

# Smart Cloud Computing Network Architecture and Services



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中華電信  
Chunghwa Telecom

# Contents

- **Cloud Computing introduction**
- **Smart Network Architecture**
  - Software Defined Network
  - Openflow
  - Open Stack
  - LISP
- **Future Cloud Computing Services**
- **CHT's Experience on SDN**



# Definition of Cloud Computing

## NIST Definition of Cloud Computing

- **five Essential characteristics**, three Service models, and four Deployment models

### Essential Characteristics

- On-demand self-service
- Broad network access
- Resource pooling
- Rapid elasticity
- Measured Service

### Service Models

- Cloud Software as a Service (SaaS)
- Cloud Platform as a Service (PaaS)
- Cloud Infrastructure as a Service (IaaS)

### Deployment Models

- Private cloud
- Community cloud
- Public cloud
- Hybrid cloud



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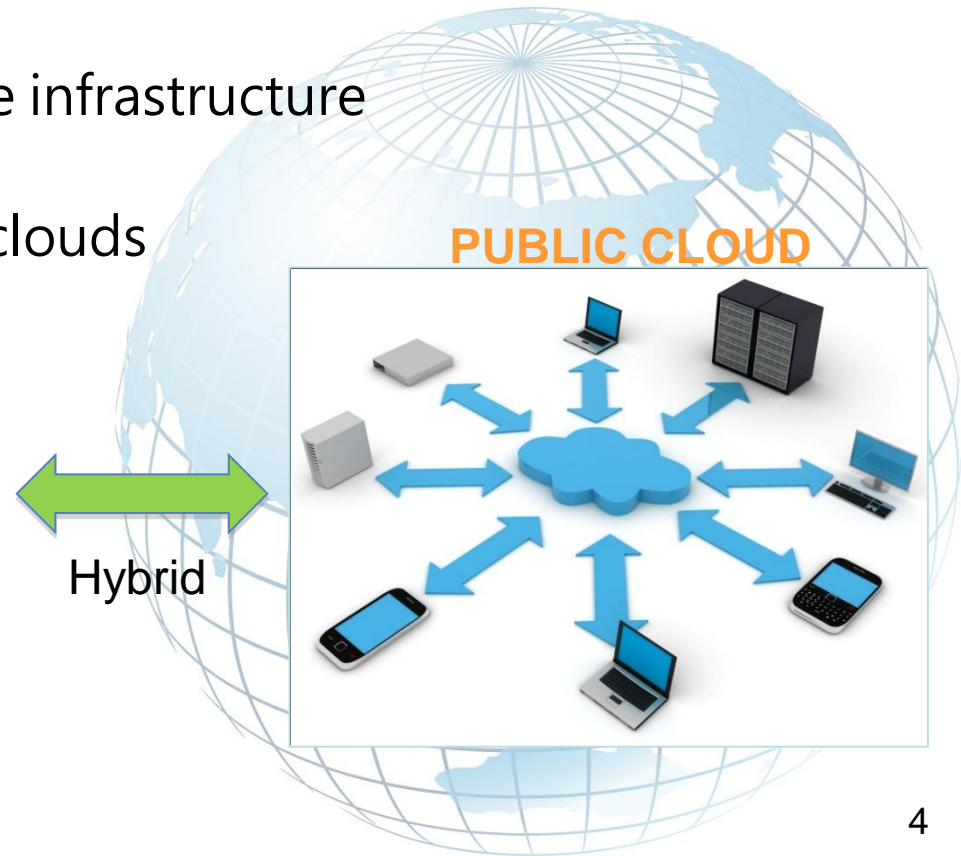
# Cloud Deployment Models

- **Private cloud**
  - Enterprise owned or leased
- **Community cloud**
  - Shared by several organizations
- **Public cloud**
  - Sold to the public, mega-scale infrastructure
- **Hybrid cloud**
  - Composition of two or more clouds



**PRIVATE CLOUD**

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# Core Principles of Cloud Computing

- Security
- On-demand self-service
  - Resources on demand
  - Auto Scale-out
  - Pay for what you use (Flexible Billing)
  - Release resources when no long needed (Green)
- High Availability
- Good Performance
- Cost-effective



# Smart Cloud Network

## Characteristic

- **On Demand Network:** Service trigger on Demand (end to end) Network Provision
- **Customized Network:** Per Customer Network Provision, Per Customer accounting, billing, ..
- **Unified Network Management:** Common Interface, Standard Protocol, Provision and Management
- **Mobility**
- **Secure**
- **Context Awareness:** Policy based Network Management
- **Robust**

## Technologies

- **Software Defined Network (SDN) – Openflow**
- **OpenStack**
- **Locator/ID Separation Protocol (LISP)**
- **Content Centric**
- **Autonomic**



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# Proprietary to Open Source

Today  
Proprietary



Browser



PC/Mac



iPhone/iPad/Android Phone



Good Reader

Future  
Open Source



VMM

CMS

OpenStack + Openflow



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CMS: Configuration Management System  
VMM: Virtual Machine Manager

# SDN (Software Defined Network)

- Open Networking Foundation promote SDN (<http://www.opennetworkingfoundation.org/>)
  - March 21rd, 2011 Kick-off, 6 boards, 17 members
  - May 23rd, 2011, 6 boards, 30 members
- OpenFlow protocol is the solution

## Member Companies

### Board of Directors

- Deutsche Telekom
- Facebook
- Google
- Microsoft
- Verizon
- Yahoo!

