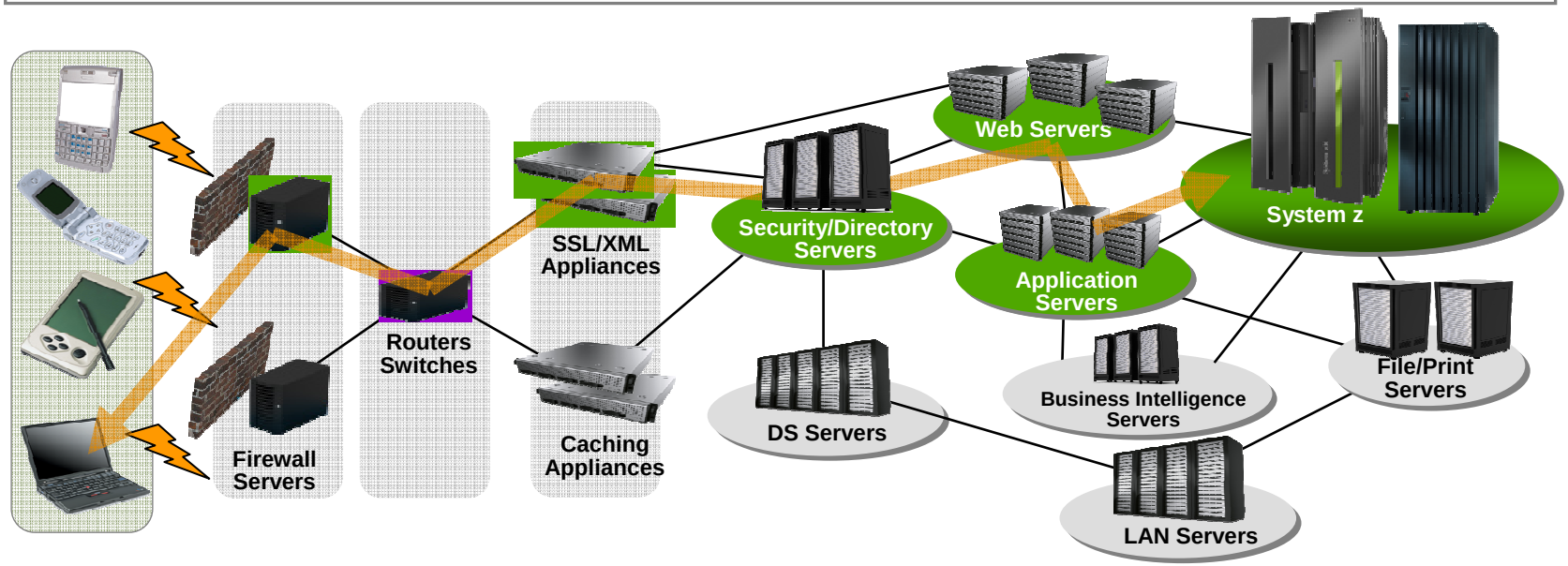
Information Technology Today

Information technology today is limited by the technology and architecture configurations available.



- Business processes and the applications that support them are becoming more service oriented, modular in their construction, and integrated.
- The components of these services are implemented on a variety of architectures and hosted on heterogeneous IT infrastructures.
- Approaches to managing these infrastructures along the lines of platform architecture boundaries cannot optimize: alignment of IT with business objectives; responsiveness to change; resource utilization; business resiliency; or overall cost of ownership.
- **Customers need better approach: The ability to manage the IT infrastructure and Business Application as an integrated whole.**

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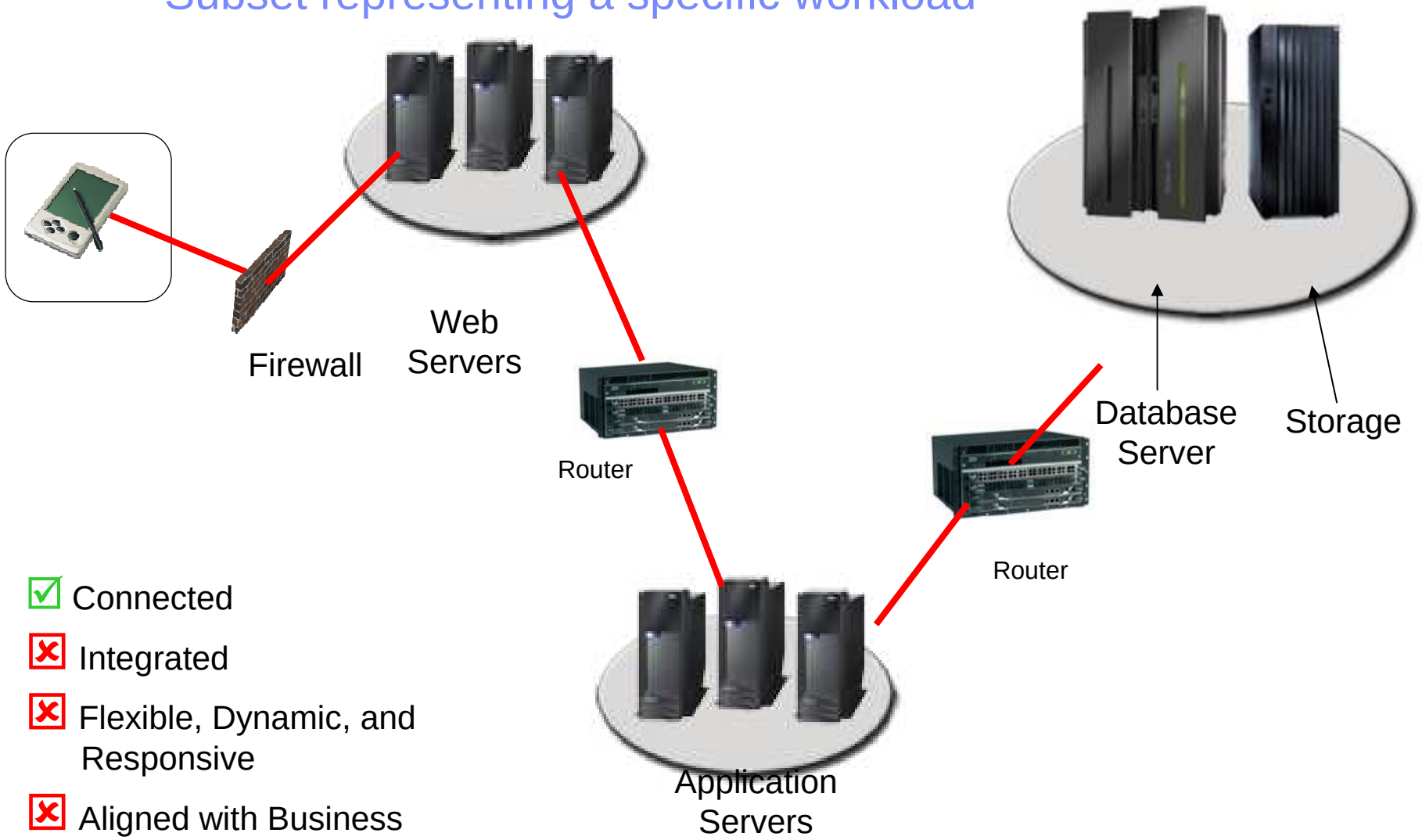
It's ALL about the workload…

Subset representing a specific workload



- ☑ Connected
- ☒ Integrated
- ☒ Flexible, Dynamic, and Responsive
- ☒ Aligned with Business Objectives

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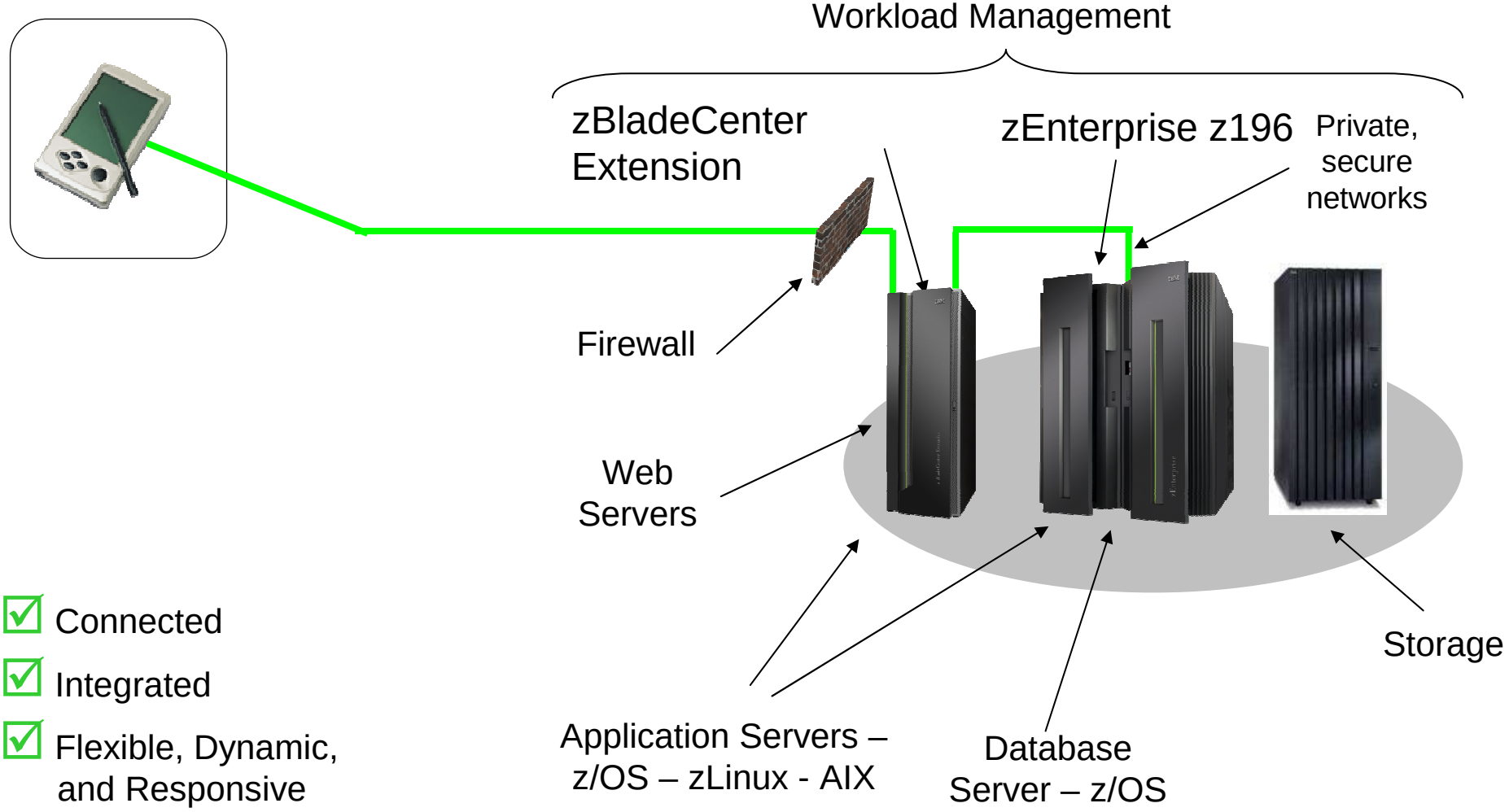
It's ALL about the workload…



- ☑ Connected
- ☑ Integrated
- ☑ Flexible, Dynamic, and Responsive
- ☑ Aligned with Business Objectives

zEnterprise System

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IBM zEnterprise System – Best in Class Systems and Software Technologies

A system of systems that unifies IT for predictable service delivery

The world's fastest and most scalable system: **IBM zEnterprise™ 196 (z196)**

- Ideal for large scale data and transaction serving and mission critical applications
- Most efficient platform for Large-scale Linux® consolidation
- Leveraging a large portfolio of z/OS® and Linux on System z applications
- Capable of massive scale up, over 50 Billion Instructions per Second (BIPS)
- **And IBM zEnterprise™ 114 (z114)**

Unified management for a smarter system: **zEnterprise Unified Resource Manager**

- Unifies management of resources, extending IBM System z® qualities of service end-to-end across workloads
- Provides platform, hardware and workload management
- Also known as zManager

Scale out to a trillion instructions per second: **IBM zEnterprise BladeCenter® Extension (zBX)**

- Selected IBM POWER7® blades and IBM System x® Blades for tens of thousands of AIX®, Linux, and Windows applications
  - Linux for system x 3Q2011
  - Microsoft Windows® 4Q2011
- High performance optimizers and appliances to accelerate time to insight and reduce cost
  - DataPower XI50z
- Dedicated high performance private network

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… and the Value Extends To Heterogeneous Platforms …

IBM zEnterprise BladeCenter Extension (zBX)
Machine Type: 2458 – Model 002

- **Integrated IBM Certified Components driven by System z order**
  - Standard parts – TOR switch, BladeCenter Chassis, Power Distribution Units, Optional Acoustic Panels
- **System z support**
  - Problem reporting, hardware and firmware updates
- **Expanding operating system support for zEnterprise**
  - AIX, Linux on System x, Microsoft Windows on System x
- **Simplified management**
  - Improved time to install and implement new applications
  - Central point of management for heterogeneous workloads
  - No change to applications

… managed by the zEnterprise Unified Resource Manager

Optimizers
- **WebSphere® DataPower® appliance**

Select IBM Blades
- **BladeCenter PS701 Express**
- **System x HX5 (7873)**

One to four – 42u racks – capacity for 112 blades
No System z software running in zBX – Passport Advantage software licensed to blades
No MIPS/MSU rating
Configured for high availability
Optional rear door heat exchanger

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zBX … Infrastructure to Support More Resources

- **zBX houses the multiplatform solutions key to the zEnterprise System.**
  - Optimizers that are dedicated to workloads.
    - *IBM WebSphere DataPower Integration Appliance XI50z for zEnterprise*
      - Closed environments with hardware and software included in solution
  - Select IBM POWER7 and System x blades – running *any* application supported by the operating system installed on the blade – with no change.
  - Mix and match Optimizer and select general purpose POWER7 and System x blades in the same rack.
  - zBX is a System z machine type for integrated fulfillment, maintenance, and support
- **Secure network connection between zBX and z196/z114 for data and support.**
  - Fast 10 Gb Ethernet connection to the data
  - Less latency – fewer 'hops' to get to the data
  - Private, isolated network - potential to eliminate requirement for encryption / firewalls
  - Traffic on user networks not affected.
- **Sharing of resources – up to eight z196/z114 servers can attach to the zBX and have access to solutions**
- **Configuration, support, monitoring, management – all by Unified Resource Manager**

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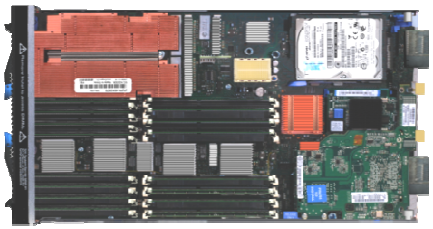
IBM POWER7 and System x Blades

General purpose processors under one management umbrella

What is it?

The zBX infrastructure can host select IBM POWER7 and System x blades. Each blade comes with an installed hypervisor that offers the possibility of running an application that spans z/OS, Linux on System z, AIX on POWER®, Linux on System x, or Windows® - but have it under a single management umbrella.



How is it different?

- **Complete management:** Advanced management brings operational control and cost benefits, improved security, workload management based on goals and policies.
- **Virtualized and Optimized:** Virtualization means fewer resources are required to meet peak demands with optimized interconnection.
- **Integrated:** Integration with System z brings heterogeneous resources together that can be managed as one.
- **Transparency:** Applications that run on the list of supported operating systems for the zBX can be deployed in the zBX blades without changes to deployed guest images.
- **More applications:** Brings larger application portfolio to System z.

