Felhő szolgáltatások felhasználása a felsőoktatásban

HBONE 2013

Szabó Gábor
mérnök-tanácsadó
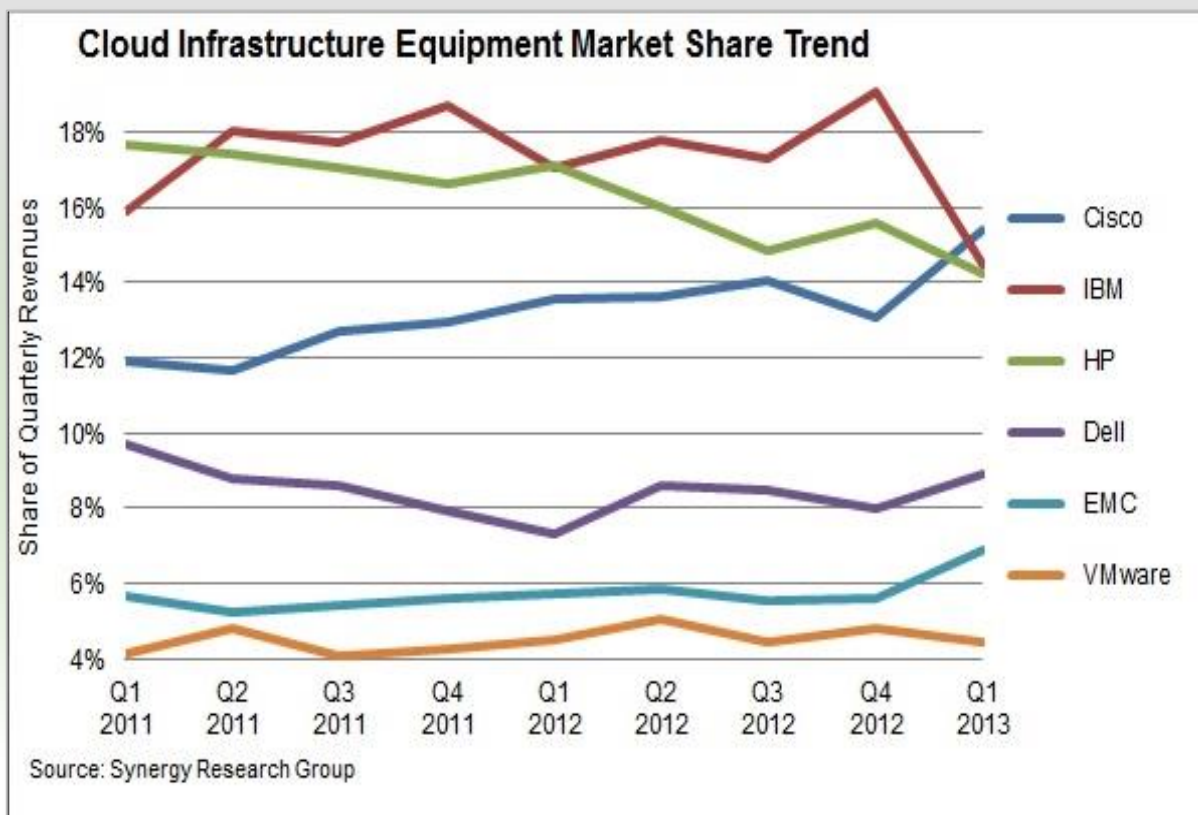
Cisco Systems Magyarország Kft.

WHY ?!?

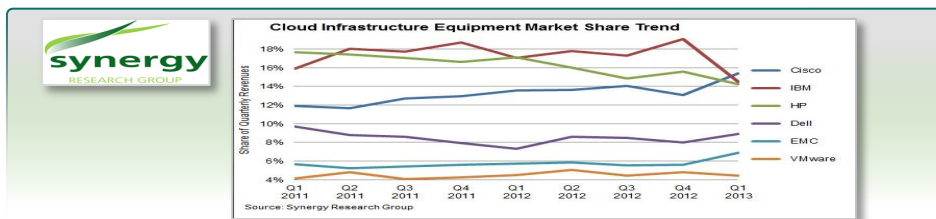- Why Cisco is talking about cloud? They are a router company…

WHY ?!?

- Why Cisco is talking about cloud? They are a router company…

Cloud Infrastructure Equipment Market Share Trend

Source: Synergy Research Group

WHY ?!?

- Why Cisco is talking about cloud? They are a router company…

- OK, fine . But why Cisco is talking about cloud to ME?
  I'm a networking geek…

Agenda

- Cloud Computing Terminology - Refresher

- Hybrid Cloud

- OpenStack

- OpenStack@Cisco

Cloud Requirements

Self Service Consumption Model

- Frees up IT from mundane setup tasks and allows end users to get what they want, when they want it

Rapid Provisioning

- Commissioning or decommissioning of resources within minutes instead of weeks
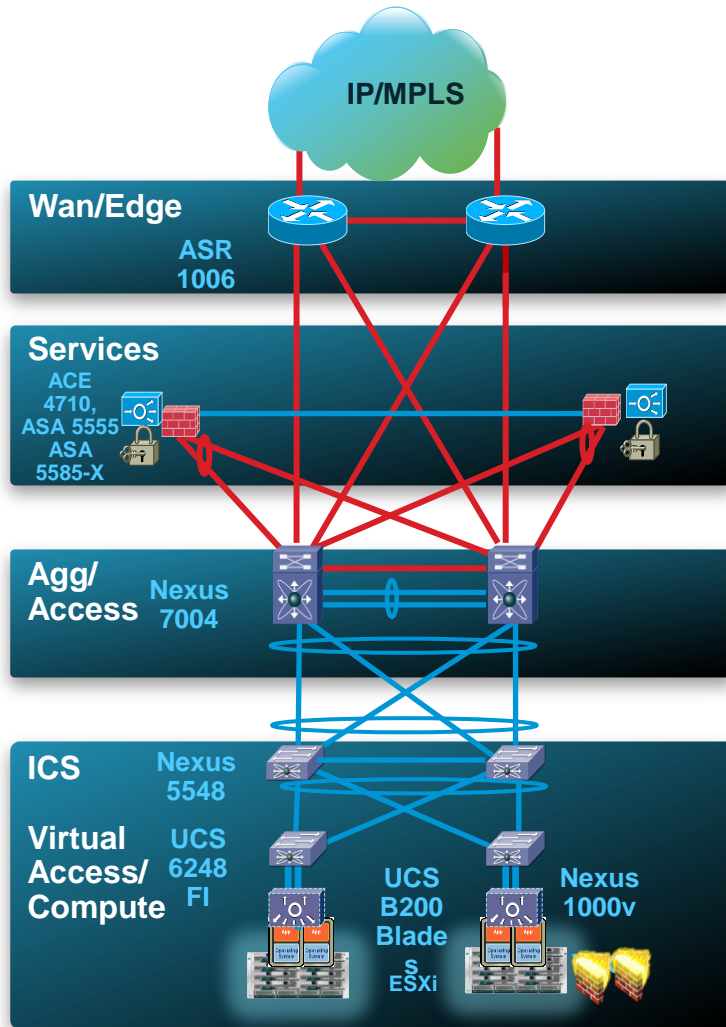
Elastic Resource Allocation

- Rapid scalability of virtual and physical
- Automated deployment

Pay-As-You-Use

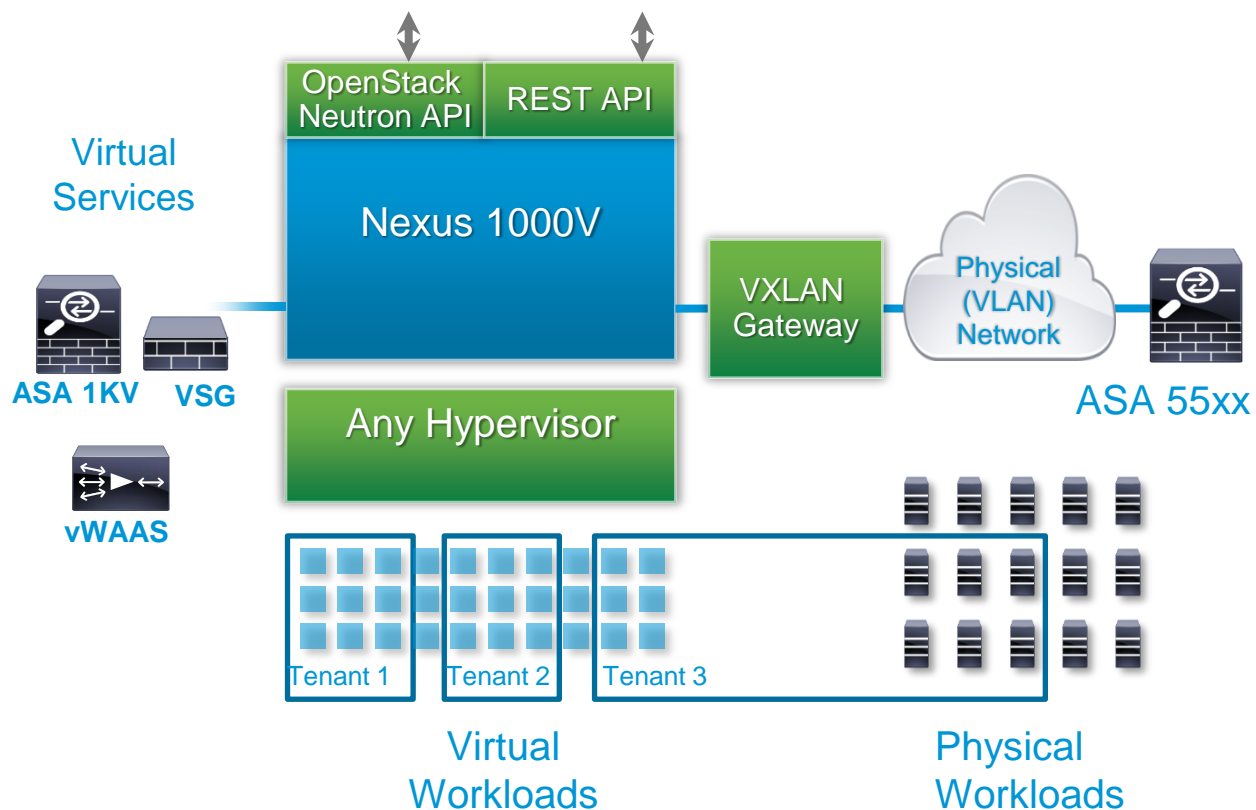- Consume metering, accounting, charge-back

Barriers of Physical Infrastructure

IP/MPLS

Wan/Edge — ASR 1006

Services — ACE 4710, ASA 5555, ASA 5585-X

Agg/ Access — Nexus 7004

ICS — Nexus 5548

Virtual Access/ Compute — UCS 6248 FI

UCS B200 Blades ESXi

Nexus 1000v

- L2 Connectivity is required between Physical Servers

- Service Scalability?
  - Only 4K VLAN

- VM migration everywhere?
  - L2 POD boundary exists

- Easy provisioning?
  - Vendor-specific VLAN creation methods
  - Create VLAN on every physical link which is required for the service
  - Complex service-chaining consume many VLANs

- What about Network Services?
  - Lot's of dedicated Appliances (FW, LB)
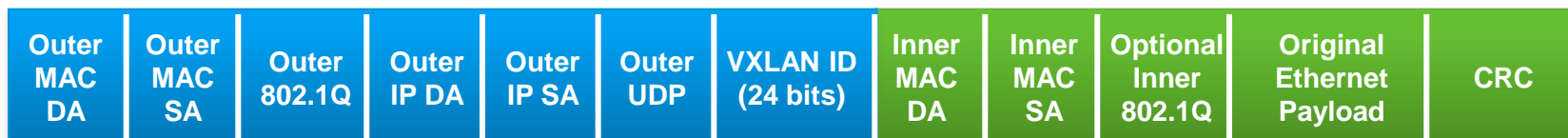 - Limited multi-context scale
  - Multi-vendor

Virtual Overlay Networks

- Large scale L2 domains: Tens of thousands of virtual ports

- Common APIs

- Scalable DC segmentation and addressing
  - VXLAN (GRE, NSX etc)