### Members

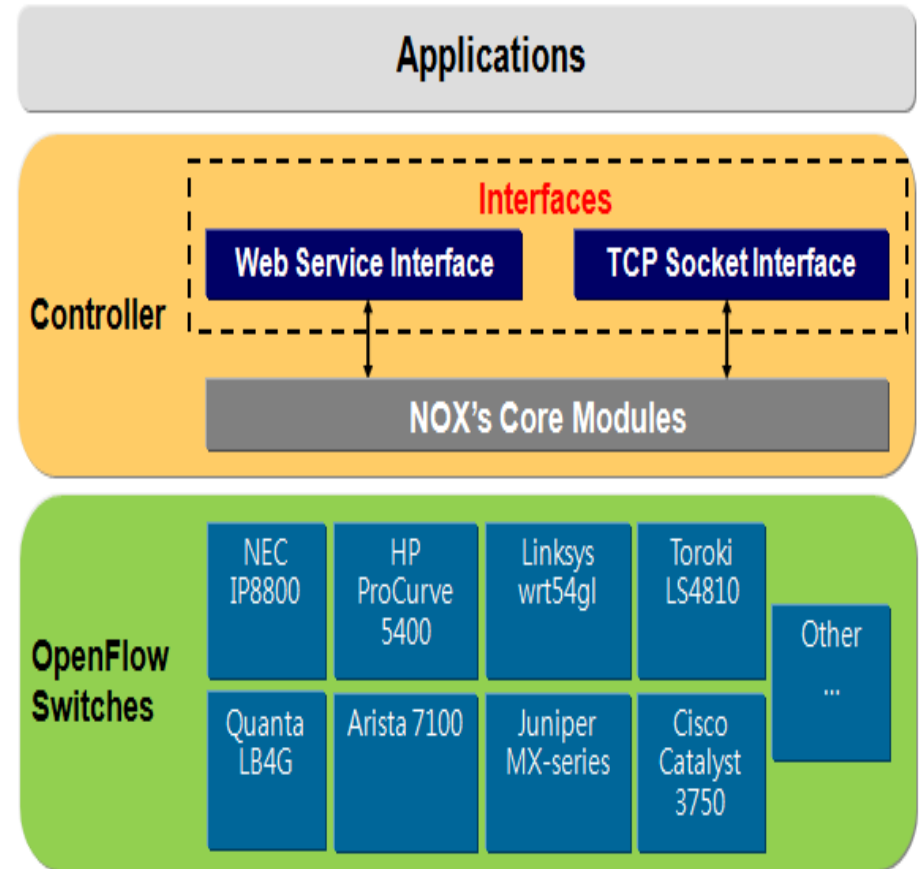
- Big Switch Networks
- Broadcom
- Brocade
- Ciena
- Cisco
- Citrix
- Comcast
- Dell
- Ericsson
- Extreme Networks
- Force10 Networks
- HP
- Huawei Technologies
- IBM
- Intel
- IP Infusion
- Juniper Networks
- Marvell
- Mellanox Technologies
- Metaswitch Networks
- NEC
- Netgear
- Netronome
- Nicira Networks
- Nokia Siemens Networks
- NTT
- Plexxi Inc.
- Riverbed Technology
- Vello Systems
- VMware





# The SDN Characteristic

- Separate control from the data path
  - New protocol (Openflow)
- Controller
  - Configuration and management
- Data path
  - Compliance and Interoperability
- API above Controllers
  - New features, New business models



# SDN Implementation

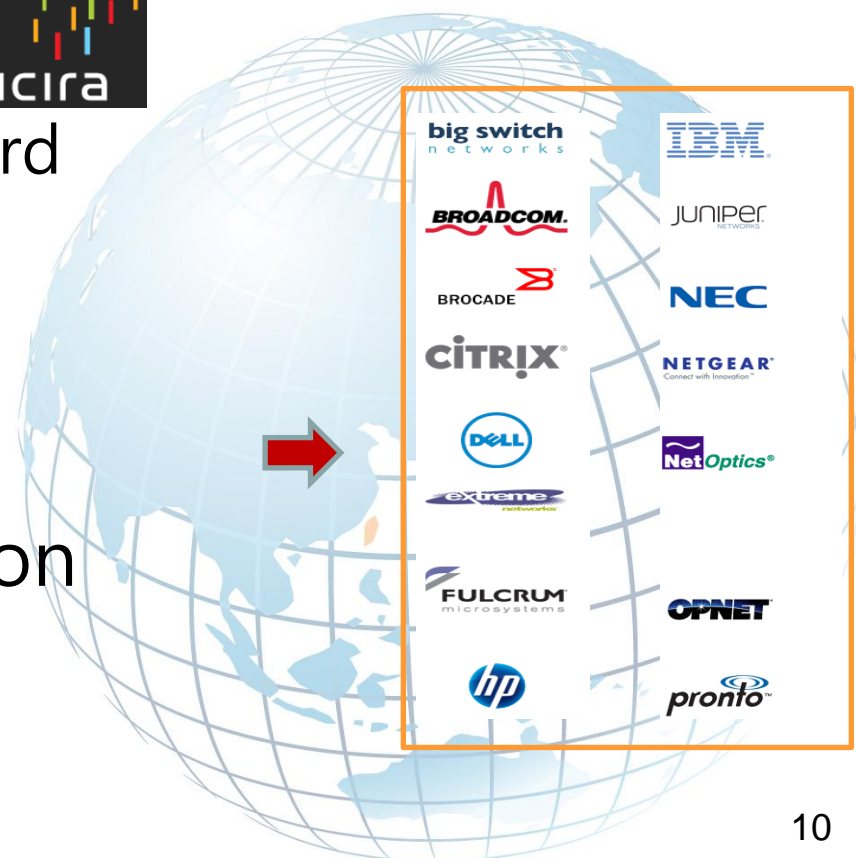
- Hypervisor Mode

- Open vSwitch (Open Source, Xen Hypervisor)
- Tunnel between VMs
- Nicira: not Openflow standard



