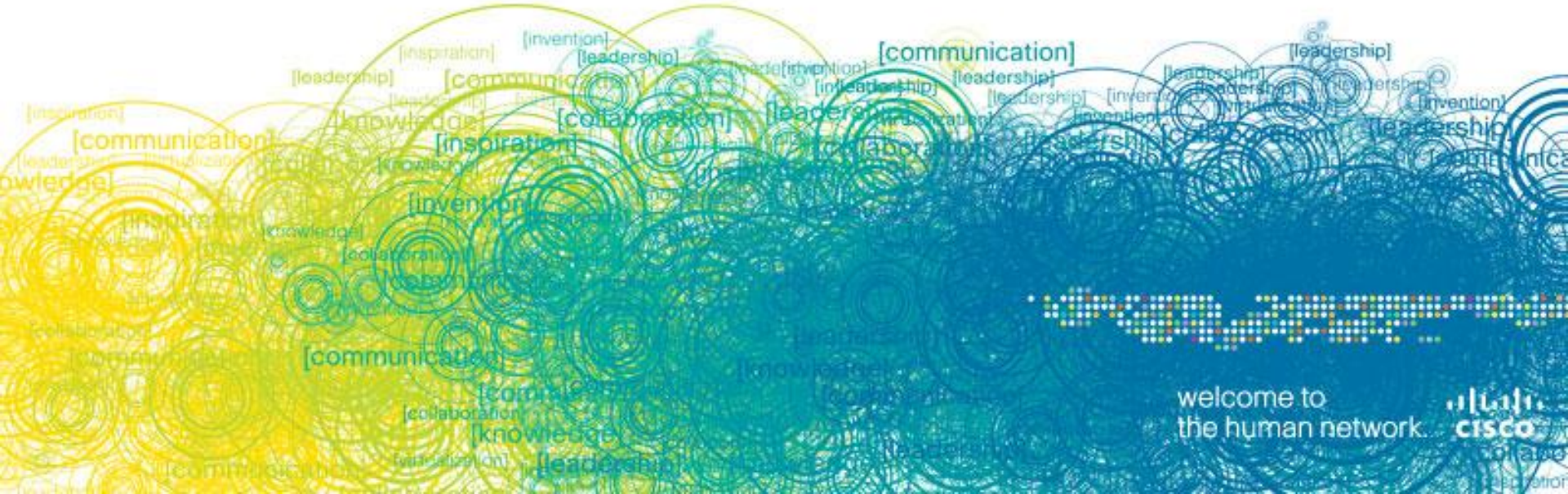
Security and Virtualization in the Data Center



What We'll Cover

- Areas of Interest
- Security for Data Center Layers
- Device Virtualization & Security Services
- Security Considerations for Server Virtualization

Where Are We Now?

- Securing virtualized environments is a big concern
- We are still early in virtualization adoption
- Two forms of virtualization we are discussing. Both apply to the Data Center
  - Server virtualization
  - Device virtualization
- Security requirements shouldn't change with virtualization

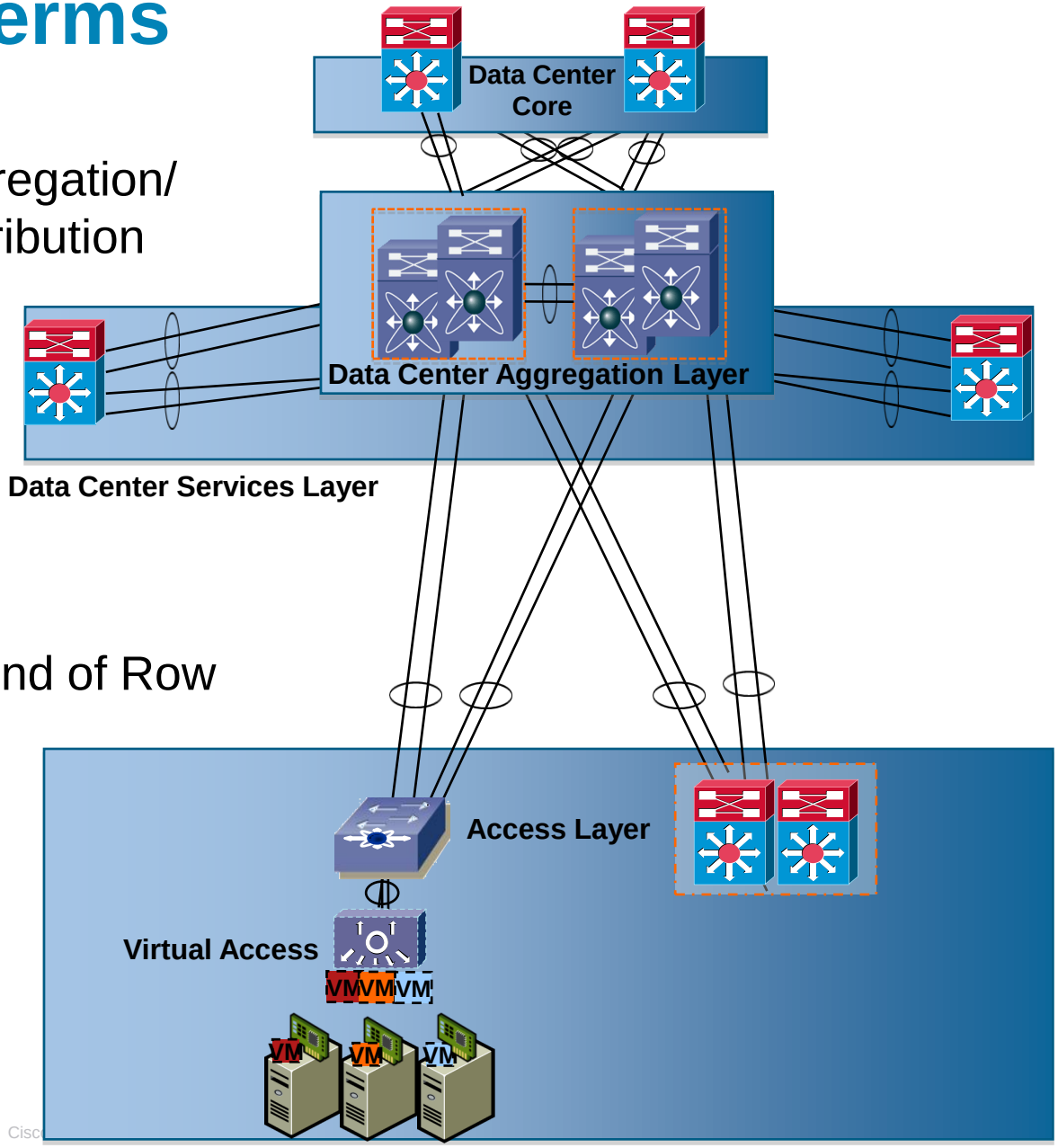
Data Center Terms

Aggregation/
Distribution

Services

Top of Rack/End of Row

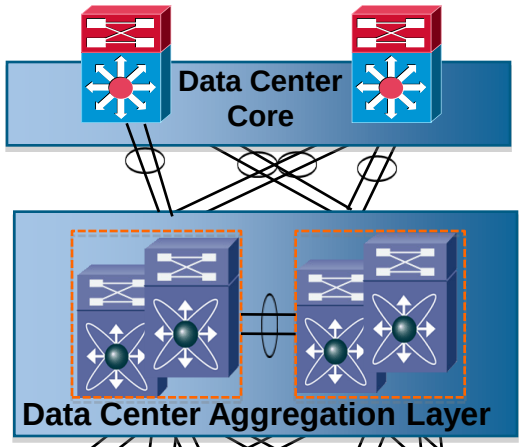
Virtual Infrastructure



Data Center Security Challenges

- Virtualization
- Applications
- Data Loss
- Compliance
- Availability

Addressing the Challenges



Network Foundation Protection
Infrastructure Security features are enabled to protect device, traffic plane, and control plane. Device virtualization provides control, data, and management plane segmentation

Stateful Packet Filtering
Initial filter for all DC ingress and egress traffic. Virtual Context allow correlation to Nexus VDC.

Network Intrusion Prevention
IPS/IDS: provides traffic analysis and forensics

Stateful Packet Filtering
Additional Firewall Services for Server Farm specific protection

Server Load Balancing
Server Load Balancing masks servers and applications

Application Firewall
Application Firewall mitigates XSS, HTTP, SQL, XML based attacks

Flow Based Traffic Analysis
Network Analysis for traffic monitoring and data analysis

XML based Application Control
XML Gateway to protect and optimize Web-based services

Data Center Services Layer

Enhanced Layer 2 Security
Access List, Dynamic ARP Inspection, DHCP Snooping, IP Source Guard, Port Security, Private VLANs, QoS

Access Layer

Virtual Access

VM VM VM

VM VM VM

Layer 2 Flow Monitoring
NetFlow, ERSPAN, SPAN

Endpoint security
Host intrusion prevention protect server against zero day attacks

Security Management

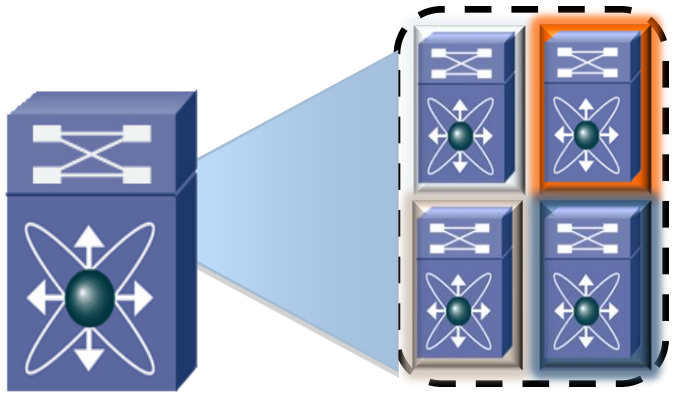
- **Visibility**
- **Even Correlation**
  - **HIPS, Firewalls, IPS, Netflow, Syslog**
- **Forensics**
- **Anomaly Detection**
- **Compliance**

CS-MARS CSM

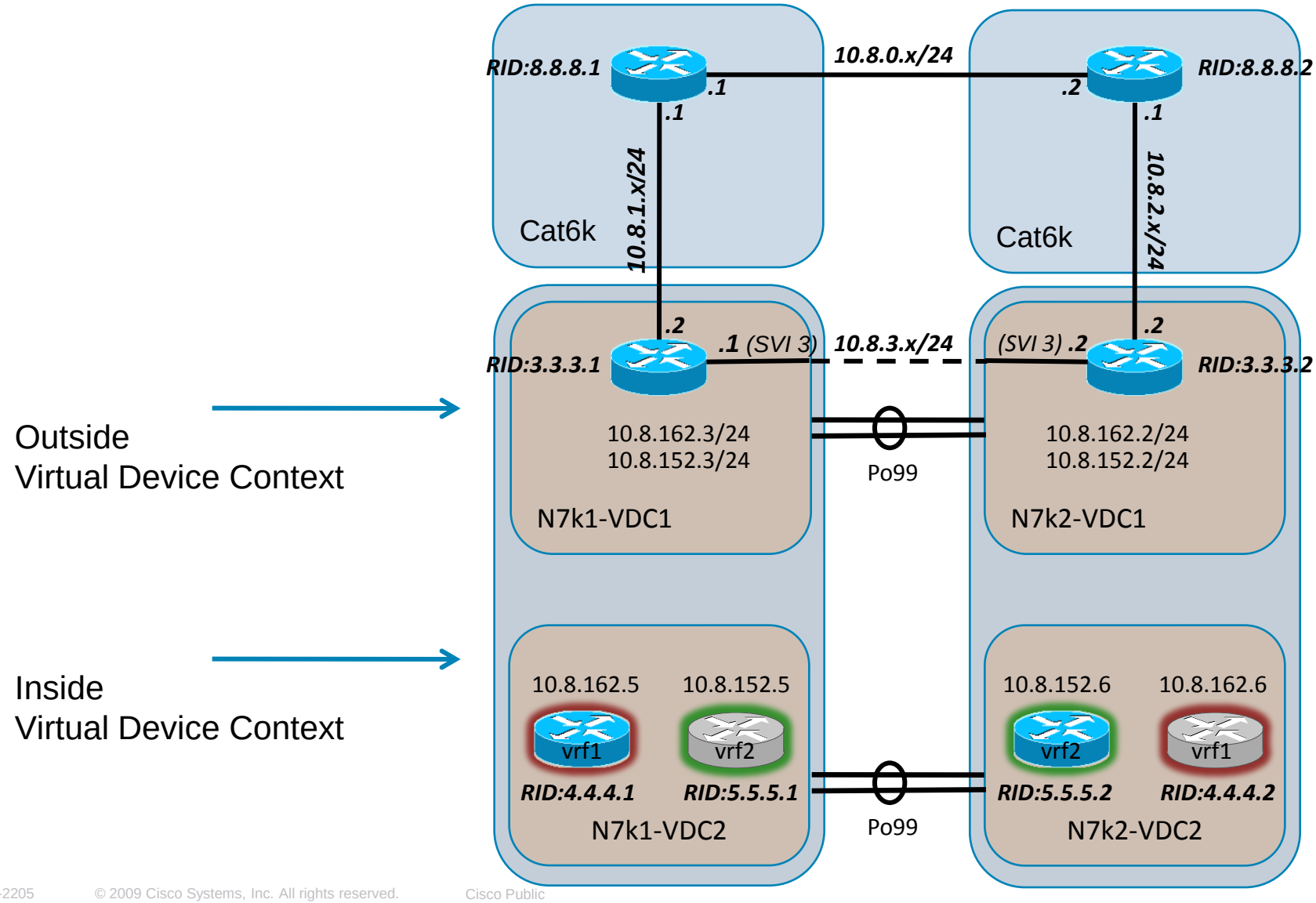
Data Center: Aggregation

Device Virtualization: Nexus 7000 Virtual Device Contexts

- Up to 4 separate virtual switches from a single physical chassis with common supervisor module(s)
- Separate control plane instances and management/CLI for each virtual switch
- Interfaces only belong to one of the active VDCs in the chassis, external connectivity required to pass traffic between VDCs of the same switch