- Virtual service appliances and service chaining/traffic steering

- Multi-hypervisor platform support: ESX, Hyper-V, OpenSource Hypervisors

- Physical and Virtual: VXLAN to VLAN Gateway

Virtual Services

ASA 1KV **VSG**

vWAAS

OpenStack Neutron API | REST API

Nexus 1000V

Any Hypervisor

VXLAN Gateway

Physical (VLAN) Network

ASA 55xx

Tenant 1 | Tenant 2 | Tenant 3

Virtual Workloads

Physical Workloads
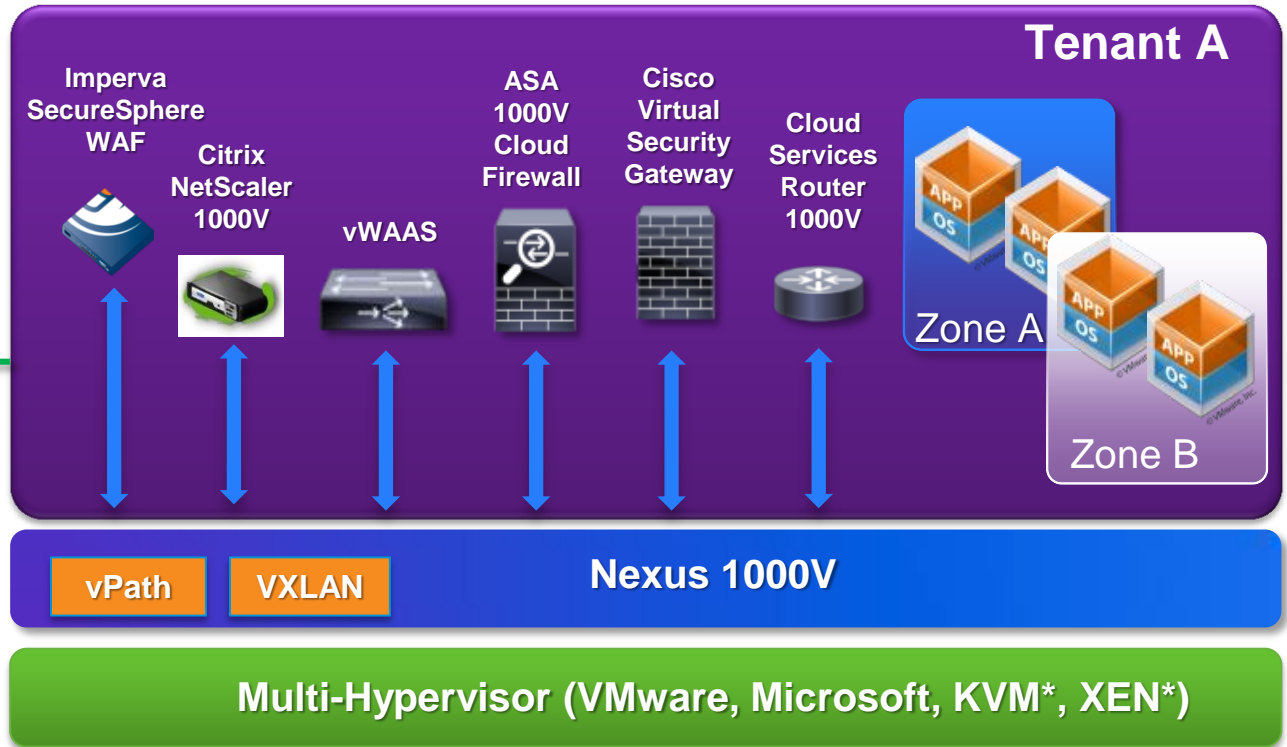
Virtual Extensible Local Area Network (VXLAN)

- Ethernet in IP overlay network

  Entire L2 frame encapsulated in UDP

  50 bytes of overhead

- Include 24 bit VXLAN Identifier

  16 M logical networks

  Mapped into local bridge domains

- VXLAN can cross Layer 3

- Tunnel between hypervisors

  VMs do NOT see VXLAN ID

- VXLAN-VLAN Gateway

  Nexus 1000v

  Nexus 3100 (future)

  Nexus 7000 (future)

- Technology submitted to IETF for standardization

  With VMware, Citrix, Red Hat, Broadcom and others

  draft-mahalingam-dutt-dcops-vxlan-05.txt

Outer MAC DA	Outer MAC SA	Outer 802.1Q	Outer IP DA	Outer IP SA	Outer UDP	VXLAN ID (24 bits)	Inner MAC DA	Inner MAC SA	Optional Inner 802.1Q	Original Ethernet Payload	CRC

← VXLAN Encapsulation → ← Original Ethernet Frame →

Cisco Virtual Networking and Cloud Network Services

Cloud Network Services

Tenant A

Imperva SecureSphere WAF

Citrix NetScaler 1000V

vWAAS

ASA 1000V Cloud Firewall

Cisco Virtual Security Gateway

Cloud Services Router 1000V

Zone A

Zone B

Physical Infrastructure

| vPath | VXLAN | **Nexus 1000V** |

Multi-Hypervisor (VMware, Microsoft, KVM*, XEN*)

Nexus 1000V	**VSG**	**ASA 1000V**	**vWAAS**	**CSR 1000V** (Cloud Router)	**Ecosystem Services**
• Distributed switch • NX-OS consistency	• VM-level controls • Zone-based FW	• Edge firewall, VPN • Protocol Inspection	• WAN optimization • Application traffic	• WAN L3 gateway • Routing and VPN	• Citrix NetScaler 1000V • Imperva Web App. Firewall
6000+ Customers	**Shipping**	**Shipping**	**Shipping**	**Shipping**	**Shipping**

Cloud Service Provider - Delivery Models

SP Clouds

Collocation Services

Resources owned and Managed by customers. in SP Data Center

Dedicated Cloud

Resources dedicated to customers. Self managed or SP managed

Virtual Private Cloud

VPC delivered from shared Multi-tenant environment Self managed or SP managed

Public Cloud

Shared resources from Multi-tenant environment. SP managed

IP WAN / Internet

Managed Cloud

Resources dedicated SP managed

Hybrid Cloud

Customer Private Cloud

Major Cloud Service Types

Private Cloud	Infrastructure as a Service (IAAS)	Platform as a Service (PAAS)	Software as a Service (SAAS)
Applications	Applications	Applications	Applications
Runtimes	Runtimes	Runtimes	Runtimes
Databases	Databases	Databases	Databases
Security	Security	Security	Security
Servers	Servers	Servers	Servers
Virtualization	Virtualization	Virtualization	Virtualization
Networking	Networking	Networking	Networking
Storage	Storage	Storage	Storage

Managed by You

Managed by Provider

1

Hybrid Cloud

Definition of Hybrid Cloud

The cloud infrastructure is a composition of two or more distinct cloud infrastructures (private, community, or public) that remain unique entities, but are bound together by standardized or proprietary technology that enables data and application portability (e.g. Cloud bursting for load balancing between clouds)

Core Workloads
- Financials
- Regulated Information
- Legal

Enterprise Private Cloud
Hosted on premise, supported by the customer
Compute | Storage | Network

Context Workloads
- Collaboration
- Test & Development
- Email

Hybrid Cloud
Elastic hosted resources, bridging on-prem & off-prem, private, Enterprise to SP virtual system resources

Powered Cloud Service

Virtual Private Cloud
Set of secured private resources on a multi-tenant public cloud, not connected to enterprise
Compute | Storage | Network

Public Cloud
Resources Available to general public
Compute | Storage | Network

Hybrid Cloud References

Drivers for Hybrid Cloud

Public cloud is not sufficient as a standalone platform for all use cases

Business customers are looking for the best of both worlds: flexibility and elasticity of the cloud and security and performance characteristics of traditional hosting.

Ability to integrate different platforms: Business application, IT assets need to be deeply integrated with virtual private cloud or public cloud services.

Community cloud – cloud shared between multiple organizations, addressing specific industries' workloads/applications.

Hybrid Cloud Economics: Vacancy Tax

- Current data center utilization 35%
- Vacancy Tax: 65%

- The economic benefit of a Hybrid Cloud is the transfer of the vacancy tax to a provider cloud

- A virtual + bare-metal hybrid-cloud solution can (theoretically) address the entire vacancy tax

All Workloads in Enterprise Data Center (No Hybrid Cloud)

Hybrid Cloud Supporting Distribution of Virtual Workloads

Hybrid Cloud Supporting Distribution of Both Bare-Metal and Virtual Workloads

Reduced CapEx

Reduced CapEx

Time

Time

Time

Vacancy Tax Reduced ≈ 20%

Vacancy Tax Reduced ≈ 90%
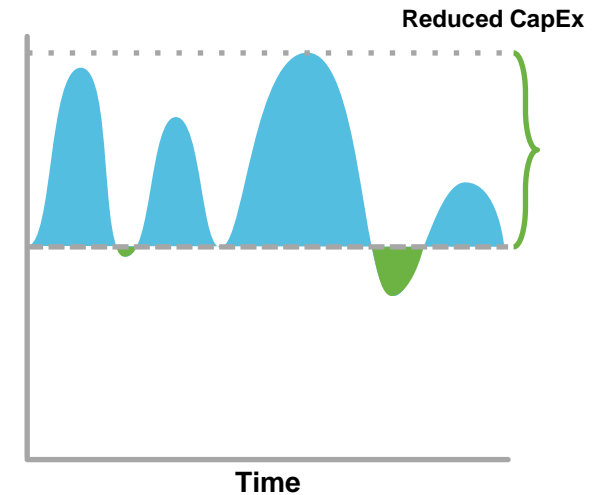
Legend

☐ Consumed Resources

◼ Vacancy Tax

◼ External Resources Consumed

IaaS Hybrid Cloud Use Cases

Cloud Burst / Peak Workload

Colo /Private Cloud

Secured Connection

SP Cloud

WEB APP DB

WEB APP DB

WEB APP DB

SLB

Load Balancing

Internet

Users

Bursting from private cloud to virtual private or public cloud for peak workloads
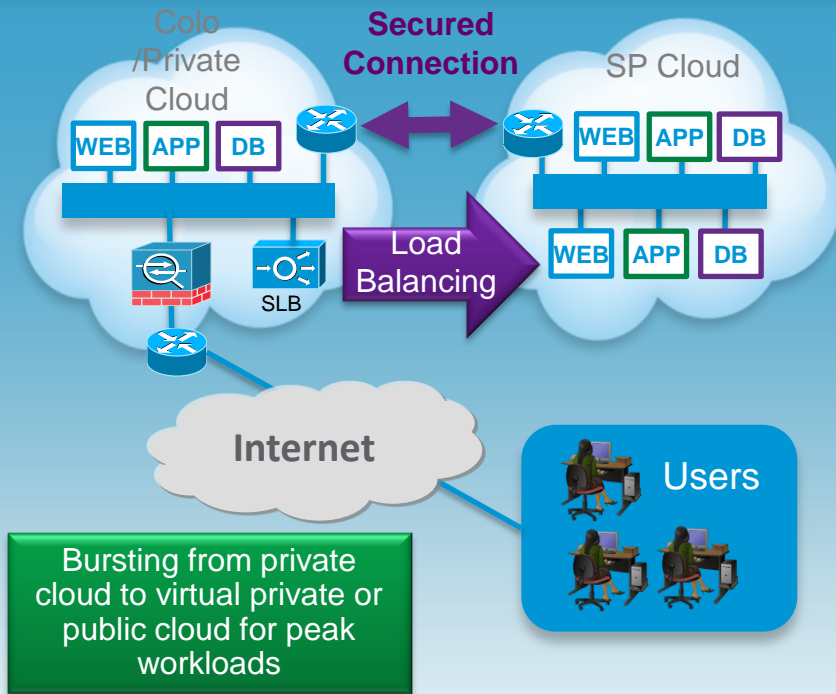
Organizations can:
- Leverage compute resources in SP cloud (Public or VPC) for planned overflow linked to Cyclical events (holiday shopping, periodic reporting, marketing campaign …)
- Scale out internal compute tiers seamlessly and securely
- Make substantial Capex saving