- Hardware Mode

- OpenFlow Switch
- Hop by Hop configuration



# OpenFlow



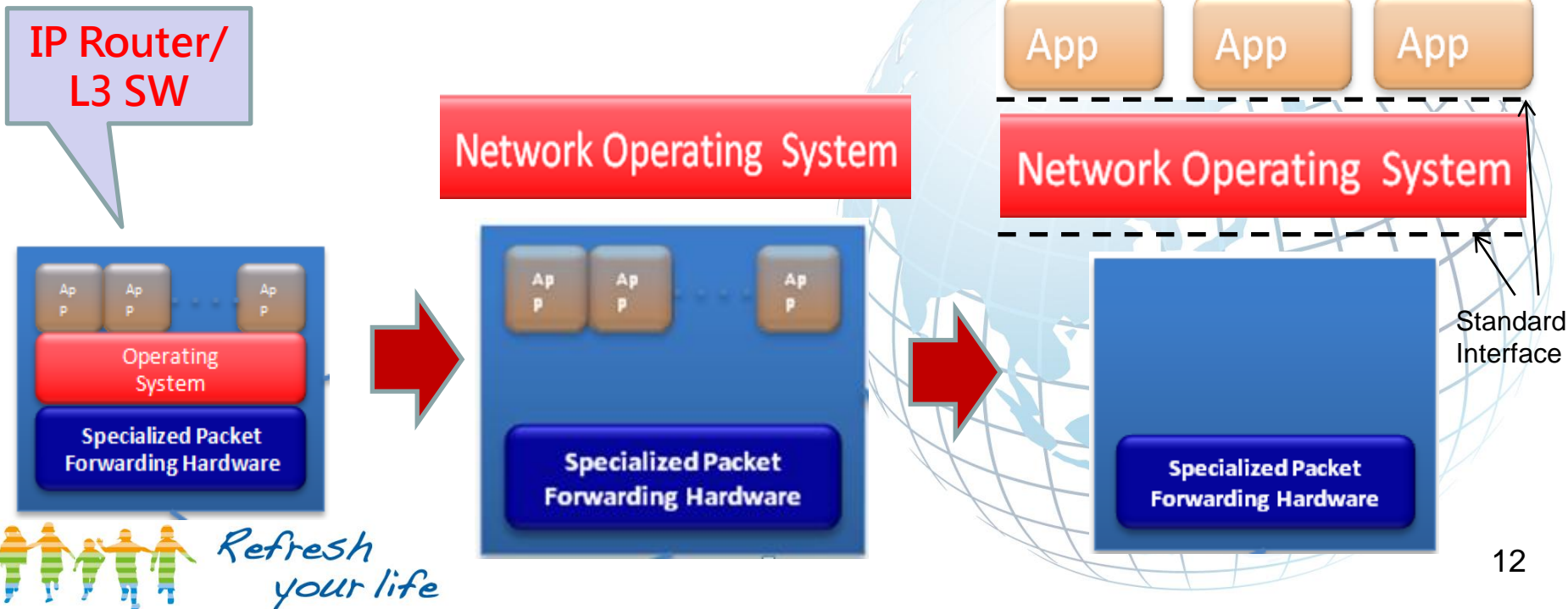
- **Stanford University** established OpenFlow Switching Consortium in 2008 to maintain and support OpenFlow specification (now transfer to ONF)
- **User-defined policies** in live production networks
- **Current Trails** (68 trials/deployments, 13 countries) 2010



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year 11

# Network Evolution based on SDN

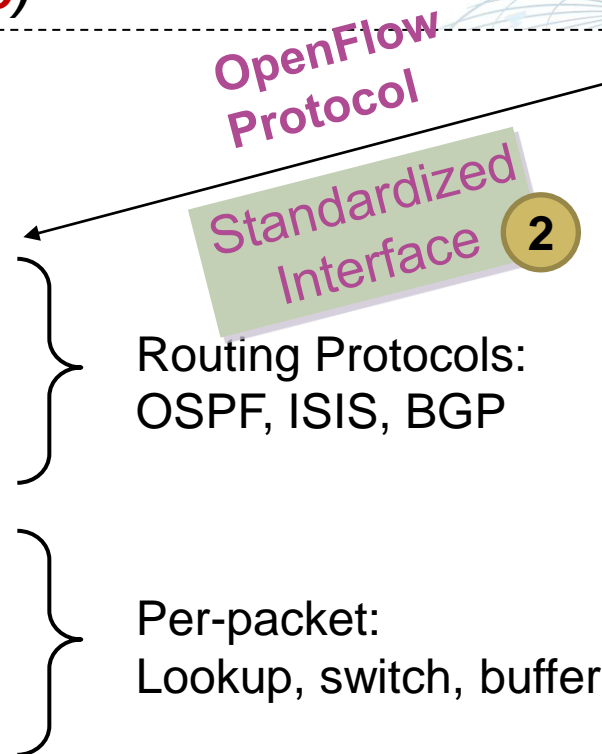
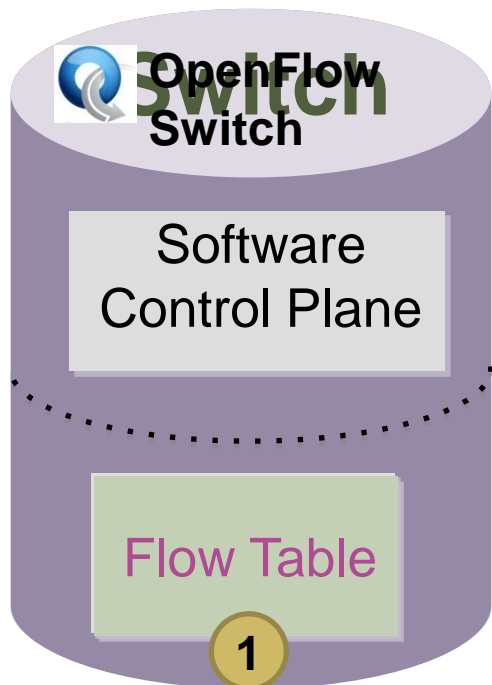
- Simplified Network Devices
- Unified Network Controller
- Separated Control Plane & Data Path
- Standard Interface/forwarding Plane