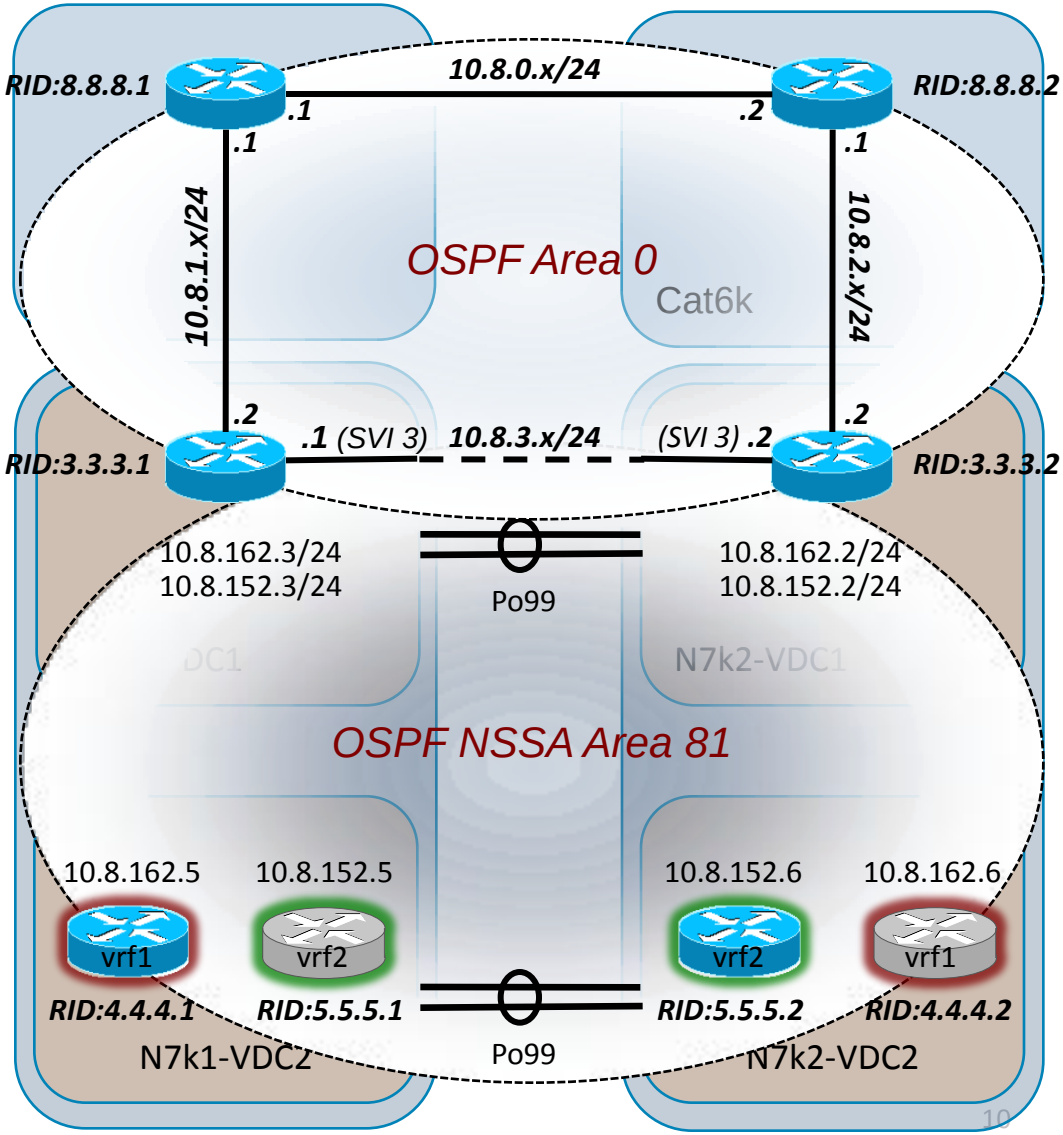


Aggregation Layer with VDCs



Control and Segmentation

- Control Routing Propagation
- Example: inject only default route to internal VDC
- Traffic between VDCs must be routed or bridged via external
- Access controlled to inside and outside contexts



Aggregation Security Features

- CoPP

  Protect the supervisor from DoS attacks preventing outages. Prevent Layer 2 broadcast storms and irrelevant traffic redirections to CPU

- Broadcast Suppression

  Protects the data center against broadcast storms at the port level that pose risks to bandwidth availability

- Packet Sanity Checks

  Forwarding engine performs extensive checks on IPv4 and IPv6 packet headers to protect the network from illegal packets.

- LinkSec

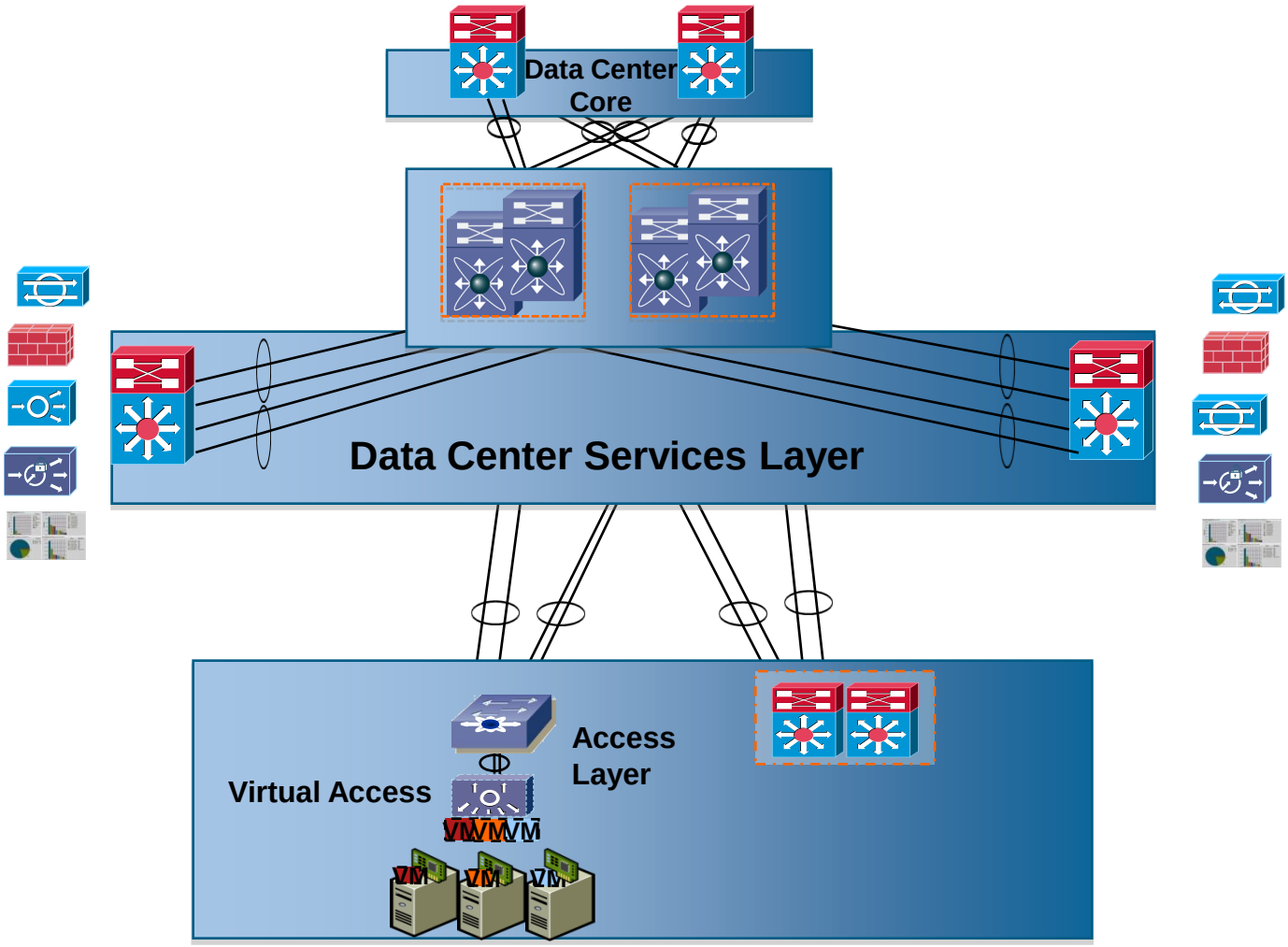
  Wire-rate link-layer cryptography is provided at all ports. Packets are encrypted on egress and decrypted on ingress so they are clear inside the device.

Additional Nexus 7000 Tidbits

- Virtualization support
  - AAA configuration and operation are local to the VDC.
  - AAA authentication methods for the console login only apply to the default VDC.
  - AAA accounting log is on per VDC basis
- Role Based Access
  - Four default roles
  - Network-admin
    - Permission to create/delete/assign resources to VDC.
    - Can create other roles and users.
  - Network-operator
    - Permission to run show command across all VDCs.
  - VDC-admin
    - Permission to manage a VDC, create other VDC roles and users for that VDC.
  - VDC-operator
    - Local to a VDC and has show command privilege

Data Center: Security Services (and Others)

Security Services



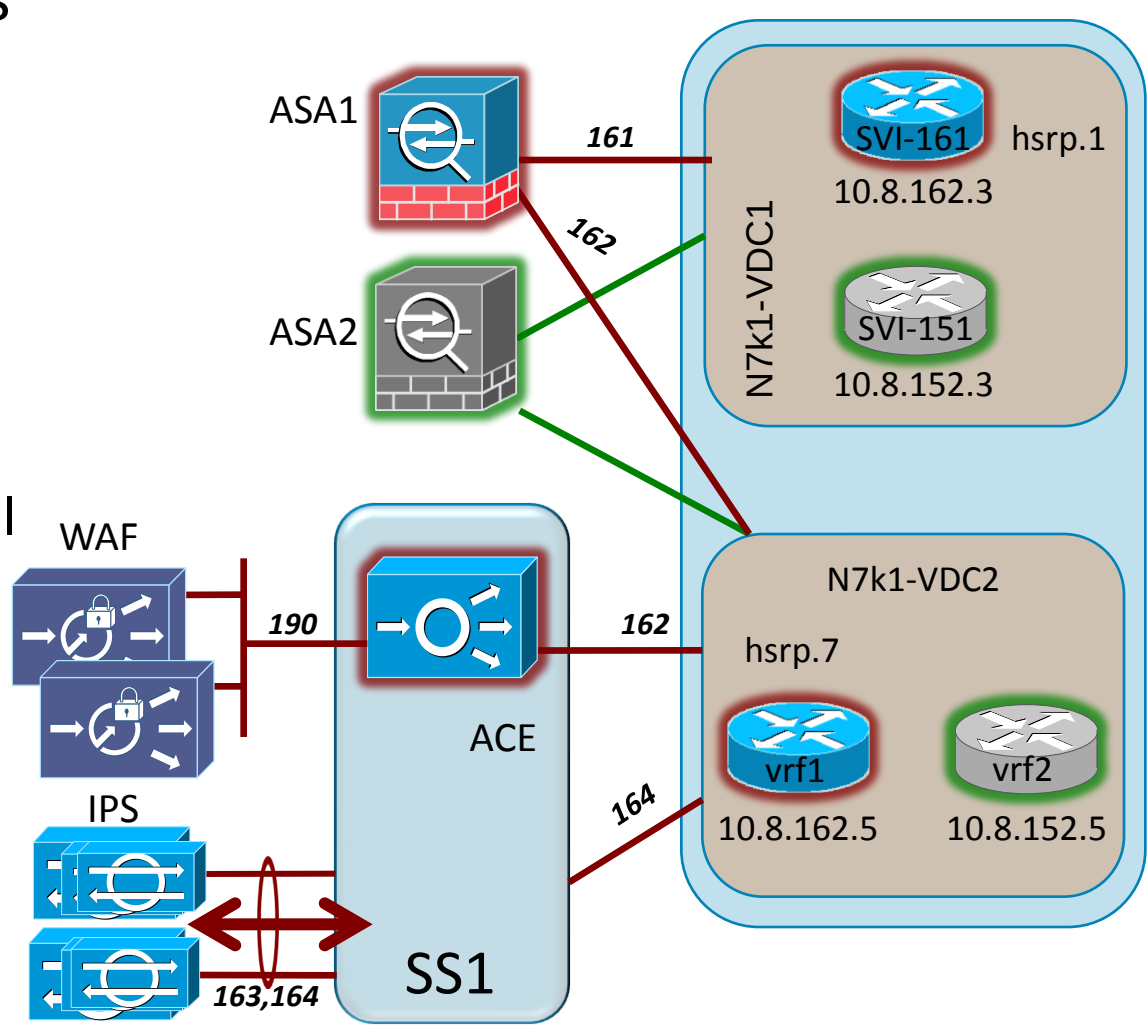
Security Service Integration

- Deploy security services and appliances as transparently as possible.
  - Maintain predictable traffic flows to ensure availability
  - Need to think about scalability of current infrastructure when planning designs.
- Create Security Zones based on Trust
- Minimal impact to allowed functions while maintaining
  - Enforcement, Isolation, Visibility
- Business model, compliance, applications, can all drive policy
- One model does not fit all but there are some design guidelines we can provide