Lab / Dev Test

DevTest Application across private and virtual private cloud

vSLB   vFW

SP Cloud

APP   APP   DB

Clone Operation

Secured Connection

vSL B   vFW

Enterprise Colo / Private Cloud

FW

APP   APP   DB
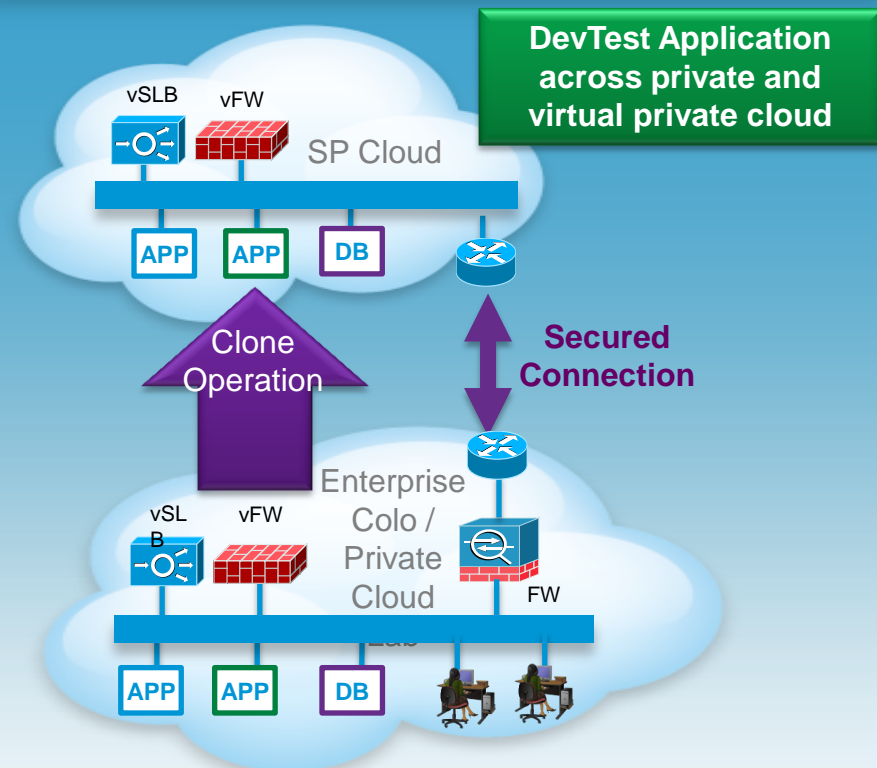
QA organization can:
- "turn on" capacity when needed
- Control cloud usage and maintain security policies
- Make substantial Capex saving

Hybrid Storage and Disaster Recovery Use Cases

Hybrid Storage Services

Central Office

Exchange | ERP | CRM | DB

Local Storage | Tiering / virtual appliance

SP Storage

SP Backup Management Portal

IP WAN

Backup Agent for Roaming Laptop

ISR G2 (UCS-E) with Cloud Tiering / NAS virtual appliance

Remote Office
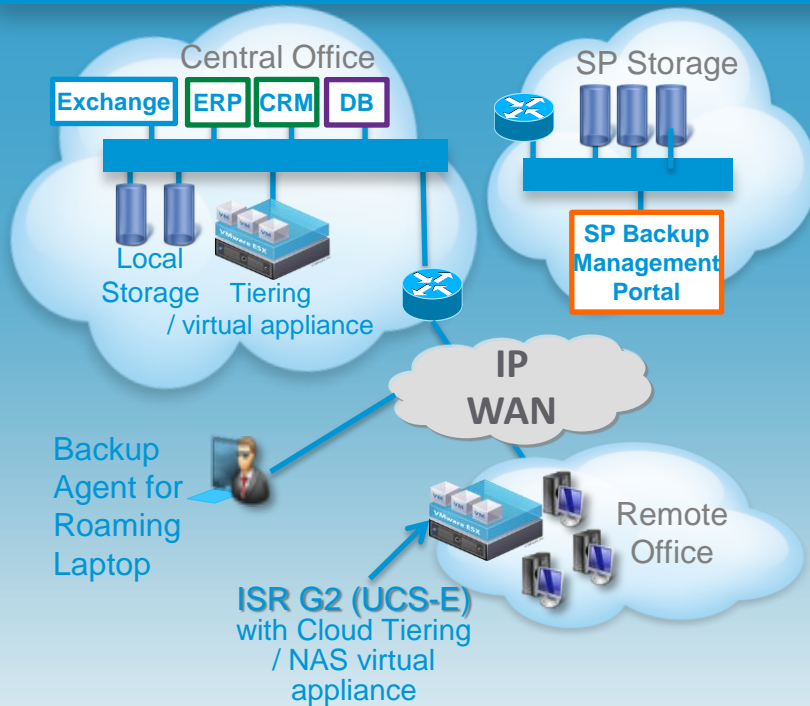
Hybrid Storage Services enables Business to keep some of their data onsite to meet strict legal compliance or internal company requirements and move data to the SP Cloud Storage services for additional archiving capacity, replication.

Disaster Recovery Services

Private Cloud

Exchange | ERP | CRM | DB

Continuous Replication

SP Storage

Local Storage | Replication Appliance

Replication Manager

Recovery

Cloud Recovery (Public or Private)

IP WAN

Exchange | Local Storage
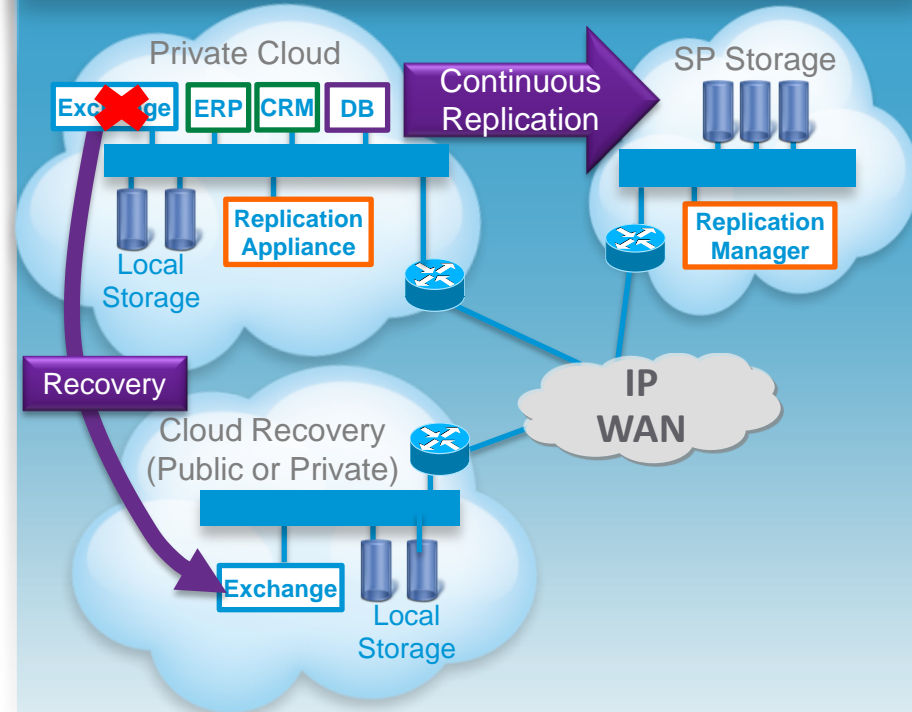
Disaster Recovery as a Service (DRaaS) provides business with cost-effective solution to replicate critical servers (Physical or Virtual) to SP Cloud and recover failed servers either in SP Cloud or customer private Cloud.

Hybrid Cloud Use Case: Peak Workload
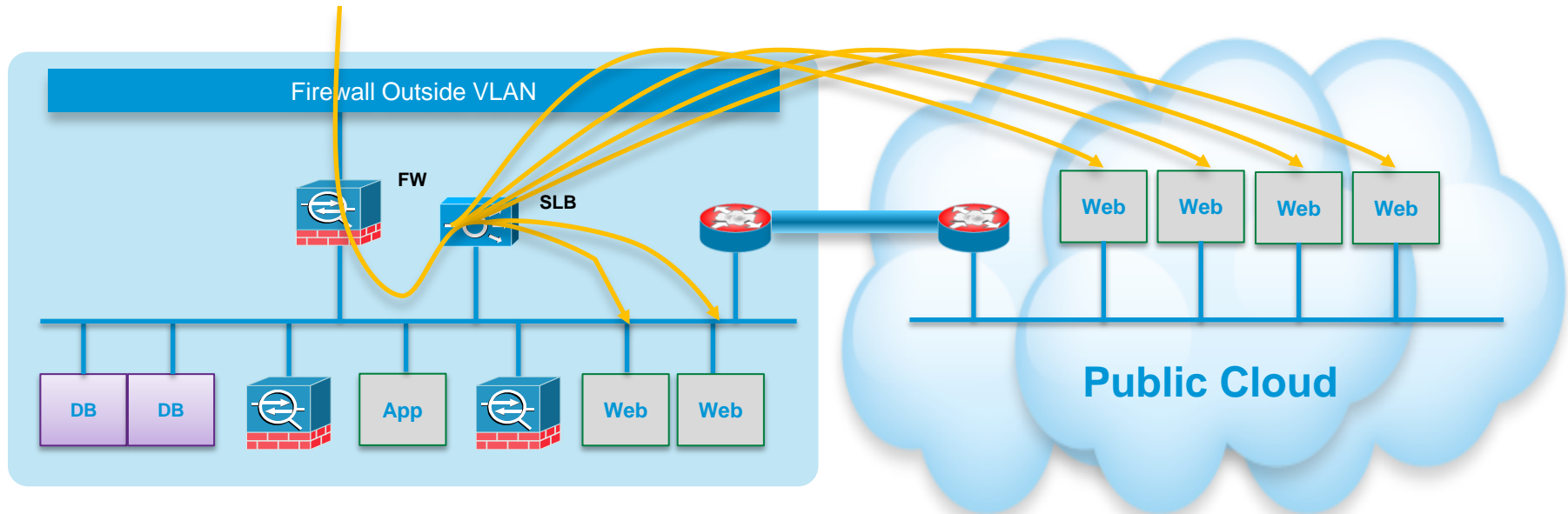
1. Upload „Router" VM image to Public Cloud

2. Upload „Web" VM image to Public Cloud

3. Create Private VLAN in Public Cloud

4. Spin-up „Router" VM

5. Configure „Router" VM for secure L2 extension

6. Attach „Router" VM to Private VLAN

7. Spin-up N pcs of „Web" VM

8. Attach „Web" VMs to Private VLAN

9. Re-configure „Web" serverfarm in Load-balancer

10. Reconfigure „Web" monitoring service

Cisco Solutions for Hybrid Cloud Network Extension

CSR 1000v (Cloud Service Router) + OTV
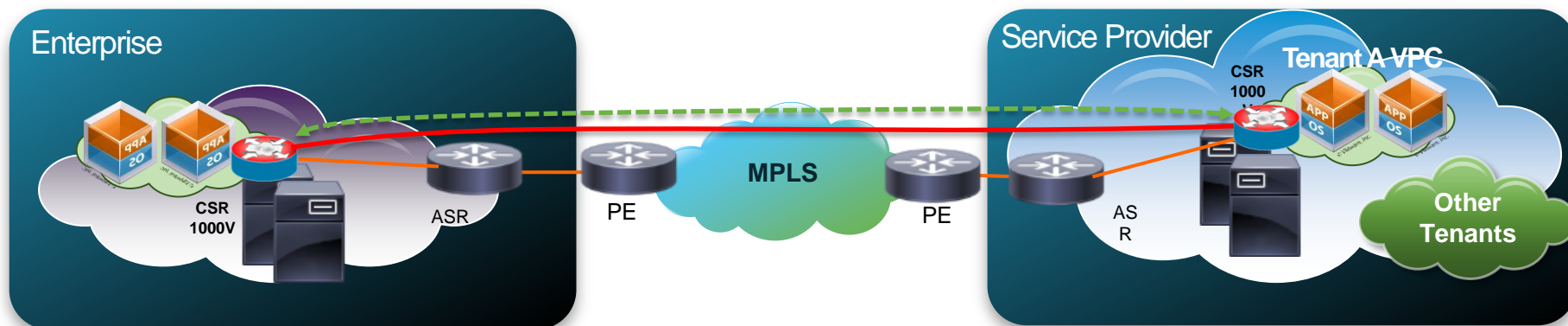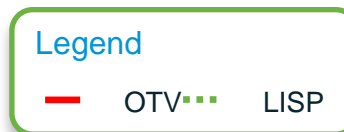
- Extends Layer 2 for both virtual and physical environments

- Requires IP connectivity (MPLS not a requirement)