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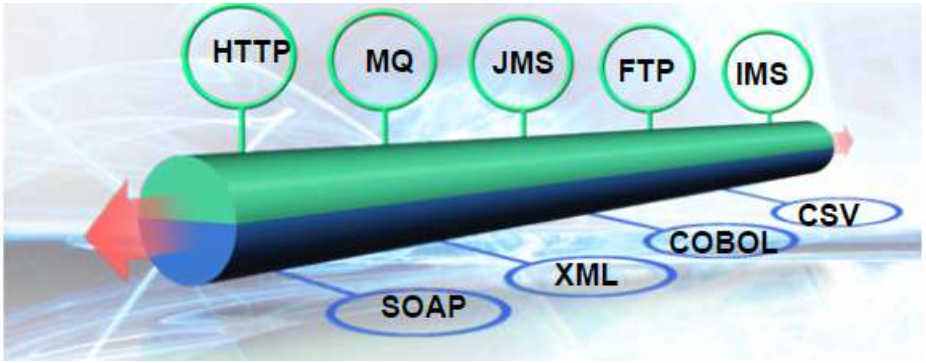
IBM WebSphere DataPower Integration Appliance XI50z for zEnterprise

Purpose-built hardware for simplified deployment and hardened security

What is it?

The IBM WebSphere DataPower Integration Appliance XI50z for zEnterprise can help simplify, govern, and enhance the security of XML and IT services by providing connectivity, gateway functions, data transformation, protocol bridging, and intelligent load distribution.



How is it different?

- **Security:** Coordinated network configuration management with the zEnterprise Unified Resource Manager which includes VLAN support for enforced isolation of network traffic with secure private networks.
- **Improved support:** Monitoring of hardware with “call home” for current/expected problems and support by System z Service Support Representative.
- **System z packaging:** Increased quality with pre-testing of blade and zBX. Upgrade history available to ease growth. Guided placement of blades to optimize.
- **Operational controls:** Monitoring rolled into System z environment from single console. Time synchronization with System z. Consistent change management with Unified Resource Manager.

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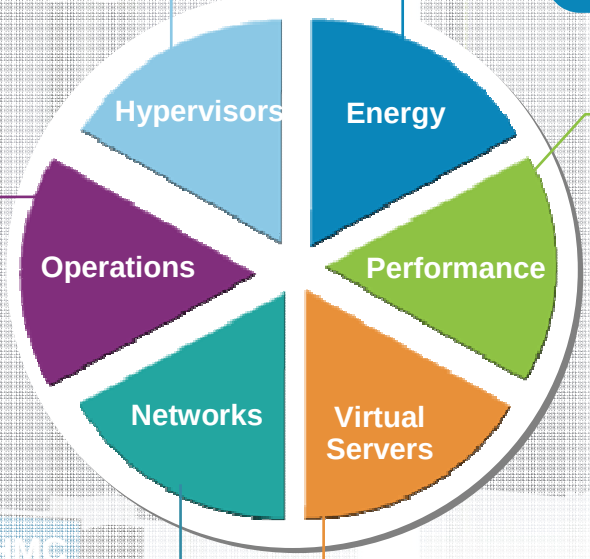
… Value Made Possible By the Unified Resource Manager

Simplified installation of hypervisors

Gain significant time to market with improved speed of deployment

Simplified energy management

Energy cost savings



Save time, cost and simplify asset management

Decrease problem determination and resolution time for cross-platform resources

Improve and simplify cross-platform availability procedures

Enable broader and more granular view of resource consumption

Allow critical workloads to receive resources and priority based on goal-oriented policies established by business requirements

Smart business adjustments based on workload insight

Provide deep insight into how IT resources are being used

Factory installed and configured network

Improved network security with lower latency, less complexity, no encryption/decryption

Gain flexibility, consistency and uniformity of virtualization

Provide the business with faster time to market

Simplified network management for applications

zEnterprise Networking Value Points

- **Network Simplification (“Network in a Box”)**
  - ✓ **Single physical network and zBX “package” (physical network integration)**
  - ✓ **Central point of Management (Unified Resource Manager via the HMC/SE)**
  - ✓ **Reduced network path length; reduced number of hops**

- **Secure communications**
  - ✓ **Physical security (internal / dedicated network equipment)**
  - ✓ **Logical security (controlled access)**
  - ✓ **Network Virtualization and Isolation**

- **High Availability**
  - ✓ **Redundant network hardware**
  - ✓ **Logical failover**

- **Unique System z QoS**
  - ✓ **Isolated / dedicated equipment**
  - ✓ **Special purpose dedicated data network & OSA-Express (potential for reduced network encryption)**

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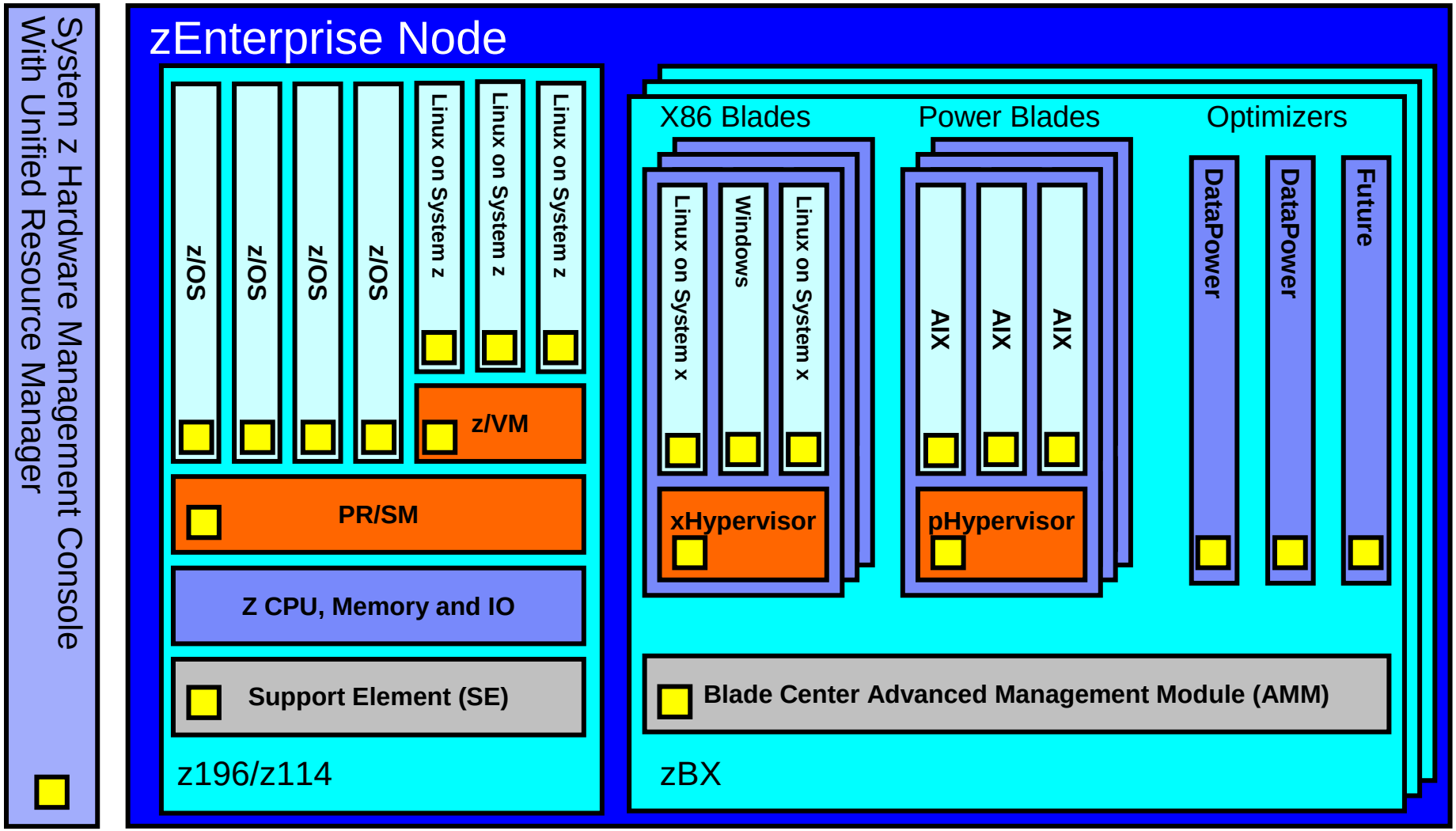
IBM zEnterprise System Overview



Connecting the pieces with zManager (aka. Unified Resource Manager)!

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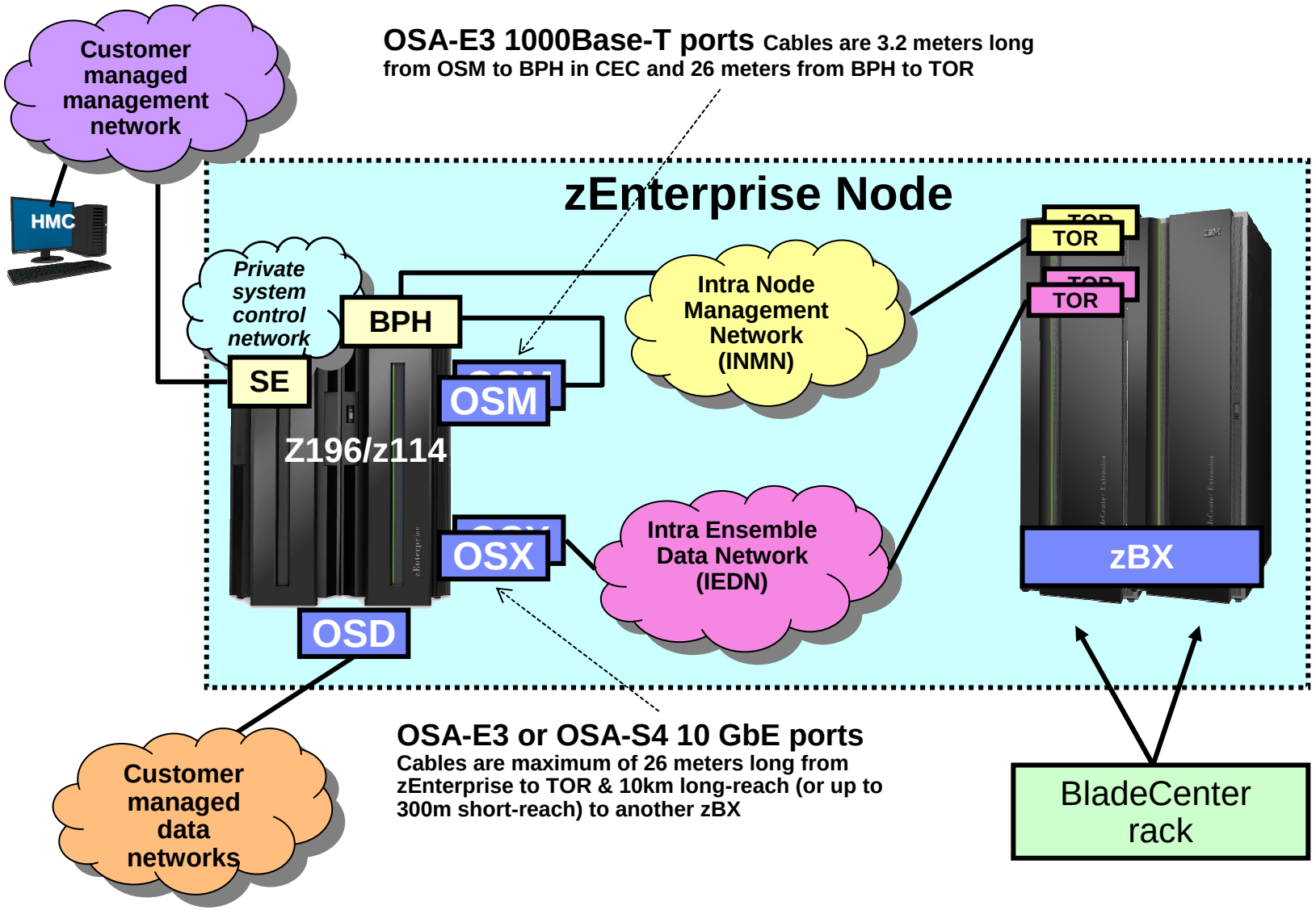
IBM zEnterprise node – the networks



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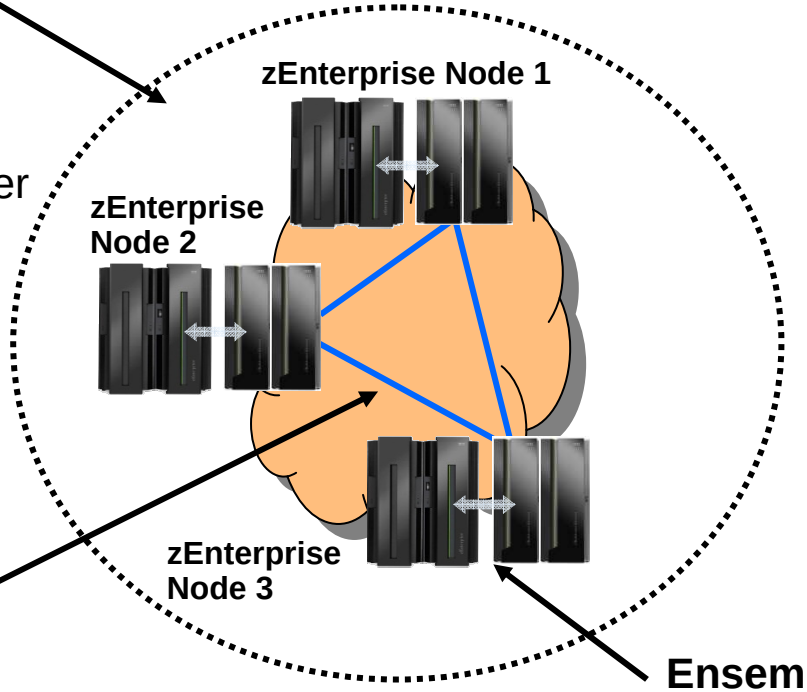
zEnterprise ensemble

zEnterprise Ensemble

A collection of one or more zEnterprise Nodes (including any optionally attached zBX) that are managed as a single logical virtualized system by the zManager using a Hardware Management Console (HMC).



Intra Ensemble Data Network (IEDN)

Ensemble Member

A zEnterprise node that has been added to an ensemble using the HMC.