# What is OpenFlow

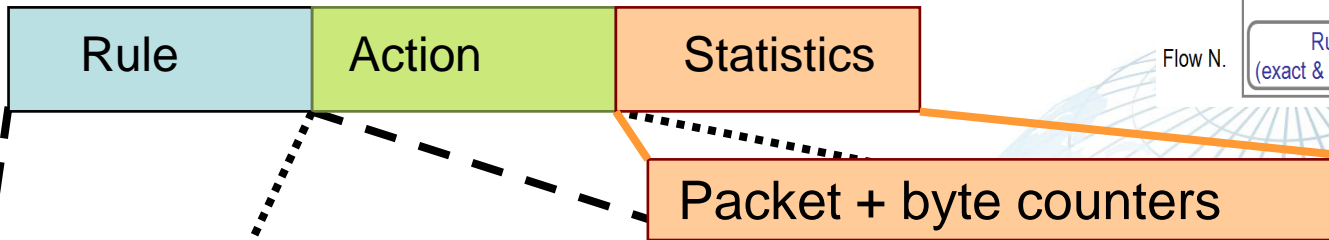
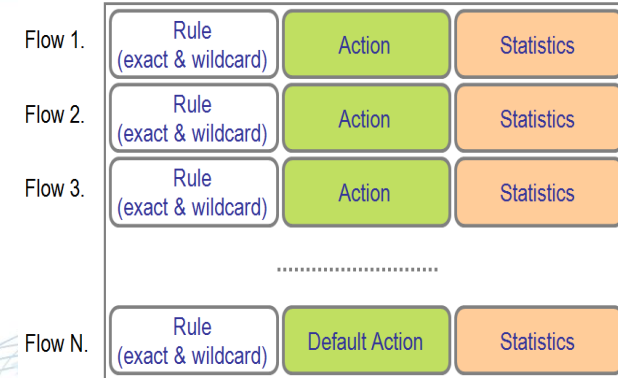
- Cheaper Network Device
- Standardized Interface/forwarding Plane
- Decoupled the control plane and data path

**OpenFlow Switch specification**  
(version 1.1/1.0/0.9.0/0.8.9)



# Flow Table (Version 1.1)

- Rules: Ethernet 、 IP 、 MPLS 、 TCP 、 any **Combination**
- Actions: Forward 、 Drop 、 **Modify field (NAT)**
- Statistics: **Volume based billing, anti DDOS**

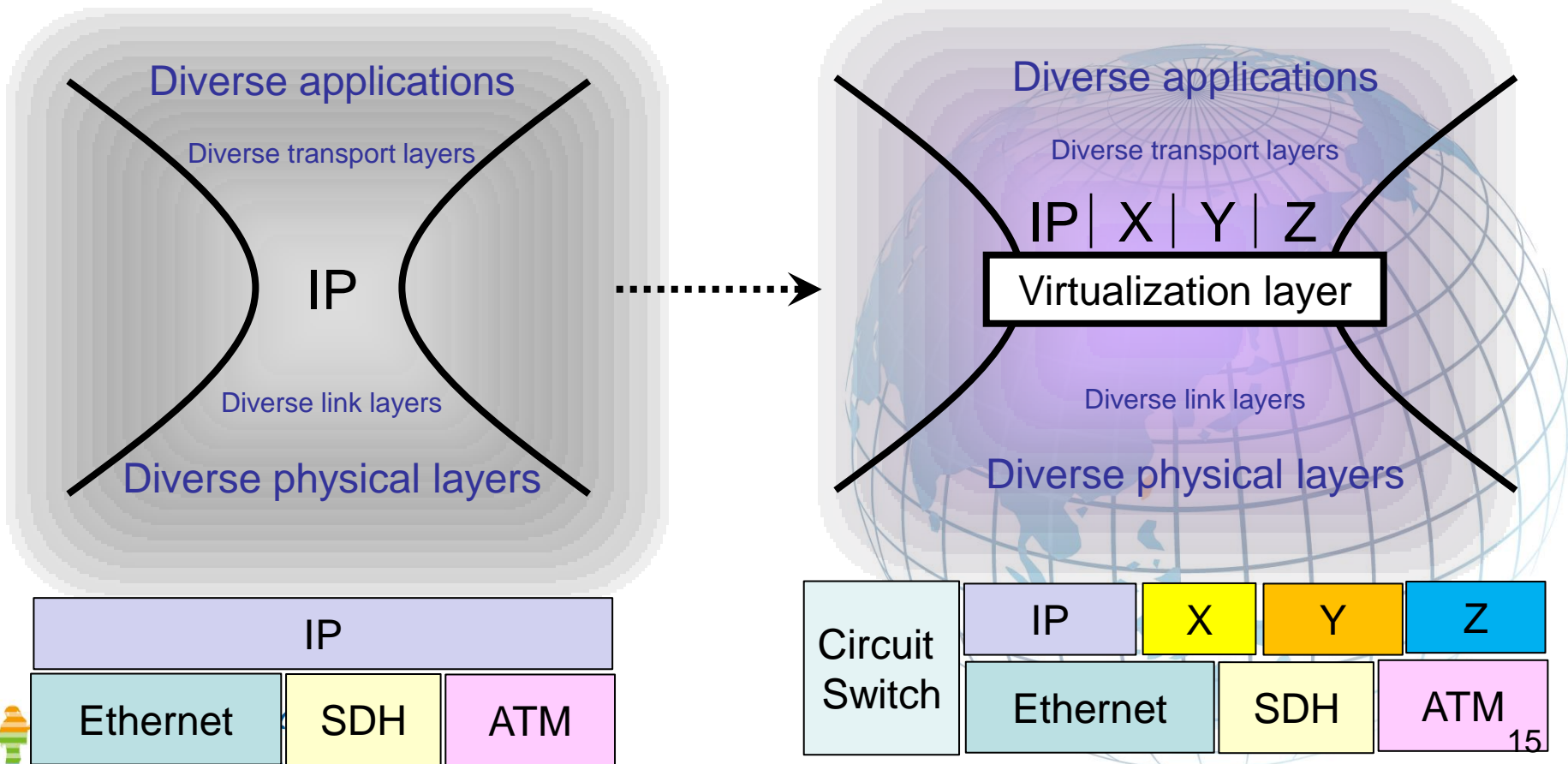


1. Forward packet to port(s)
2. Forward to controller
3. Drop packets
4. Modify field
5. Map to queue

Ingress Port	Metadata	Ether src	Ether dst	Ether type	VLAN id	VLAN priority	MPLS label	MPLS traffic class	IPv4 src	IPv4 dst	IPv4 proto / ARP opcode	IPv4 ToS bits	TCP / UDP / SCTP src port	ICMP Type	TCP / UDP / SCTP dst port	ICMP Code
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# OpenFlow: Substrate Change

- Supporting Heterogeneous Protocol base on flow
- Packet/Circuit Switching: Ethernet、IP、MPLS、TCP、any Combination