- Can be used also to terminate MPLS/IPSec VPNs in Tenant VPC

Cisco Solutions for Hybrid Cloud Network Extension

Nexus 1000v InterCloud
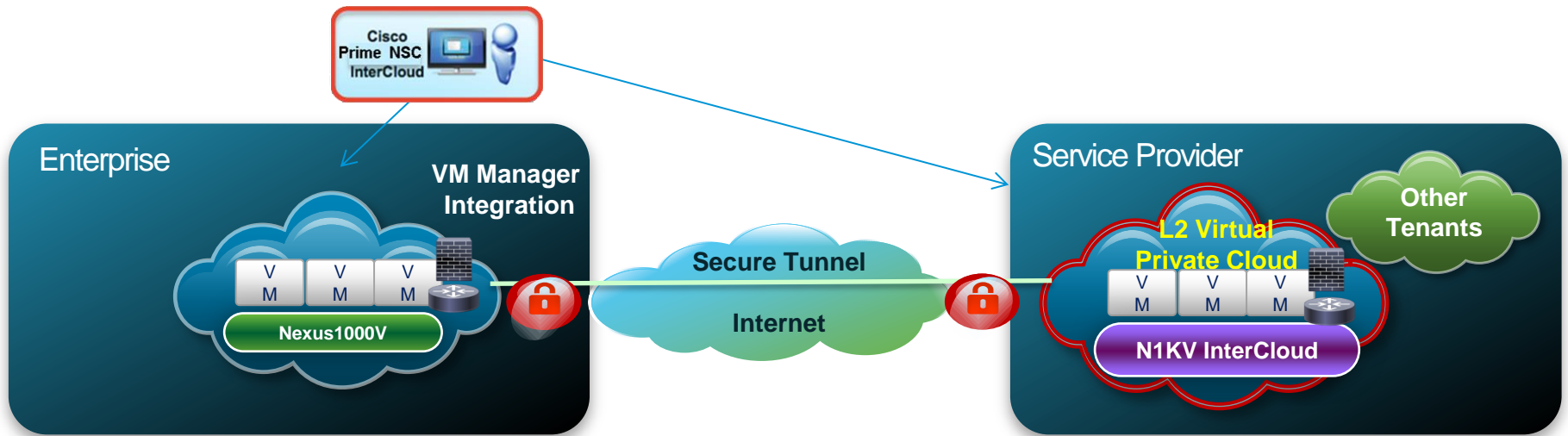
- Secure L2 extension to the Cloud with workload mobility

- Extends Nexus 1000v port-profile/security-profile to cloud without provider intervention, controlled by enterprise manager

Public / Hybrid Cloud Reference Architecture

End User

Public Cloud Admin

Enterprise Cloud Portal

Public Cloud Portal

Enterprise Cloud Orchestration Engine

Cloud API

Public Cloud Orchestration Engine

Private Cloud

WAN

Public Cloud
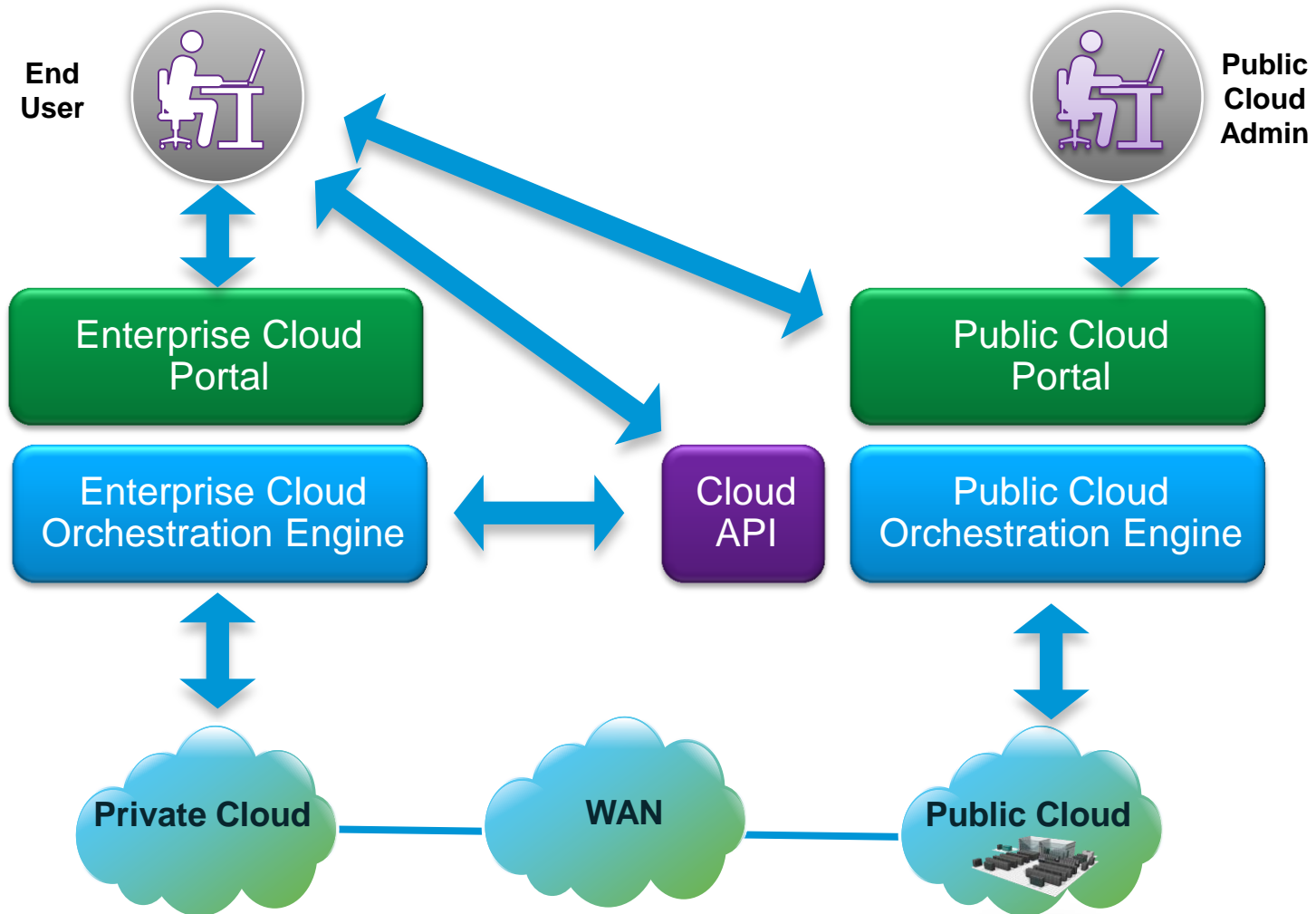
Cloud Technology Stacks

	vmware	Microsoft	openstack cloudstack	CISCO
Cloud Portal and Orchestration	vCloud Director/ DynamicOps	System Center	Open Source	CIAC/ OpenStack/ Partners
	ONE Controller	ONE Controller	ONE Controller	ONE Controller
Virtual Network Infrastructure	ASA 1KV vWAAS CSR 1K	ASA 1KV vWAAS CSR 1KV	ASA 1KV vWAAS CSR 1KV	ASA 1KV vWAAS CSR 1KV
	vPath	vPath	vPath	vPath
	Nexus 1KV	Nexus 1KV	Nexus 1KV	Nexus 1KV
Hypervisor	vSphere	Hyper-V	Open Source (Xen, KVM)	vSphere, Hyper-V, Xen, KVM
Computing Platform	UCS				UCSM
Physical Network	Nexus 2K-7K + ASR 9K (Edge)				onePK
Storage Platform	EMC²	NetApp	HITACHI		

UCS Central

ONE Controller

Example Hybrid Cloud Providers

Service Provider	Cloud Technology	Cloud API
Savvis	VMware vCloud	REST (XML)
Verizon Terremark	VMware vCloud; CloudStack	REST (XML)
RackSpace	OpenStack	REST (XML/JSON)
HP	OpenStack	REST (XML/JSON)
Amazon AWS	EC2	Query

Cloud APIs: REST

- The REST interface use only the standard components of HTTP request messages to represent the API action that is being performed:

  - HTTP method: describes the action the request will perform

  - Universal Resource Identifier (URI): path and query elements that indicate the *resource* on which the action will be performed

  - Request Headers: pieces of metadata that provide *more information* about the request itself or the requester

  - Request Body: the *data* on which the service will perform an action

    - Data format: XML or JSON

REST API example (Verizon Terremark)

- Create VM

```
POST
https://services.enterprisecloud.terremark.com/clouda
pi/spec/virtualMachines/computePools/{computePoolId}/
action/createBlankVirtualMachine
<CreateBlankVirtualMachine name="">
  <ProcessorCount></ProcessorCount>
  <Memory>
    <Unit></Unit>
    <Value></Value>
  </Memory>
  <Layout>
    <Row href="" name="" />
    <Group href="" name="" />
    <NewRow></NewRow>
    <NewGroup></NewGroup>
  </Layout>
  <Description></Description>
  <Tags>
    <Tag></Tag>
  </Tags>
  <OperatingSystem href="" name="" />
```

```
<Disks>
    <Disk>
      <Index></Index>
      <Size>
        <Unit></Unit>
        <Value></Value>
      </Size>
      <Name></Name>
    </Disk>
  </Disks>
  <NetworkAdapterSettings>
    <NetworkAdapter>
      <Network href="" name="" />
      <IpAddress></IpAddress>
      <IpAddressV6></IpAddressV6>
    </NetworkAdapter>
  </NetworkAdapterSettings>
  <DetachedDisks>
    <DetachedDisk href="" name="" />
  </DetachedDisks>
</CreateBlankVirtualMachine>
```

REST API example (Verizon Terremark)

- Stop VM

```
POST https://services.enterprisecloud.terremark.com/cloudapi/spec/virtualMachines/{virtualMachineId}/action/powerOff
```

- Query VM Configuration

```
GET https://services.enterprisecloud.terremark.com/cloudapi/spec/virtualMachines/{virtualMachineId}/hardwareConfiguration
```

REST API example (Rackspace)

- ## Create VM

```
POST https://dfw.servers.api.rackspacecloud.com/v2/$account/servers
 {
    "server": {
        "name": "my_server_with_network",
        "imageRef": "d42f821e-c2d1-4796-9f07-af5ed7912d0e",
        "flavorRef": "2",
        "max_count": 1,
        "min_count": 1,
        "networks": [
            {"uuid": "538a112a-34d1-47ff-bf1e-c40639e886e2"},
            {"uuid": "00000000-0000-0000-0000-000000000000"},
            {"uuid": "11111111-1111-1111-1111-111111111111"}
        ]
    }
 }
```

- ## Delete VM

```
DELETE https://dfw.servers.api.rackspacecloud.com/v2/$account/servers/<id>
```

- ## Query VM configuration

```
GET https://dfw.servers.api.rackspacecloud.com/v2/$account/servers/<id>
```

Cloud APIs: Query

- The Query interface also use the standard components of the HTTP protocol to represent API actions; however these interfaces use them in a different way.

- Query requests rely on parameters, simple name and value pairs, to express both the action the service will perform and the data the action will be performed on.

- When you are using a Query interface, the HTTP envelope serves merely as a way of delivering these parameters to the service.

Query API example (Amazon EC2)

- Create VMs

```
https://ec2.amazonaws.com/?Action=RunInstances
&ImageId=ami-beb0caec
&InstanceType=m1.large
&MaxCount=1
&MinCount=1
&KeyName=my-key-pair
&NetworkInterface.0.DeviceIndex=0
&NetworkInterface.0.PrivateIpAddresses.0.Primary=true
&NetworkInterface.0.PrivateIpAddresses.0.PrivateIpAddress=10.0.2.106
&NetworkInterface.0.PrivateIpAddresses.1.Primary=false
&NetworkInterface.0.PrivateIpAddresses.1.PrivateIpAddress=10.0.2.107
&NetworkInterface.0.SubnetId=subnet-a61dafcf
&AUTHPARAMS
```

- Stop VM

```
https://ec2.amazonaws.com/?Action=StopInstances
&InstanceId.1=i-10a64379
&AUTHPARAMS
```

http://docs.aws.amazon.com/AWSEC2/latest/APIReference/Welcome.html

"Is the Amazon Web Services API the equivalent of Cisco's command line interface?

Alistair Croll (Information Week)

http://www.informationweek.com/cloud-computing/infrastructure/cloud-stack-wars-tough-questions/240162798

So What? What can I do with all this?

- Let's create an Educational Cloud - Operated by NIIFI

- Acts as Community Cloud – common addressing, existing trust

- Develop/establish Self-Service Portal for efficient provisioning
  - Both for „external" organizations and internal operation people

- Large organizations (universities) MAY have Private Clouds

- So develop/establish Cloud API

- Hybrid Cloud use cases (Peak workload)

- Recommended Cloud operating system: OpenStack

- Cisco Hungary is willing to contribute

Why OpenStack?