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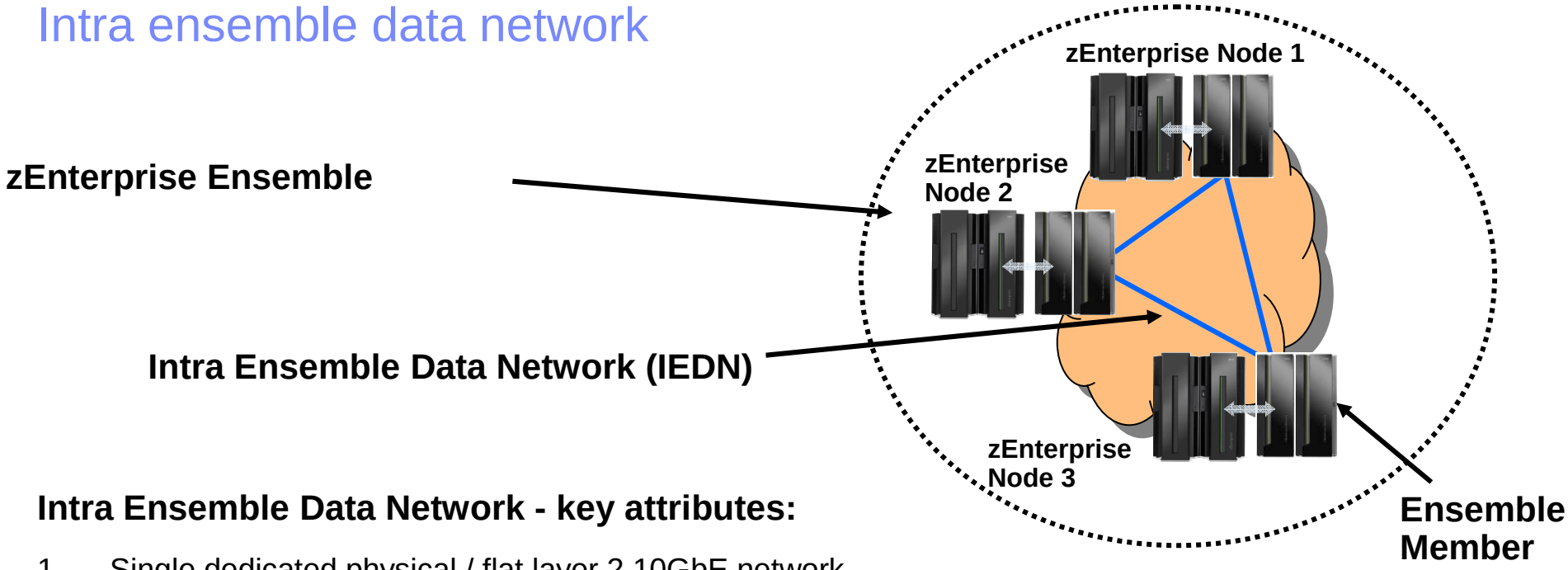
Intra ensemble data network



Intra Ensemble Data Network - key attributes:

1. Single dedicated physical / flat layer 2 10GbE network
2. Comprised of IBM zEnterprise (redundant) equipment (no external / customer hardware)
3. Can span nodes (can be shared by all co-located nodes within the Ensemble)
   - At distances up to 10km with contiguous LR fiber
   - Can now be extended up to 100km with DWDM
     - IBM® GDPS® Application Qualification support for the ADVA FSP3000 Release 10.3 Dense Wavelength Division Multiplexer (DWDM) – includes zBX IEDN connections
4. No layer 3 IP Routing required to communicate within the Ensemble
5. IP addresses (IPv4 or IPv6) are customer controlled and provisioned
6. MAC addresses (prefixes) are provisioned / coordinated by zManager (HMC)
7. Access to the network is controlled by the zManager (HMC) via SE via OSX, hypervisors and physical switches
8. Virtual servers can be isolated into multiple groups on the physical network by defining multiple virtual networks (multiple VLANs) based on workloads and other isolation requirements

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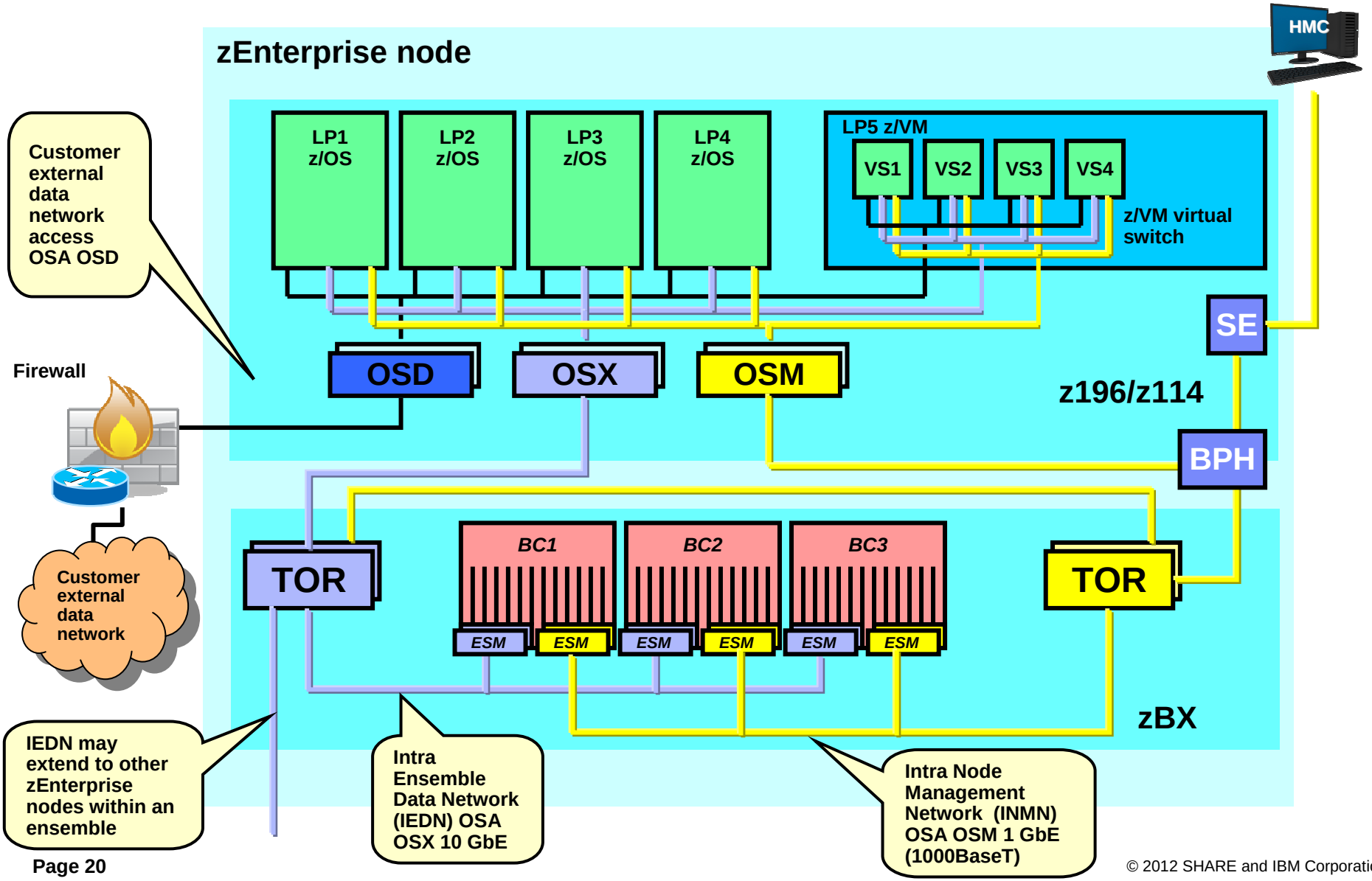
IBM zEnterprise – OSA and Network Types



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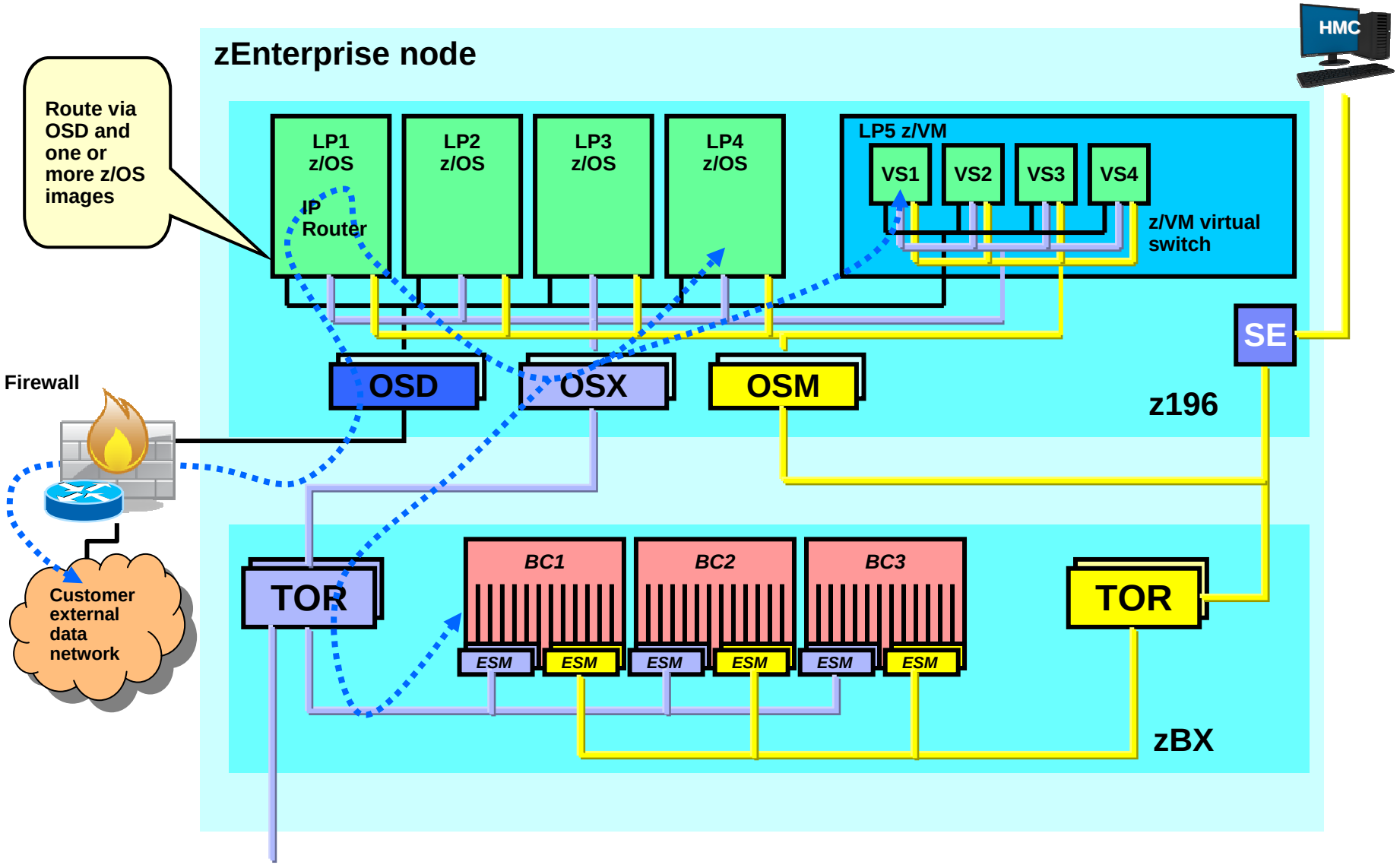
External Network Access – Option 1 – System z (LP) IP Router



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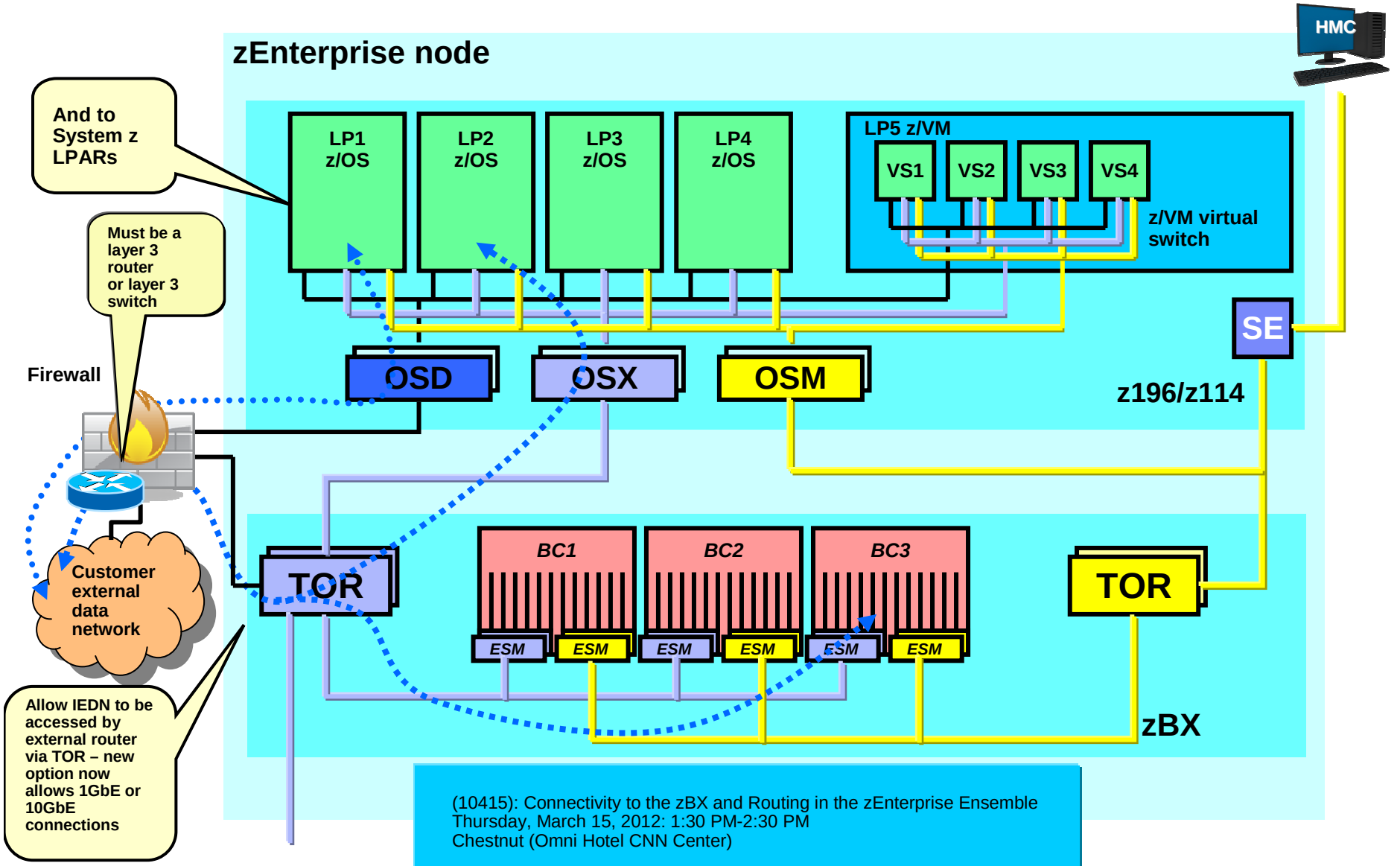
External Network Access – Option 2 – External IP Router



(10415): Connectivity to the zBX and Routing in the zEnterprise Ensemble
Thursday, March 15, 2012: 1:30 PM-2:30 PM
Chestnut (Omni Hotel CNN Center)

Speaker: Gwen Dente (IBM Corporation)

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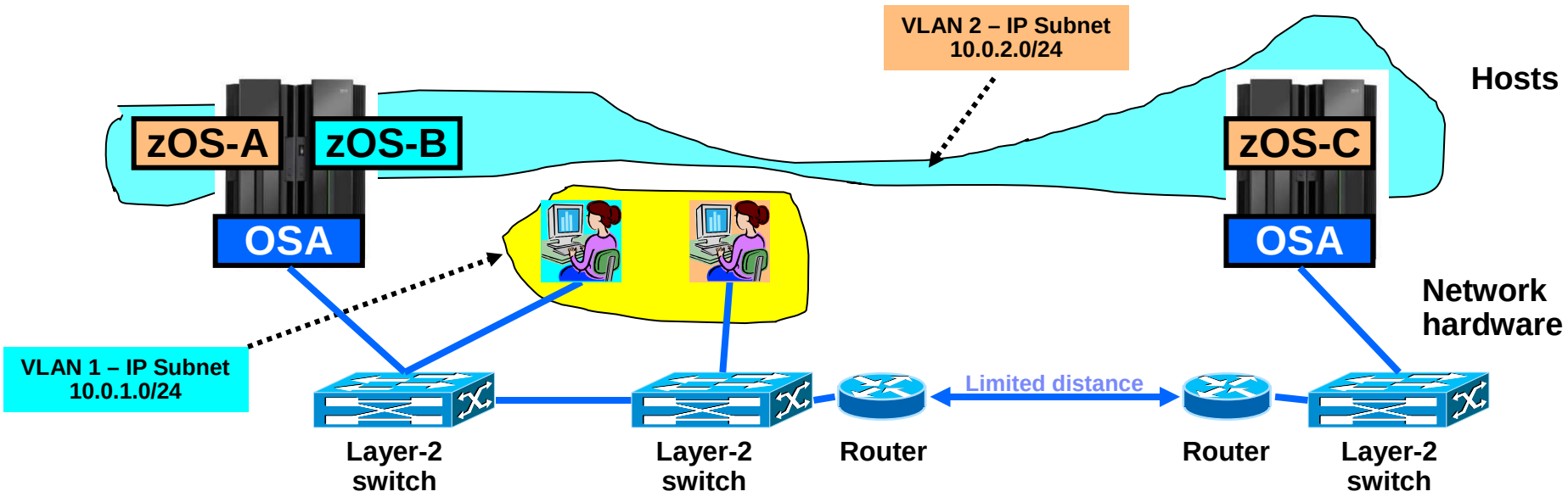
What is a Virtual LAN (a VLAN)?