# OpenFlow Interop

- Fifteen Vendors Demonstrate OpenFlow Switches at Interop (Interop Las Vegas) (May 8-12, 2011)

big switch  
networks

IBM

BROADCOM

JUNIPER  
NETWORKS

BROCADE

NEC

CITRIX

NETGEAR  
Connect with Innovation

DELL

NetOptics

extreme  
networks

FULCRUM  
microsystems

OPNET

hp

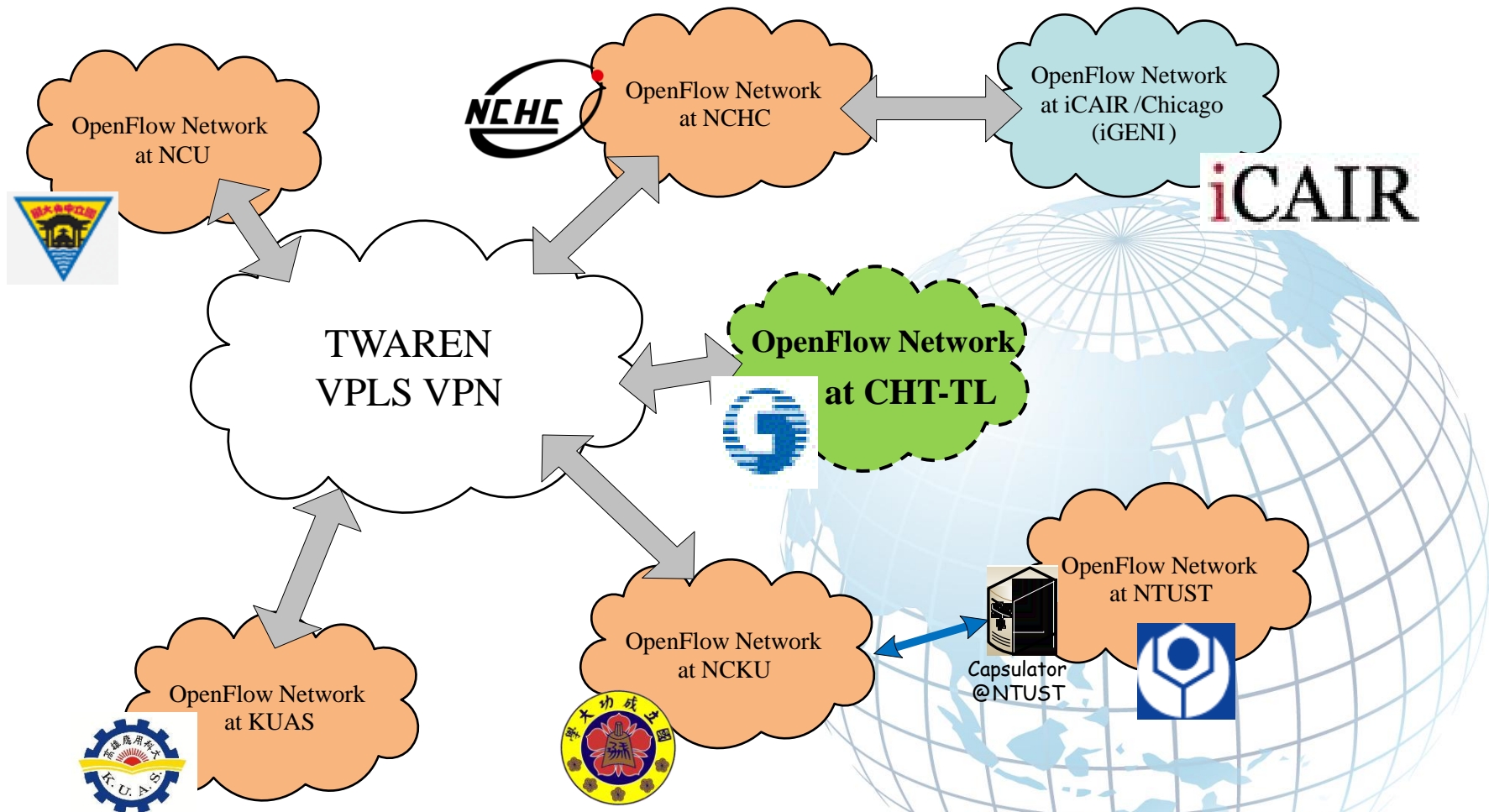
pronto



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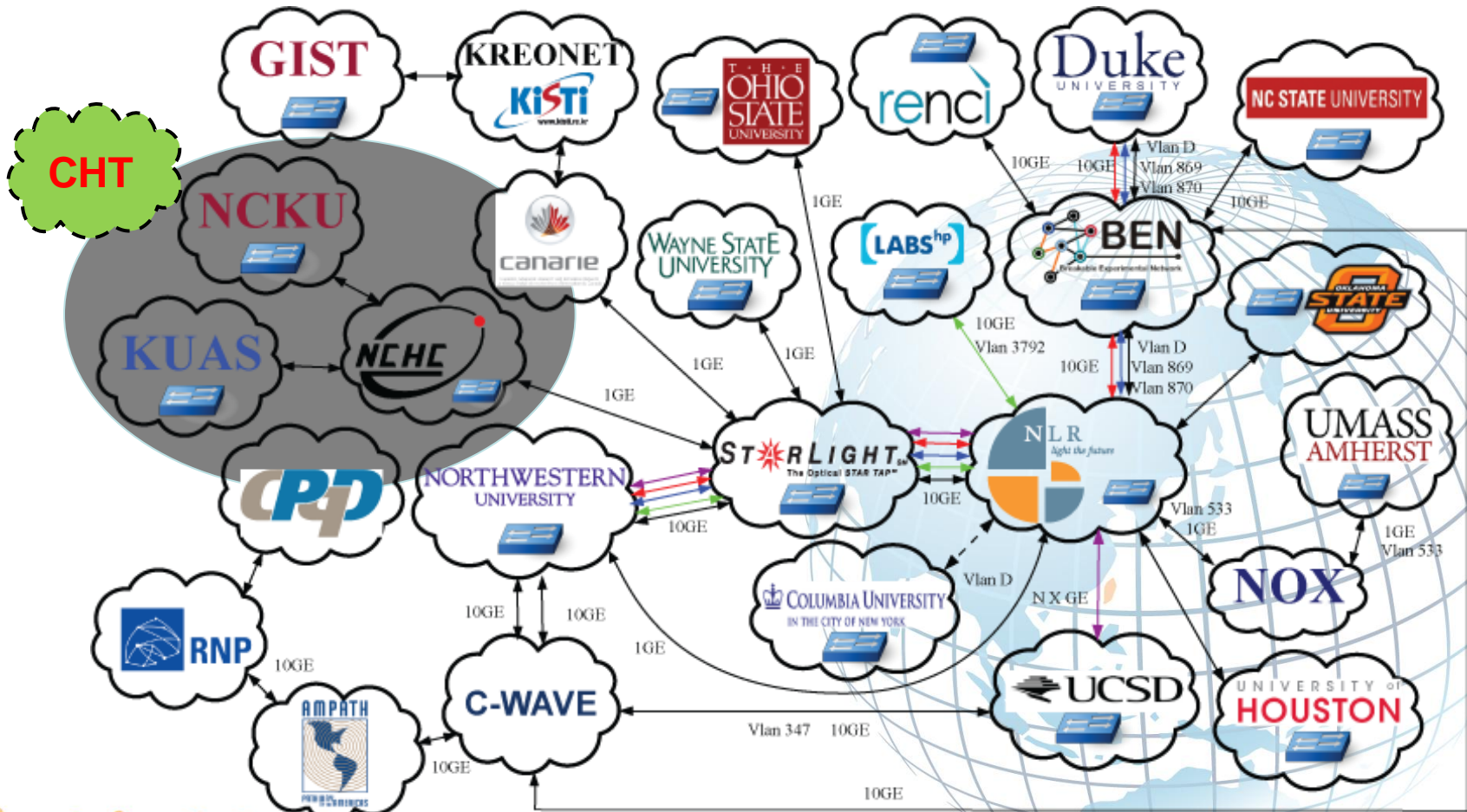
# OpenFlow Testbed @ Taiwan