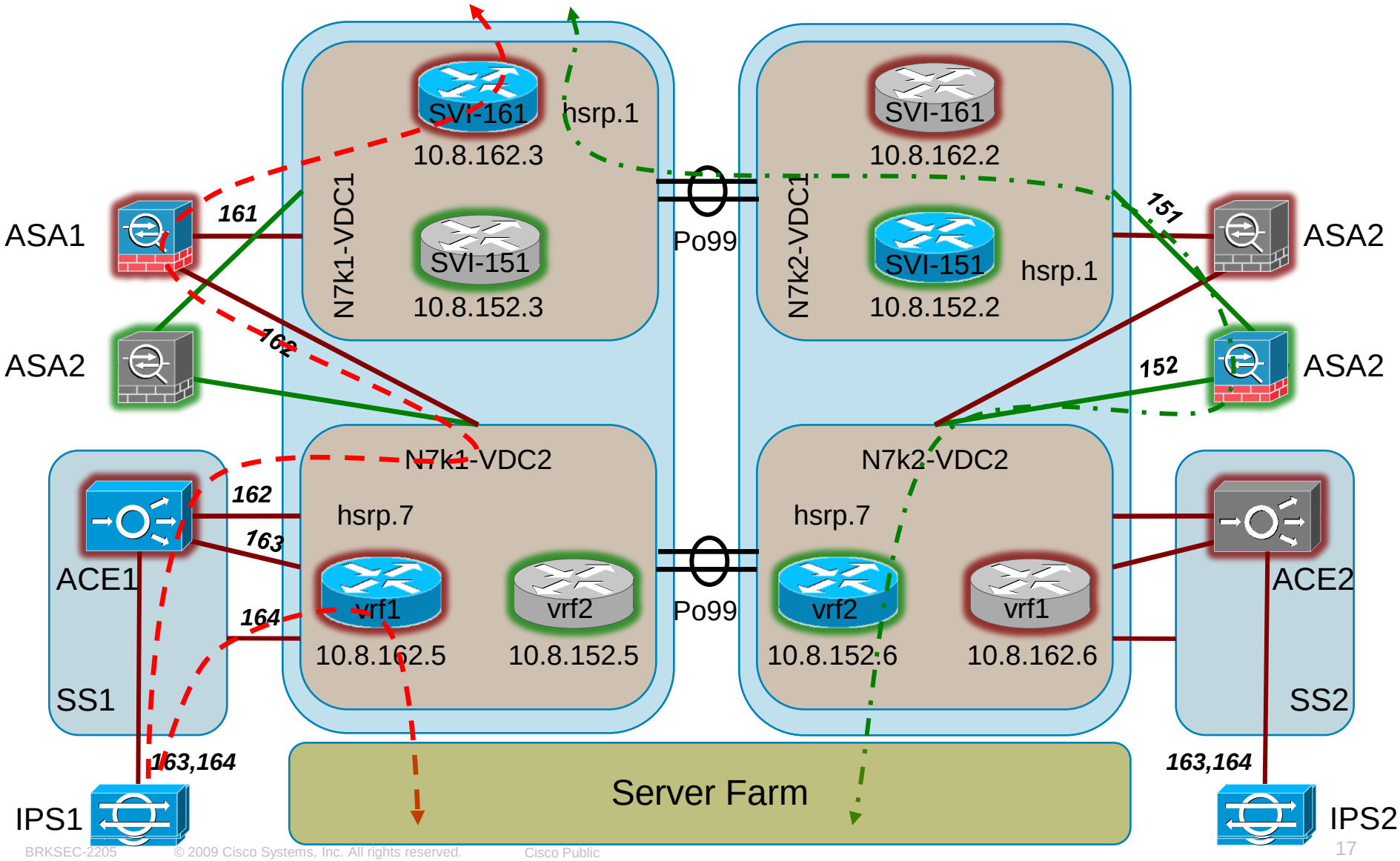
Security Services

Transparent Services Are “Sandwiched” between Nexus VDCs

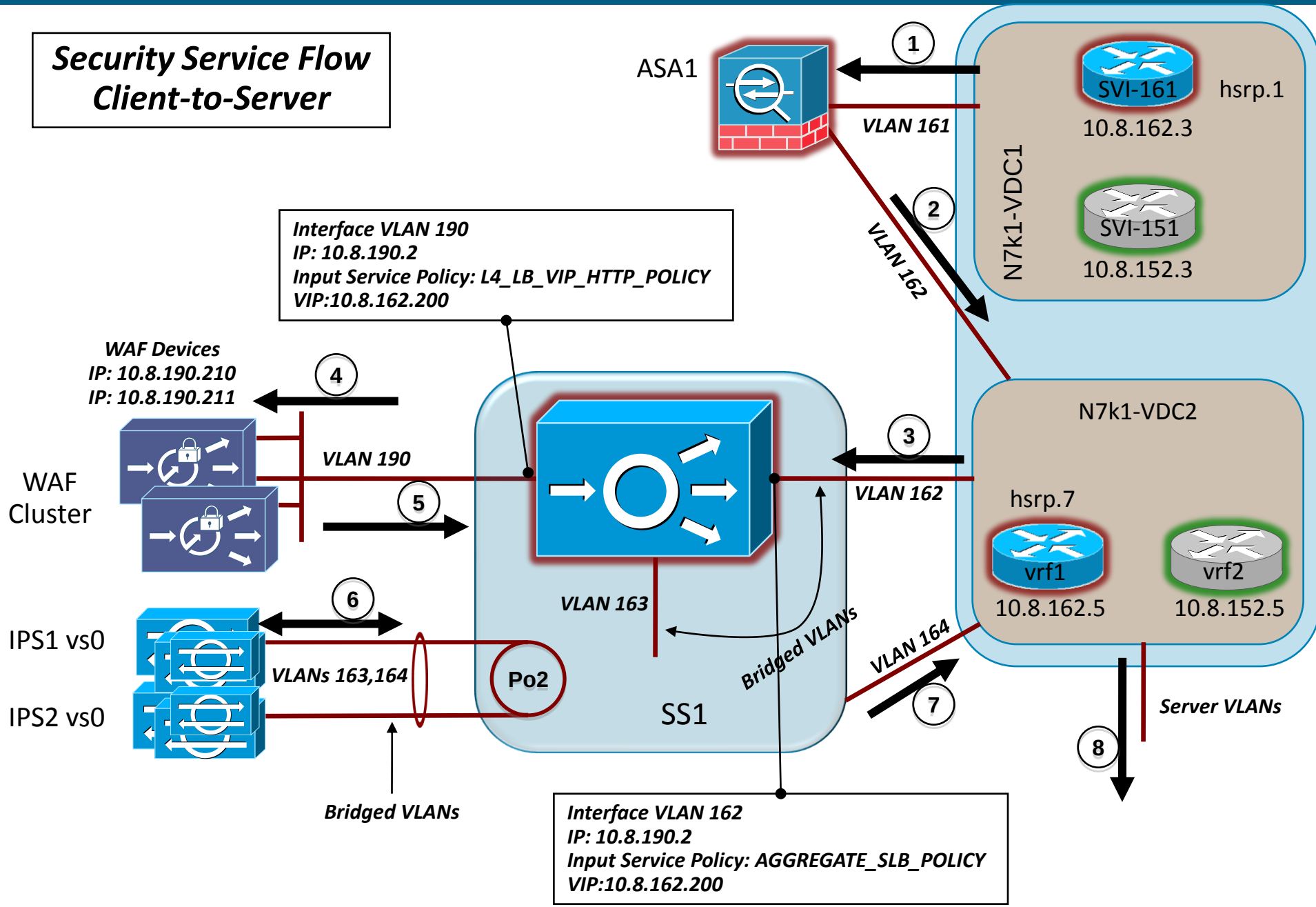
- ASA Stateful Firewall
  - Virtual Contexts
  - Transparent mode
- ACE LB
  - Transparent mode
- Web Application Firewall
  - Firewall farm
- Network IPS/IDS
  - Inline or promiscuous



Traffic Flows



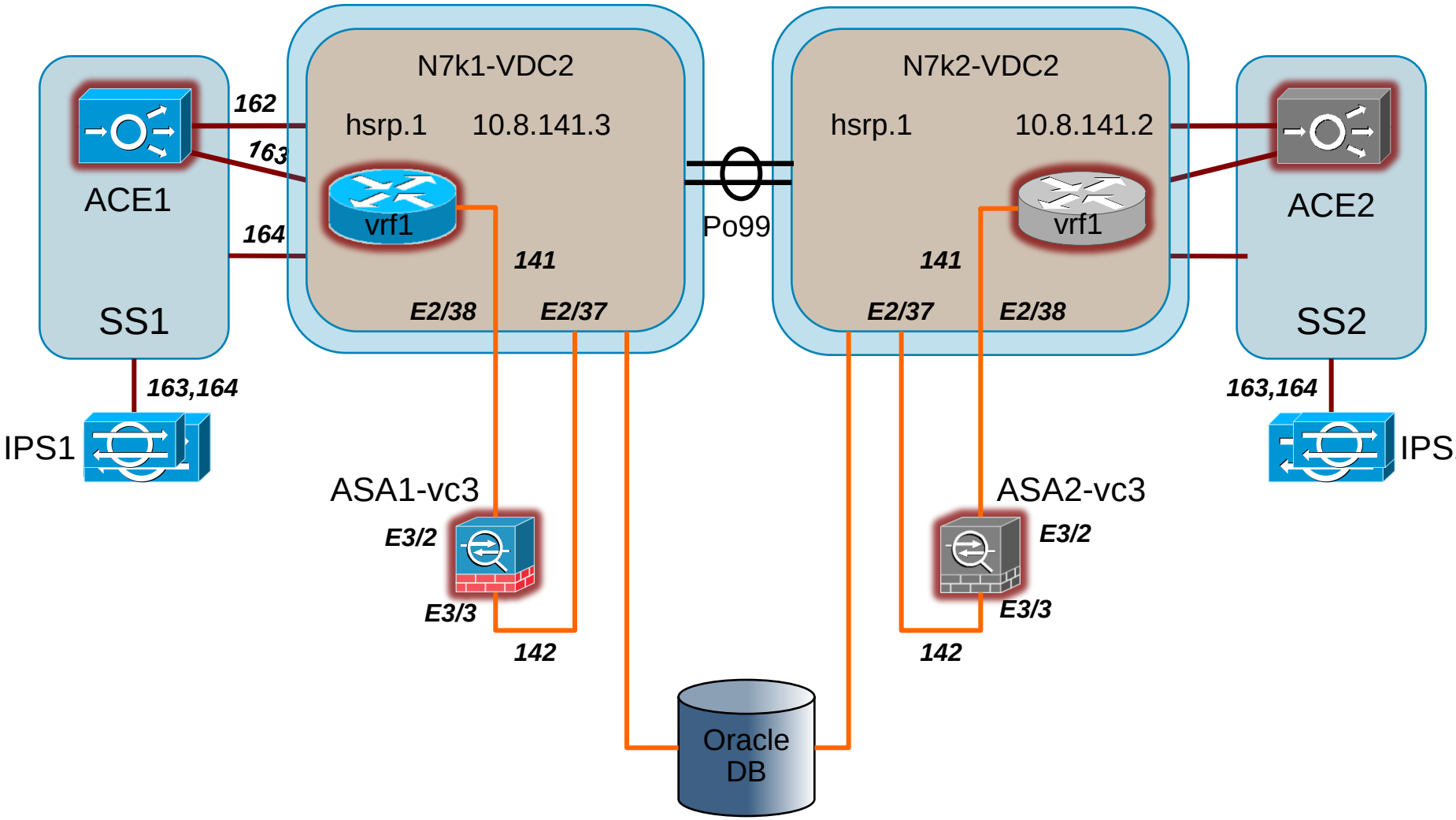
Security Service Flow Client-to-Server



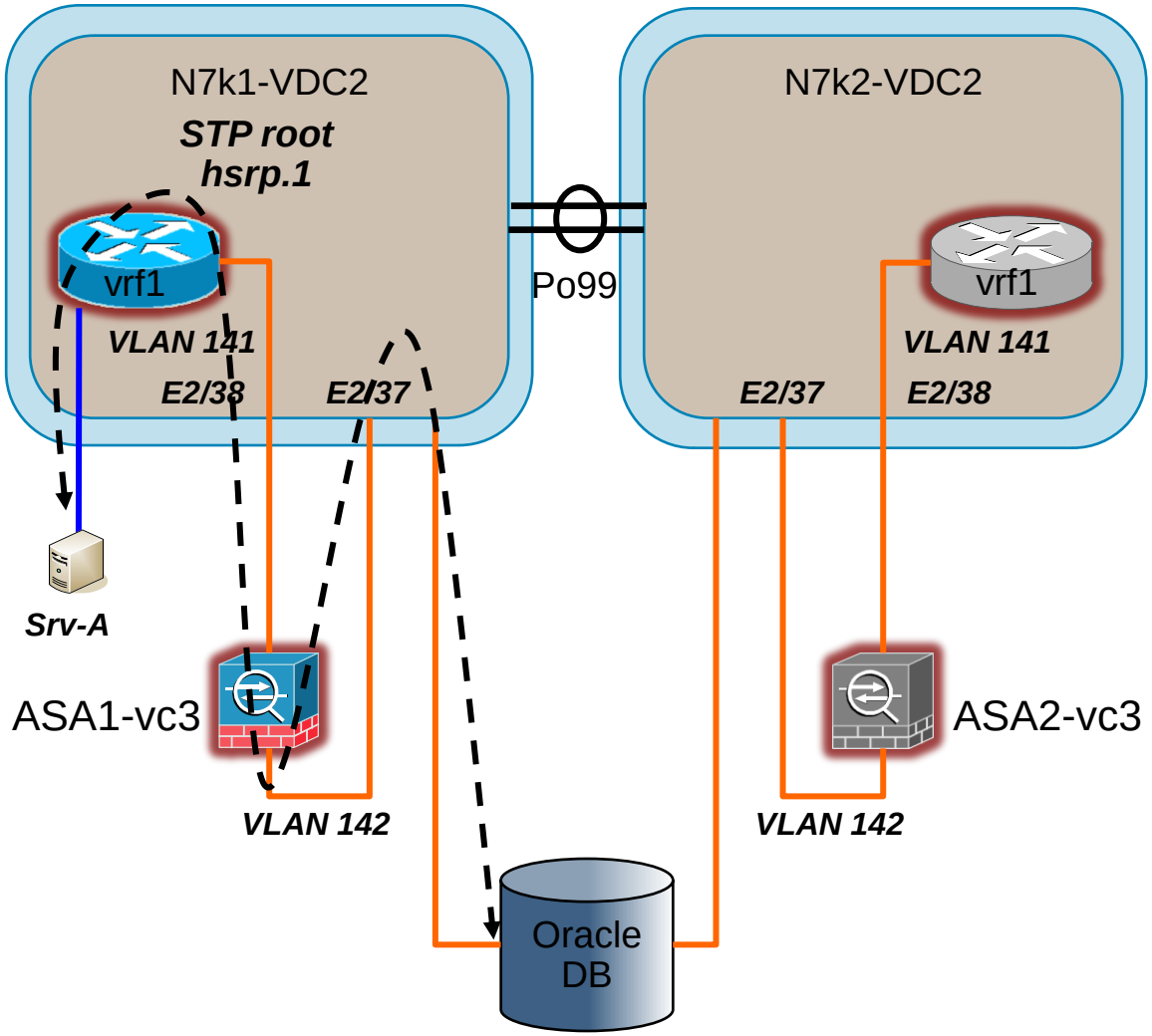
Examples


[communication]
[leadership]
[inspiration]
[invention]
[knowledge]
[collaboration]

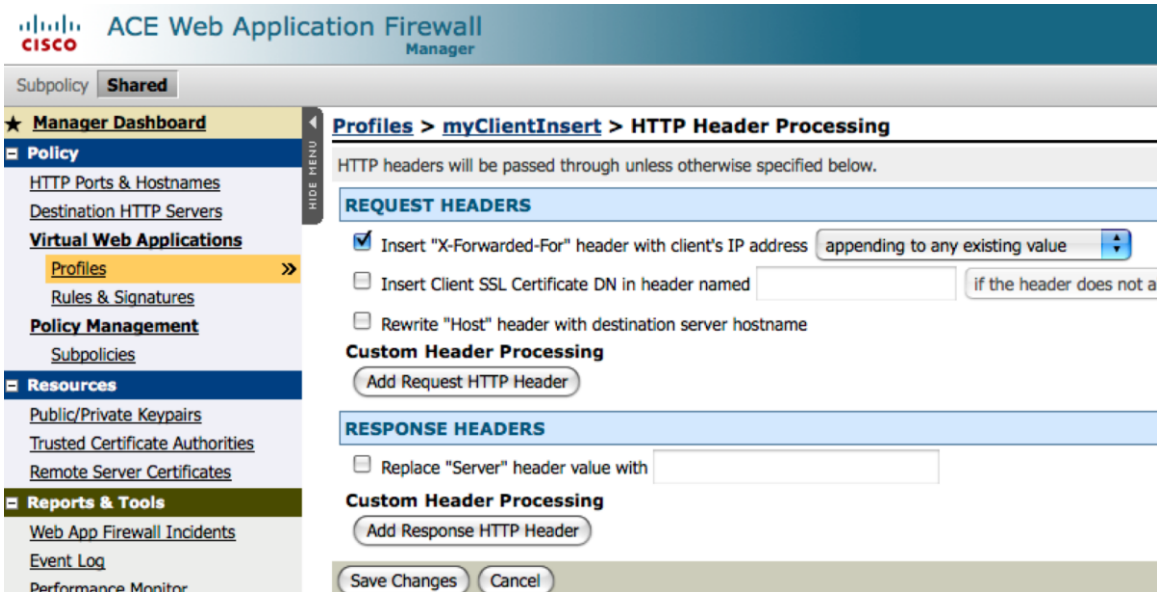
Virtual Context on ASA for ORACLE DB Protection



Example of Server to Database access through virtual firewall context.