Wikipedia:

- A **virtual LAN**, commonly known as a **VLAN**, is a ***group of hosts*** with a common set of requirements that communicate as if they were ***attached*** to the same ***broadcast domain***, regardless of their physical location.
- A VLAN has the same attributes as a physical LAN, but it allows for end stations to be grouped together even if they are not located on the same network switch.
- Network reconfiguration can be done through software instead of physically relocating devices.



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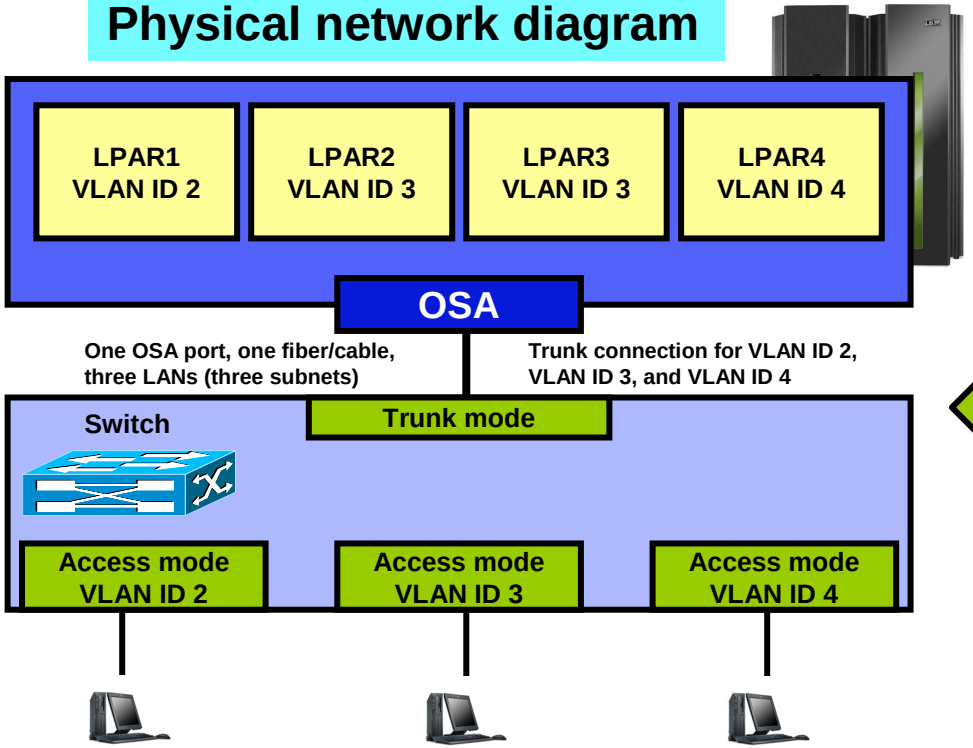
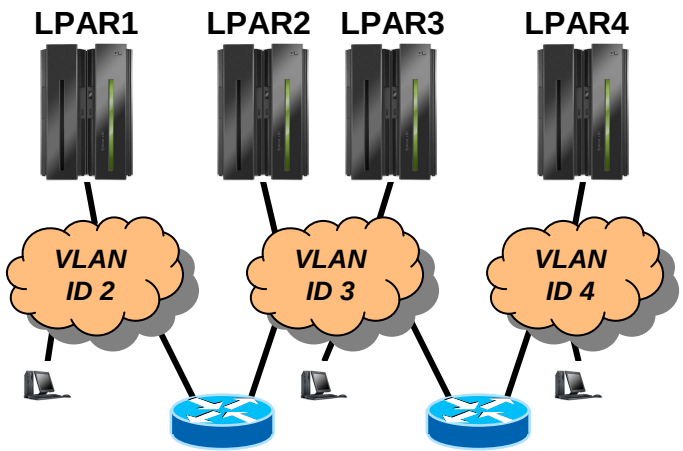
z/OS and VLANs

Physical network diagram



Logical network diagram



- Depending on switch configuration, the switch may interconnect the VLANs using a layer-3 IP router function.
- The subnets may belong to different routing domains or OSPF areas:
  - Test, production, demo
- The subnets may belong to different security zones:
  - Intranet, DMZ

- Each frame on the trunk mode connection carries a VLAN ID in the IEEE802.3 header that allows the network equipment to clearly identify which virtual LAN each frame belongs to.
- On an access mode connection, the switch will transport frames belonging to the configured VLAN ID for that access mode connection only.

VLAN is a LAN media virtualization technology that allows multiple independent IP networks (IP subnets) to share one physical media, such as a cable, an adapter, or a layer-2 switch. Connectivity between VLANs is under control of IP routers.

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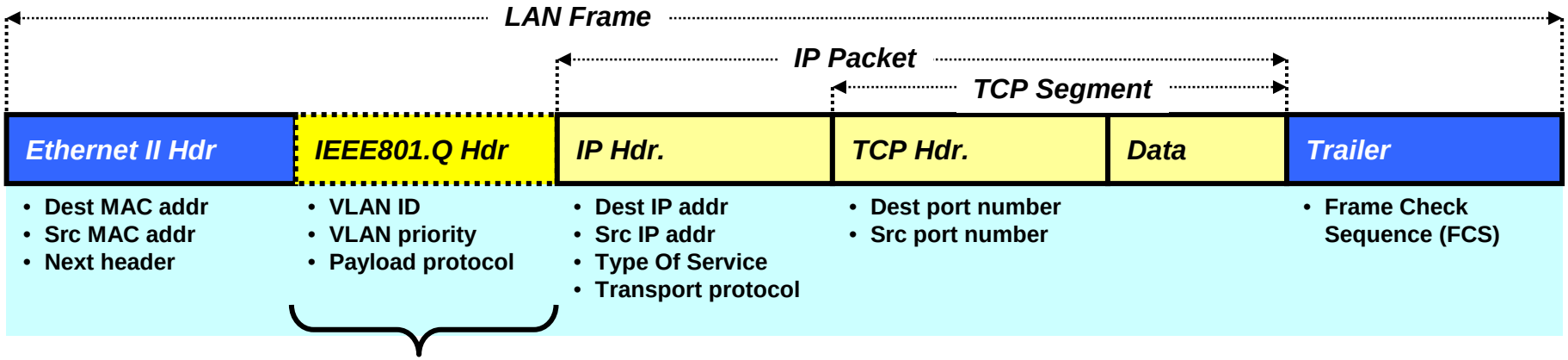
Some basic LAN technology overview

- The LAN infrastructure transports “Frames” between Network Interface Cards (NICs) that are attached to the LAN media (Copper or fiber optic)
- Each NIC has a hardware address
  - A Media Access Control (MAC) address
    - Burned in (world-wide unique by vendors) or alternatively locally administered
- Every frame comes from a MAC and goes to a MAC
  - There are special MAC values for broadcast and multicast frames
- Every frame belongs to the physical LAN or to one of multiple Virtual LANs (VLAN) on the physical LAN
  - A VLAN ID is in the IEEE801.Q header if VLAN technologies are in use
- A frame carries a payload of a specified protocol type, such as ARP, IPv4, IPv6, SNA LLC, etc.



The VLAN tag (the IEEE801.Q header) is only present if VLANs are used by the network interface.

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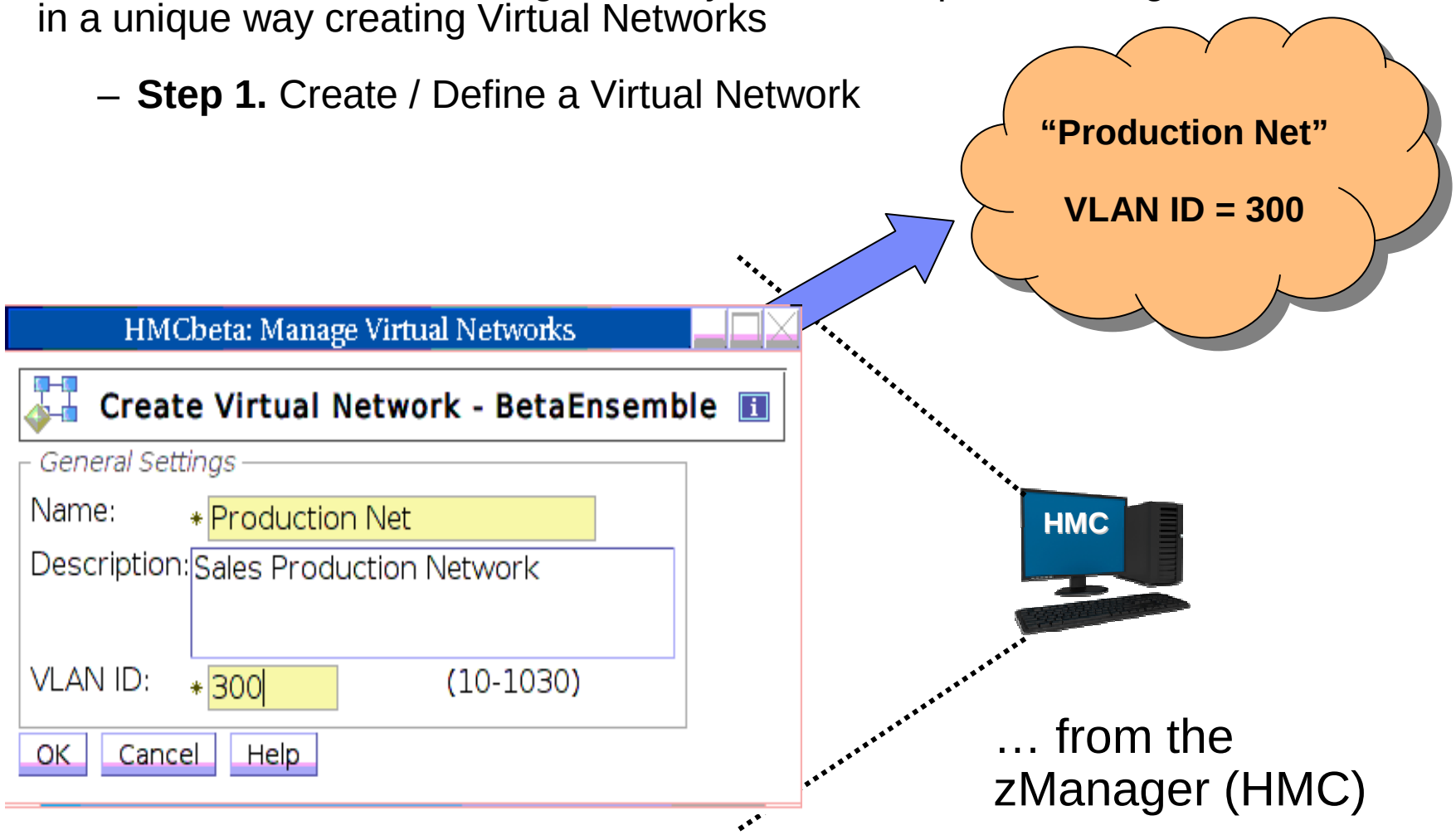
Virtual Network Concepts – Creating Virtual Networks

The Unified Resource Manager and System zEnterprise leverage VLAN technology in a unique way creating Virtual Networks

- **Step 1.** Create / Define a Virtual Network



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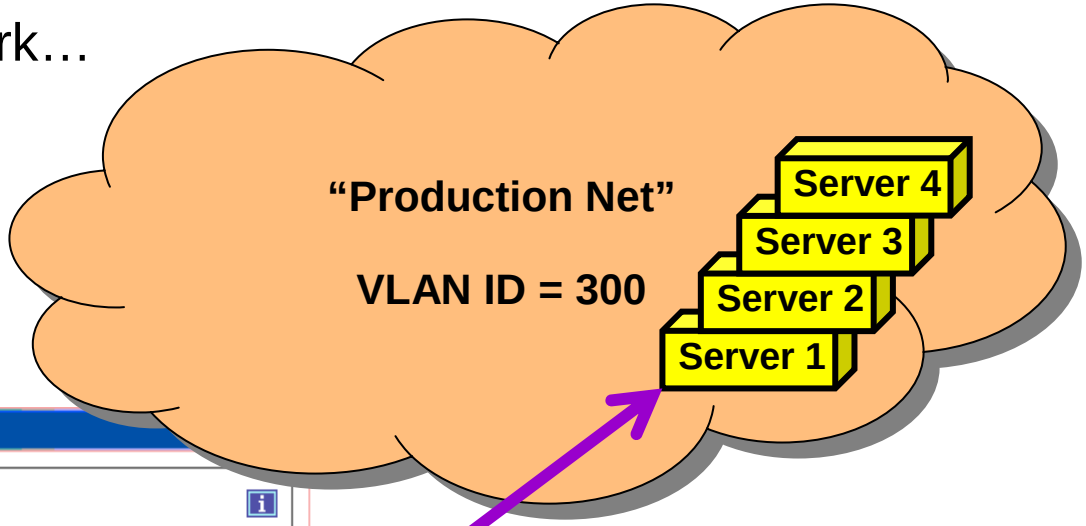
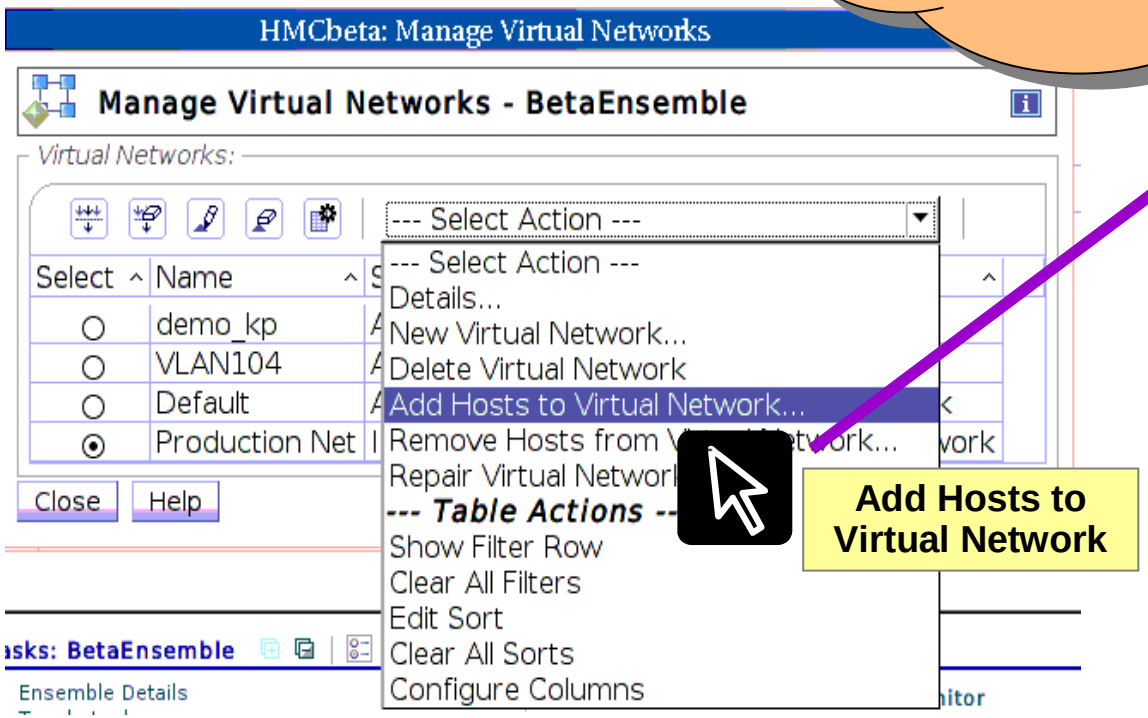
Virtual Network Concepts – Adding Virtual Servers

… once you have a Virtual Network…

– **Step 2.** add (associate / authorize) Virtual Servers to the Virtual Network





Virtual Networks in the zEnterprise consist of two key properties:

