

DNA Sequencing with the z/VM Virtual Switch

A look at Virtual Switch security and Directory Network Authorization

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Agenda

- An Overview of the z/VM Virtual Switch
- User-Based Vs. Port-Based Access
- **New:** Directory Network Authorization (DNA)
 - How it works
 - Changes in CP
 - Implications to Guest Mobility (VMRELOCATE)
 - Changes in DirMaint
 - ESM Implications
 - Migration from Old to New



z/VM
V6.4



A
VM Workshop
Original
Presentation

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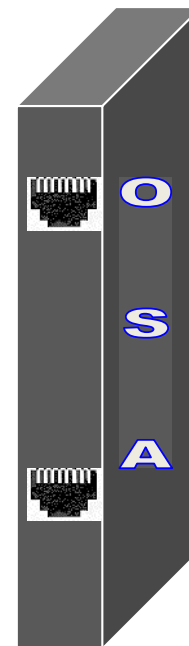
Overview of the z/VM Virtual Switch

Switch – a box that creates a LAN

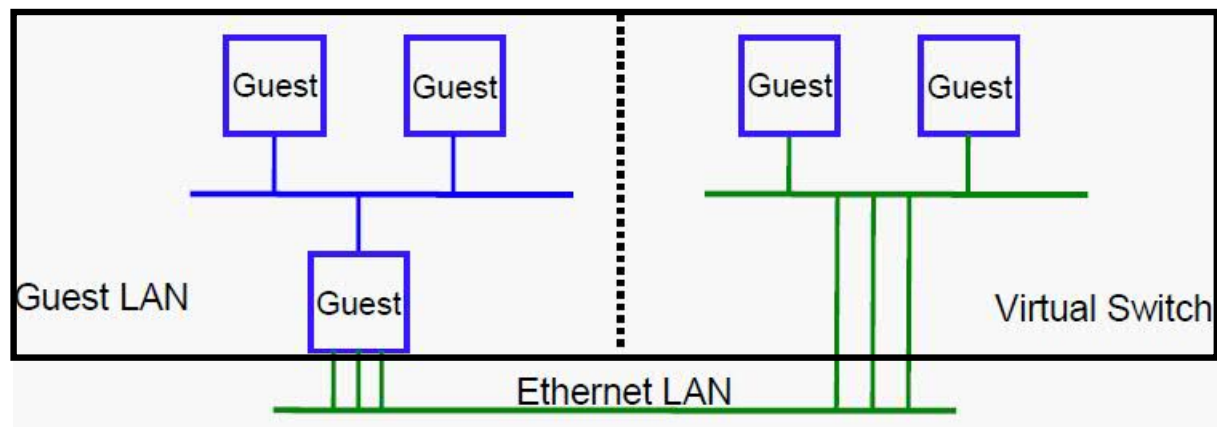
- Enable and disable a port
- Set port type: trunk or access
- Assign port to one or more VLANs
- Set port speed: 10 / 100 / 1000 / Auto
- Set port duplex mode: Simplex / Duplex / Auto
- Define an internal router
- Define SNAP (sniffer) ports



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Guest LAN vs. Virtual Switch



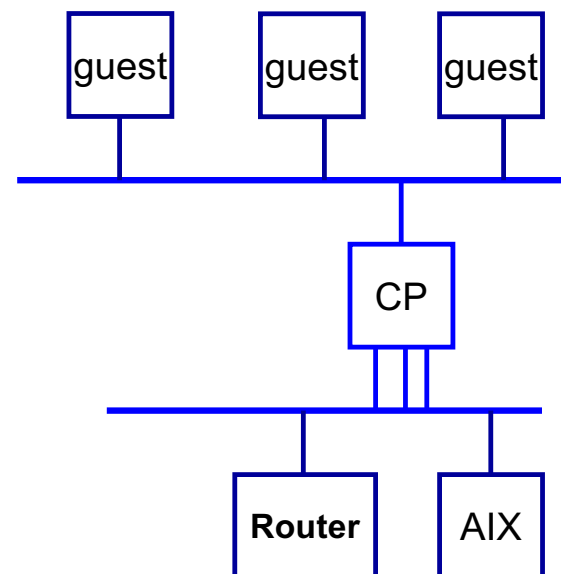
- Virtual router is required
- Different subnet
- External router awareness
- Guest-managed failover
- No virtual router
- Same subnet
- Transparent bridge
- CP-managed failover

z/VM Virtual Switch

- A special-purpose Guest LAN
 - Ethernet
 - Built-in IEEE 802.1q bridge to an outside network
 - IEEE VLAN capable

Defining in z/VM:

- `SYSTEM CONFIG` (static definition)
- `CP DEFINE VSWITCH` command

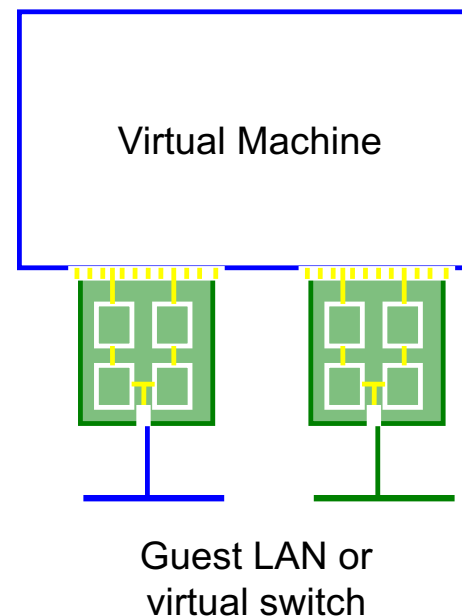


Virtual Switch Attributes

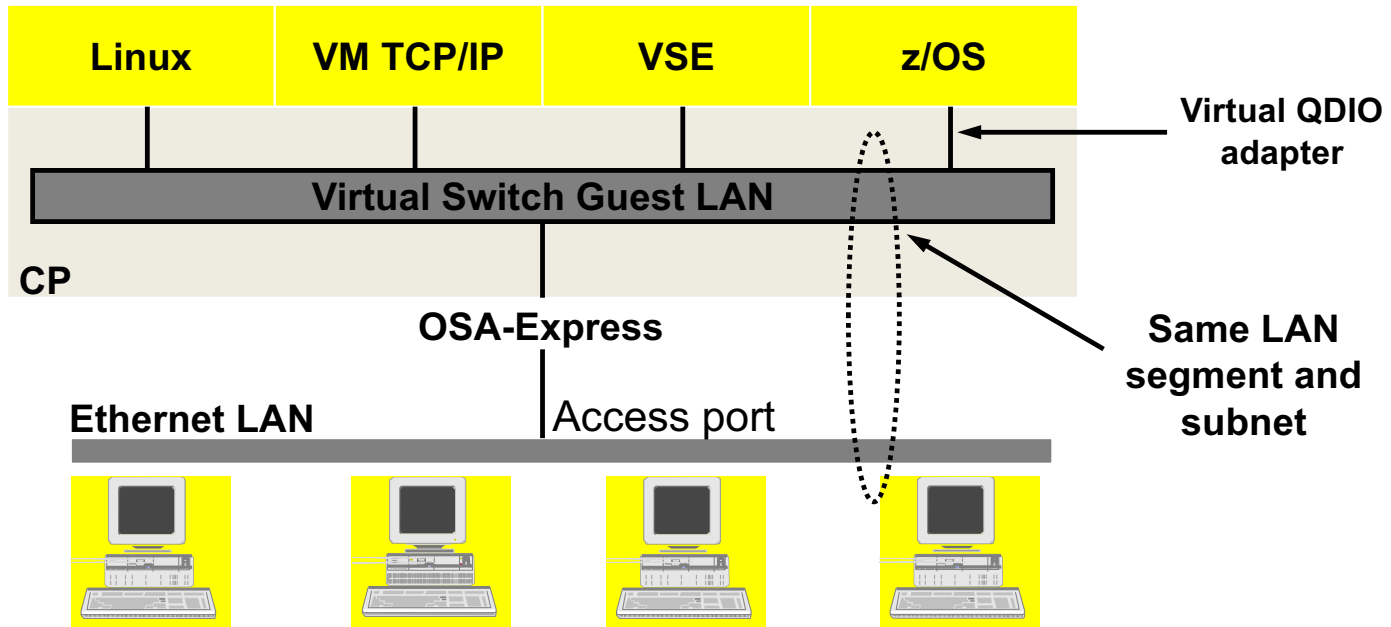
- Name of the Switch
- Associated OSAs (up to 8) (may be aggregated and/or shared)
- Access Control List for z/VM userids
- 1+ controller VMs (minimal VM TCP/IP stack servers)
 - User pre-configured DTCVSW1 and DTCVSW2
 - Controller not involved in data transfer
 - Starts, stops, and monitors OSAs
 - Do not ATTACH or DEDICATE
- Similar to Guest LAN
 - Owner SYSTEM
 - Type QDIO
 - Persistent
 - Restricted

Virtual Network Interface Cards (NICs)

- A simulated network adapter
 - OSA-Express QDIO
 - HiperSockets
 - Must match LAN type
- 3 or more devices per NIC
 - More than 3 to simulate port sharing on 2nd-level system or for multiple data channels
- Provides access to Guest LAN or Virtual Switch
- Created by directory or CP DEFINE NIC command



z/VM Virtual Switch – VLAN unaware



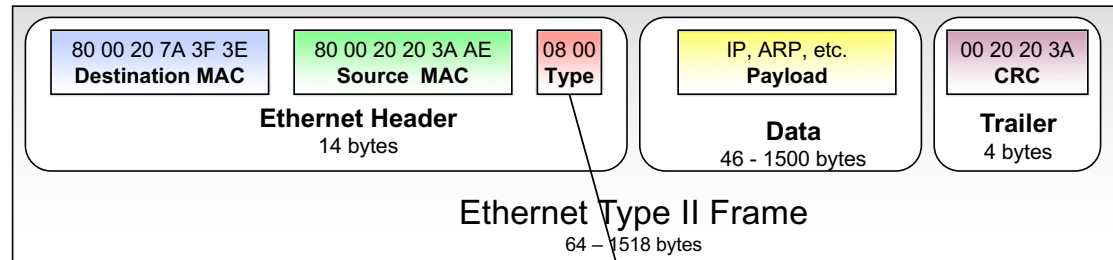
What's a "VLAN"?

(This slide gleefully stolen from Alan Altmark. Sshhhh.)