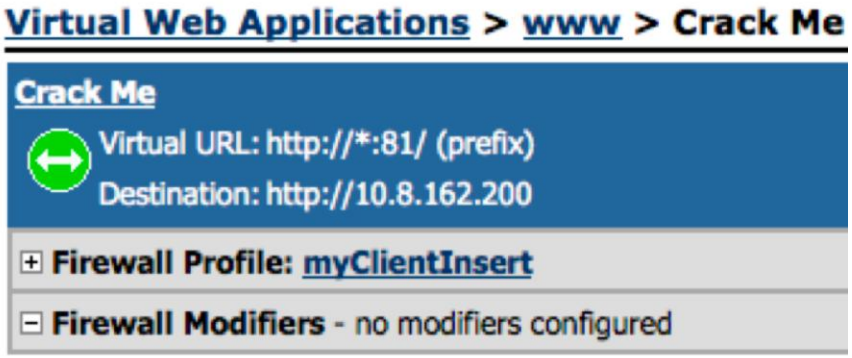


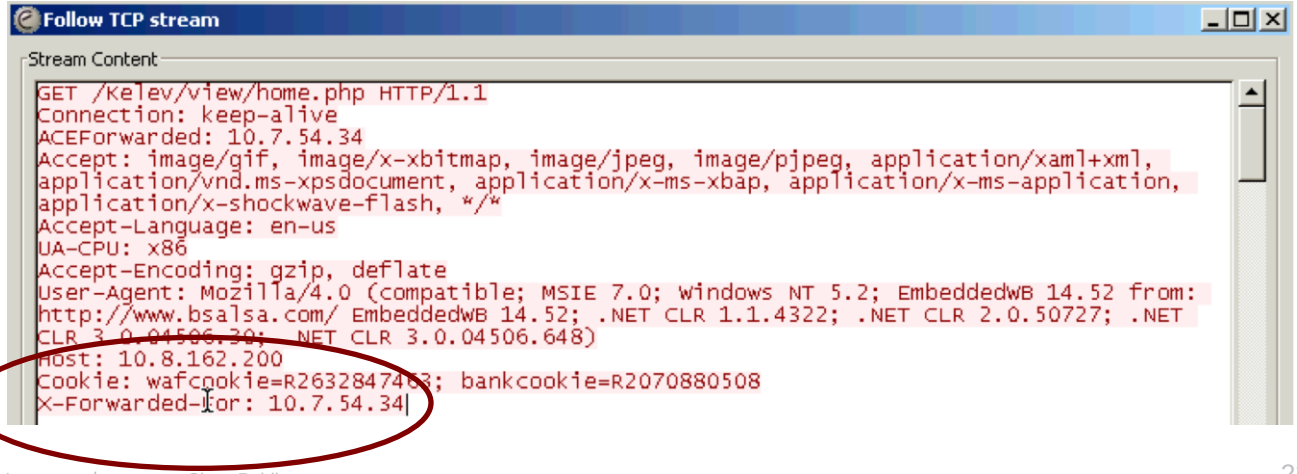
Using ACE and WAF to Maintain Real Client IP Address as Source in Server Logs



Server Logging

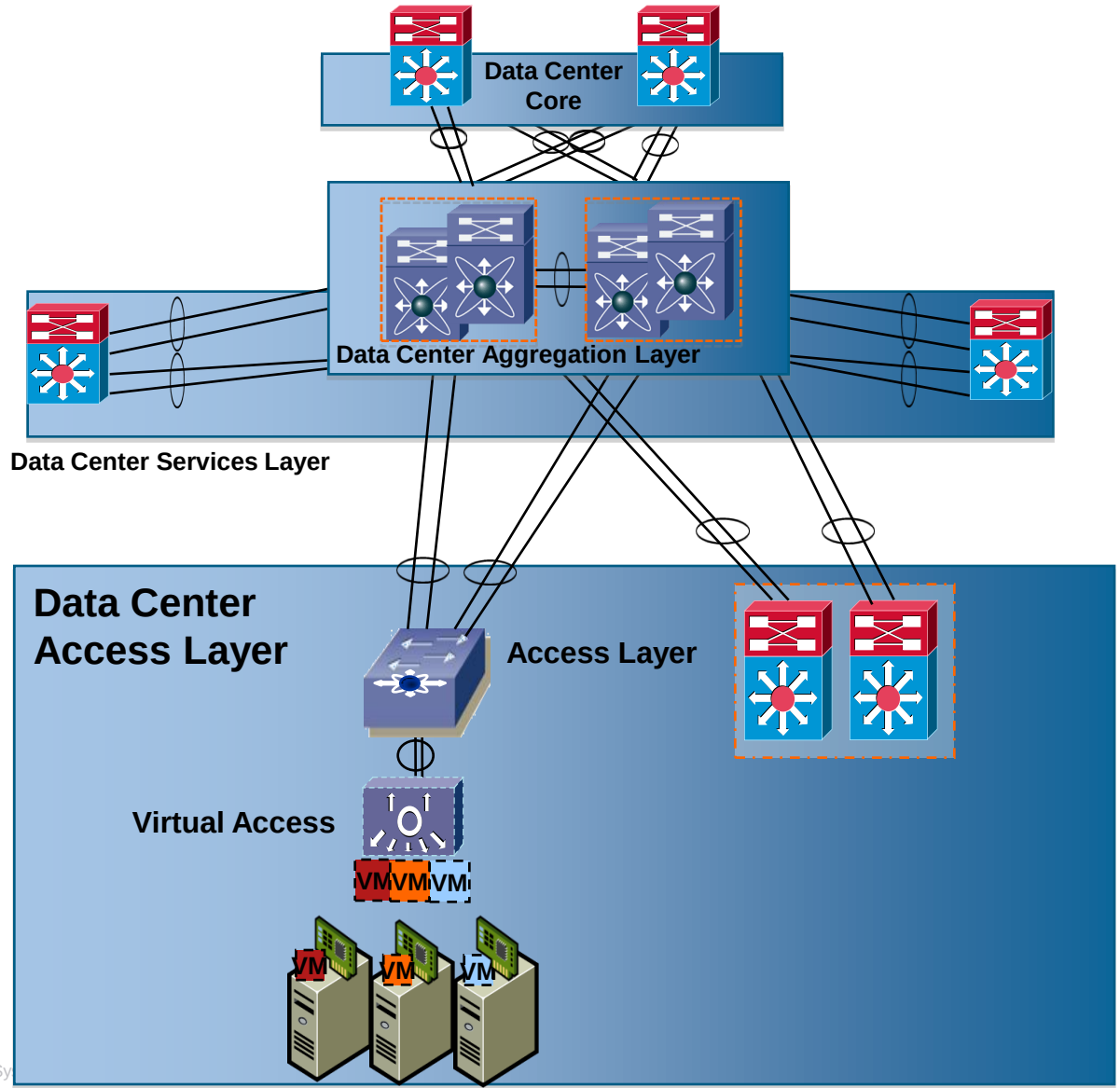
- Session persistence maybe maintained via HTTP header insertion
- ACE LB and Web Application Firewall support this functionality





Access Layer

Data Center Access



Security Considerations

- In many cases server tiers/clusters are separated by VLANs
- Servers are often Layer 2 adjacent
- Must allow for mobility

  DR

  Maintenance
- Security is key in maintaining availability of servers and applications connected here.

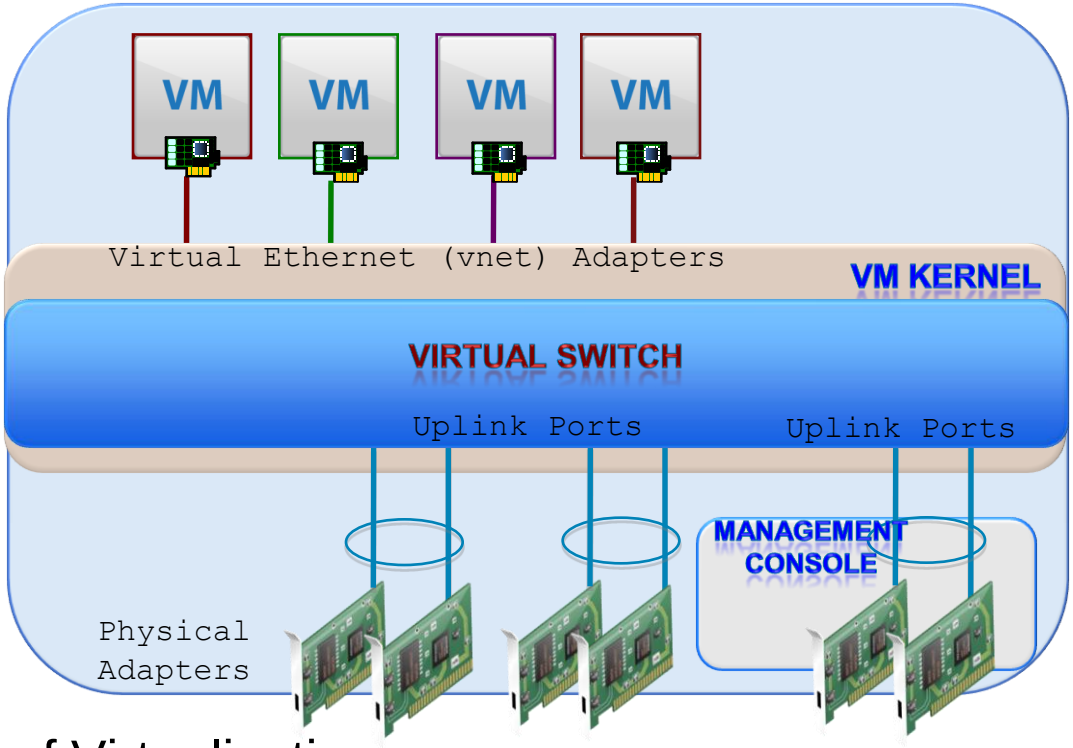
Make Use of Switch Security Features

- Anti-spoofing features

  Dynamioc ARP Inspection, IP Source Guard, DHCP Snooping
- STP protection (BPDU Guard)
- QoS
- Broadcast Packet Suppression
- PVLANs
- Access Lists
- SPAN, ERSPAN, NetFlow

Virtual Access and Security

Server Virtualization



Benefits of Virtualization

- Power savings
- Consolidation of resources
- Server portability
- Application failover

Server Virtualization

- Hypervisors: Type 1 or Type 2

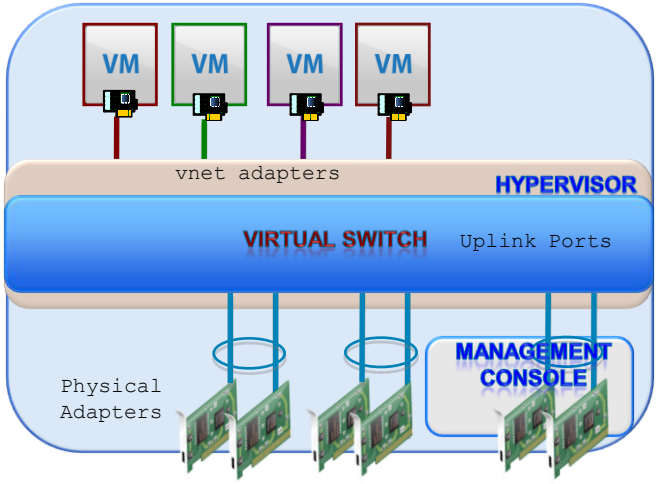
  Type 1 hypervisors as shown below are built into a pre-hardened host. There is no distinct boundary between the host operating system and the hypervisor.

  Type 2 hypervisors as shown below are installed as separate software on top of the existing host operating system

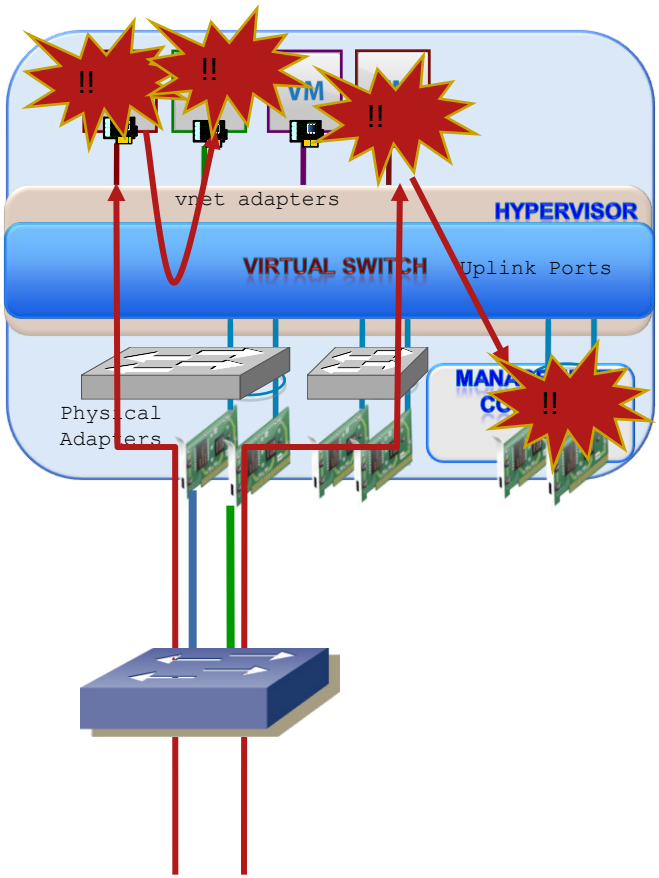
- Primary role of the host OS or hypervisor is to work with the VMM to coordinate access to the physical host system's hardware resources (CPU, Device Drivers, etc)
- Theoretically the hypervisor should have fewer security vulnerabilities because it runs minimal services and contains only essential code BUT maintaining security updates is still important!

Server Virtualization Security Concerns

- Secure Hypervisor
  - Mitigate risk towards the hypervisor
  - an attacker gaining unauthorized access to the hypervisor and taking control of the physical server and related virtual servers
- Rogue VMs
  - Has a guest operating system been compromised?
  - Virtual Server Mobility
- Inter-VM traffic visibility and security
  - Traffic between two virtual machines can flow across the bus inside the hosting physical server and not be required to be switched on an external network where traditional tools can be used
  - VMware “virtual switch” lacks security features available in Cisco switching platforms
- Shared File system between VMs
  - VMFS and VMotion
  - Consolidated SANs or NAS attached storage

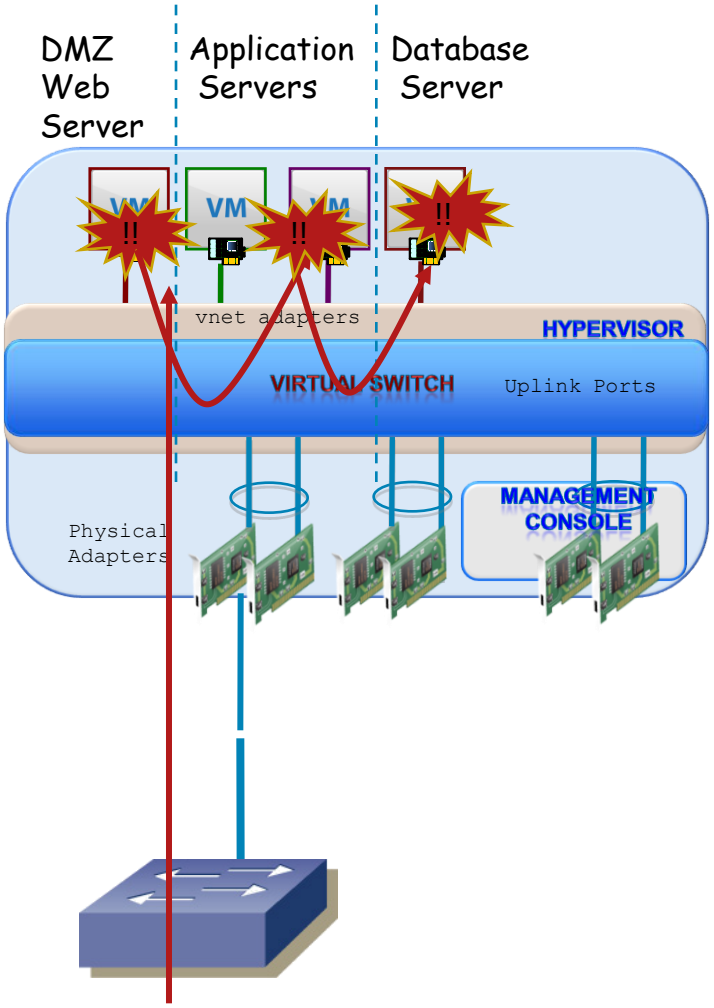


Securing the Hypervisor…



- Hypervisor has access to all resources
  - Manages all system resources
  - Manages LAN & SAN access
- vSwitch lacks “standard” network functions
  - No visibility into VM-to-VM traffic on a port group
  - No visibility into VM-to-Hypervisor calls