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# International GENI (iGENI) Testbed

- Taiwan has joined iGENI testbed

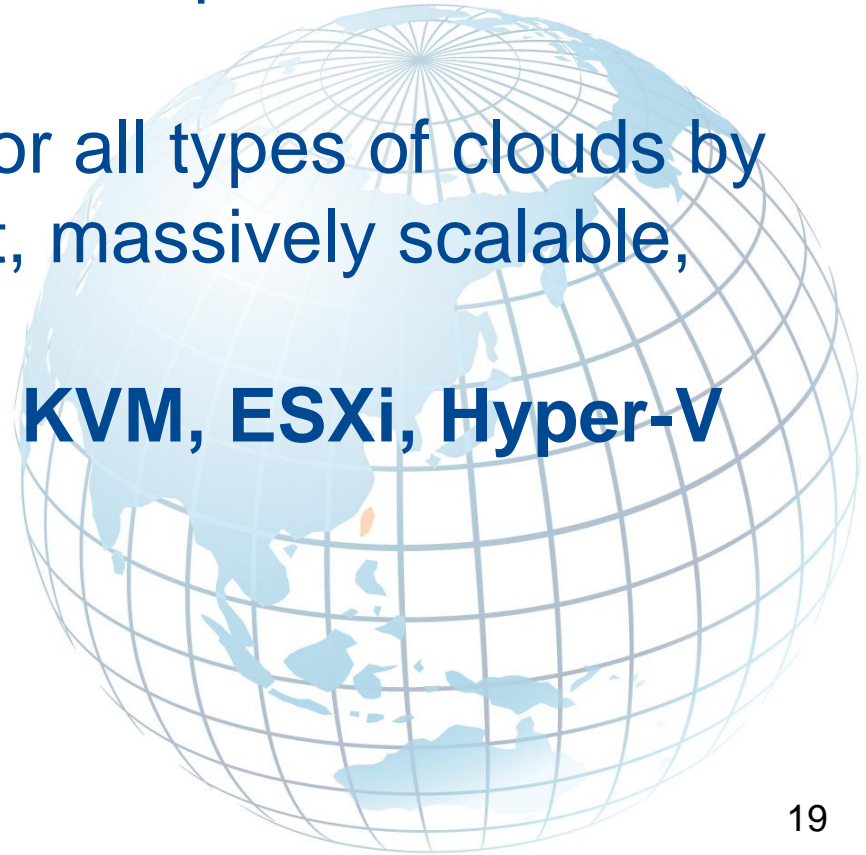


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# What is OpenStack?



- Open source software for building private and public clouds
- Originated at NASA, with Rackspace  
<http://openstack.org>
- Aims to deliver solutions for all types of clouds by being simple to implement, massively scalable, and feature rich.
- Multiple hypervisors: **Xen, KVM, ESXi, Hyper-V**
- 92+ Companies join



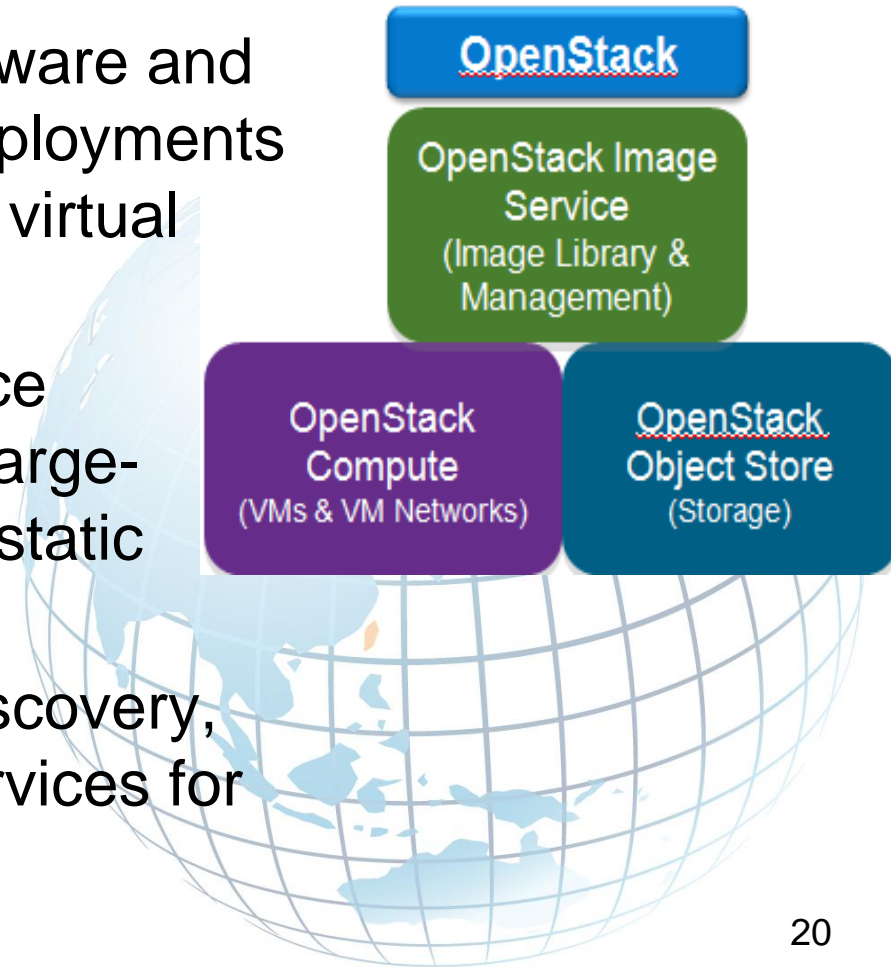
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# Open Stack Focus