Avoids vendor lock-in

- **Open source with more than 180 vendors contributing**
- **Rapid build-out of Public or Private clouds**
- **Easily customizable by Internal Software teams**

Ready for mission-critical private clouds

- **8th major release**
- **Market Traction**

Comcast	CERN	Bloomberg	PayPal
Intel	NASA	Best Buy	HubSpot	Others

High Cisco Contribution

- **Cisco Cloud CTO is Vice-chair of board**

  Lew Tucker
- **Support for Cisco's entire Cloud portfolio**
- **Cisco Accelerating Innovation** (Neutron)

OpenStack

What is OpenStack?

OpenStack is an Infrastructure As A Service (IaaS) cloud computing project

"...provides a means to control (administer) compute, storage, network and virtualization technologies..."

OpenStack: A Brief History

- **NASA Launches Nebula**
  - One of the first cloud computing platforms built by the Federal Government for the Federal Government

- **March 2010:** Rackspace Open Sources Cloud Files software, aka Swift

- **May 2010:** NASA open sources compute software, aka "Nova"

- **June 2010:** OpenStack is formed

- **July 2010:** The inaugural Design Summit
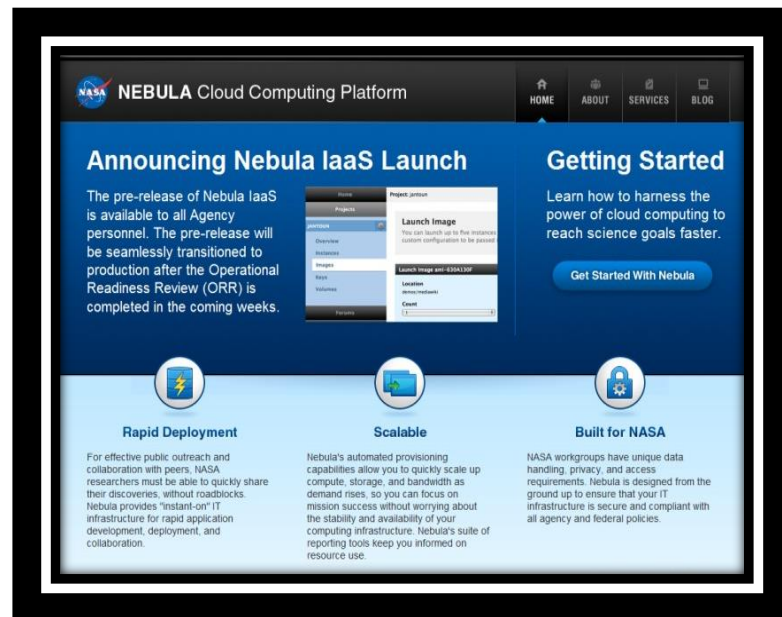
OpenStack Timeline and Releases

2010

Mar	May	June	July
Rackspace Open Sources Swift	NASA Open Sources Nebula	OpenStack Formed	Inaugural Design Summit in Austin

2010 **2011** **2012** **2013**

Oct — Feb — Apr — Sep — Apr — Sep — Apr — Oct

Austin   Cactus   Essex   Grizzly   Icehouse

Bexar   Diablo   Folsom   Havana

OpenStack Community

AT&T

Dell

Deutsche Telekom

IBM

ARISTA
Arista Networks

rackspace HOSTING

f5

hp
HP

Mellanox TECHNOLOGIES

intel
Intel

VYATTA
Vyatta

NASA

vmware

BROCADE
Brocade

BROADCOM.
Connecting everything®

CITRIX

NEC
NEC

MIRANTIS

big switch networks
Big Switch

CISCO

NTT
NTT

OpenStack Production Deployments

Rackspace
Hosting & Cloud Computing

INTERNAP
Internap
Service Provider

HP
Information Technology

iSuperGrid
HPC & Cloud Services Provider

Deutsche Telekom
Service Provider
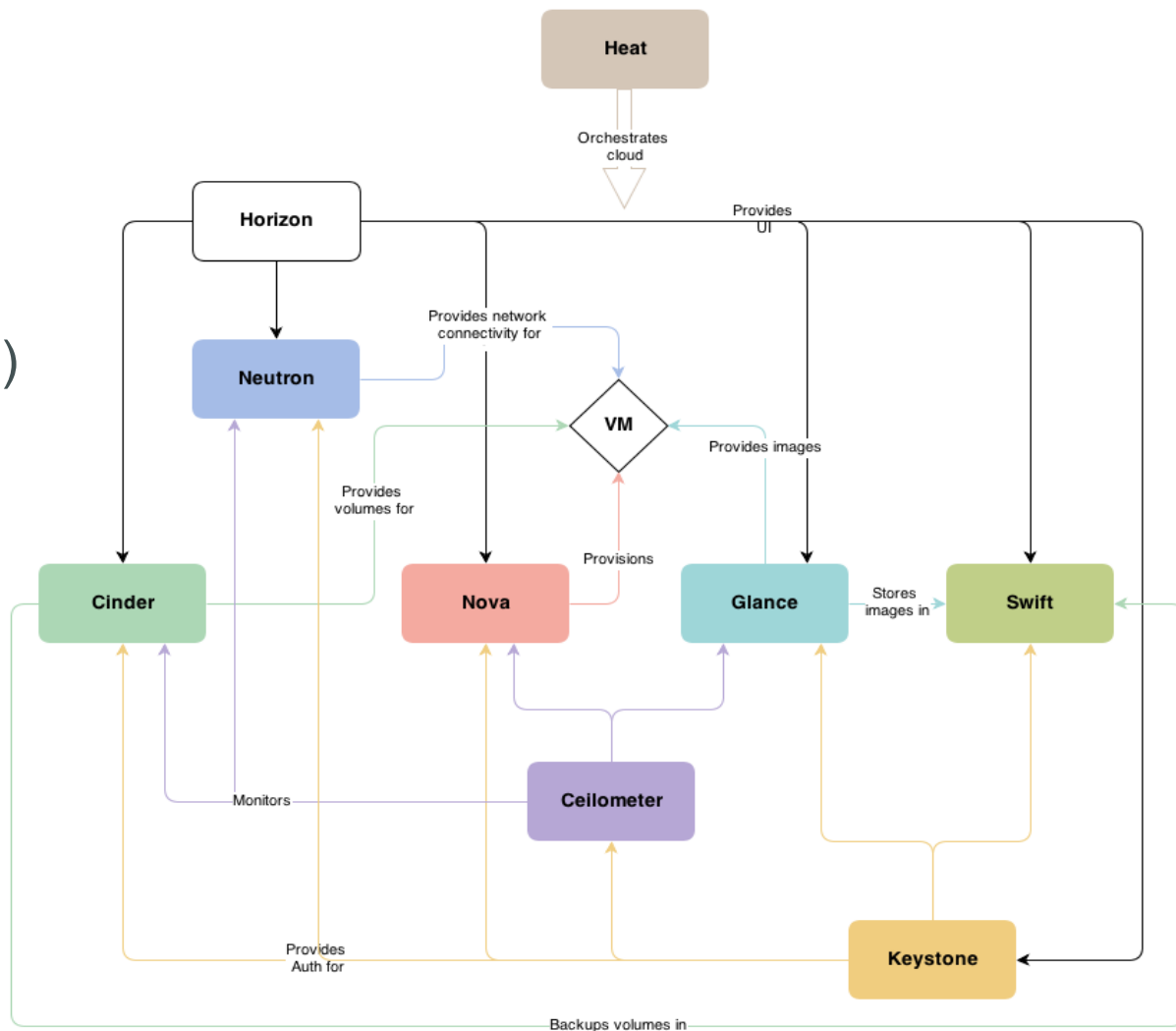
AT&T
Communications

CISCO
Webex

OpenStack Software Modules („Projects")

- Orchestration („Heat")

- Dashboard („Horizon")

- Compute („Nova")

- Block Storage („Cinder")

- Object Storage („Swift")

- Network („Neutron")

- Image („Glance")

- Identity („Keystone")

- Metering („Celiometer")

OpenStack Network Service (Neutron)

- Provides "network connectivity as a service" between devices managed by other OpenStack services

- Provides abstractions and functionality needed for cloud networking

- Why Neutron?
  - First-gen networking under Nova is limited
  - Provide tenants an API to build rich networking topologies
  - Foster innovation through plug-ins

- Former name was Quantum
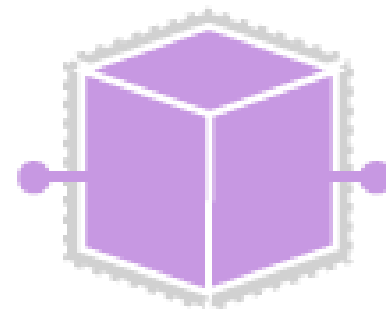
Neutron

Basic Neutron API Abstractions

Nova

VM1
10.0.0.2

VM2
10.0.0.3

virtual server

virtual interface
(VIF)

virtual port

L2 virtual network

Neutron

Net1
10.0.0.0/24
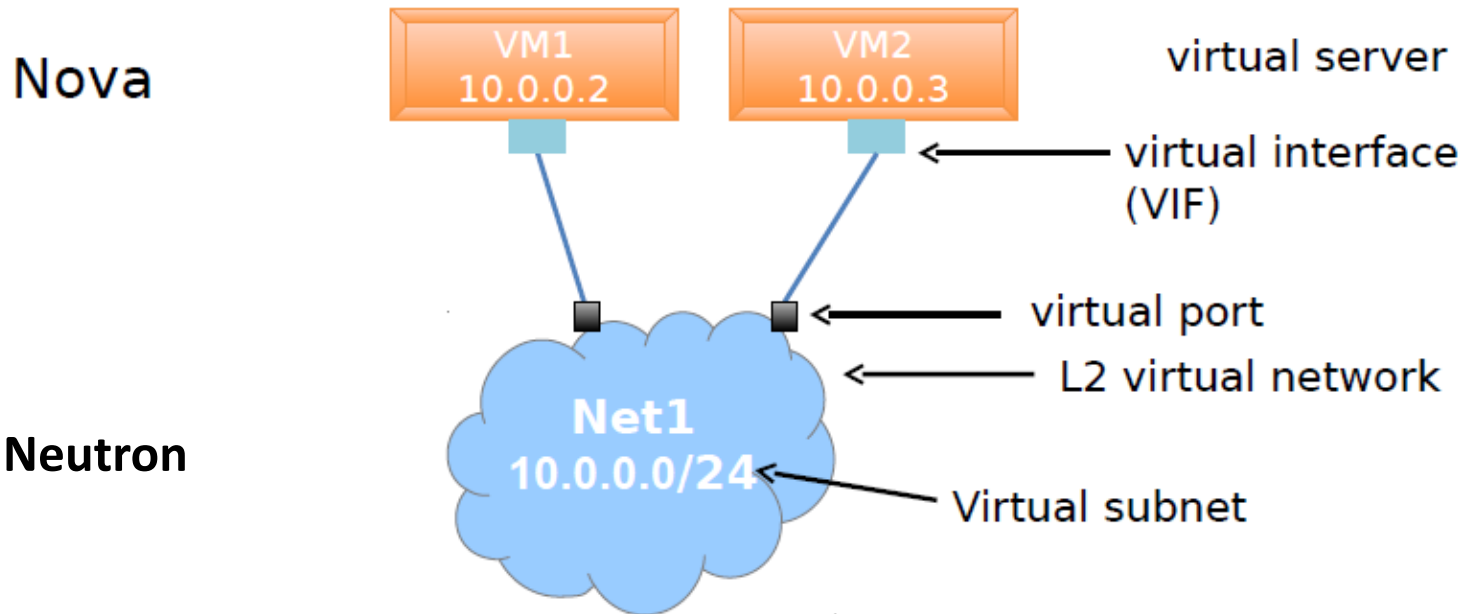
Virtual subnet

"virtual networks" and virtual subnets are fundamentally multi-tenant, just like virtual servers (e.g., overlapping IP's can be used on different networks)