- Defined by IEEE 802.1Q standard (not z/VM!)
 - “A subset of the active topology of a bridged LAN.”
- **A bridged LAN is what you get when you use a switch instead of a hub**
 - Enables the application of ingress and egress rules to the frames that enter and exit the switch ports
- IEEE 802.1Q establishes a new set of rules and frame formats
 - Associated with each VLAN is a VLAN Identifier (VID).
 - VLAN-tagged frames carry the VID within the frame. Allowed only on trunk ports.
 - Untagged frames do not carry the VID, but are instead associated with a VID by the switch and then managed as though they were tagged
- **VLAN-aware bridges create logical groups** of end stations that can communicate as if they were on the same LAN by associating the physical port used by each of those end stations with the same VID.
- **Traffic between VLANs is restricted.** Bridges forward unicast, multicast, and broadcast traffic to ports that serve the VLAN to which the traffic belongs.
 - Routers connect to multiple VLANs

VLAN tags

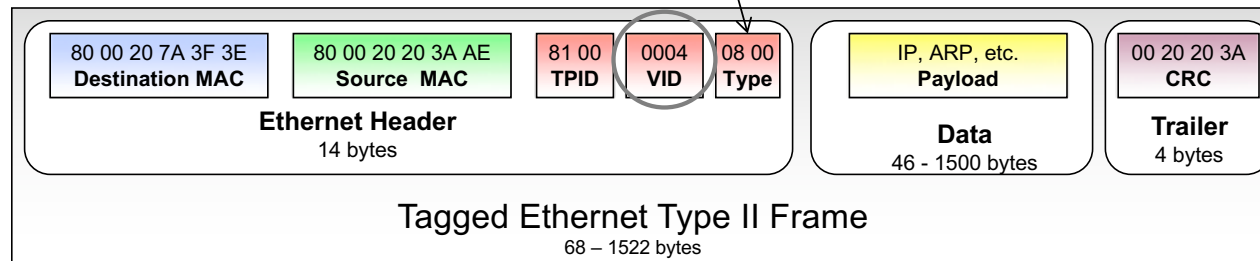
(This slide gleefully stolen from Alan Altmark. Sshhhh.)



Access port and Trunk port

When used on a trunk port, the switch will associate (but not tag) it with the **native** VID.

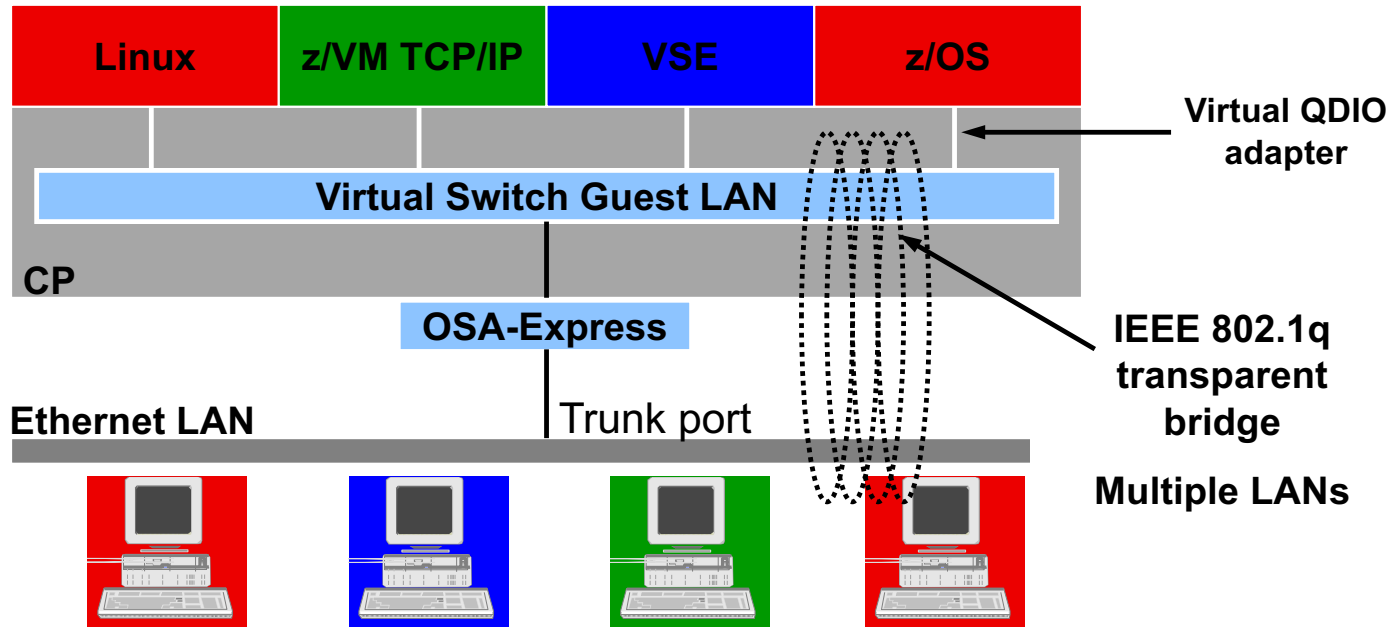
Type/length 0800 means IPv4 (IETF RFC 894)