1. ***VLAN ID (along with an IP subnet)***
2. ***List of Authorized Servers***

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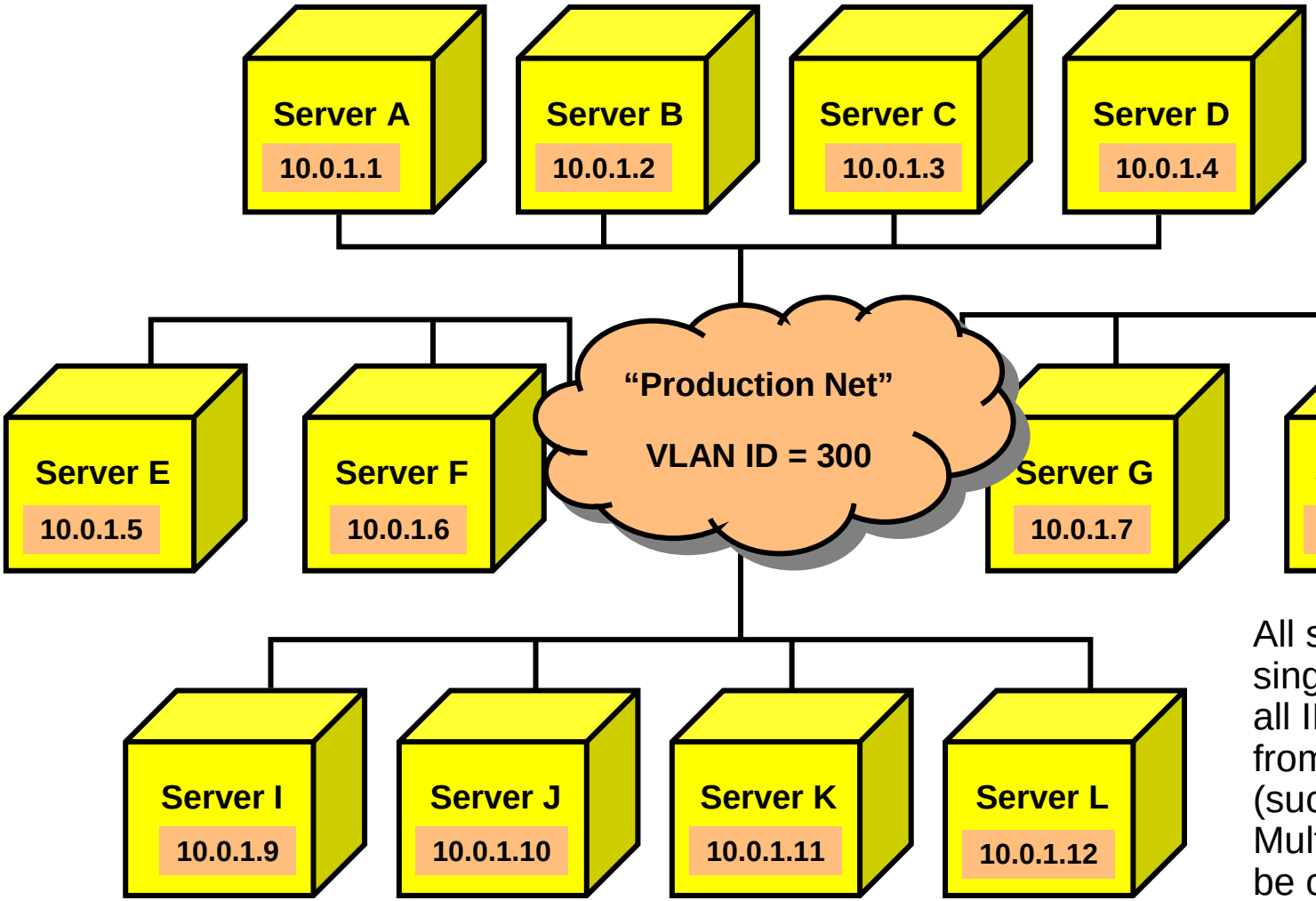
Deploying a Virtual Network – Example 1



Single Virtual Network, Single IP subnet, and VLAN ID

All servers can have a single IP interface and all IP addresses are from the same IP subnet (such as 10.0.1.x/24) Multiple Interfaces may be created for redundancy!

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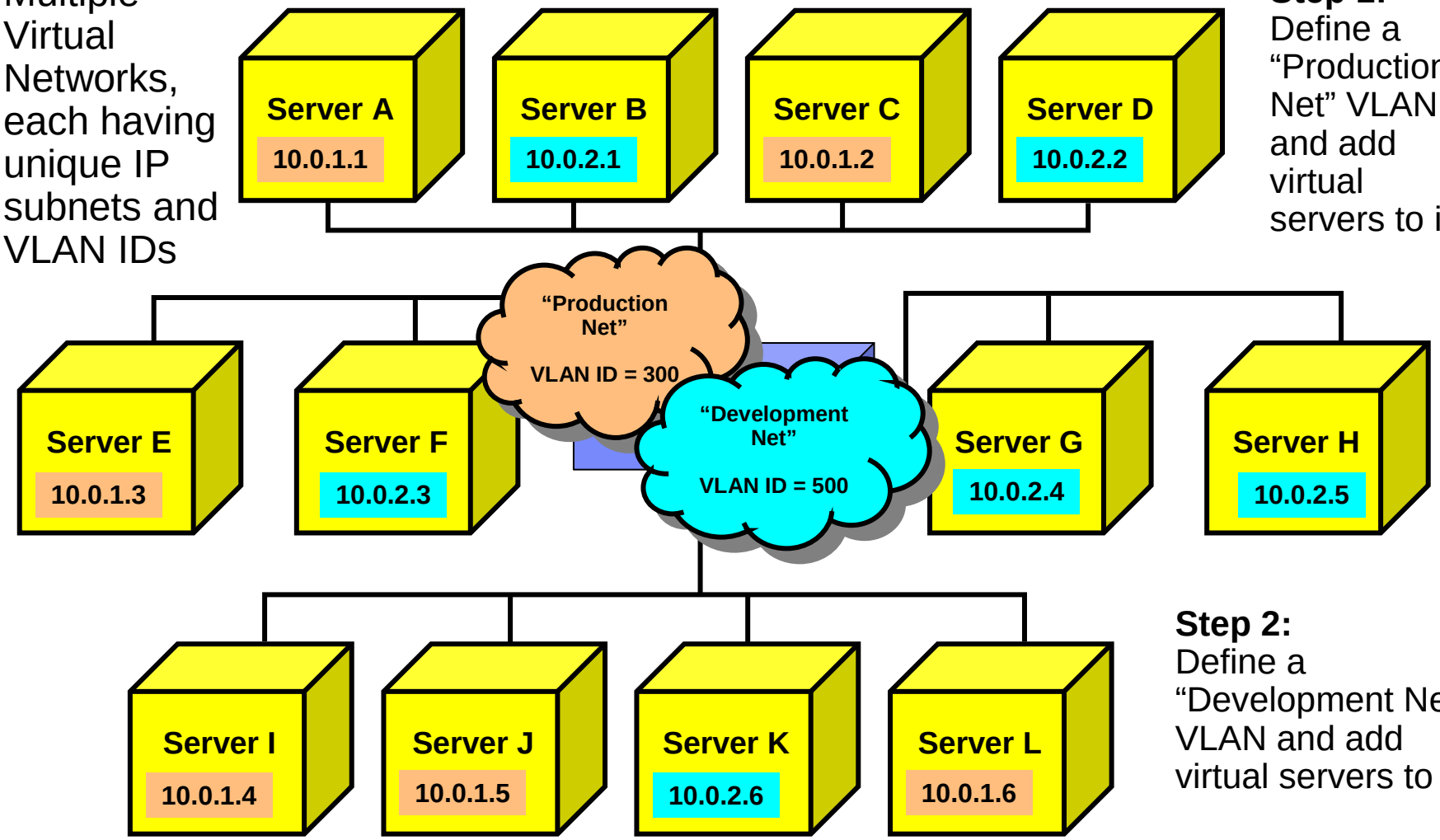
Deploying Multiple Virtual Networks – Example 2 - Isolation

Multiple Virtual Networks, each having unique IP subnets and VLAN IDs



Step 1: Define a "Production Net" VLAN and add virtual servers to it.

Step 2: Define a "Development Net" VLAN and add virtual servers to it.

which isolates "Production Servers" from "Development Servers"

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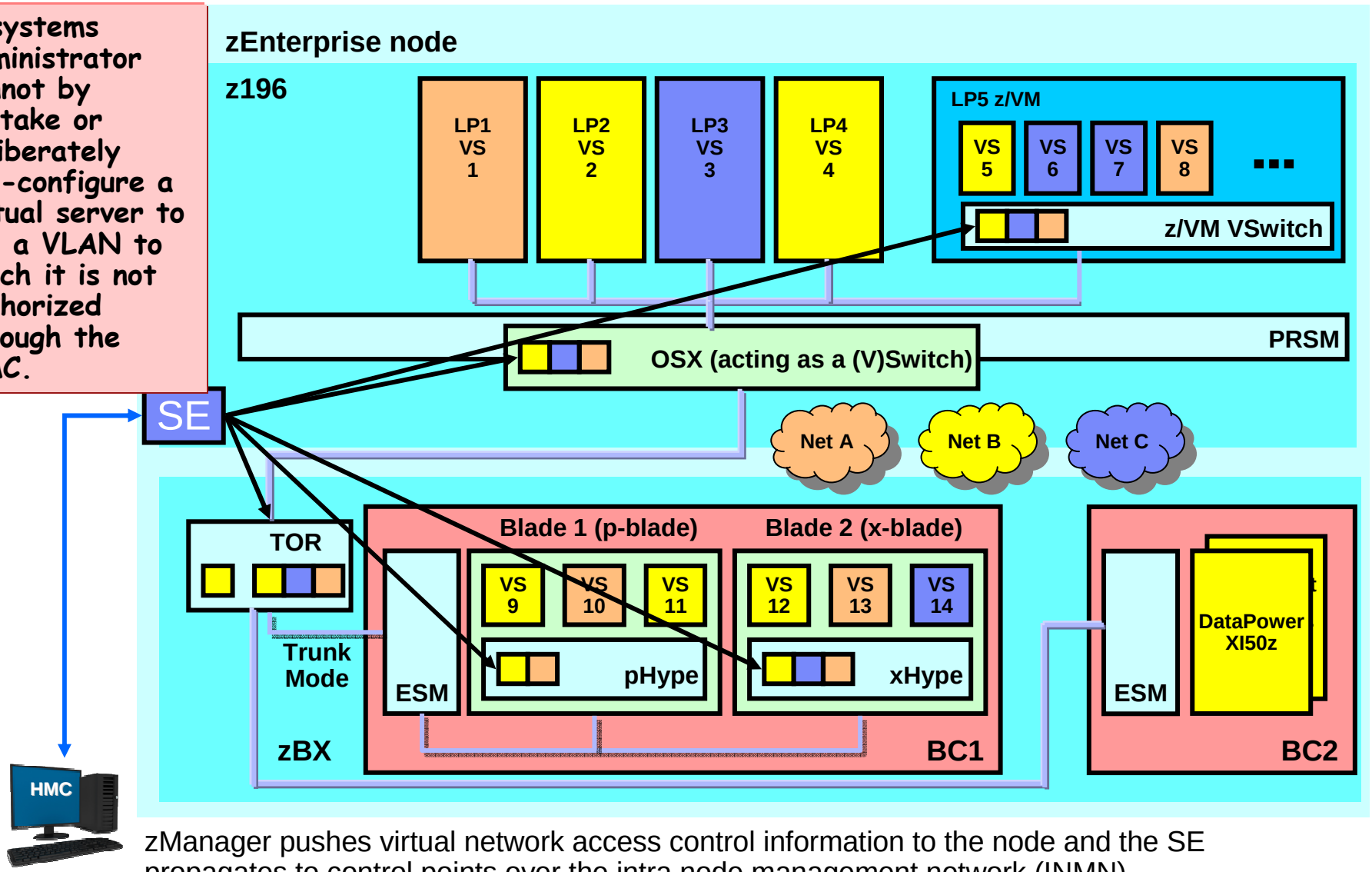
zEnterprise virtualization and network access control

A systems administrator cannot by mistake or deliberately mis-configure a virtual server to use a VLAN to which it is not authorized through the HMC.



zManager pushes virtual network access control information to the node and the SE propagates to control points over the intra node management network (INMN).

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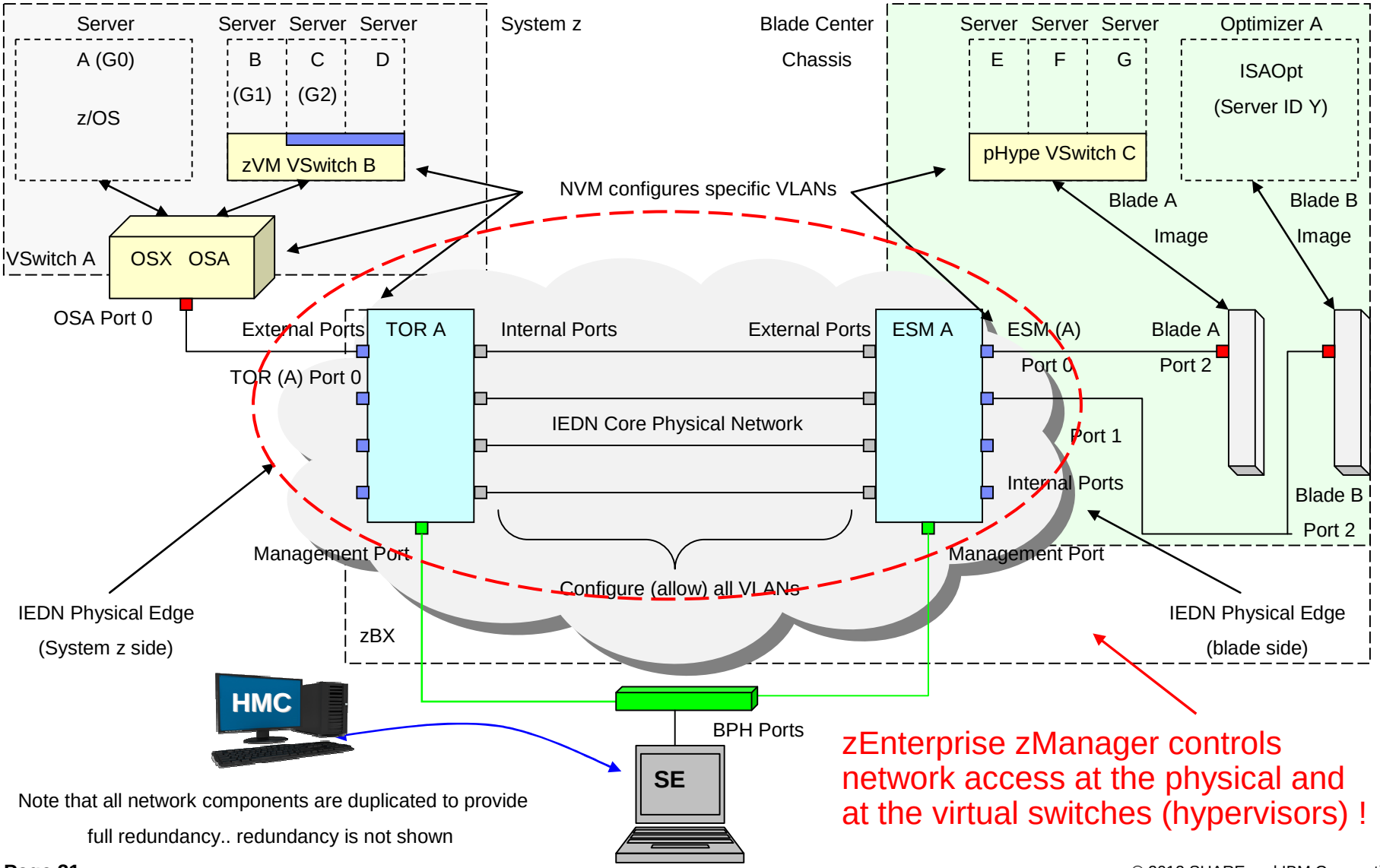
Putting It All Together…with secure access control !