Virtual Machine LAN Security



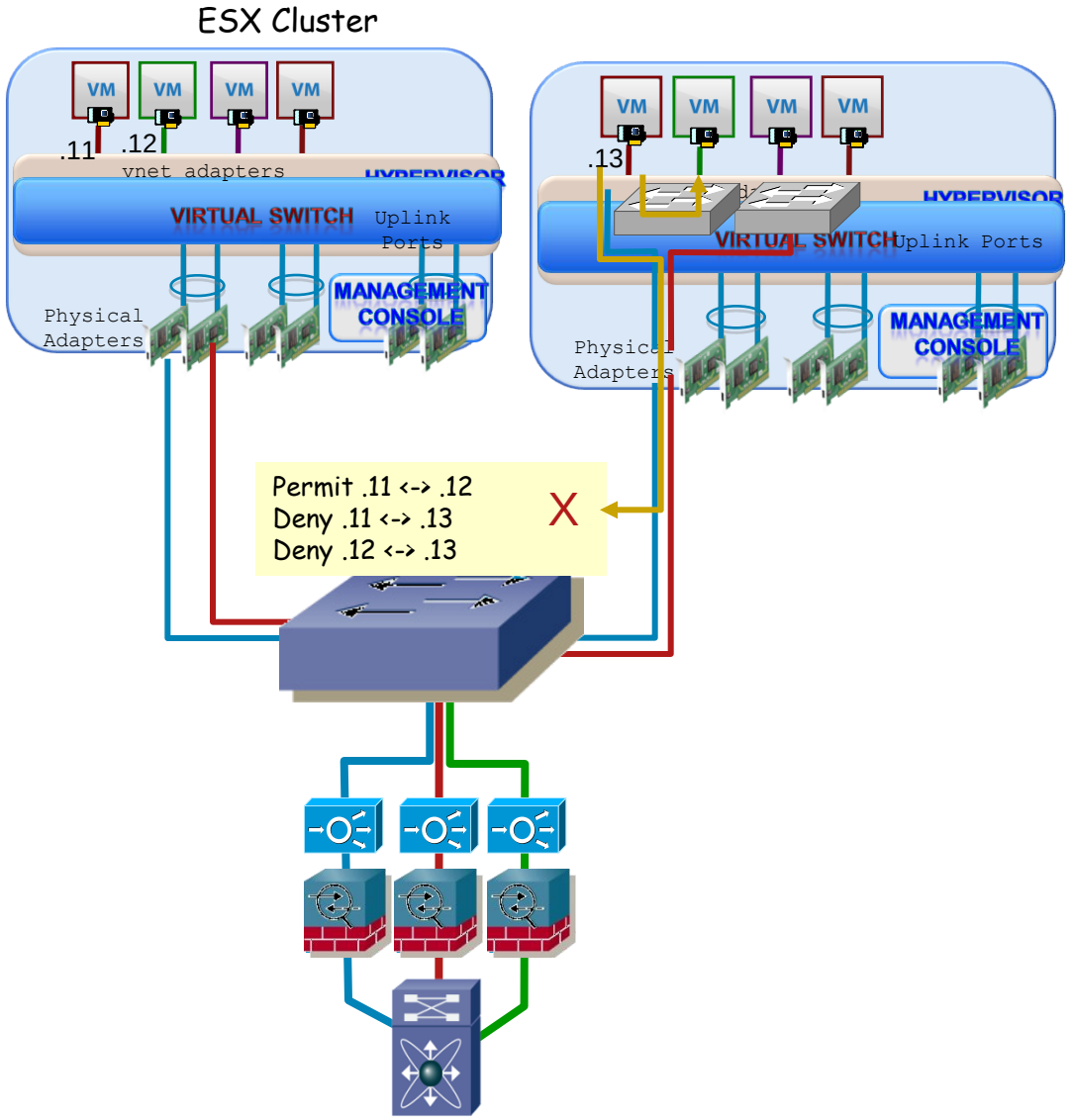
- Be aware of security affinities

  Would you place all your applications on the same VLAN?

- Challenging troubleshooting & monitoring environment

- Recommendation: Do not consolidate servers with unlike security affinities onto a single VLAN

Virtual Machine VMotion Security



- VMotion enables workload mobility & Disaster Recovery
- Increases server utilization efficiency by balancing workloads between servers
- VMs can move between ESX cluster members with the same configuration
  - Port-groups, VLANs, etc
- Inconsistent security policies enforcement and visibility
  - Policies applied at the server port or VLAN cannot be consistently applied
- Vmotion traffic sent in clear text. Take precautions for isolating

Virtual Machine Exploits

- Several Theoretical Exploits
  - Gain Control of the Hypervisor
  - Exploiting vMotion
- Reconnaissance: Virtual Machine Detection
  - VME artifacts
  - Malware that detects virtual machines
  - Tools: (The Red Pill, Scoopy & Doo, VMDetect, etc)
  - Virtual machine-based root kits

Theoretical attacks are interesting but lets focus on the simple things that cover 99% of the issues. Most people don't even have the simple items covered!

Lets worry about this before we worry about theoretical Hypervisor attacks.

Things to Ponder…

- Traditional Security Problems Unchanged
- Security Policies still need to be enforced
- Virtualization introduces some new flavors
  - Hypervisor is a new layer of privileged software
  - Potential loss of separation of duties
  - Limited visibility into inter-VM traffic
- So What's the Secret Ingredient?

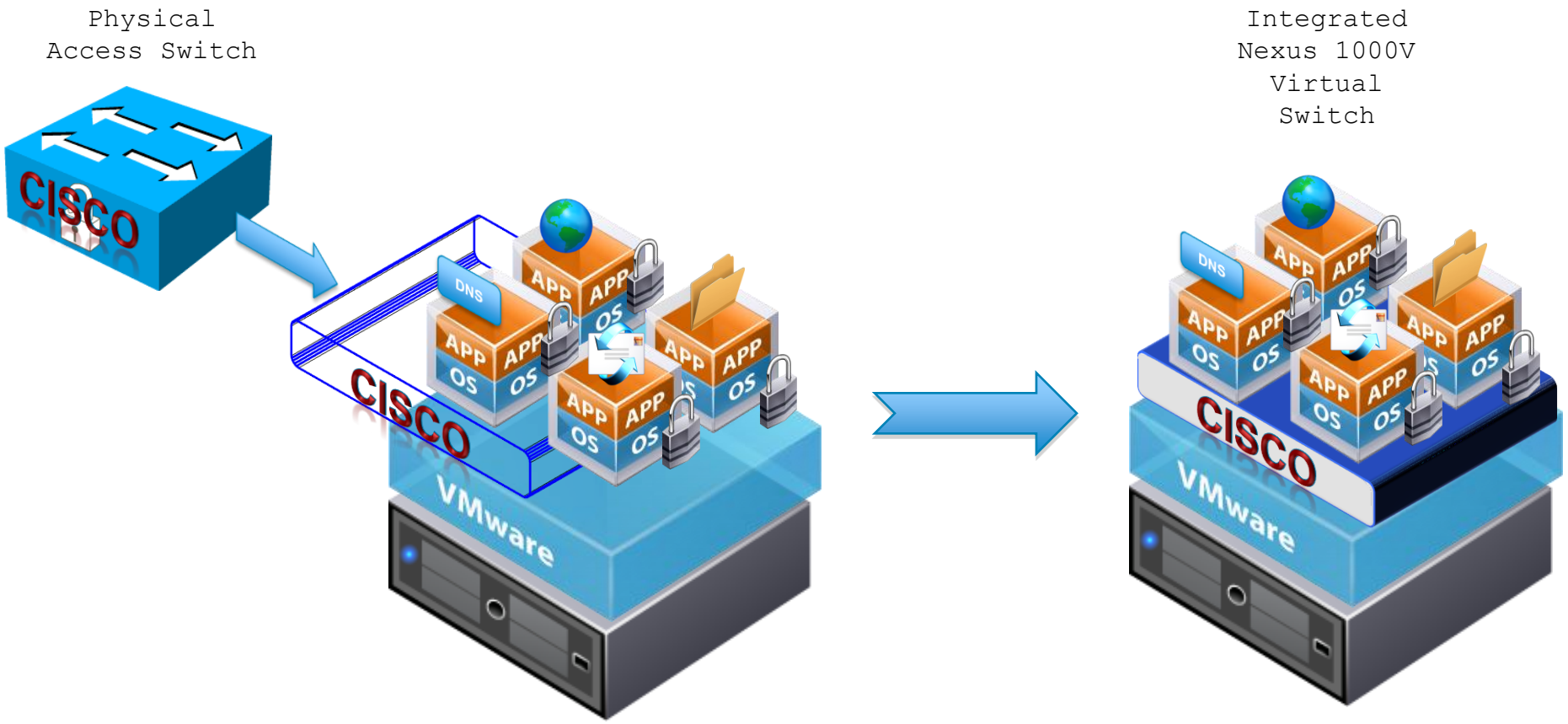
There Is NO Secret Ingredient!

Security best practices still apply!

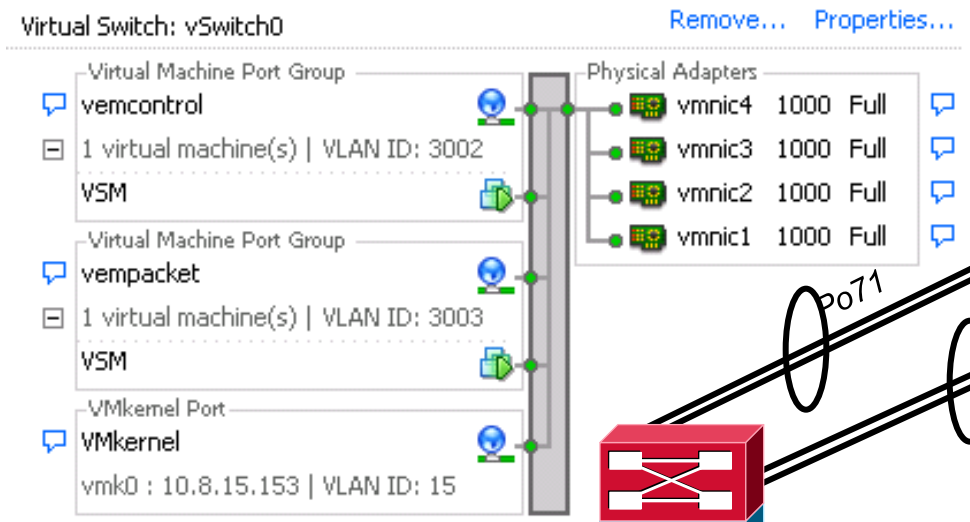
If you would not do it on a non-virtualized server, you probably should not do it on a virtualized server.

But we can address the virtualization concerns…

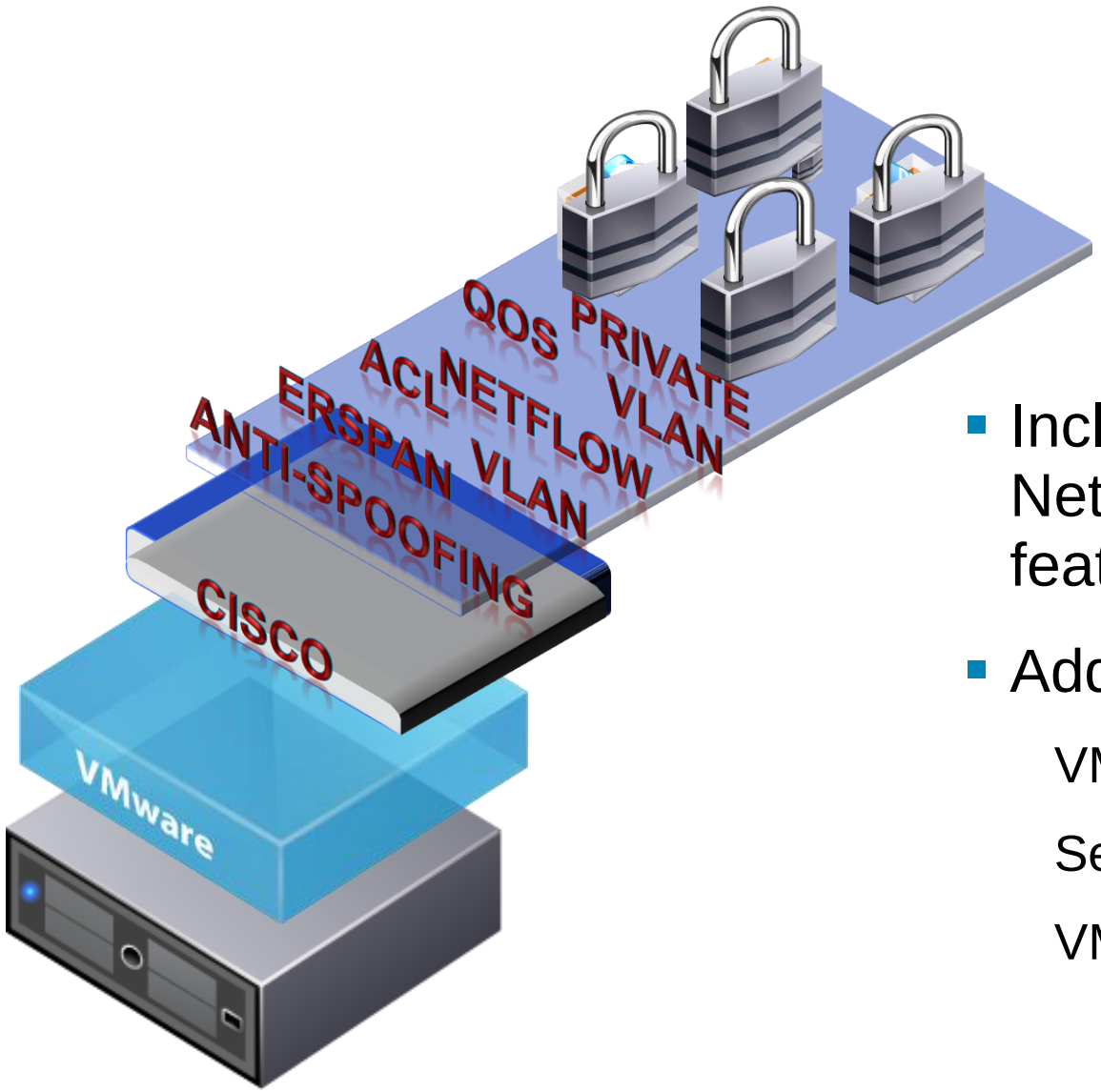
Merging Physical to Virtual Infrastructure