Neutron API Extensions

Neutron Base API v2.0

- **Networks**

  Create, Delete, Update

  List, Show

- **Subnets**

  Create, Delete, Update

  List, Show

- **Ports**

  Create, Delete, Update

  List, Show

Neutron API Extensions

- **Routers**

  Create, Delete, Update, List, Show

- **FloatingIP**

  Create, Delete, Update, List, Show

- *QoS, ACLs, LBaaS*

- *Security Filter Policies*

- *Netflow*

- *Port Profiles/Statistics*

OpenStack Processes, Networks and Hosts

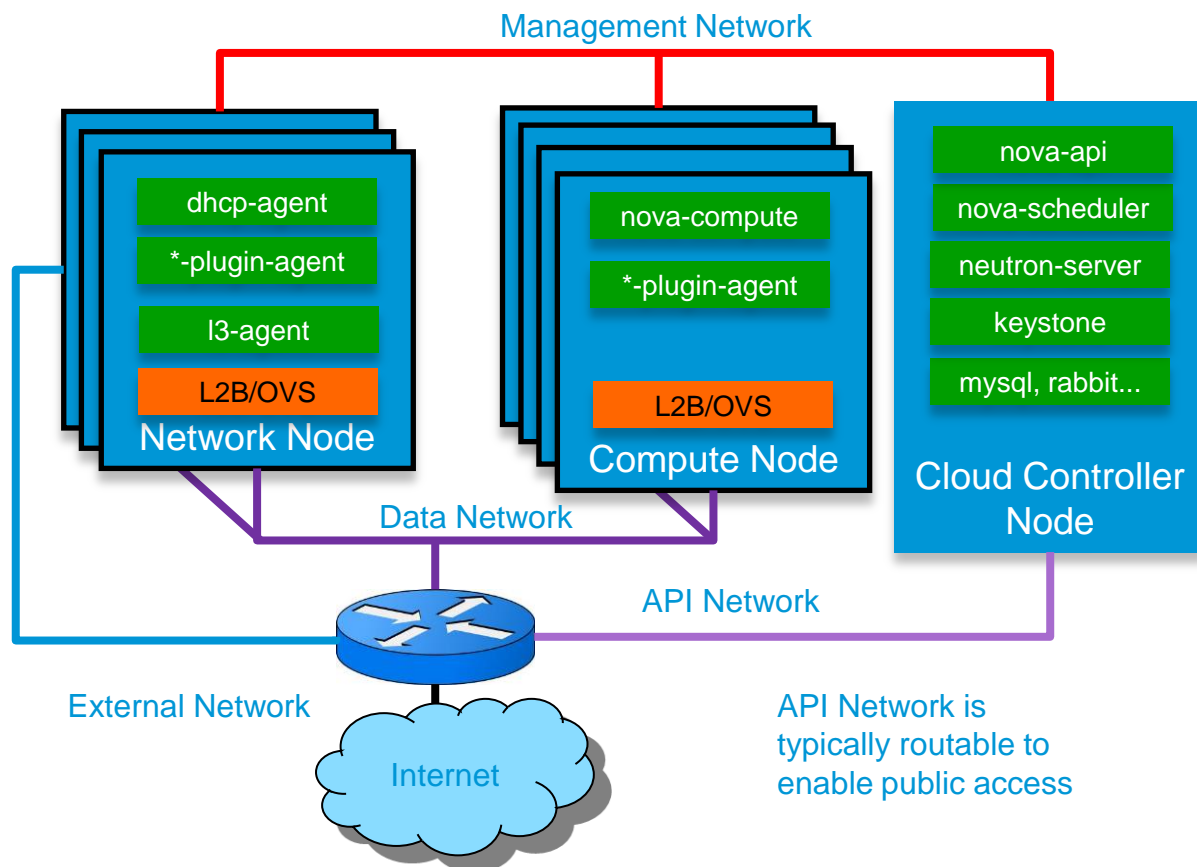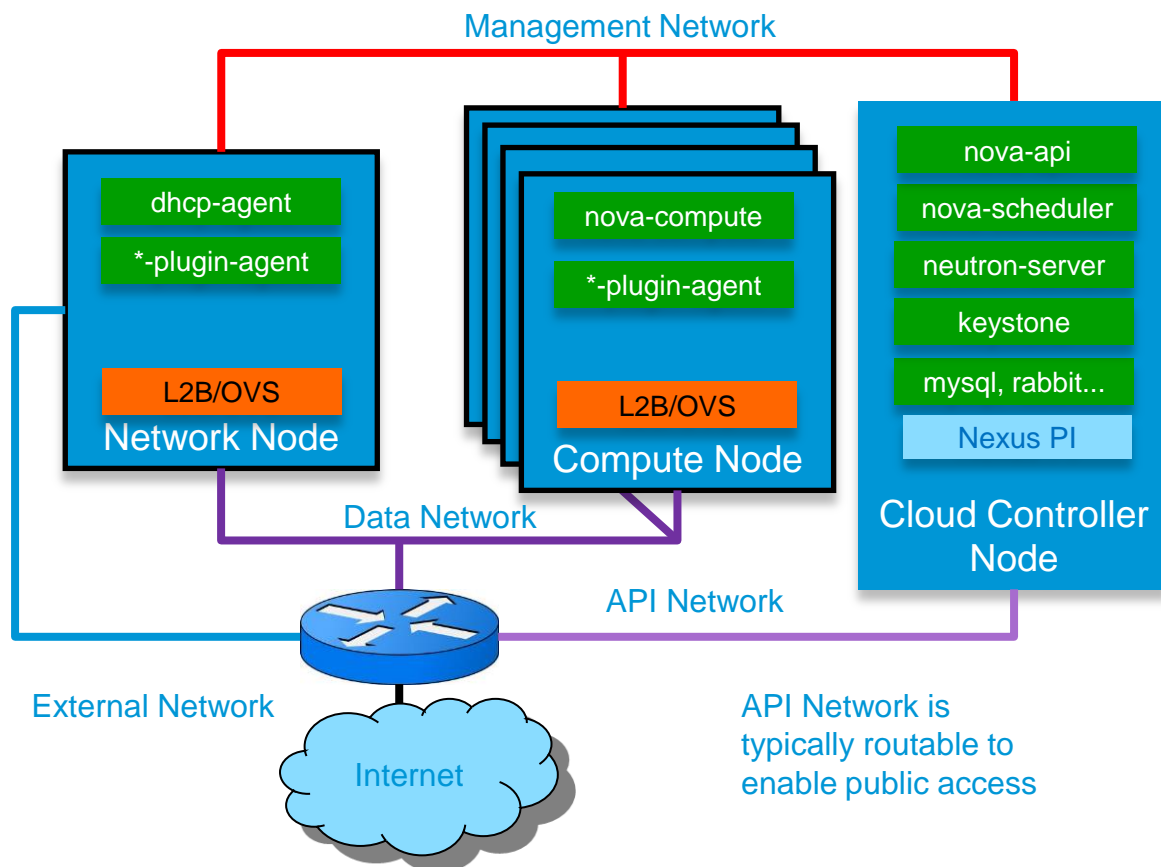- Network node(s) functions as L3 router for gateway and adjacent VLAN traffic (via IP tables configured by L3 Agent)

- Data Network:
  - *Private Tenant Network Traffic*

    Local L2 VM traffic bridged/switched on host
  - *Flat Networking Traffic*

    VLAN Traffic across Nodes
  - *GRE or XVLAN tunnels across Nodes*

- North/South Traffic uses Network Nodes as Gateway to Public/External Networks

- Multiple Network Nodes for high throughput

Management Network

Network Node
- dhcp-agent
- *-plugin-agent
- l3-agent
- L2B/OVS

Compute Node
- nova-compute
- *-plugin-agent
- L2B/OVS

Cloud Controller Node
- nova-api
- nova-scheduler
- neutron-server
- keystone
- mysql, rabbit...

Data Network

API Network

External Network

Internet

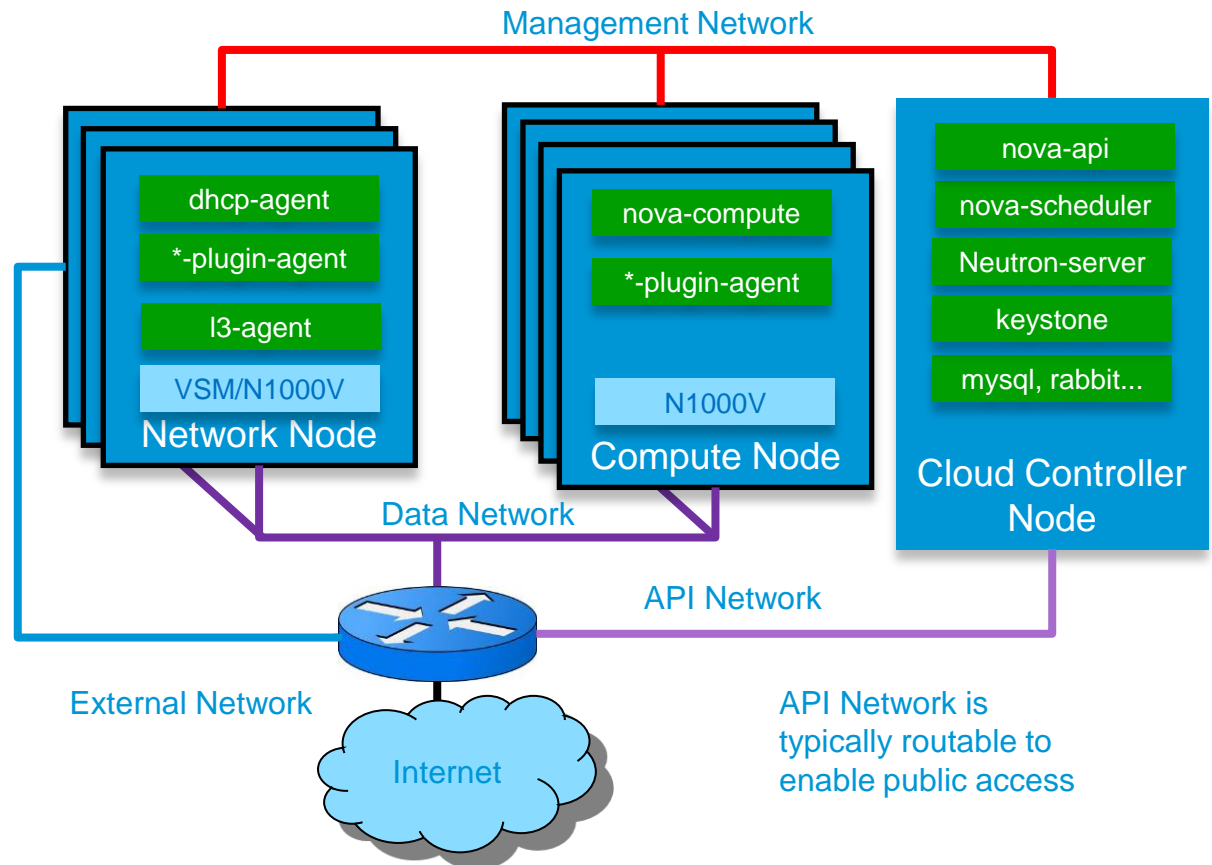API Network is typically routable to enable public access

Nexus Routing with VLAN Networking

- Network node(s) function as L3 router for gateway and adjacent VLAN traffic (via IP tables configured by L3 Agent)

- Data Network:
  - ***Private Tenant Network Traffic***

    Local L2 VM traffic bridged/switched on host
  - ***Flat Networking Traffic***

    VLAN Traffic across Nodes
  - ***GRE or XVLAN tunnels across Nodes***

- SVI configured on Nexus for L3 forwarding and external Gateway

Management Network

Network Node
- dhcp-agent
- *-plugin-agent
- L2B/OVS

Compute Node
- nova-compute
- *-plugin-agent
- L2B/OVS

Cloud Controller Node
- nova-api
- nova-scheduler
- neutron-server
- keystone
- mysql, rabbit...
- Nexus PI