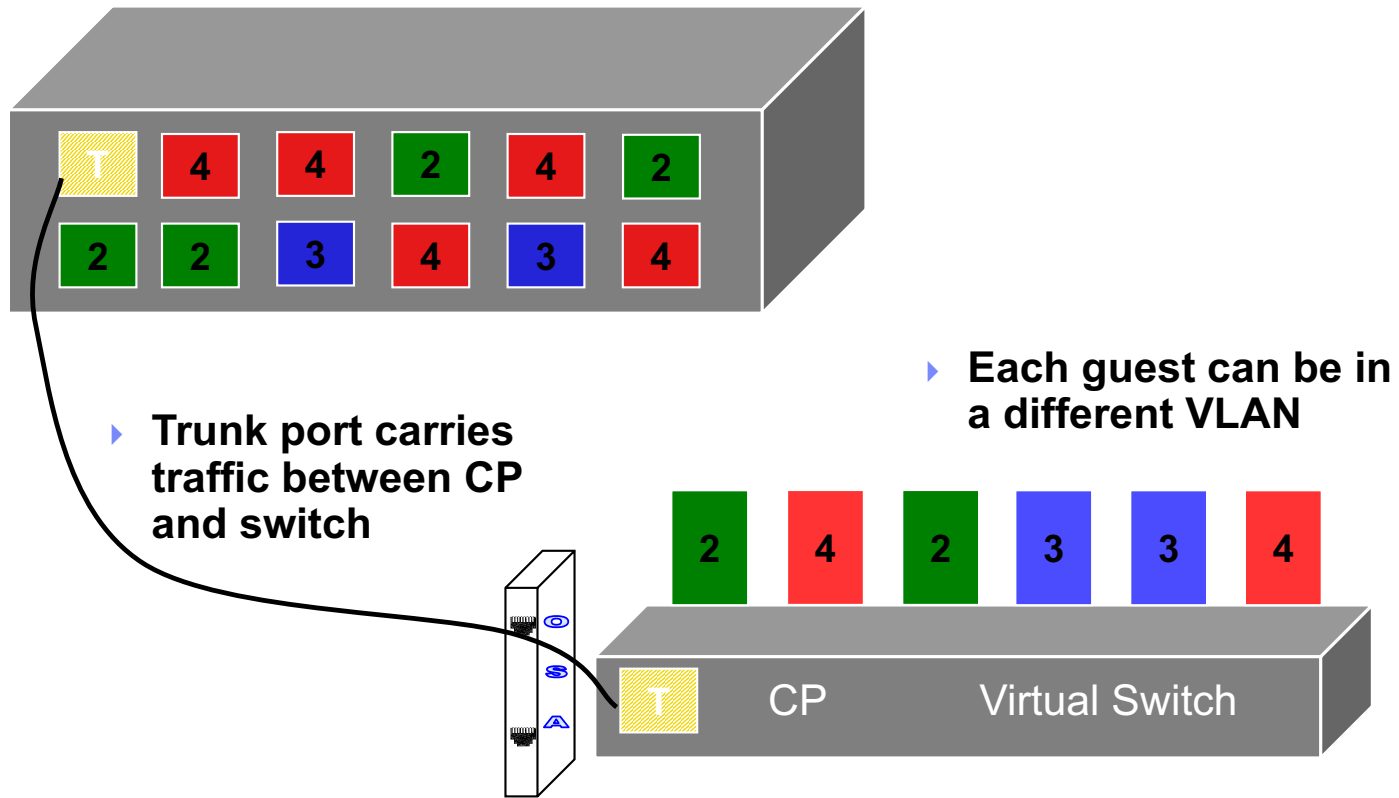
Trunk port only

Value 8100 in the Type field means a VLAN tag follows, followed by the actual type/length field

z/VM Virtual Switch – VLAN aware



Physical Switch to Virtual Switch

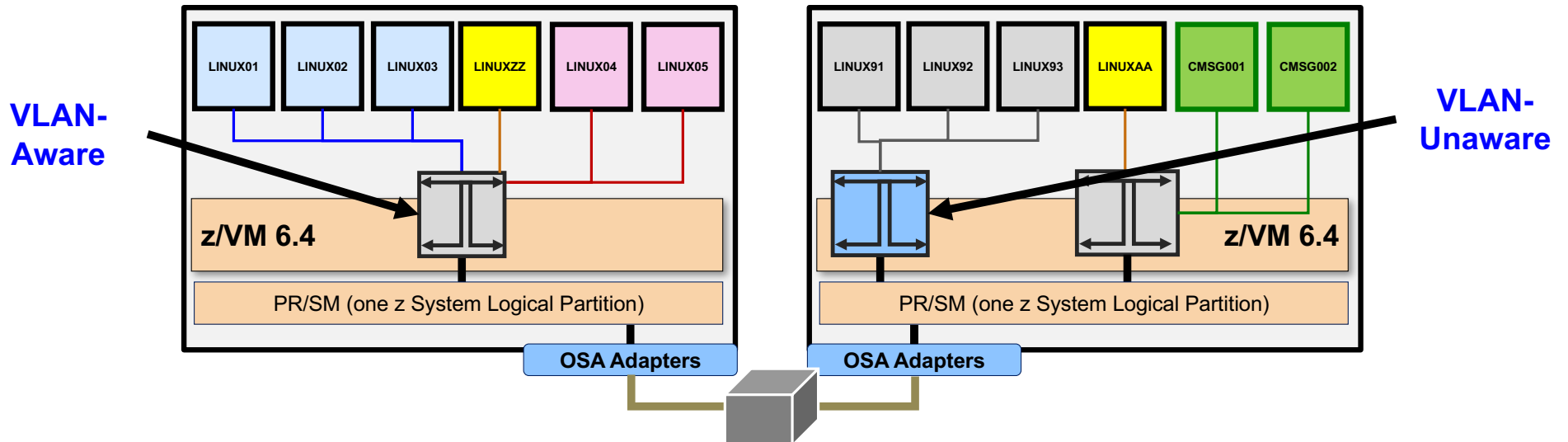


Security controls on the VSWITCH

- Virtual Sniffers
 - Guest must be authorized via SET VSWITCH or security server
 - Guest enables promiscuous mode using CP SET NIC or via device driver controls (tcpdump -P)
 - Guest receives copies of all frames sent or received for authorized VLANs
- Port Isolation or VEPA modes
 - Isolation: Shut off OSA “short circuit” to other members of the VLAN
 - Virtual Edge Port Aggregator (VEPA) pushes separation to physical switch
- Access lists
 - Not all guests can access a VSWITCH by default
 - Userid list defined via CP command or configuration statement

- An **External Security Manager** will provide granular control (of course)