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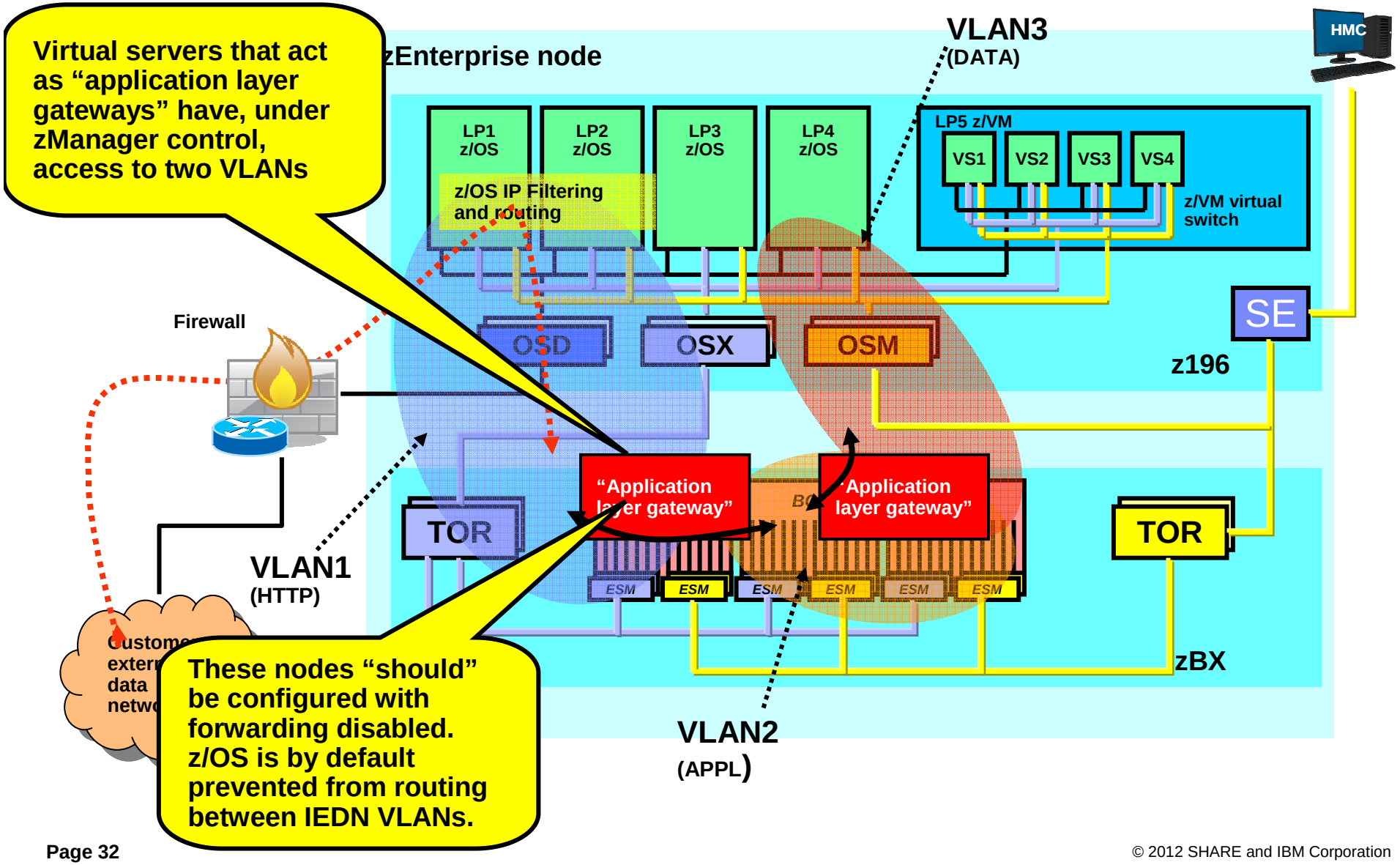
Use of multiple VLANs on the IEDN – no routing, but "application layer gateways" between VLANs



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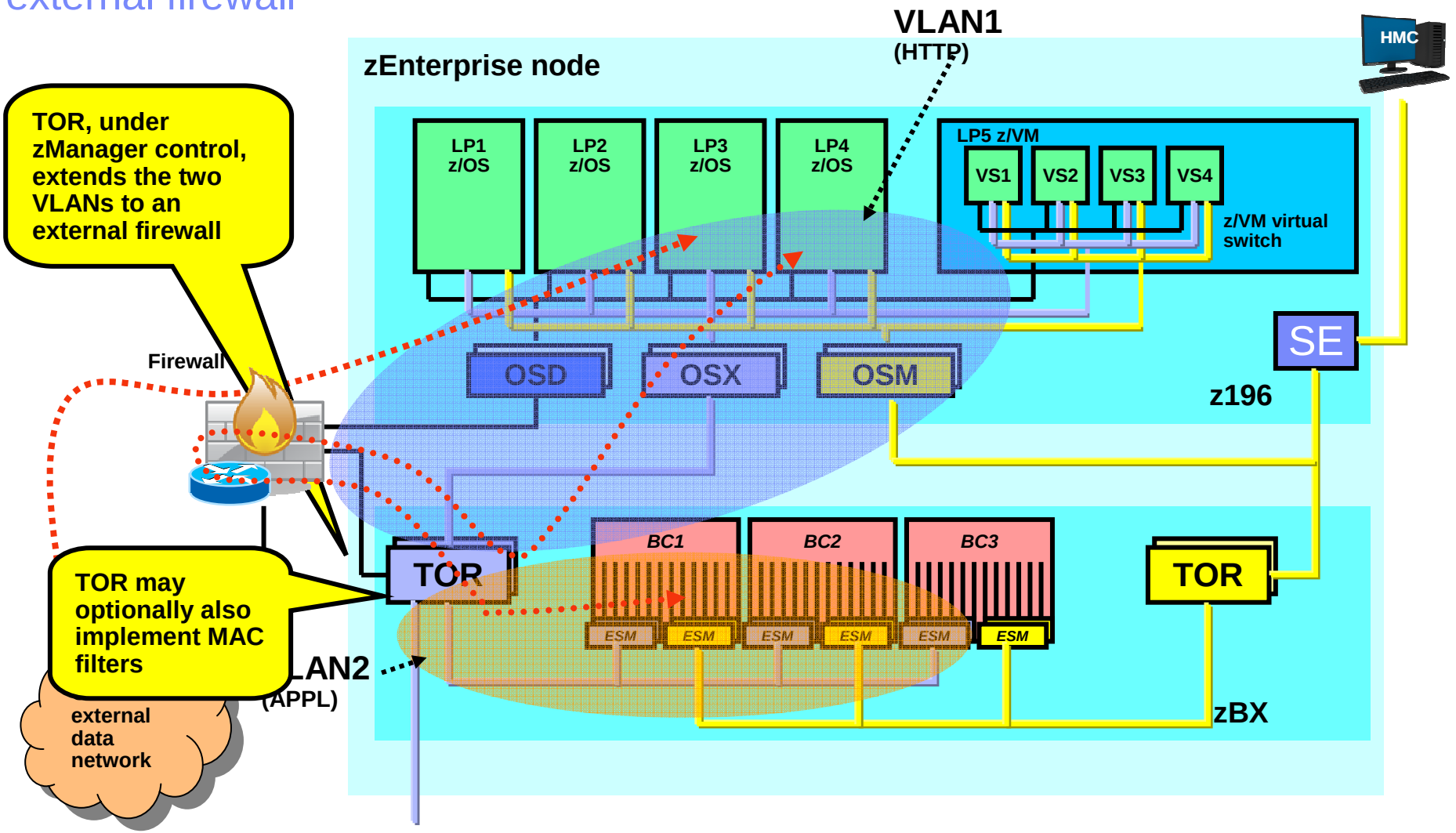
Use of multiple VLANs on the IEDN – Routing between VLANs using an external firewall



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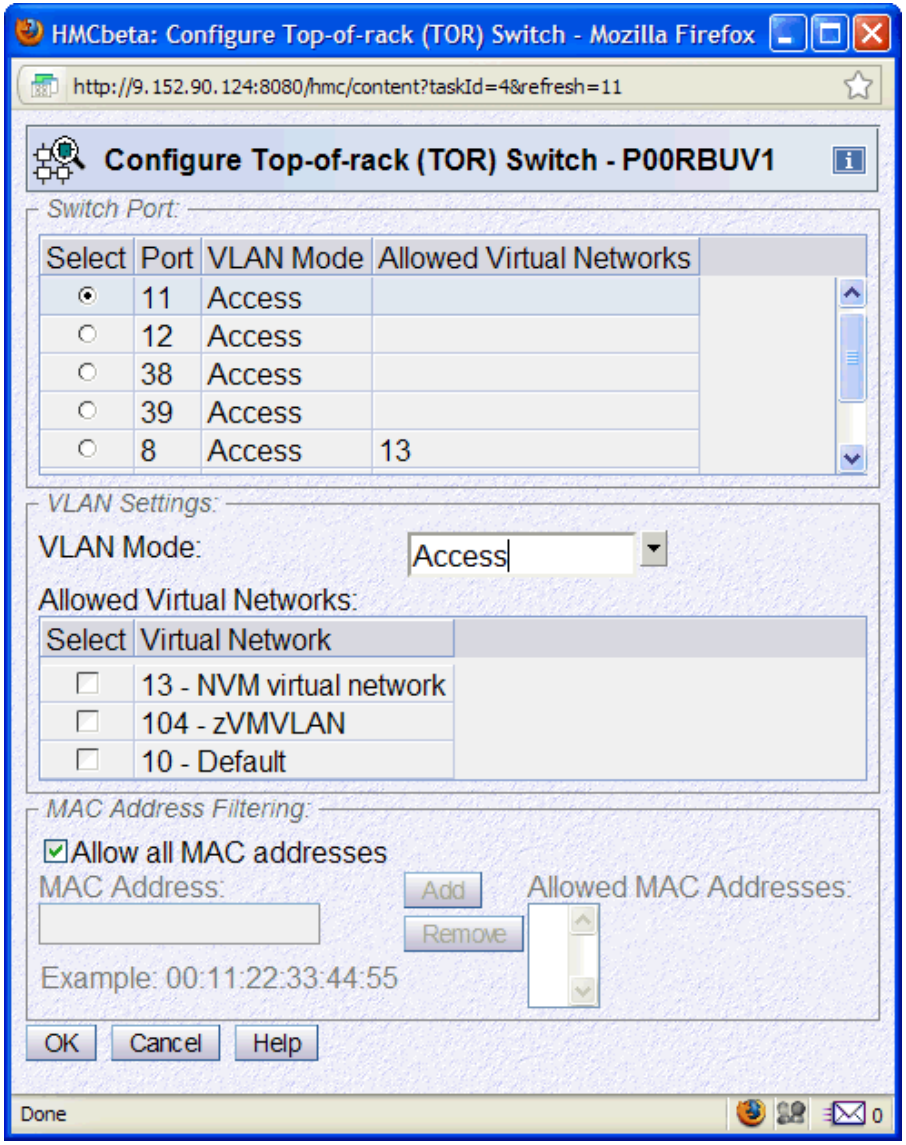
Configuring TOR - External Network Access

- Ability to control who can connect to external TOR ports
  - Can specify MAC addresses that can connect to specific ports
- Ability to control what IEDN VLANs are accessible via the external ports
  - Access Mode: A Single VLAN enforced/tagged by TOR switch
  - Trunk Mode: A list of VLANs that can flow over that port



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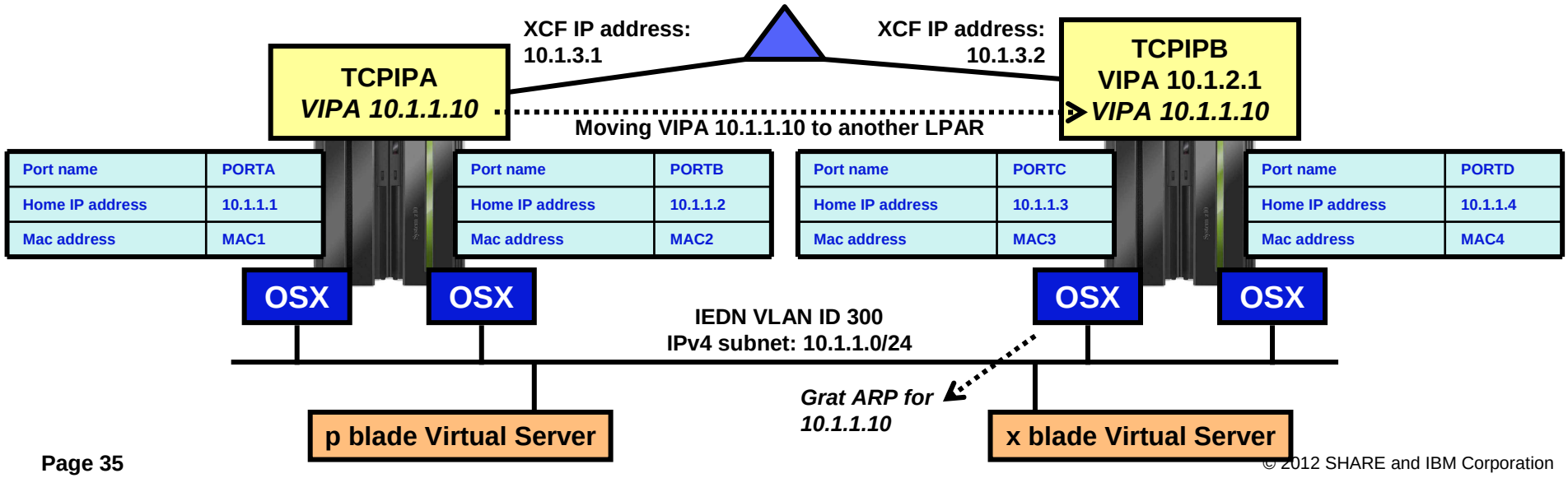
OSA redundancy and IEDN network bandwidth

- The design of the zEnterprise is such that the use of a dynamic routing protocol on the IEDN, is not needed
- z/OS must be configured to use its existing layer-2 redundancy and availability functions
  - Configure at least two OSX ports to each VLAN
    - Establishing LAN groups where IP addresses move dynamically between the OSX ports in case one of them becomes unavailable
  - Assign VIPA addresses out of the same subnet as the IEDN VLAN
    - ARP processing will be used to control which z/OS LPAR in a Sysplex currently owns a specific Dynamic VIPA address
- The IEDN is based on 10 Gbit Ethernet, so there is lots of bandwidth from start
  - z/OS does not support link aggregation (z/VM virtual switch does)
  - For outbound bandwidth management, z/OS can be configured to use multipath where it will distribute outbound packets over all OSX ports that are configured to the same VLAN



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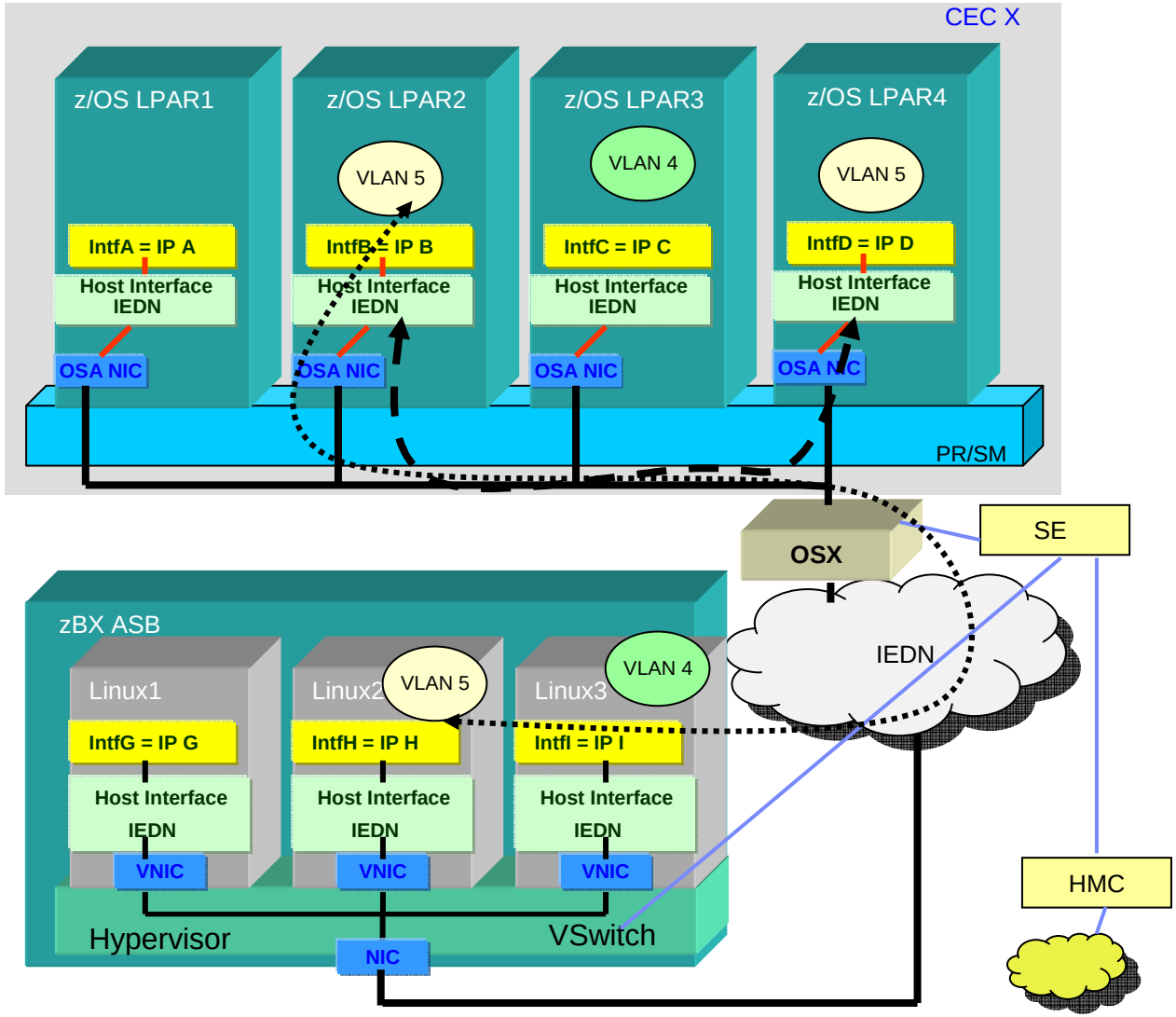
zEnterprise IEDN without Hipersockets

.... Intra Ensemble Data Network with platform managed virtualization, isolation and access controls



HiperSockets is another type of System z internal network that is a System z differentiator!