Virtual Access Fabric: Nexus 1000V



Nexus 1000V Key Features

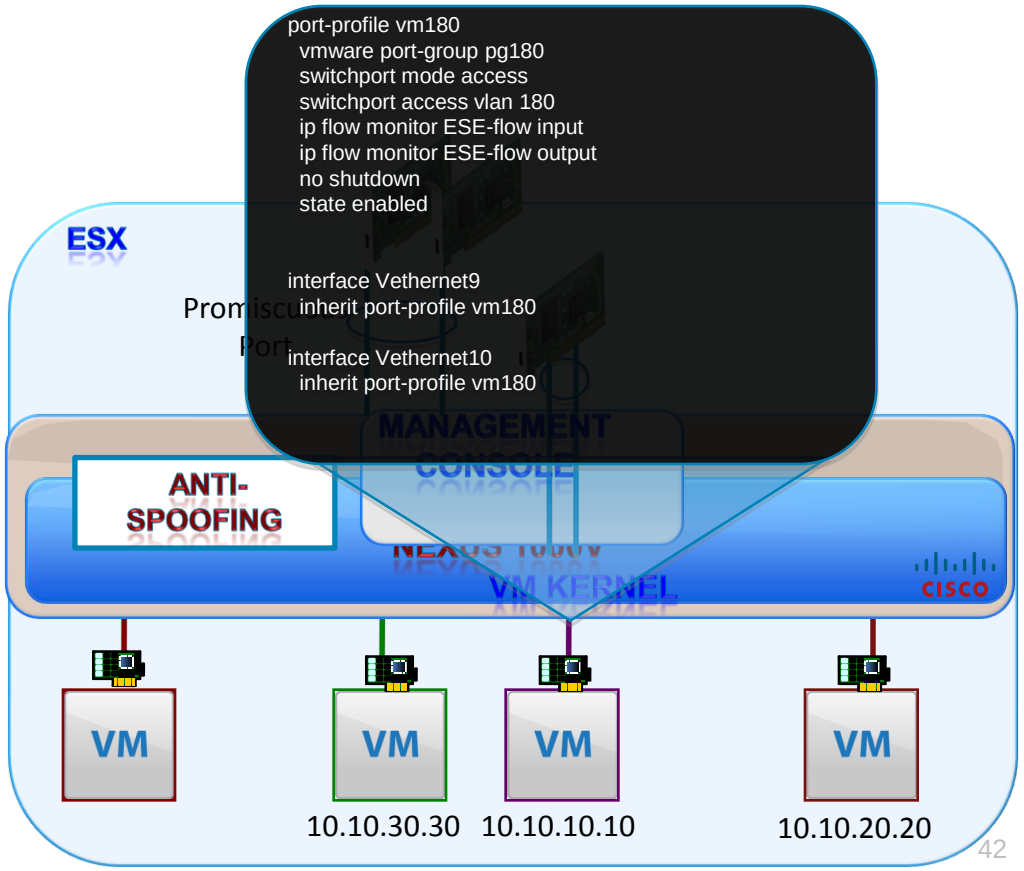


- Includes Key Cisco Network and Security features
- Addressing Issues for:
  - VM Isolation
  - Separation of Duties
  - VM Visibility

Separation of Duties: Network and Server Teams

Port Profiles

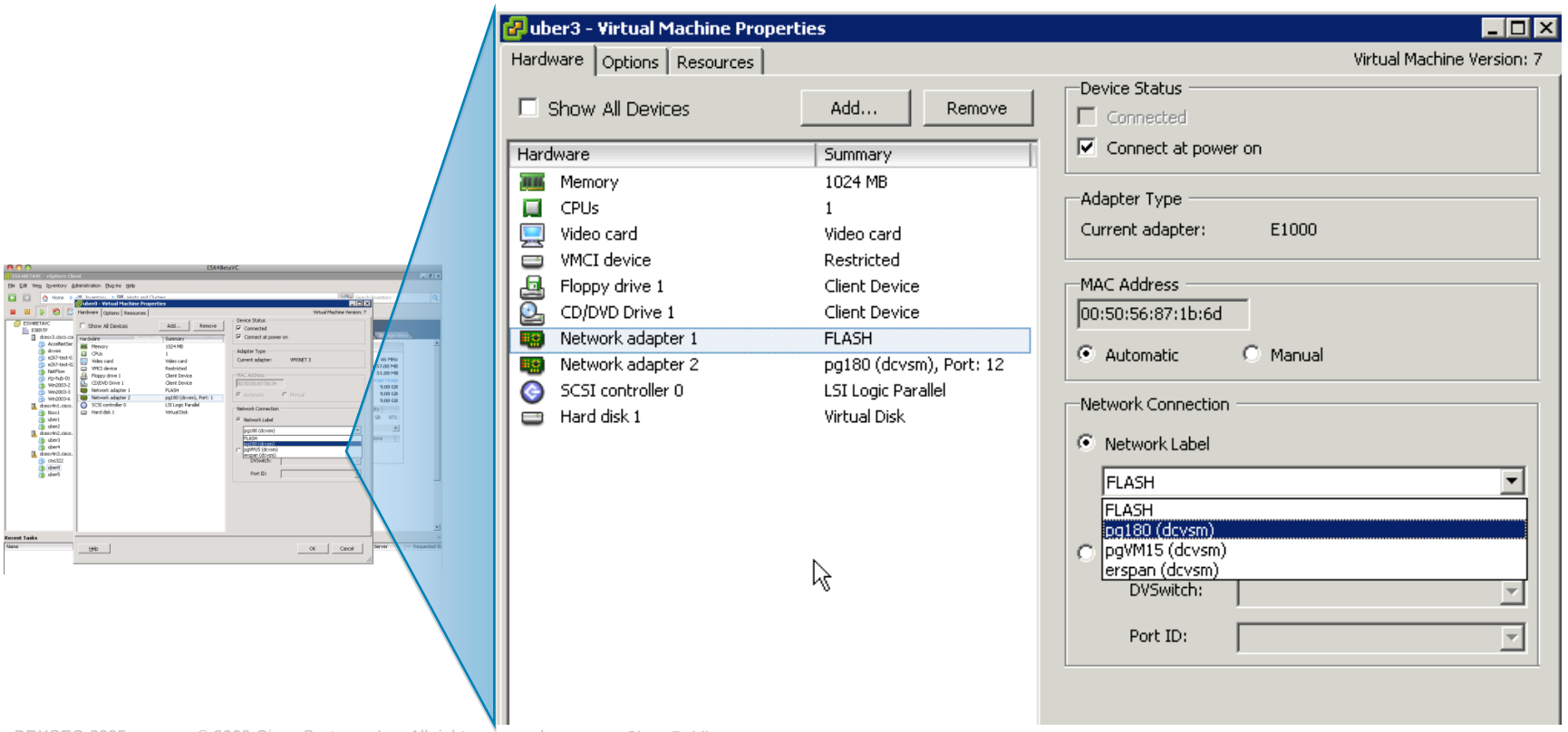
- A network feature macro
- Example: Features are configured under a port profile once and can be inherited by access ports
- Familiar IOS look and feel for network teams to configure virtual infrastructure



Separation of Duties: Network and Server Teams

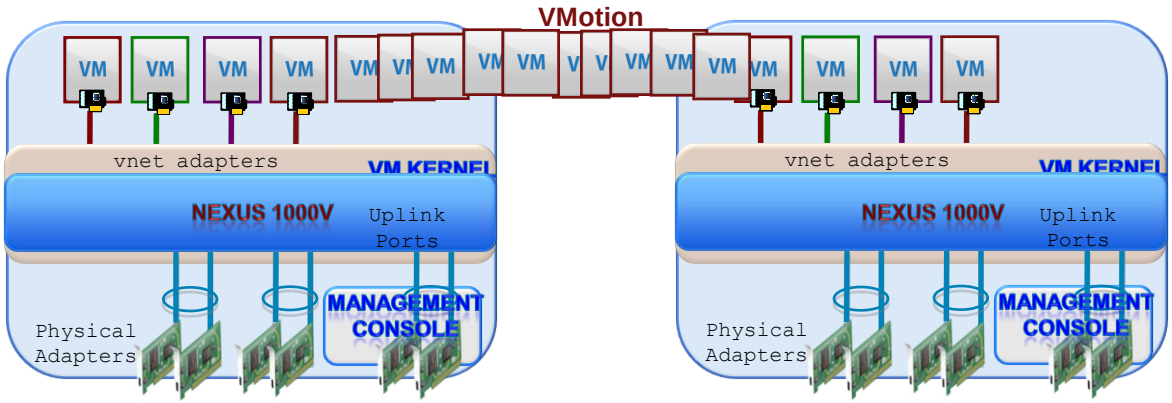
1. Nexus 1000V automatically enables port groups in Virtual Center via API
2. Server Admin uses Virtual Center to assign vnic policy from available port groups
3. Nexus 1000V automatically enables VM connectivity at VM power-on

Workflow remains unchanged



VMotion

1. Virtual Center kicks off a VMotion (manual/DRS) & notifies Nexus 1000V
2. During VM replication, Nexus 1000V copies VM port state to new host
3. Once VMotion completes, port on new ESX host is brought up & VM's MAC address is announced to the network

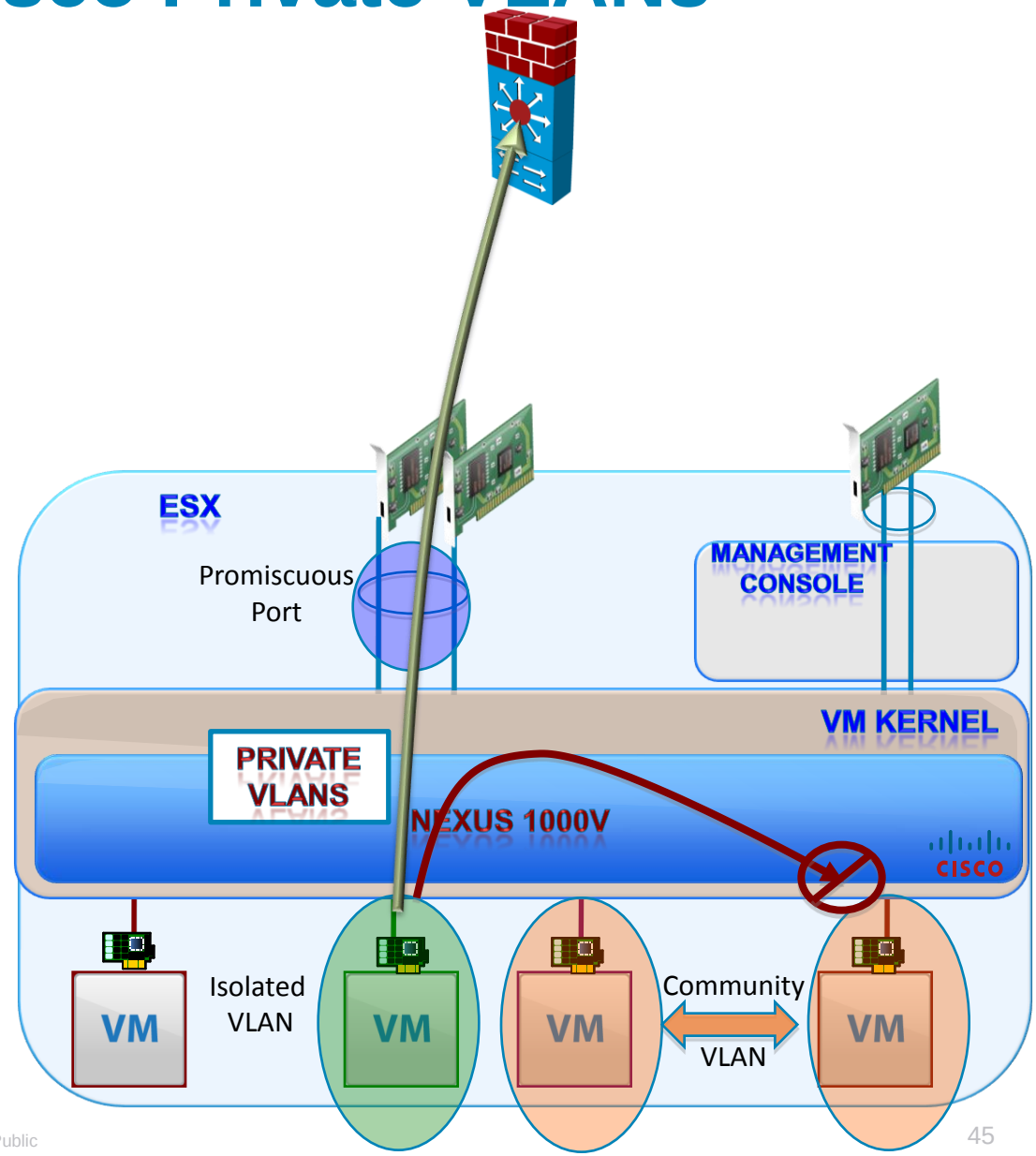


Mobile Properties Include:

- Port policy
- Interface state and counters
- Flow statistics
- Remote port mirror session

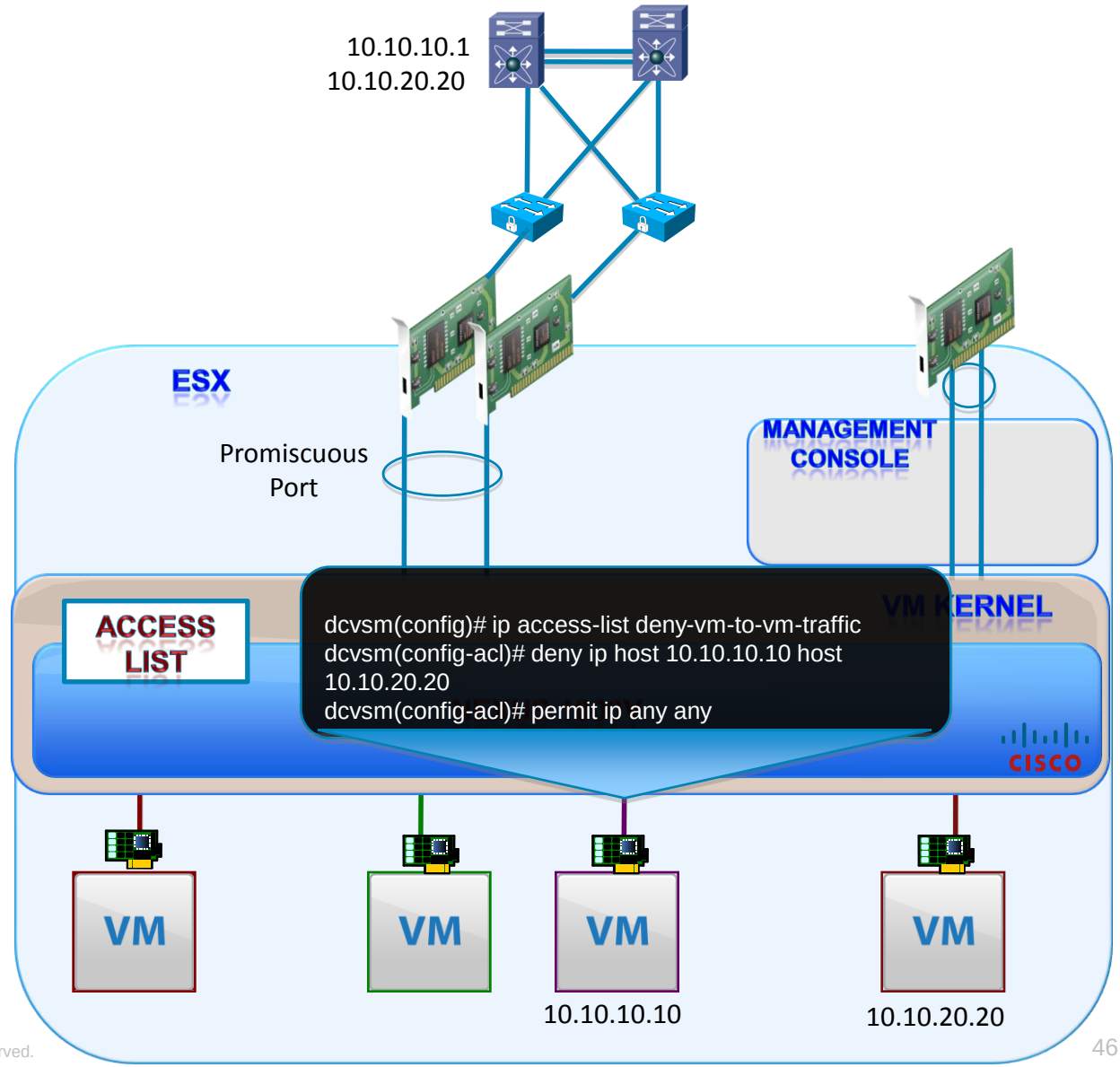
VM Isolation: Cisco Private VLANs

- Private VLANs provide layer 2 isolation for hosts in the same subnet
- Traditional Cisco PVLANs are supported: Isolated & Community ports
- Physical Infrastructure is PVLAN aware. You can carry PVLAN to physical devices ie: FWSM