Zoning with the z/VM Virtual Switch

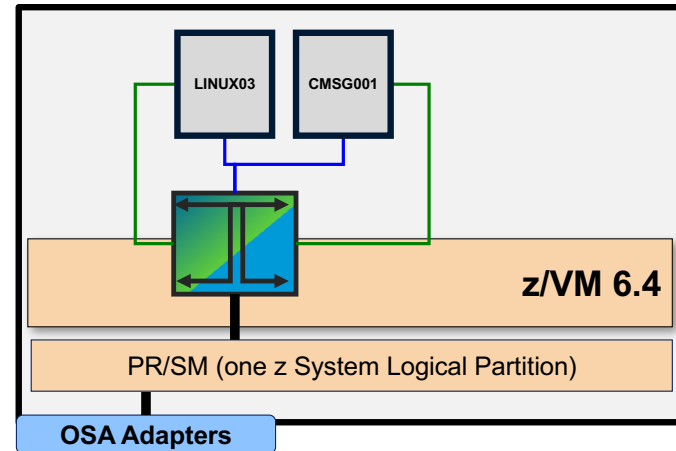


- Guests with a common VLAN can talk to one another (the OSA "hairpin turn")
- Guests that pass a security decision point (firewall) can communicate
- Separate traffic at VSwitch (VLAN), OSA (Port Isolation), or at physical switch (VEPA mode)

Port to Port – Virtual Machine Access to the Virtual Switch

Does a guest need to be VLAN-aware?

- "It depends" on Virtual Switch configuration
 - **TRUNK** – frames are VLAN-tagged
 - **ACCESS** – VLAN-unaware
- Linux guests often define ports to represent a particular *eth.n* connection
 - Don't necessarily care about VLAN id
- The Port-Based Vswitch allows a guest with multiple vNICs to connect via ACCESS ports to a single VLAN-aware virtual switch
 - Associate Port with VLAN
 - Guest doesn't need to care



```
DEFINE VSWITCH SWT1 RDEV 2A00 ETHERNET CONTROLLER * VLAN AWARE PORTBASED NAT 1
SET VSWITCH SWT1 PORTNUMBER 20 GRANT GUEST VLAN 200
SET VSWITCH SWT1 PORTNUMBER 21 GRANT GUEST VLAN 300
```

Solution – VSWITCH PORTBASED definition

A guest may have multiple vNICs connect to a VSwitch – as ACCESS Port connections.

The PORTNUMBER option makes this possible.

```
DEFINE VSWITCH LAGGSWT1 ETHERNET RDEV NONE CONTROLLER * VLAN AWARE PORTBASED NAT 1
GROUP SPG1

SET PORT GROUP SPG1 JOIN 5700.P00 5703.P01 5600.P00 5603.P01

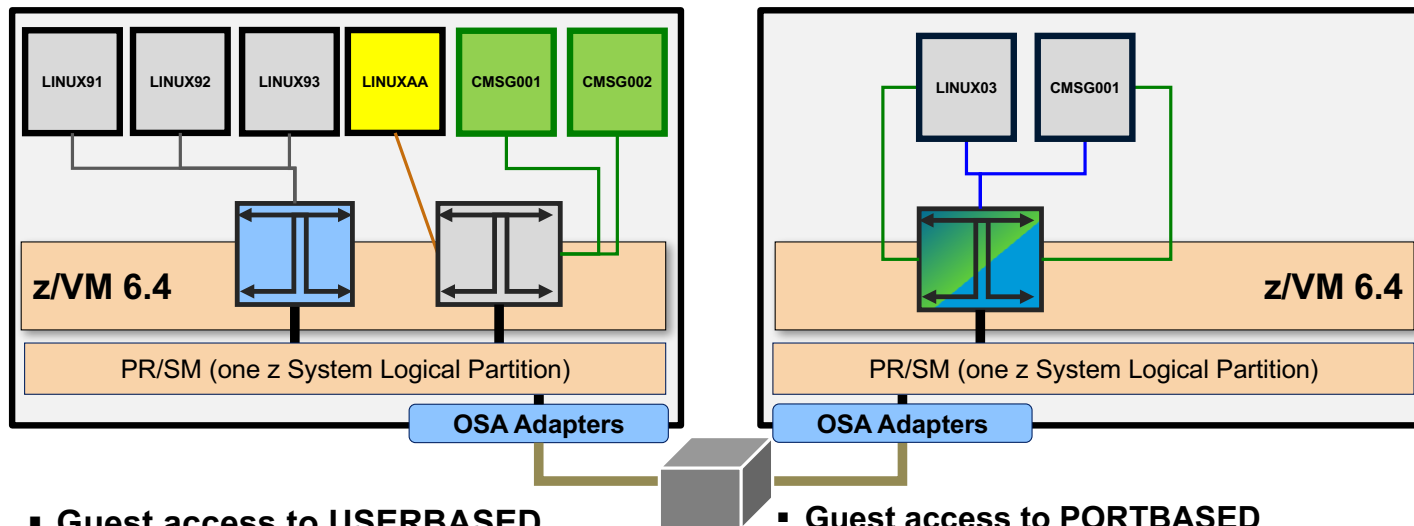
SET VSWITCH LAGGSWT1 PORTNUMBER 15 USERID SUSE80 VLAN 1
SET VSWITCH LAGGSWT1 PORTNUMBER 16 USERID SUSE80 VLAN 192
SET VSWITCH LAGGSWT1 PORTNUMBER 17 USERID SUSE80 VLAN 300
SET VSWITCH LAGGSWT1 PORTNUMBER 18 USERID SUSE80 VLAN 700
```

Solution – VSWITCH PORTBASED definition

- PORTNUMBERS don't have to start with (or increment by) 1 – just have to be different.
- Can migrate user-based definitions to port-based with no impact
- RACF doesn't care either way, either – no substantive change to security policy

```
q vswitch
VSWITCH SYSTEM DTCSMAPI Type: QDIO Connected: 0 Maxconn: INFINITE
PERSISTENT RESTRICTED ETHERNET Accounting: OFF
USERBASED
VLAN Unaware
MAC address: 02-00-10-00-00-19 MAC Protection: Unspecified
State: Defined
IPTimeout: 5 QueueStorage: 8
Isolation Status: OFF
VSWITCH SYSTEM LAGGSWT1 Type: QDIO Connected: 10 Maxconn: INFINITE
PERSISTENT RESTRICTED ETHERNET Accounting: OFF
PORTBASED
VLAN Aware Default VLAN: NONE Default Porttype: Access GVRP: Enabled
Native VLAN: 0001 VLAN Counters: OFF
```

And then the drama started ...