…yet HS is missing from the IEDN … in order to exploit HS it requires explicit and separate network config (IP address, IP route, OS config etc.)

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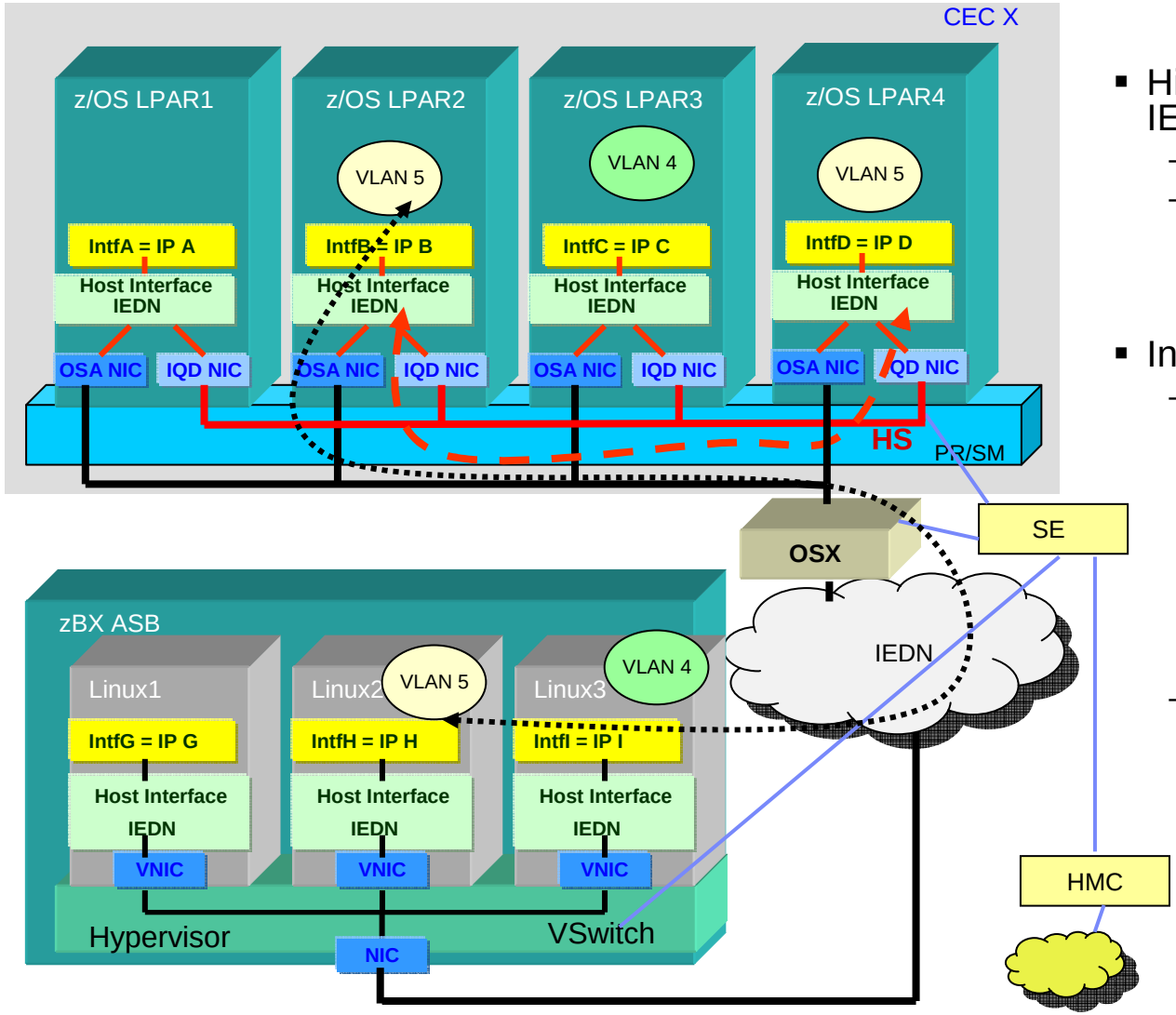
IEDN enabled HiperSockets

.... Intra Ensemble Data Network with platform managed virtualization, isolation and access controls



- HiperSockets becomes part of the IEDN
  - z/OS support in V1R13
  - Announcement of support on zEnterprise (now) and zVM 6.2 support (April 2012)
- In a transparent manner
  - The virtual servers present a single IP address (their IEDN address) for both internal (HiperSockets) and external (IEDN) access
    - No IP topology changes or routing changes required
    - The optimal path is selected automatically without requiring unique routing configuration
  - Also enables relocation of System z virtual servers across z CECs without reconfiguration
    - Same IP address used
    - Current HiperSockets IP topology is CEC specific
      - Moving to another CEC requires IP address and routing changes.

For more information on recent announcement:
http://www-01.ibm.com/common/ssi/rep_ca/6/897/ENUS112-026/ENUS112-026.PDF

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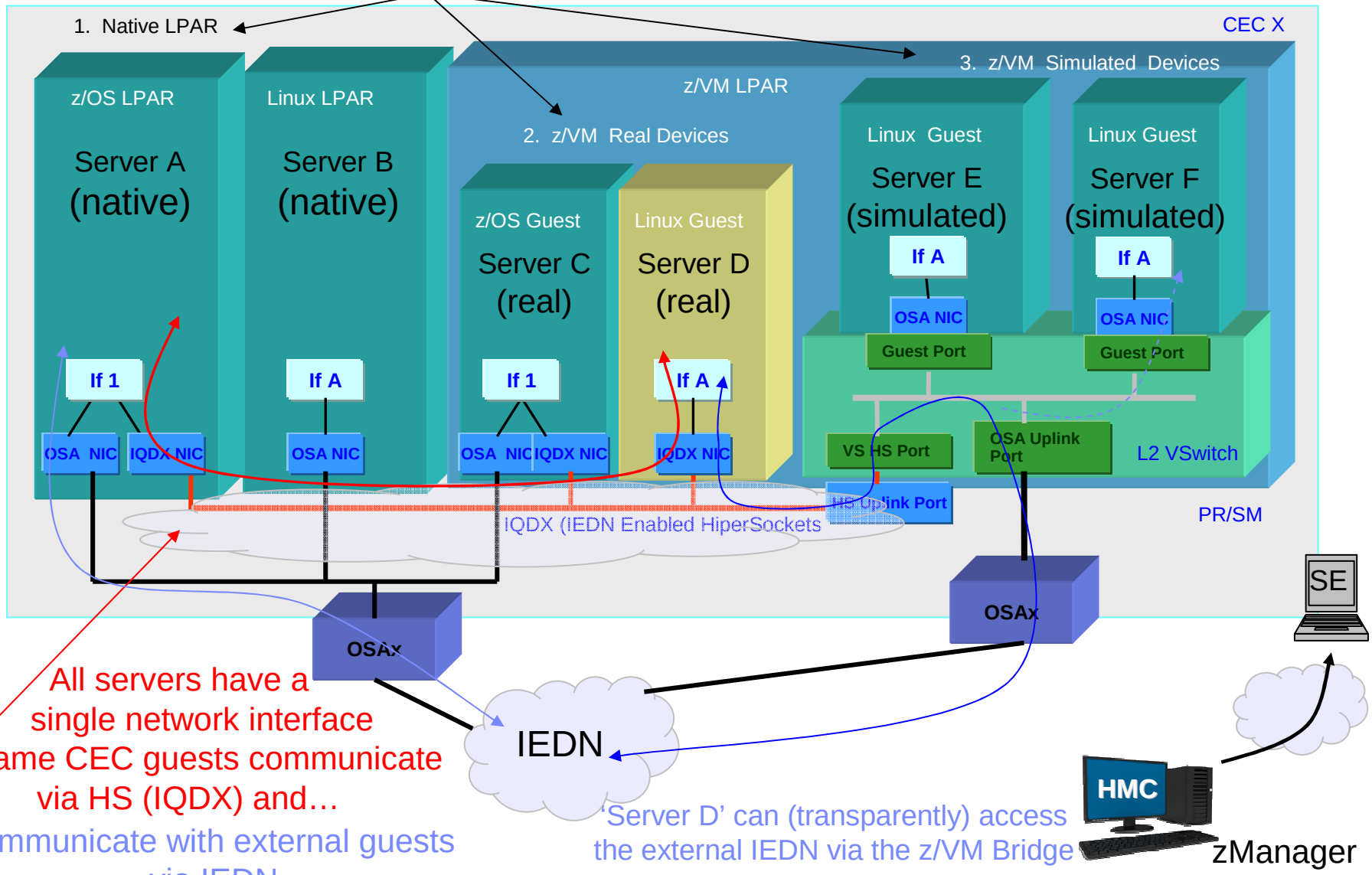
Complete IEDN enabled HiperSockets solution



All servers have a single network interface … same CEC guests communicate via HS (IQDX) and… communicate with external guests via IEDN

'Server D' can (transparently) access the external IEDN via the z/VM Bridge

For more information on recent announcement:
http://www-01.ibm.com/common/ssi/rep_ca/6/897/ENUS112-026/ENUS112-026.PDF

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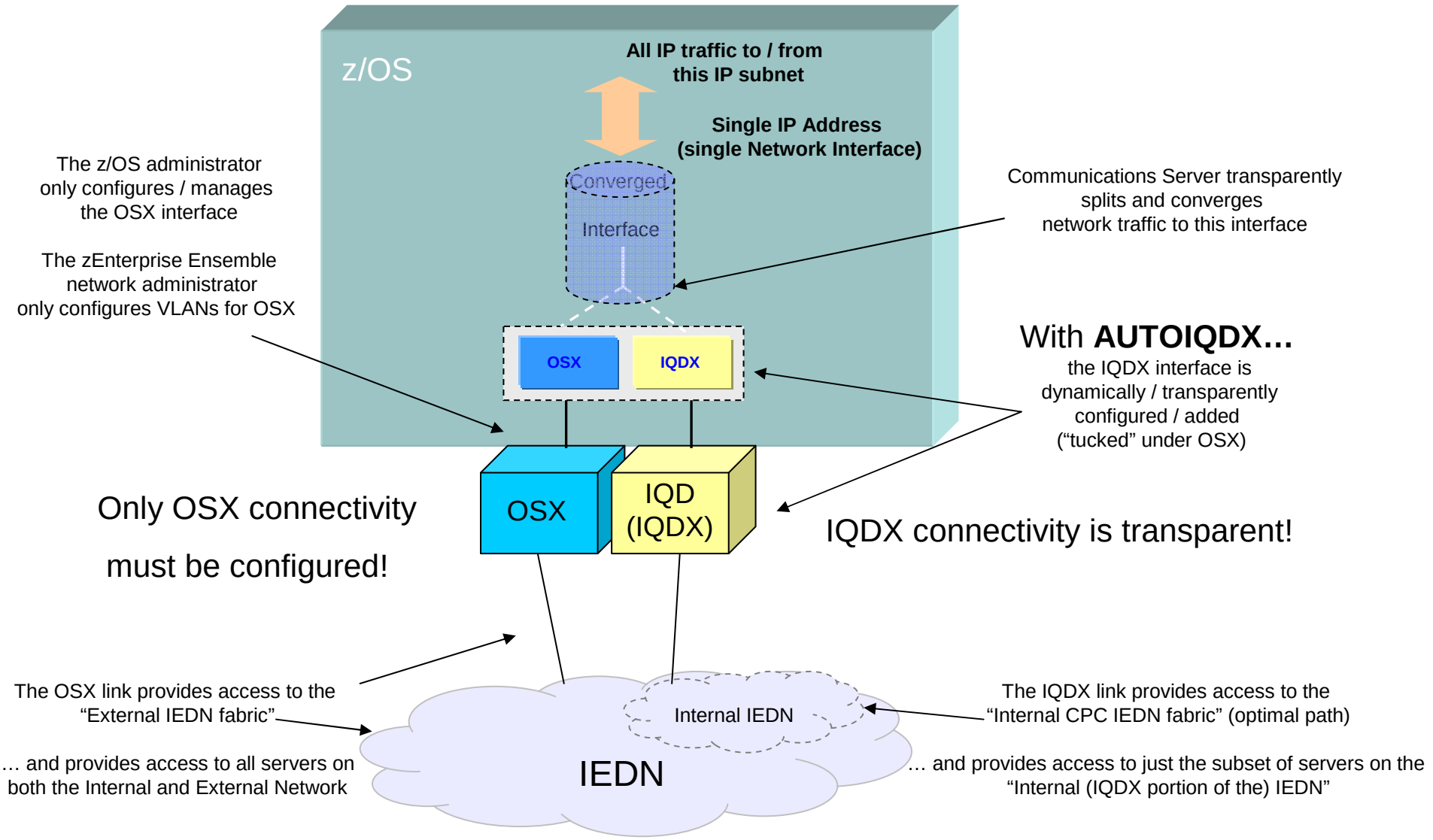
System z/OS “Converged IQDX Link” - Concepts



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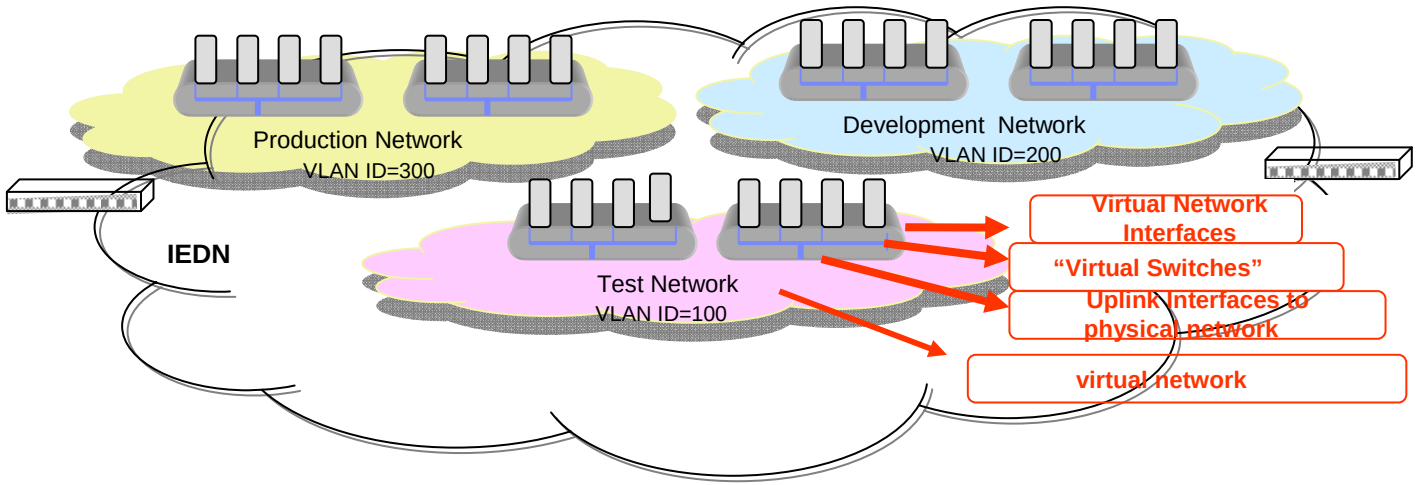
Monitoring the IEDN – New feature