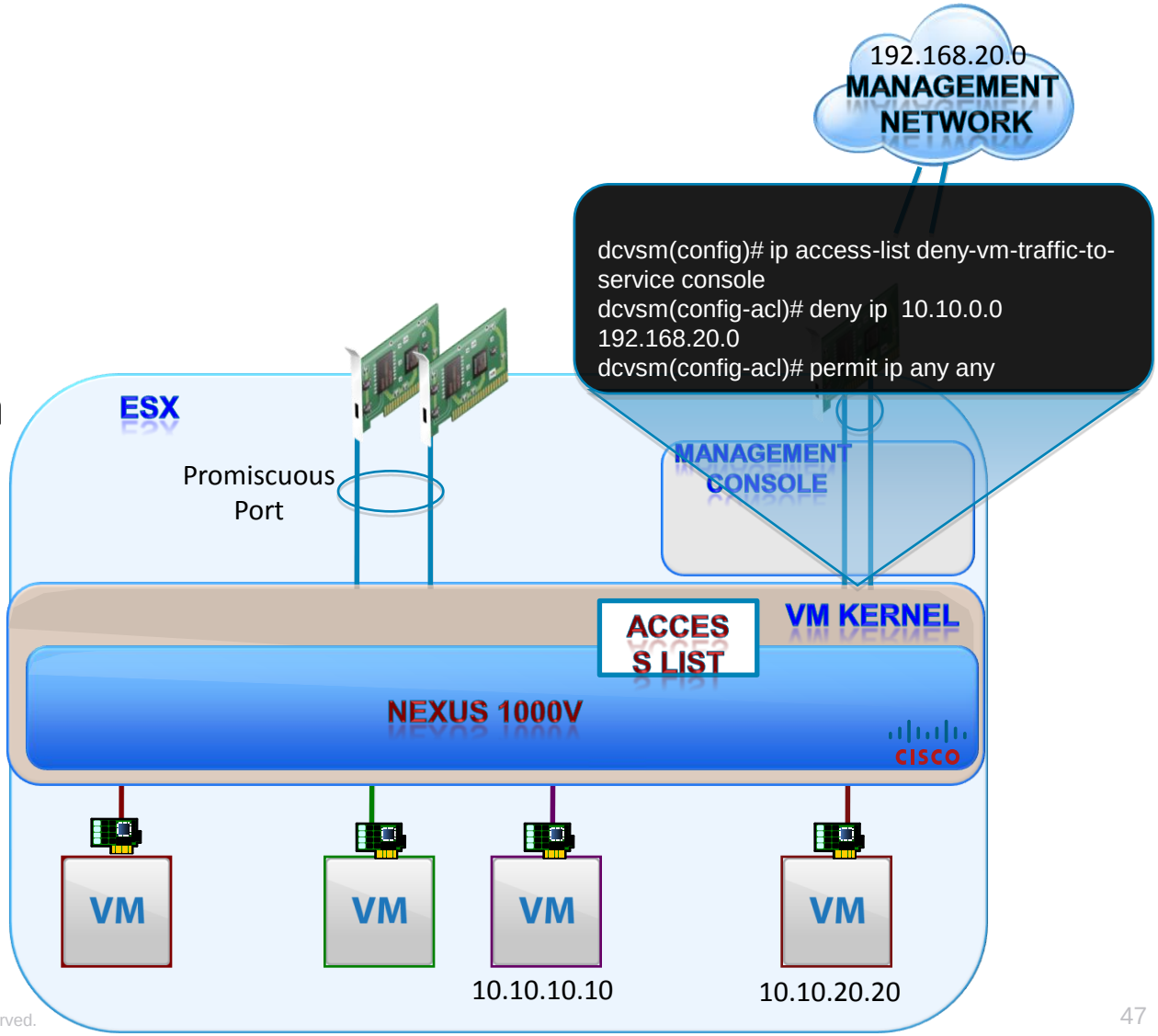
VM Isolation and Traffic Control

- Port ACLs
- Limit VM to VM traffic flows
- Enforce the way you enforce between physical servers today
- Use in conjunction with VLANs, PVLANs



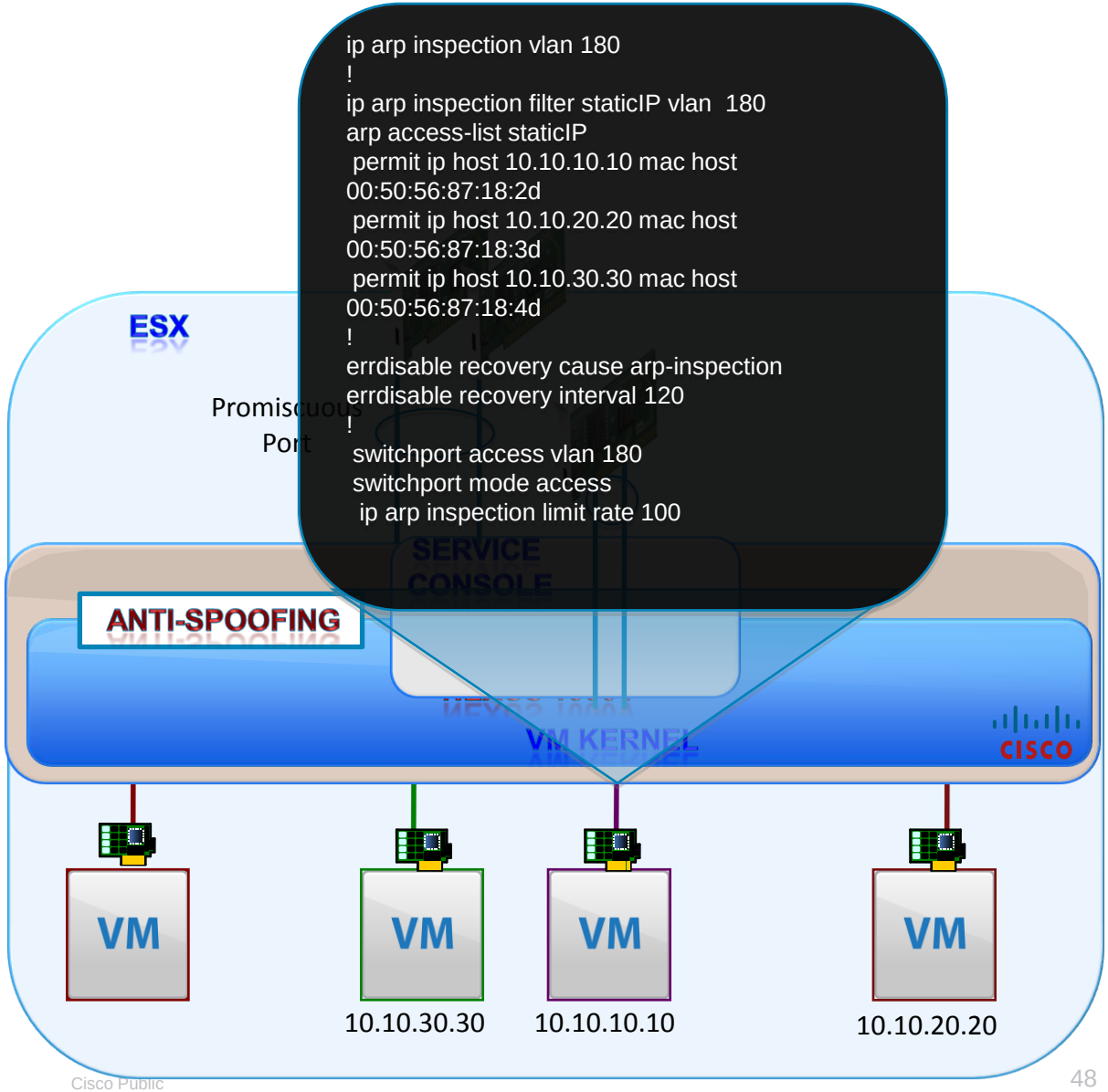
Isolating Production and Management Traffic

- Isolate management traffic from production
- Enforce physical separation and virtual separation



Anti-Spoofing

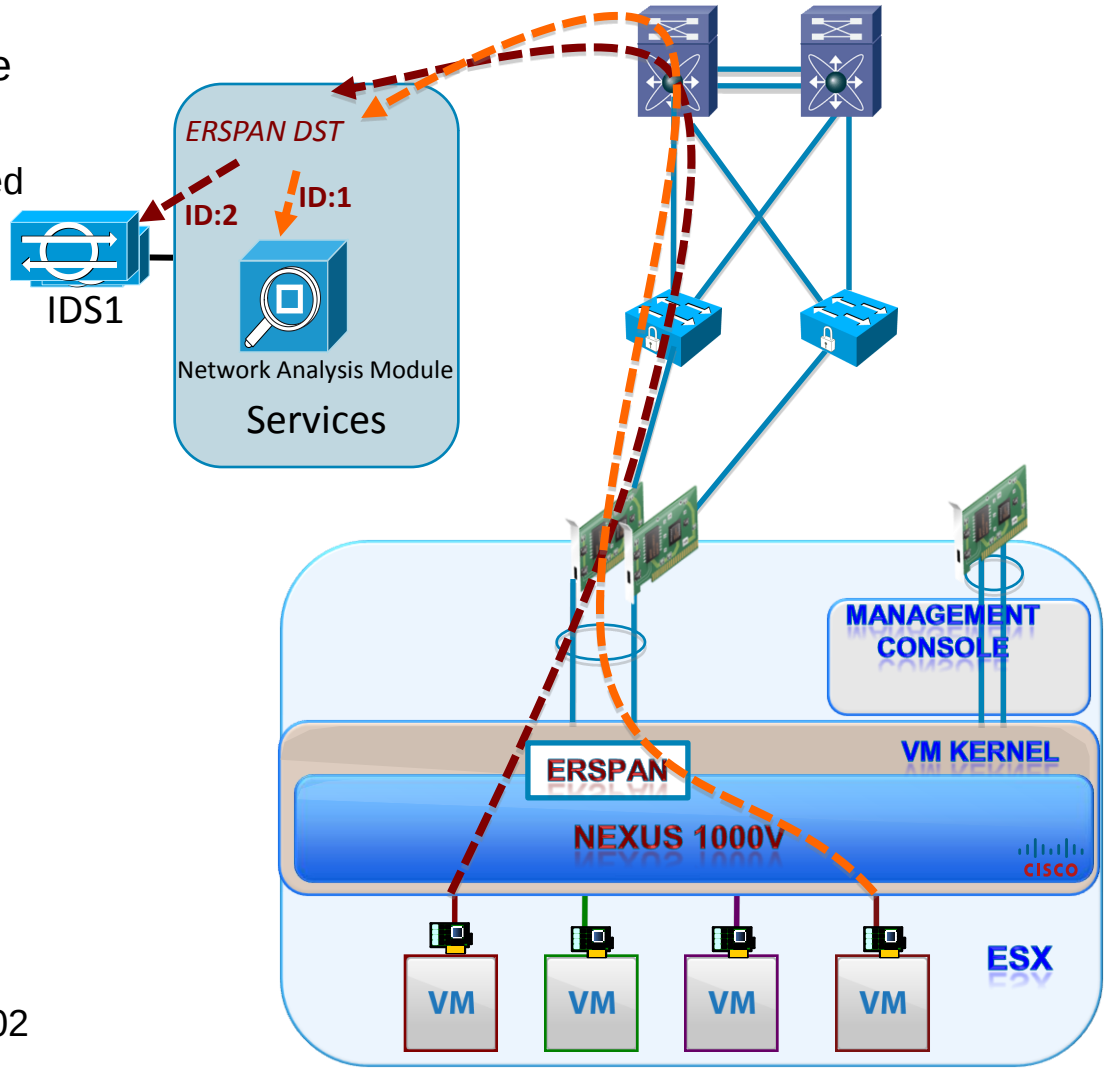
- Protection against man-in-the middle attacks
- Dynamic ARP Inspection, DHCP Snooping, IP Source Guard



VM to VM Visibility

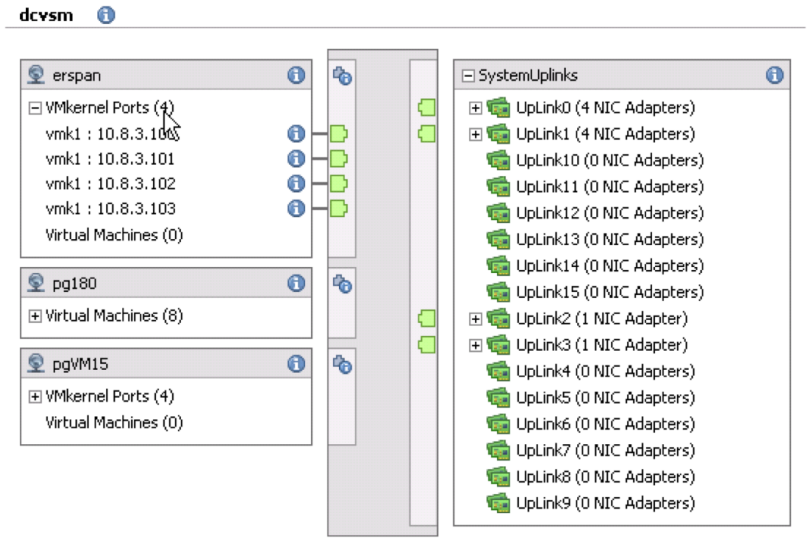
ERSPAN

- ERSPAN source requires use of ERSPAN destination
  - Only one IP address associated with the ERSPAN source/destination per switch
- ERSPAN ID provides segmentation
- Permit protocol type header “0x88BE” for ERSPAN GRE
- ERSPAN frame considerations:
  - ERSPAN does not support fragmentation
  - Appends 50 Byte header to frame
  - Default 1500 MTU allows for 1468 byte frames
  - Max frame size supported 9,202 bytes