- **Guest access to USERBASED**

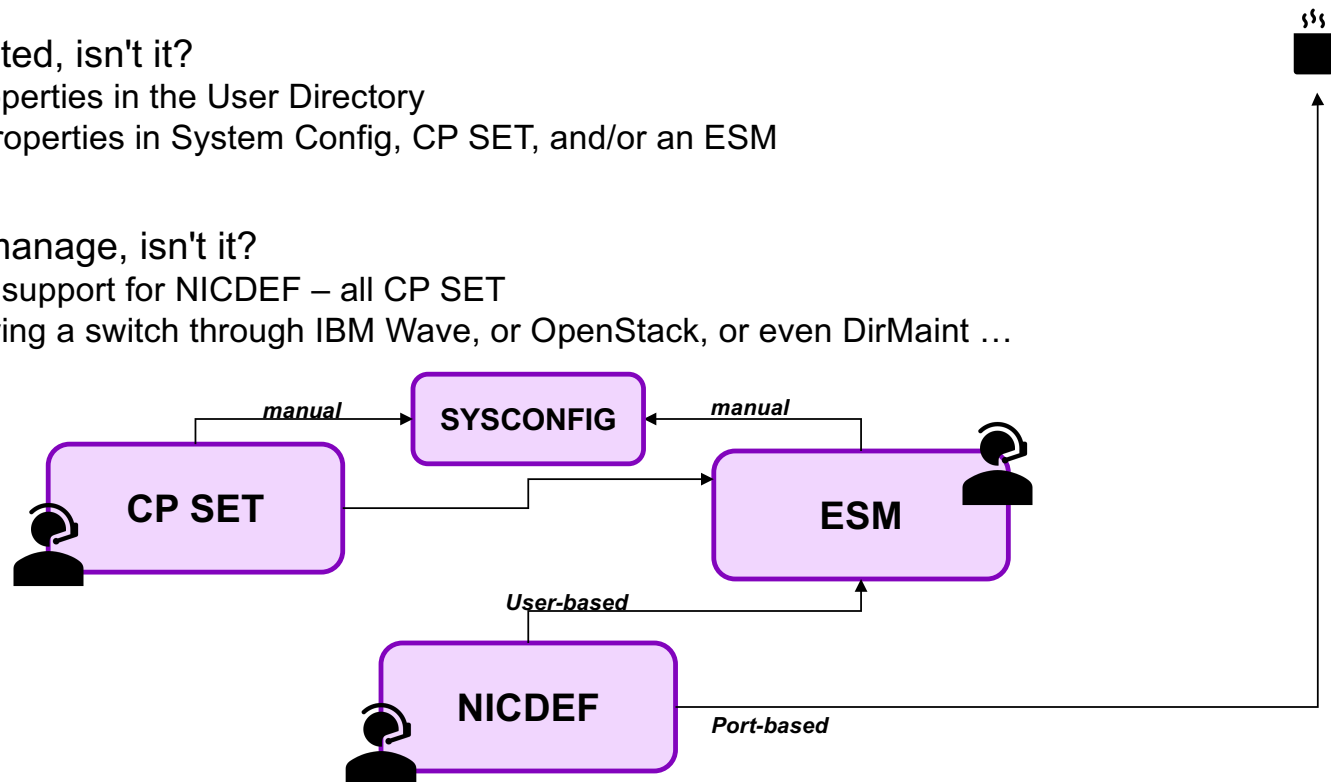
- NICDEF statement, or
- CP commands
- DIRM NICDEF support
- RACF Connector support (z/VM 6.4)

- **Guest access to PORTBASED**

- CP commands only
- COMMAND statement
 - Makes user stanzas complicated
 - Timing issues
- No DIRM NICDEF equivalence
- No RACF Connector support (not on NICDEF)

And then the drama started ...

- Kind of complicated, isn't it?
 - NIC device properties in the User Directory
 - NIC network properties in System Config, CP SET, and/or an ESM
- Kind of hard to manage, isn't it?
 - No port-based support for NICDEF – all CP SET
 - Now try deploying a switch through IBM Wave, or OpenStack, or even DirMaint ...

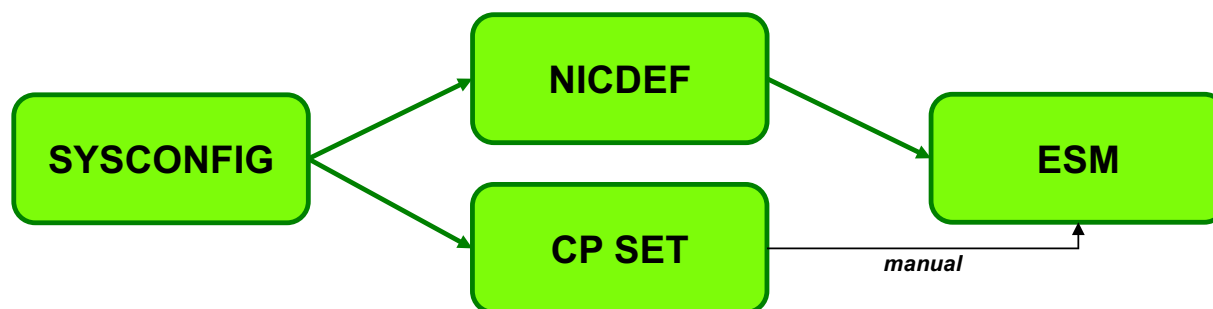


Directory Network Authorization (DNA)