Data Network

API Network

External Network

Internet

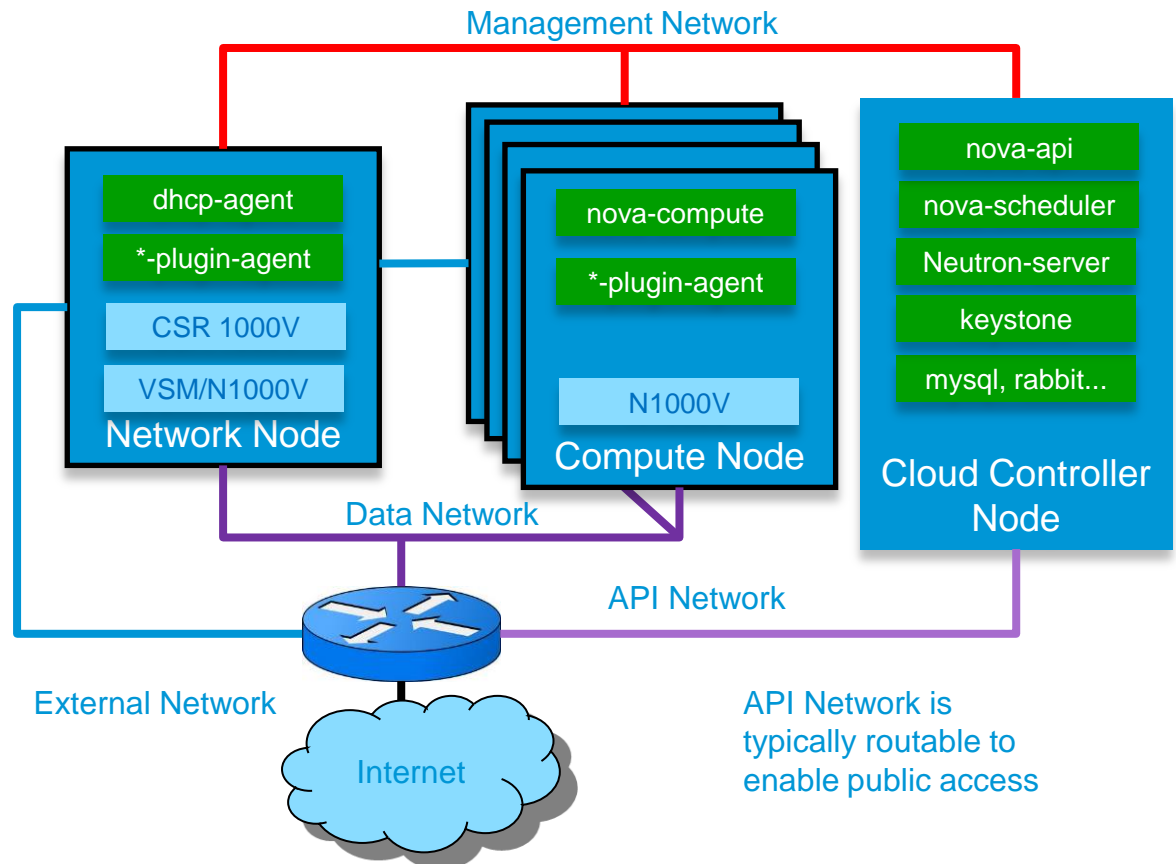API Network is typically routable to enable public access

OpenStack with Nexus 1000V

- Foundation of VMDC Virtual Services Architecture

- vPath Service Insertion/Chaining

- VXLAN Overlay Networking

- CSR, VPN, Firewall, etc.

Management Network

Network Node
- dhcp-agent
- *-plugin-agent
- l3-agent
- VSM/N1000V

Compute Node
- nova-compute
- *-plugin-agent
- N1000V

Cloud Controller Node
- nova-api
- nova-scheduler
- Neutron-server
- keystone
- mysql, rabbit...

Data Network

API Network

External Network

Internet

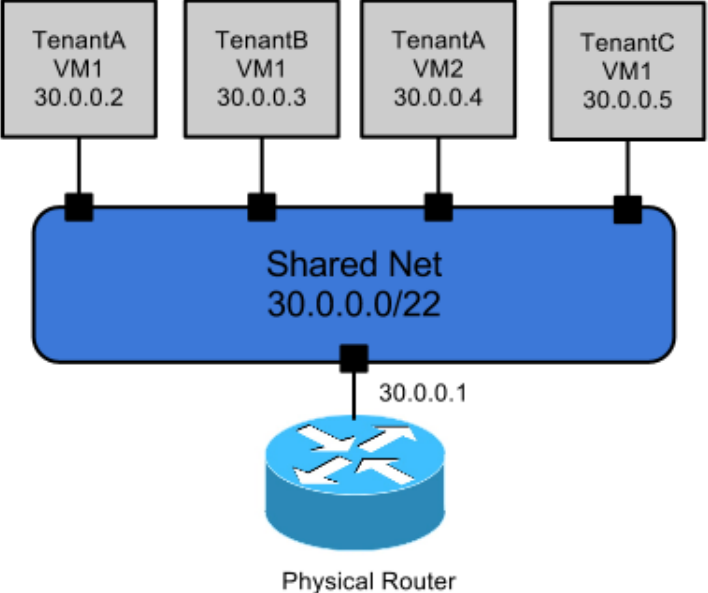API Network is typically routable to enable public access
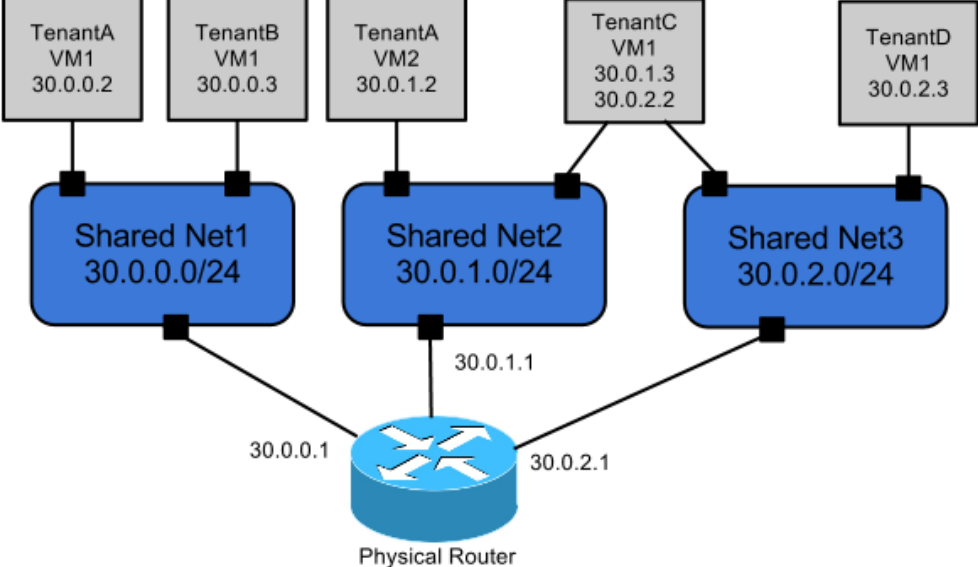
CSR 1000V Routing

- Network or Compute node(s) hosts CSR router(s) as VM for gateway and adjacent VLAN traffic

- CSR Provides per tenant isolation and full IOS capabilities including VPN, BGP, OSFP, MPLS, etc.

Management Network

Network Node
- dhcp-agent
- *-plugin-agent
- CSR 1000V
- VSM/N1000V

Compute Node
- nova-compute
- *-plugin-agent
- N1000V

Cloud Controller Node
- nova-api
- nova-scheduler
- Neutron-server
- keystone
- mysql, rabbit...

Data Network

API Network

External Network

Internet

API Network is typically routable to enable public access

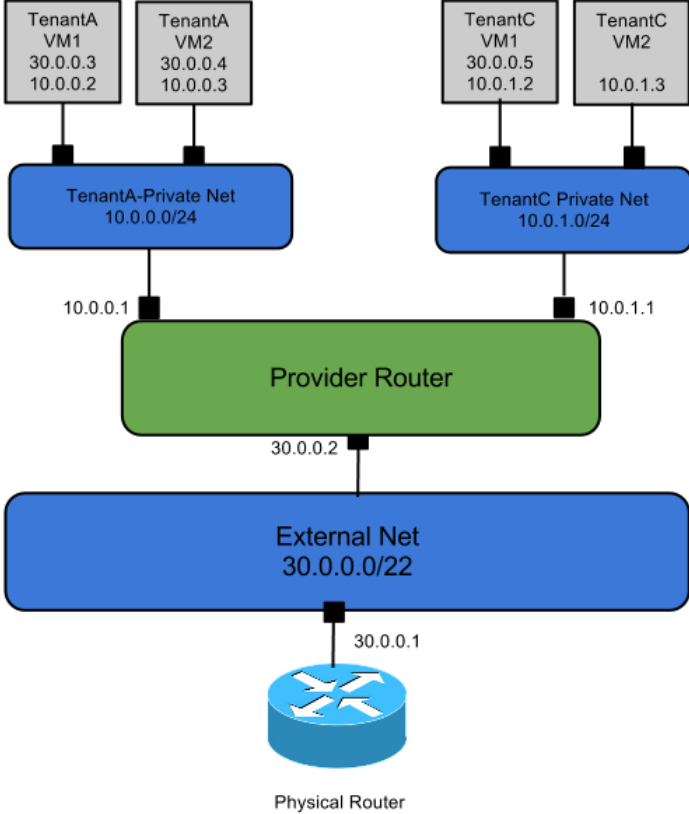# OpenStack Network Topologies

Single Flat Network

Multiple Flat Networks
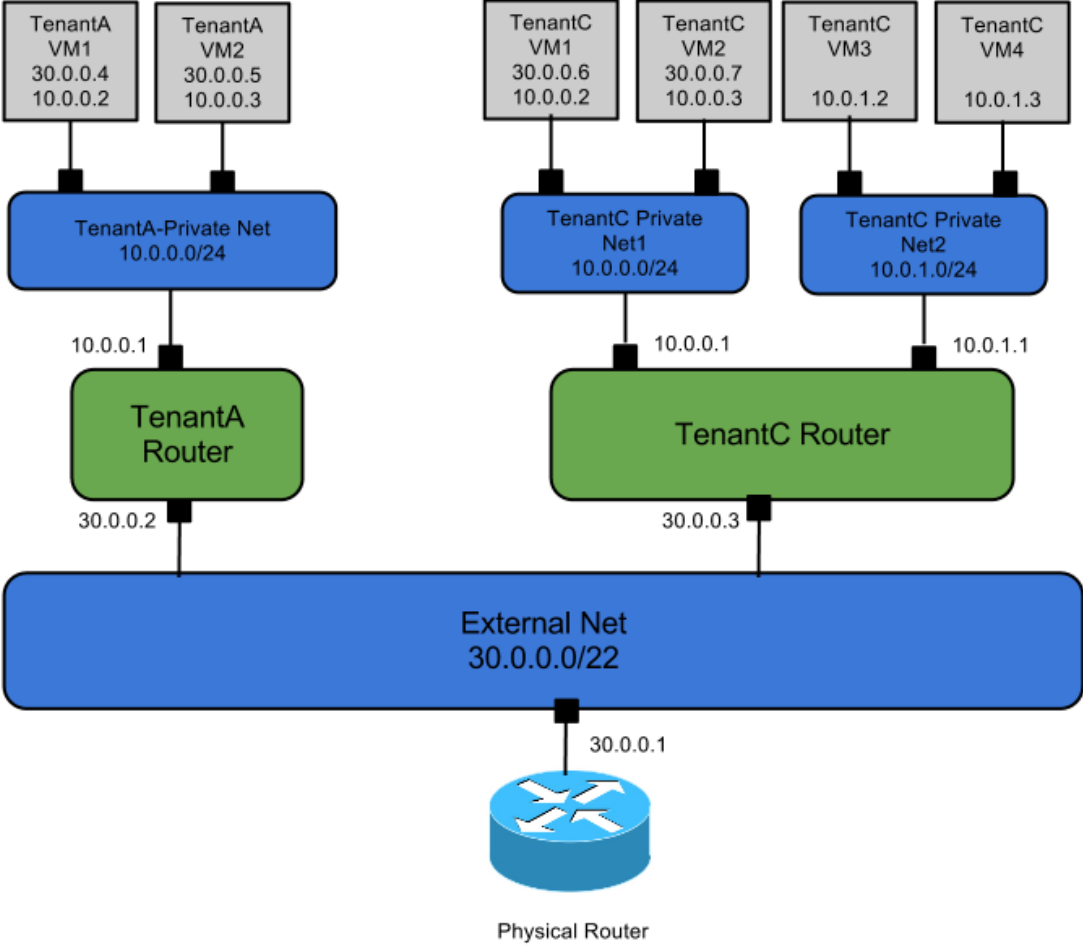
OpenStack Network Topologies
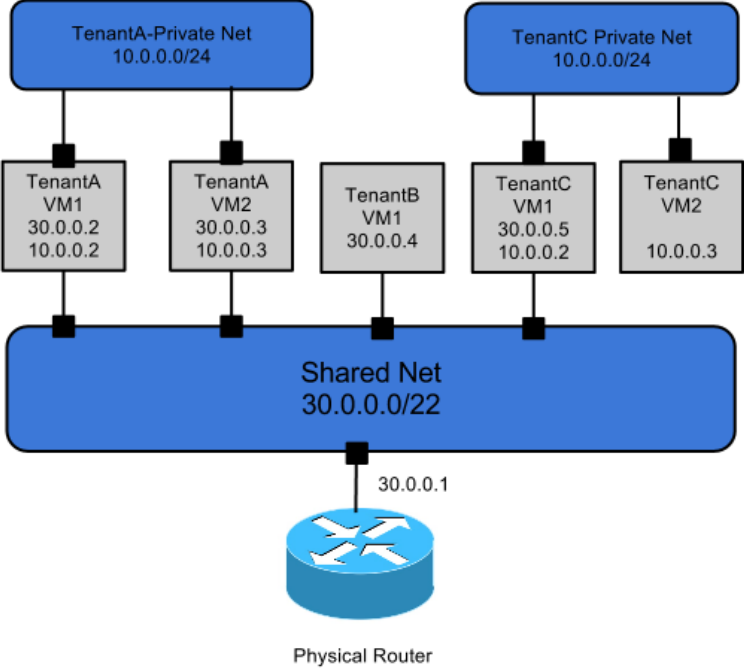
Mixed Flat and Private Network