- **Three projects for a cloud infrastructure:**

- **Compute**: open source software and standards for large-scale deployments of automatically provisioned virtual compute instances
- **Object Storage**: open source software and standards for large-scale, redundant storage of static objects
- **Image Service**: provides discovery, registration, and delivery services for virtual disk images



# Open Source based Cloud Architecture



Portal

OpenStack 

Openflow Controller 

**CITRIX** **KVM**  
**Microsoft Hyper-V** **vmware**

Hypervisor

Server

Storage

Database

IPS

Firewall

Switch

SLB

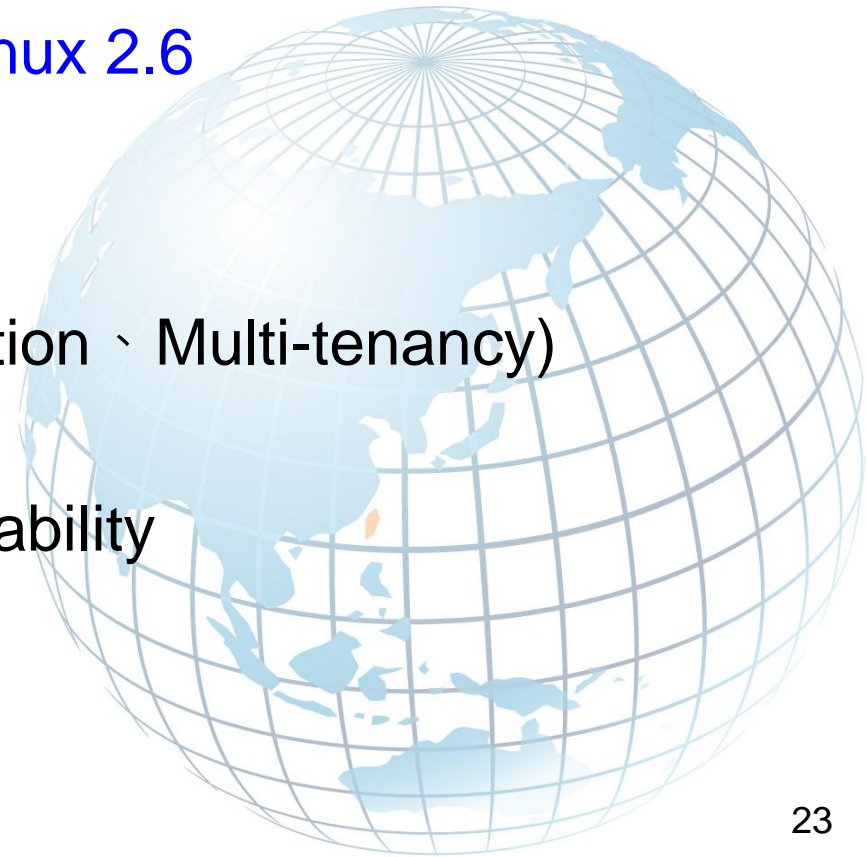


# OpenStack Worldwide

- No Taiwan Company join yet



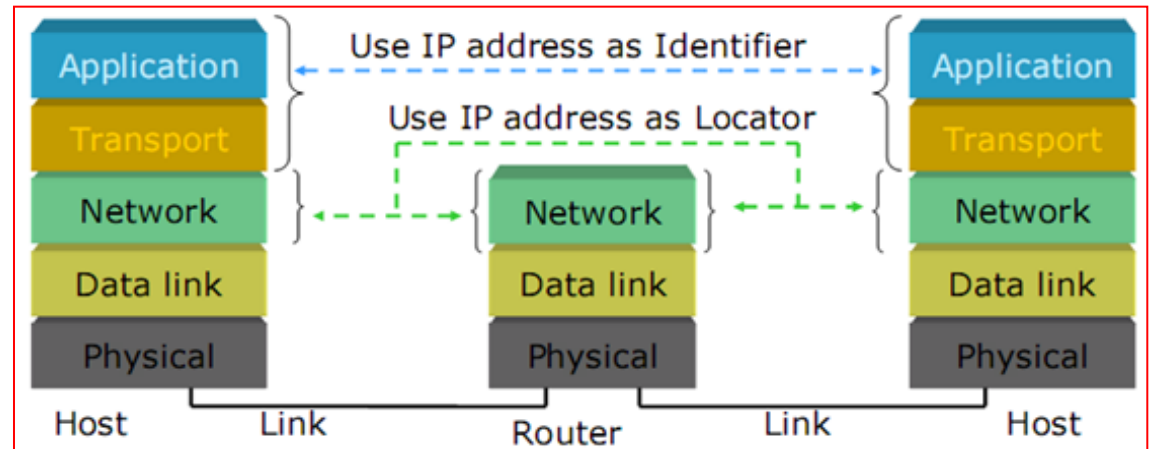
- New Routing Architecture
- LiSP is being developed under the IETF LiSP WG
- LiSP is implemented in
  - FreeBSD: OpenLiSP and Linux 2.6
  - CISCO LiSP: NX-OS
- LiSP can be applied to
  - Data Center: VM Live Migration 、 Multi-tenancy)
  - Mobility: Subscriber & VM
  - Multi-homing: increase availability
  - Workload distribution
  - IPv6 Transition