Directory Network Authorization

(APARs VM65925, VM65926, and VM65931 – August 2017)

- Centralize everything on the NICDEF statement
 - New parameters included
 - NICDEF takes precedence over CP SET VSWITCH (still supported)
 - NICDEF LAN authorizes network access
 - No meaningful distinction between user-based and port-based anymore



How do I enable DNA? (And what if I change my mind?)

- System Configuration VMLAN statement:

```

                                     +-- ENABLE ---v
>>--VMLAN [...] - DNA ---+-----+-----><
                                     +-- DISABLE --^

```

- Or CP SET VMLAN:

```

>>--CP SET VMLAN [...] - DNA --+-- ENABLE ---+-----><
                                     +-- DISABLE --^

```

- New message if there's a conflict with state vs. configuration:

```

HCP3224I NICDEF network configuration is ignored due to the current
setting of VMLAN DNA.

```

What do I do to use DNA?

- Step 1: Apply PTFs when available. (*C'mon, that was the easy part.*)
 - z/VM DIRECTXA processes the new directory statement changes
 - NICDEF statement defines properties of virtual NIC
 - NICDEF also now supports network attributes defined by CP SET VSWITCH
- Then, secure it. Recommend change access be restricted for:
 - LAN, MACID, PORTNUMBER, VLAN, PROMISCUOUS
 - Impacts security policy, should be administrator-only
 - DirMaint will have these changes when you apply that PTF

```
NICDEF vdev [TYPE HIPERS | QDIO]
            [DEVices devs]
            [LAN owner name]
            [CHPID xx]
            [MACID xxyyzz]
            [PORTNUMBER nnnn]
            [PORType ACCESS|TRUNK]
            [VLAN vidset]
            [PROMiscuous|NOPROMiscuous]
```

Tell me about ... LAN

- **NICDEF LAN now authorizes the connection** to a virtual network
 - Unless VMLAN DNA is DISABLED in the System Configuration file
 - LAN statement still optional

```
NICDEF vdev [TYPE HIPERS | QDIO]
            [DEVices devs]
            [LAN owner name]
            [CHPID xx]
            [MACID xxyyzz]
            [PORTNUMBER nnnn]
            [PORType ACCESS|TRUNK]
            [VLAN vidset]
            [PROMiscuous|NOPROMiscuous]
```

Tell me about ... PORTNUMBER

- New, Optional configuration setting
 - Decimal value 1-2048
 - System will assign a port 2176-4095 if not specified
 - Virtual NIC is connected to nnnn of the specified network
 - If specified port is already in use, the COUPLE will fail
 - If **PORTNUMBER** is omitted, **VSWITCH** will use a system-assigned port number

```
NICDEF vdev [TYPE HIPERS | QDIO]
            [DEVICES devs]
            [LAN owner name]
            [CHPID xx]
            [MACID xxyyzz]
            [PORTNUMBER nnnn]
            [PORTYPE ACCESS|TRUNK]
            [VLAN vidset]
            [PROMISCUOUS|NOPROMISCUOUS]
```

Tell me about ... PORTTYPE

- New, Optional configuration setting
 - For a VLAN-Aware Virtual Switch only
 - Port type TRUNK is valid for any number of VLAN groups
 - Port type ACCESS is only valid for a single VLAN (frames are untagged)
 - If keyword omitted, COUPLE will resolve it (with the VSWITCH default)

```
NICDEF vdev [TYPE HIPERS | QDIO]
            [DEVICES devs]
            [LAN owner name]
            [CHPID xx]
            [MACID xxyyzz]
            [PORTNUMBER nnnn]
            [PORTType ACCESS|TRUNK]
            [VLAN vidset]
            [PROMiscuous|NOPROMiscuous]
```

Tell me about ... VLAN Specification

- New, Optional keyword (defaults to VSWITCH VLAN)
 - For a VLAN-Aware Virtual Switch only
 - List of VLAN IDs and/or ranges
 - Each VLAN ID is a decimal number 1-4096
 - For ACCESS, it must be precisely one number
 - For TRUNK, it may be as complicated as you want (e.g. **VLAN 1 200-204 529**)

```
NICDEF vdev [TYPE HIPERS | QDIO]
            [DEVices devs]
            [LAN owner name]
            [CHPID xx]
            [MACID xxyyzz]
            [PORTNUMBER nnnn]
            [PORType ACCESS|TRUNK]
            [VLAN vidset]
            [PROMiscuous|NOPROMiscuous]
```

Tell me about ... Promiscuous Mode

- New, Optional keyword (defaults to NOPROMiscuous)
 - Authorizes virtual NIC to trace network traffic
 - *Use sparingly*

```
NICDEF vdev [TYPE HIPERS | QDIO]
            [DEVices devs]
            [LAN owner name]
            [CHPID xx]
            [MACID xxyyzz]
            [PORTNUMBER nnnn]
            [PORType ACCESS|TRUNK]
            [VLAN vidset]
            [PROMiscuous|NOPROMiscuous]
```


How do I know what I'm using?