Provider and Tenant Networks

OpenStack Network Topologies

Tenant Routers and Private Networks

OpenStack@Cisco

Cisco's Focus on OpenStack

Community

- **Neutron – Network Service**
- **Horizon – Dashboard**
- **Keystone – Identity**
- **Swift – Object Storage**
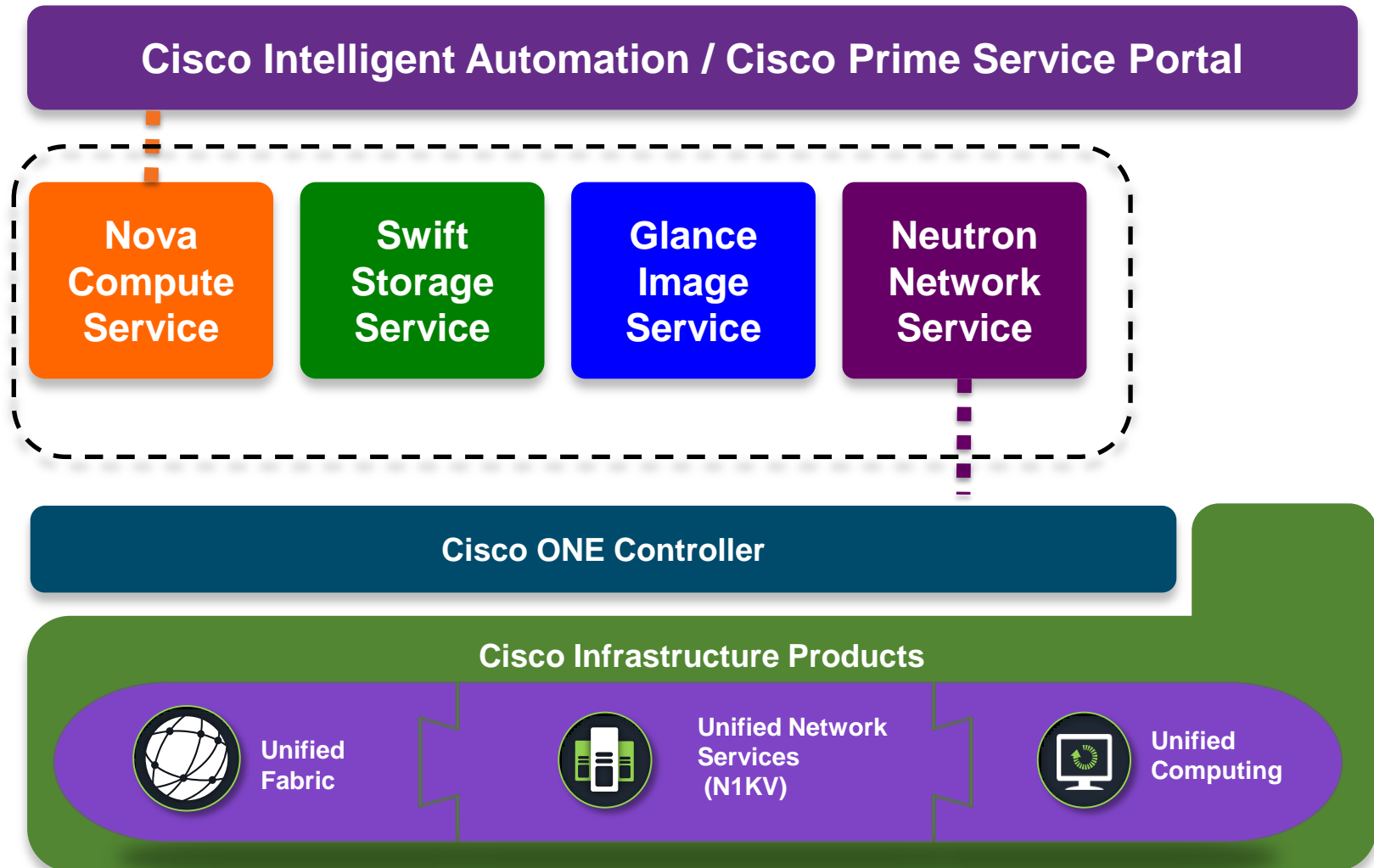- **Automation – PuppetLabs**
- **HA Design**
- **OpenStack Board/PTL**

Engineering

- **Cisco Product Integration**
- **Nexus Plugins – Neutron**
- **UCS**
- **CIAC**
- **Many other integration efforts**
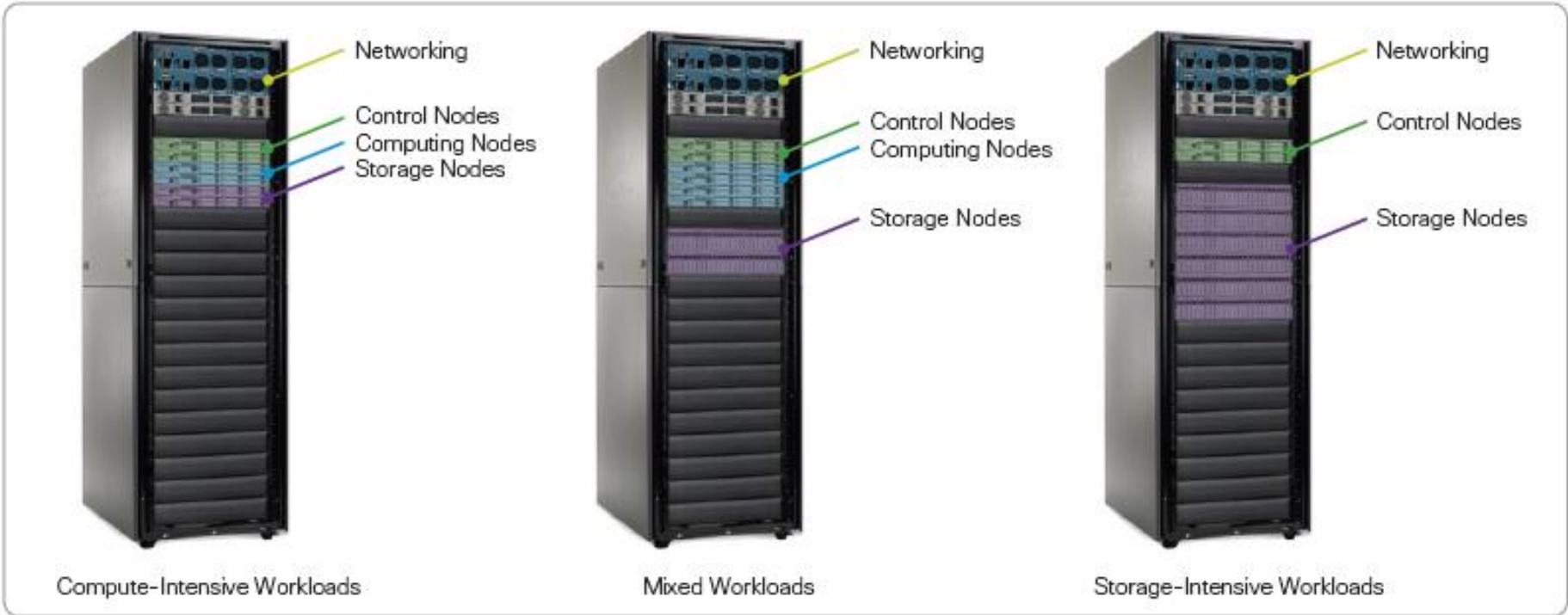
Customers

- **Cisco Validated Designs**
- **Start simple, build from there – Focus on automation and HA**
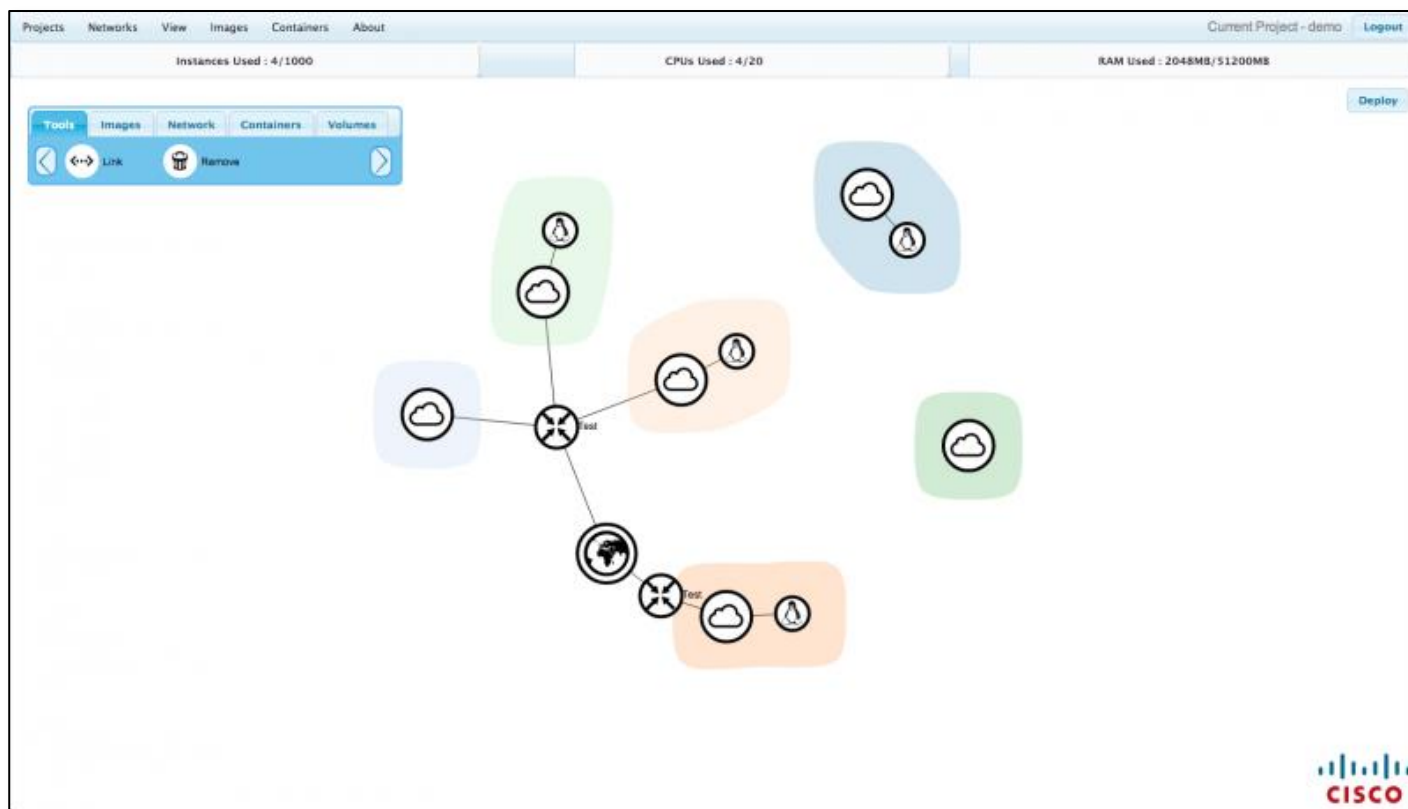- **Evangelization of what Cisco is doing - Thought Leadership – Help customers know What, When, Where & How**

Cisco Integrates OpenStack

Cisco Intelligent Automation / Cisco Prime Service Portal

Nova Compute Service

Swift Storage Service

Glance Image Service

Neutron Network Service

Cisco ONE Controller

Cisco Infrastructure Products

Unified Fabric

Unified Network Services (N1KV)

Unified Computing

Cisco UCS Packages for OpenStack

Cisco Public

Curvature (demo @ April'13 summit)

- Visualisation tool for designing virtual application topologies
- Being developed at Cisco as a companion application for OpenStack

Thank you.