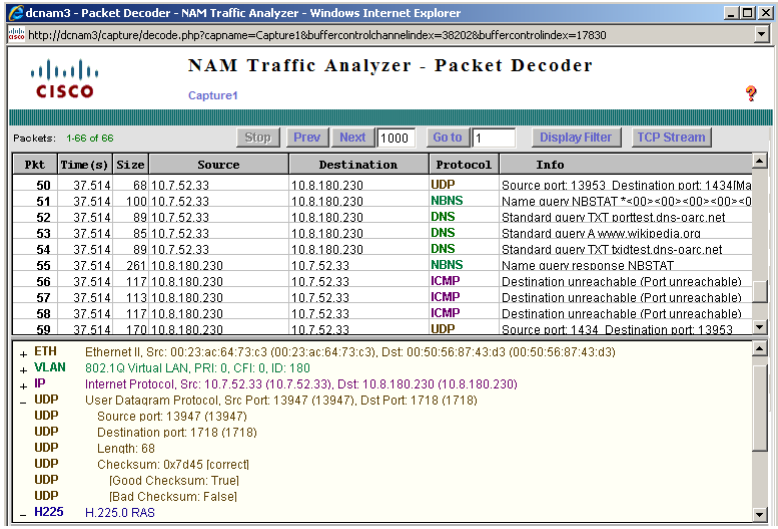
ERSPAN

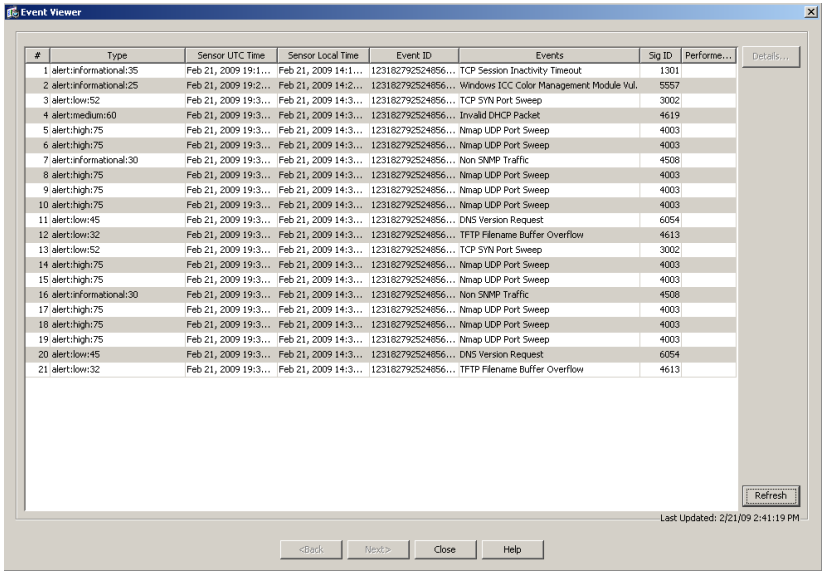
Nexus 1000 Configuration



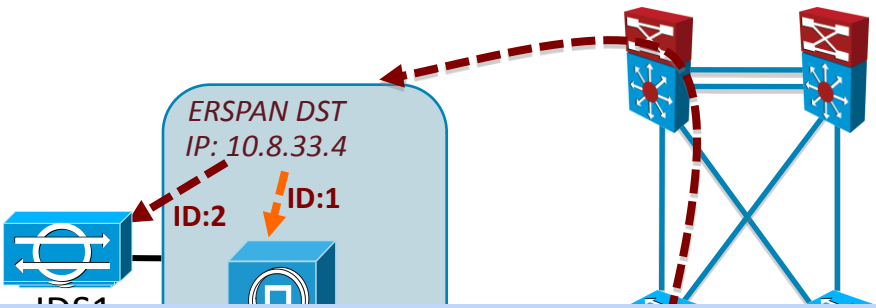
ERSPAN – IDS and NAM

- Comprehensive view of VM traffic via ERSPAN to two network analysis devices simultaneously
- NAM and IDS provide clarity. In this example, port scan of VM detected on IDS and visible on NAM





Example: Using ERSPAN to IDS for VM to VM Traffic



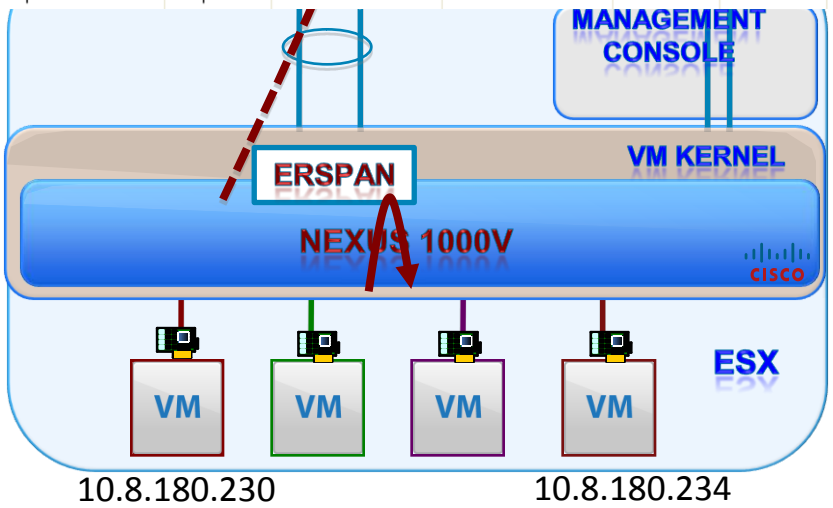
Event Monitoring > Event Monitoring > My Views

View Settings

Video

Pause | Event | Show All Details | Filter | Edit Signature | Create Rule | Stop Attacker | Tools | Other

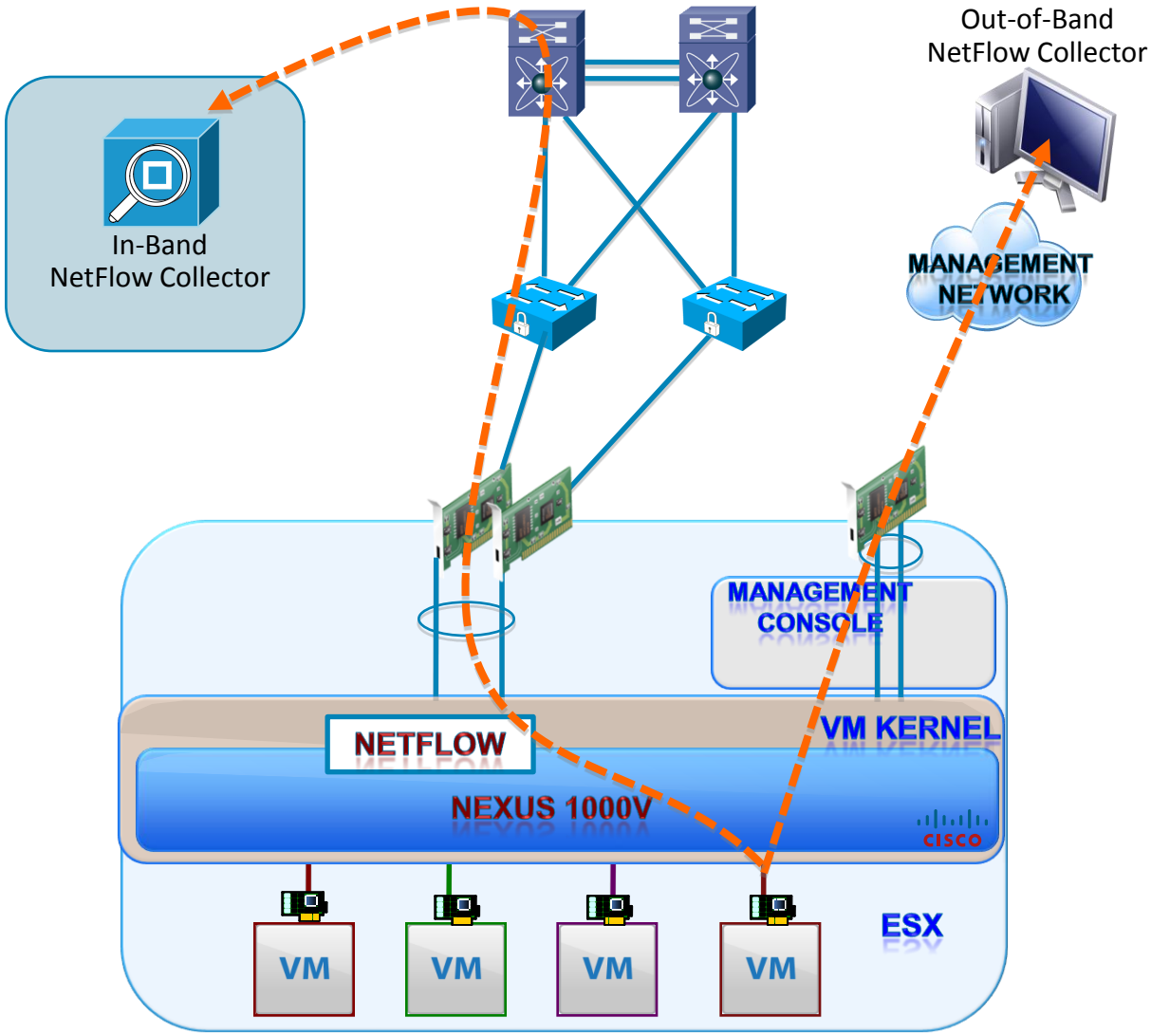
Severity	Date	Time	Device	Sig. Name	Sig. ID	Attacker IP	Victim IP	Actions T...	Victim Port	Threat Ra...	Risk Rating	Virtual
medium	03/02/2009	12:05:05	dca-ips1	Malformed HTTP Request	5769/1	10.8.180.230	10.8.180.234		80	61	61	vs1



VM to VM Visibility

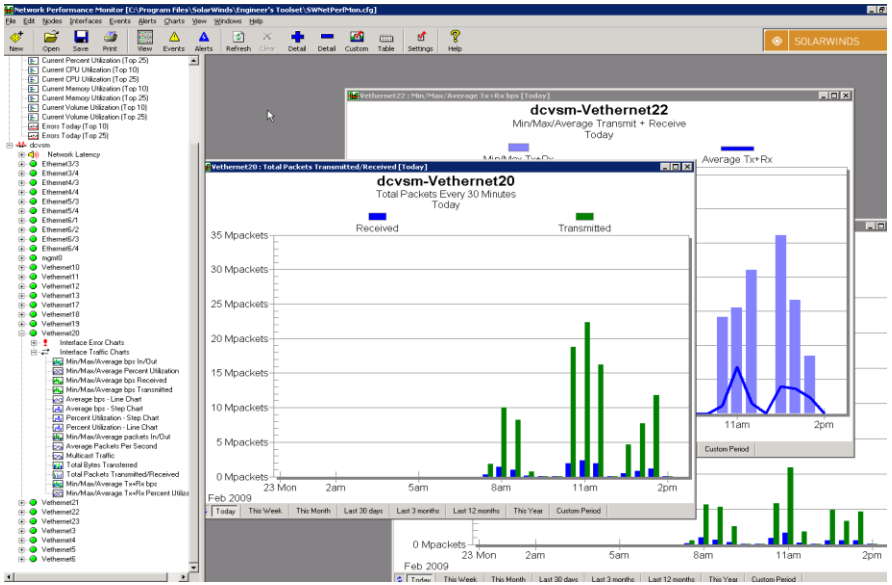
NetFlow

- N1k requires Netflow source interface
  - Defaults to Mgmt0
  - Support v9 format

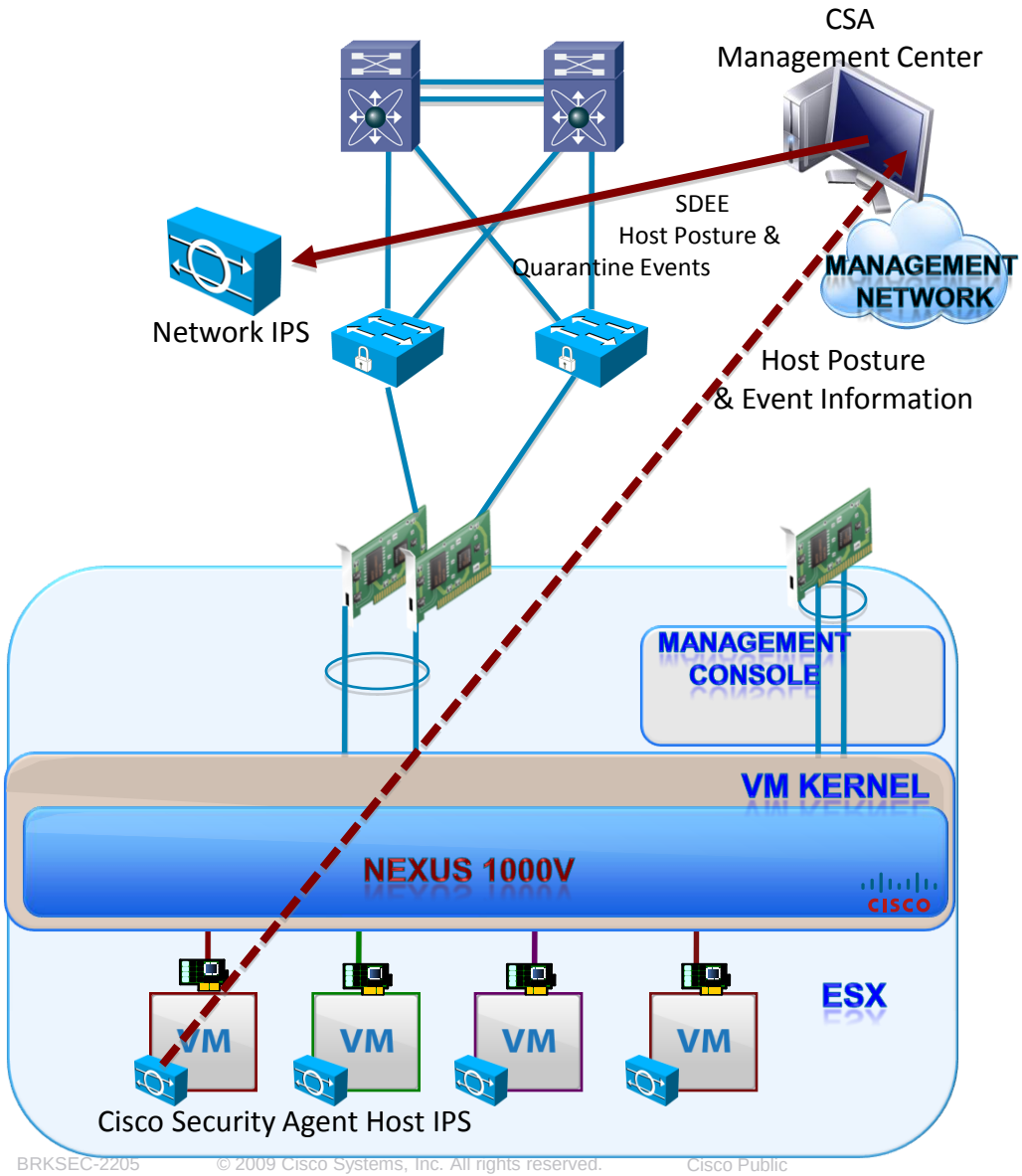


NetFlow

- Maximum of one flow monitor per interface per direction is permitted
- Maximum of two flow exporters per monitor are permitted
- Port profiles afford easy deployment



VM Guest OS Protection



Host IPS and Integration with Network IPS

- A host is quarantined manually by a Cisco Security Agent MC administrator or rule-generated by global correlation
- Quarantine events include

  the reason for the quarantine

  the protocol associated with a rule violation (TCP, UDP, or ICMP), an indicator on whether a rule-based violation was associated with an established TCP connection or a UDP session

  the IP address of the host to be quarantined.

Protect the Endpoint

Remember…

- Security best practices still apply
- Limit Data Flow to other servers and resources
- Do not use non-persistent disks
- Harden the Host OS, Hypervisor, & Guest OS
- Use AV, maintain patches and updates
- Consider using a HIPS solution

Takeaways

- Device Virtualization
  - Scale use of network and security components
  - Flexible integration options
  - Can get complicated…plan accordingly
- Server Virtualization
  - Secure virtual machine environment
  - Use features to maintain visibility
  - Ensure Separation of Duties is maintained
  - Don’t do what you wouldn’t do on a physical machine

Additional Resources

- Data Center Design Zone

  http://www.cisco.com/go/designzone