- CP QUERY VMLAN Command
- QUERY VMLAN output is changed to include the current system-wide DNA setting:

```
22:17:30 VMLAN maintenance level:
22:17:30   Latest Service: VM65925
22:17:30 VMLAN MAC address assignment:
22:17:30   System MAC Protection: OFF
22:17:30   MACADDR Prefix: 02110A USER Prefix: 02110A
22:17:30   MACIDRANGE SYSTEM: 000001-FFFFFF
22:17:30   USER: 000001-7FFFFFFF

22:17:30 VMLAN default accounting status:
22:17:30   SYSTEM Accounting: OFF      USER Accounting: OFF
22:17:30 VMLAN general activity:
22:17:30   PERSISTENT Limit: INFINITE Current: 6
22:17:30   TRANSIENT Limit: INFINITE Current: 0
22:17:30   Trace Pages: 8
22:17:30 VMLAN Directory Network Authorization: ENABLED
22:17:30 IVL Domain: None
```

What about SET VSWITCH?

- **SET VSWITCH** still supports dynamic changes to PORTTYPE, VLAN and PROMISC.
- LOGON and DEFINE with NICDEF attributes overrides prior SET VSWITCH settings.
- Note that SET VSWITCH with GRANT/REVOKE affects ALL connections for the given user!
- ESM changes are not reflected to CP dynamically, so user must UNCOUPLE/COUPLE to adopt ESM updates.

What about VMRELOCATE?

- VMRELOCATE is not directly affected, but be advised:
 - Systems without this PTF will not recognize new NICDEF features
 - Common User Directory interpreted differently on each member
 - Be cautious

If you have a ...	on a ...	Then be warned that ...
System-assigned port	Port-based VSwitch	No relocation to a pre-DNA system. Ports > 2048 unsupported
User-defined port	User-based Vswitch	It may not have the same port if relocated to a pre-DNA system
User-defined port	User-based Vswitch	Relocation may fail if the port belongs to a different user on target system

What about DirMaint?

- The Directory Maintenance Facility (DIRMAINT) for z/VM 6.4 is updated through the PTF for APAR VM65926.

- Changes include:
 - DIRM NICDEF support for new options (command and menu)
 - NICDEF command is now a DirMaint-Class-A command, and not Class G
 - Update to DVHRVN (RACF Connector Exit) to transmit changes in new options

What about RACF?

- RACF for z/VM 6.4 is updated through the PTF for APAR VM65931.

- RACF handles user-based and port-based virtual switches the same way already, so there was no need for major processing changes.

- The RPIDIRCT utility now supports the new NICDEF processing
 - Tolerates old format, too
 - Processes PROMISCUOUS into ACC(CONTROL)
 - Processes VLAN ids into discrete profiles
 - Updates to support of SPECIAL statement
 - Some smaller bug fixes

Questions?

Conclusion

- VM65925 simplifies and streamlines hypervisor network security
 - Centralized location for network security policy
 - Can eliminate excessive use of COMMAND statements
 - The ESM still always wins, though

- DNA is enabled by default, but changes won't be immediate
 - Clues off new options in the User Directory
 - Some changes to DirMaint to reflect NICDEF's importance
 - No changes in RACF

- Be mindful of guest relocation
 - Changes in port behavior could complicate security policy requirements
 - User-based switches subject to similar constraints now

Best Practices for VLAN-aware VSWITCH

- Use NICDEF to assign VLANs and port numbers (NEW)

- Define VSWITCH with “VLAN AWARE NATIVE NONE”
 - Guest that has not been given access will get errors
 - No chance of untagged frames escaping from z/VM

- Use ESM and groups to manage VLAN assignments
 - Simplifies VLAN changes
 - Overrides VLAN specification on NICDEF
 - CP will use NICDEF if ESM defers

Best Practices for all VSWITCHes

- Use ETHERNET mode

- Do not specify PORTTYPE TRUNK on DEFINE VSWITCH
 - This controls the default guest port type, not the OSA!

- Do not specify CONTROLLER

- Do not put CONTROLLER ON in your own TCP/IP stacks
 - For VSWITCH controllers only!

- Specify MACPROTECT ON and LIMIT TRANSIENT 0 on VMLAN statement in SYSTEM CONFIG

Useful diagnostic commands

▪ CP QUERY VMLAN

- to get global VM LAN information (e.g. limits)
- to find out what service has been applied

▪ CP QUERY LAN ACTIVE

- to find out which users are coupled
- to find out which IP addresses are active

▪ CP QUERY NIC DETAILS

- to find out if your adapter is coupled
- to find out if your adapter is initialized
- to find out if your IP addresses have been registered
- to find out how many bytes/packets sent/received

▪ CP QUERY PORT GROUP

- To determine the members of a particular groupname
- To determine which groups are active or inactive

Most popular VSWITCH configuration problem?


- Not issuing the COUPLE for your virtual NIC.

- Measure twice, cut once.
 - QUERY VIRTUAL NIC (a Class G command)

For More Information ...

- <http://www.vm.ibm.com/virtualnetwork/>
- <http://www.vm.ibm.com/virtualnetwork/linkag.html> -- z/VM Link Aggregation Development
- <http://www.ibm.com/servers/eserver/zseries/os/linux/>
- <http://www.linuxvm.org/>
- **With special thanks to:**
 - Sue Farrell, Dennis Musselwhite, and Rick Tarcza (z/VM Networking Development)
 - Patty Rando (z/VM DirMaint Development)
 - Alan Altmark (z/VM networking nerd and security enthusiast)

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Brazilian
Portuguese

谢谢

Chinese

Thank You

Dankon

Esperanto

ありがとうございます

Japanese

Trugarez

Breton

Danke

German

Tak

Danish

Grazie

Italian

நன்றி

Tamil

děkuji

Czech

ขอบคุณ

Thai

go raibh maith agat

Gaelic

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