- Monitor and collect metrics for network resources at the network interface level
  - Virtual network interfaces (by vlan)- between guest and the vSwitch
  - Physical network interfaces- between the vSwitch and the physical NIC
- Aggregate metrics to the following levels:
  - Virtual Server and appliance
  - Virtual Switch (hypervisor level, including OSX)
  - Virtual Network (across all platforms)
- Allows for viewing relationships between the resource levels (ex: OSAx is contributing to virtual VLANx)
- Monitoring is performed on all platforms (hypervisor) and collected a fixed intervals
  - Metrics are:
    - Bytes sent/received, Packets sent/received
    - Packets dropped, packets discarded, etc..
  - Collect from System z, p, x and appliances
- Collected metrics are saved at the zManager:
  - Current (time) metrics are cached
  - Historical metrics are stored in a database (36 hrs worth)
- Metrics are used by the Network Monitor's Dashboard and to the zManager External API

Conceptual View of IEDN



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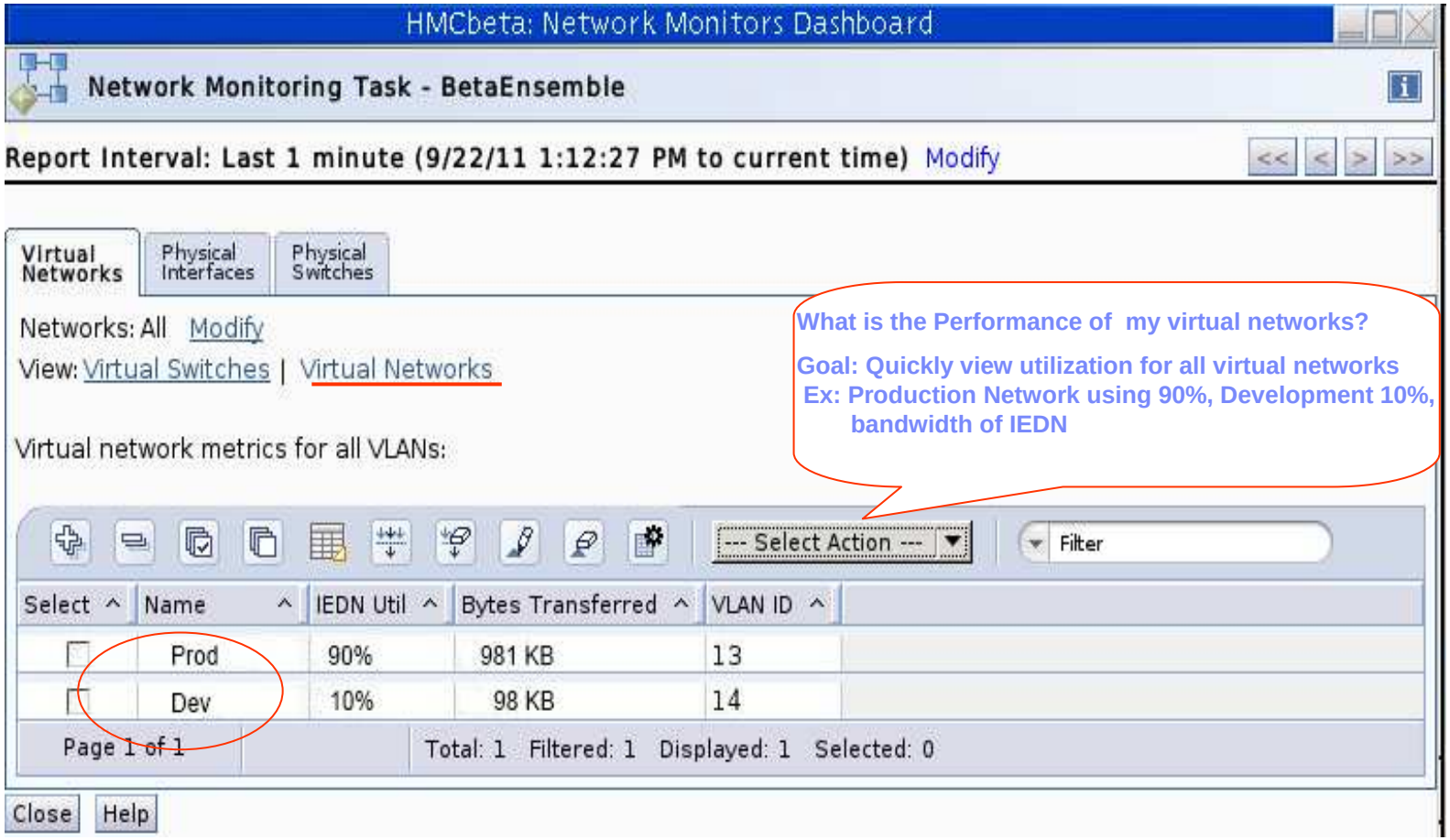
Aggregated Virtual Network Performance



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Summary - Exploiting the intraensemble data network

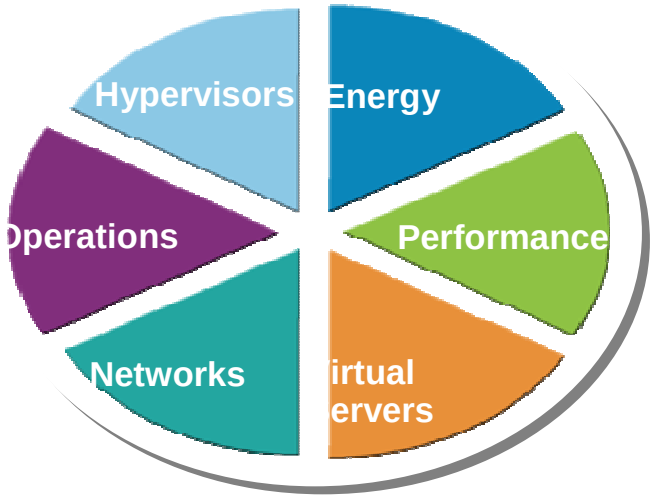
Once all hardware / physical installation and System z HCD configuration tasks are complete… then you are ready to exploit the IEDN:

Key concepts / reminders:

1. All network traffic on the IEDN must use an “authorized” VLAN ID!
2. The VLAN ID maps to a corresponding Virtual Network
3. All host images (Operating Systems) on all platforms within the Ensemble are represented as a Virtual Server

Key Unified Resource Manager network related tasks:

1. Virtual Network Configuration (at the HMC) consist of:
   – defining a virtual network (VLAN ID)
2. Virtual Server configuration:
   – Define each virtual server
   – Associate each virtual server with the proper Virtual network
3. Virtual Switch configuration (if applicable – N/A to native LPs)



Finally - Operating System network configuration tasks (IP address, VLAN ID, etc.) remain within the OS – the OS VLAN ID must match the HMC VLAN ID configuration

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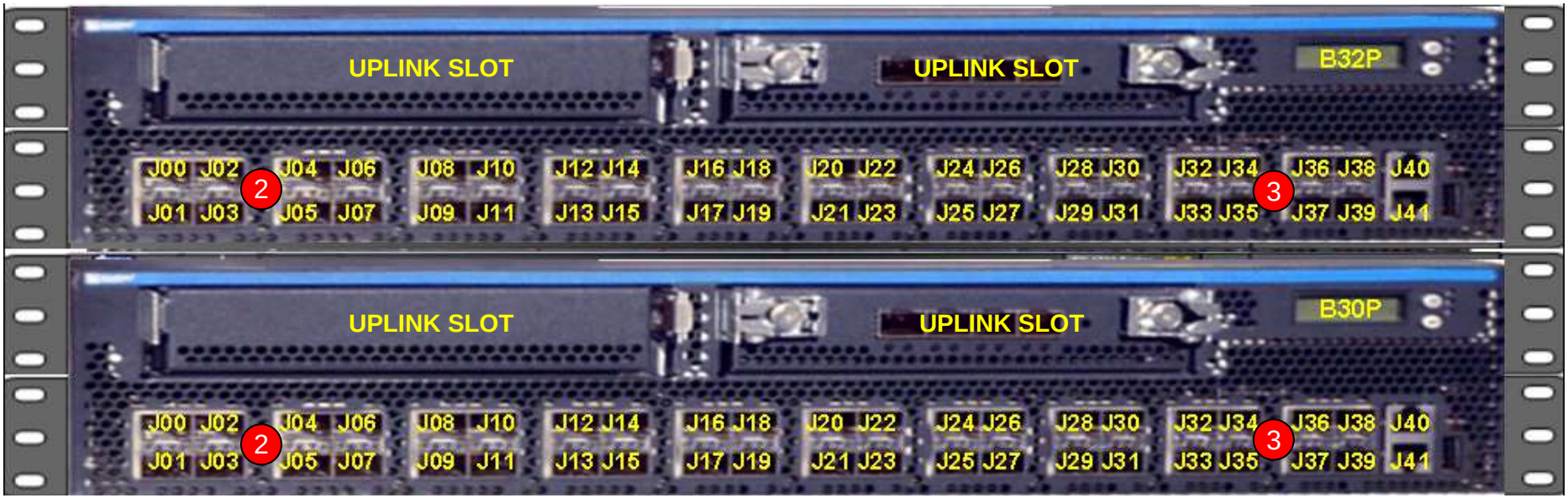
zBX Top of Rack (TOR) Switch

INMN TOR SWITCH

1.Intra-Node Management Network
2.Intra-Ensemble Data Network
3.Existing Customer Network



IEDN TOR SWITCH

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References (White Papers, FAQs, Presentations)

- **zEnterprise System Frequently Asked Questions (FAQs)**
  - www.**ibm.com**/systems/z/faq

- **zEnterprise Network Security White Paper (ZSW03167-USEN-00) and Other Resources**
  - **www.ibm.com/systems/z/resources** (Select "Literature" Entries)
  - http://www.**ibm.com**/common/ssi/cgi-bin/ssialias?infotype=SA&subtype=WH&appname=STGE_ZS_ZS_USEN&htmlfid=ZSW03167USEN&attachment=ZSW03167USEN.PDF

- zEnterprise Network Security Frequently Asked Questions:
  - http://www-03.ibm.com/support/techdocs/atsmastr.nsf/WebIndex/FQ130131

- **IBM zEnterprise System Network Virtualization, Management, and Security (Parts 1 and 2: Overview and Detail)**
  - http://www-03.ibm.com/support/techdocs/atsmastr.nsf/WebIndex/PRS4160

- **IBM System z Hardware Management Console Security White Paper**
  - Author Kurt Schroeder (schroedk@us.ibm.com), Sept. 2008
  - http://nascpok.pok.**ibm.com**/rsf/zHMCSecurityWhitepaper.pdf

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References (Software and Security)

- **z/OS Ensemble Implementation**
  - z/OS Communications Server V1R12 SNA Network Implementation Guide (SC31-8777)
  - z/OS Communications Server V1R12 SNA Network Definition Reference (SC31-8778)
  - z/OS Communications Server V1R12 IP Configuration Guide (SC31-8775)

- **IPv6 Information**
  - IPv6 Network and Application Design Guide Version 1 Release 12 (SC31-8885)

- **z/VM Ensemble Implementation**
  - *z/VM: CP Planning and Configuration (SC24-6083)*

- **Introducing the IBM Security Framework and IBM Security Blueprint to Realize Business-Driven Security; IBM RedGuide REDP-4528-00, July 2009**
  - www.redbooks.**ibm.com**

- **Security on the IBM Mainframe, SG24-7803-00 R*edbooks*®, published 30 April 2010**
  - www.redbooks.**ibm.com**

- **Introduction to the New Mainframe: Security, SG24-6776-00 *Redbooks,* published 3 April 2007, last updated 26 April 2007**
  - www.redbooks.**ibm.com**

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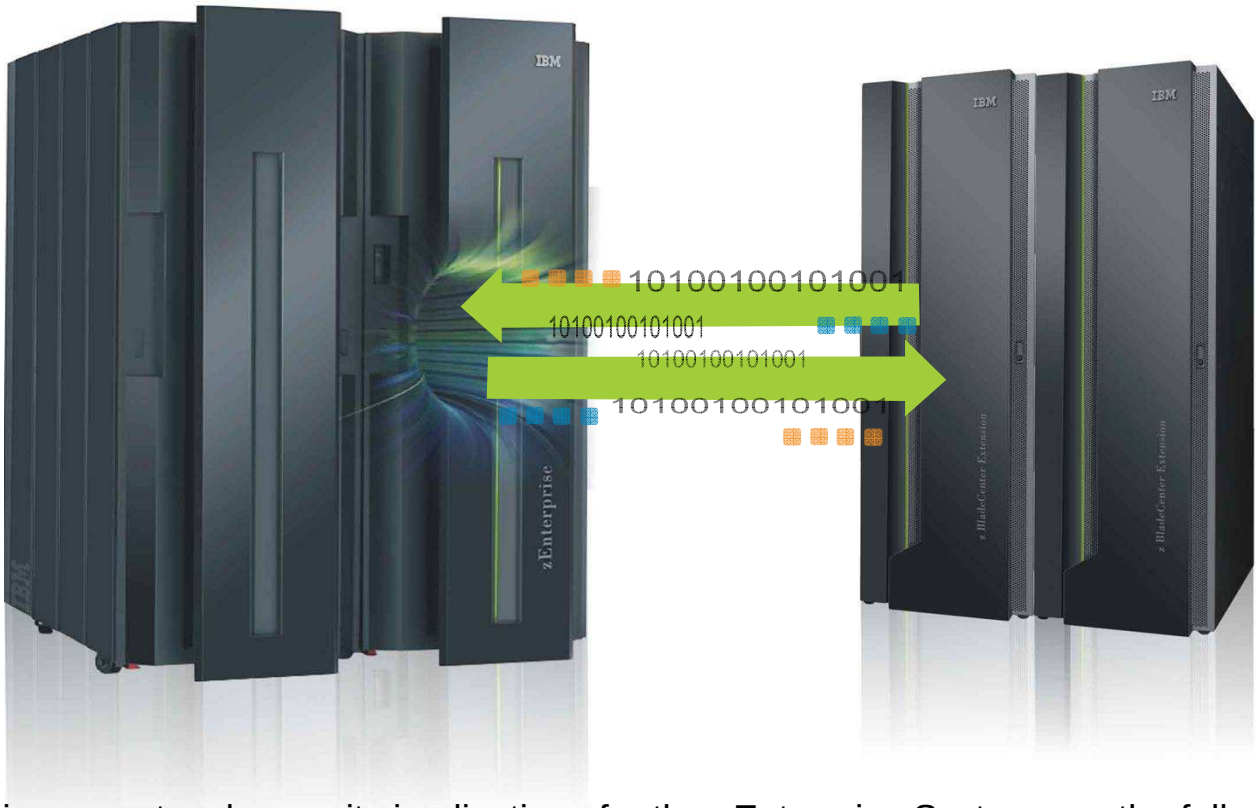
Questions? - Thank You !



For more information on network security implications for the zEnterprise System see the following white paper:

ftp://public.dhe.ibm.com/common/ssi/ecm/en/zsw03167usen/ZSW03167USEN.PDF

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