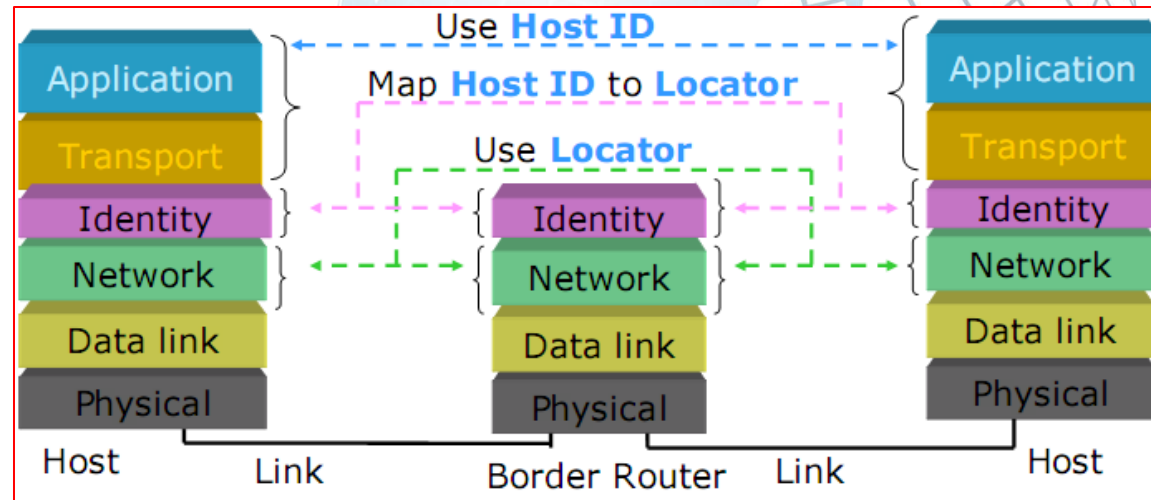
# Comparison of IP & LISP Architecture

- New identity layer
- Network layer independent transport and upper layers
  - Heterogeneous network layer protocols supported

Existing IP architecture



LISP architecture





# LISP in IETF

- IRTF/IETF

Router-based

- Routing Research Group (RRG)

- developing a technical framework for ID/locator split-based routing architecture

Host-based

- Host Identity Protocol (HIP) Research/ Working Groups

- Developed a number of RFCs (5201-5205) on ID/locator split-based host protocols for secure mobility and multihoming

- SHIM6 Working Group

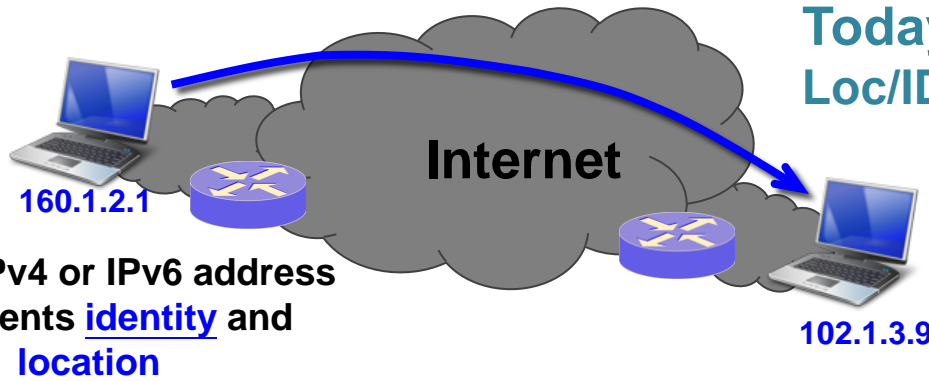
- Developing protocols to support site multihoming in IPv6

IETF Draft:

- draft-farinacci-lisp-12.txt
- draft-fuller-lisp-alt-05.txt (LISP Alternative Topology (LISP+ALT) )
- draft-lewis-lisp-interworking-02.txt
- draft-farinacci-lisp-multicast-01.txt
- draft-ietf-lisp-09.txt (Locator/ID Separation Protocol (LISP) )
- draft-ietf-lisp-ms-07.txt (LISP Map Server )
- draft-ietf-lisp-multicast-04.txt (LISP for Multicast Environments)



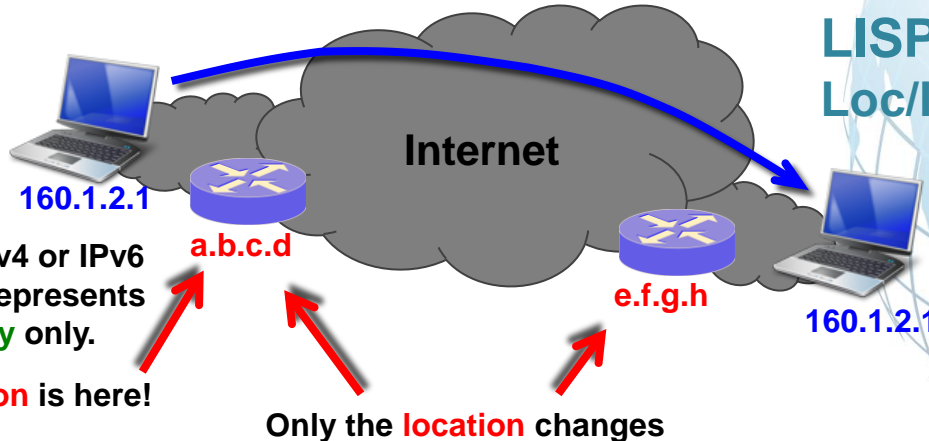
# LISP Support Mobility



Today's Internet Behavior  
Loc/ID "overloaded" semantic

Device IPv4 or IPv6 address represents identity and location

When the device moves, it gets a new IPv4 or IPv6 address for its new identity and location



LISP Behavior  
Loc/ID "split"

Device IPv4 or IPv6 address represents identity only.

Its **location** is here!

Only the **location** changes

When the device moves, keeps its Identity, It has the same **identity**



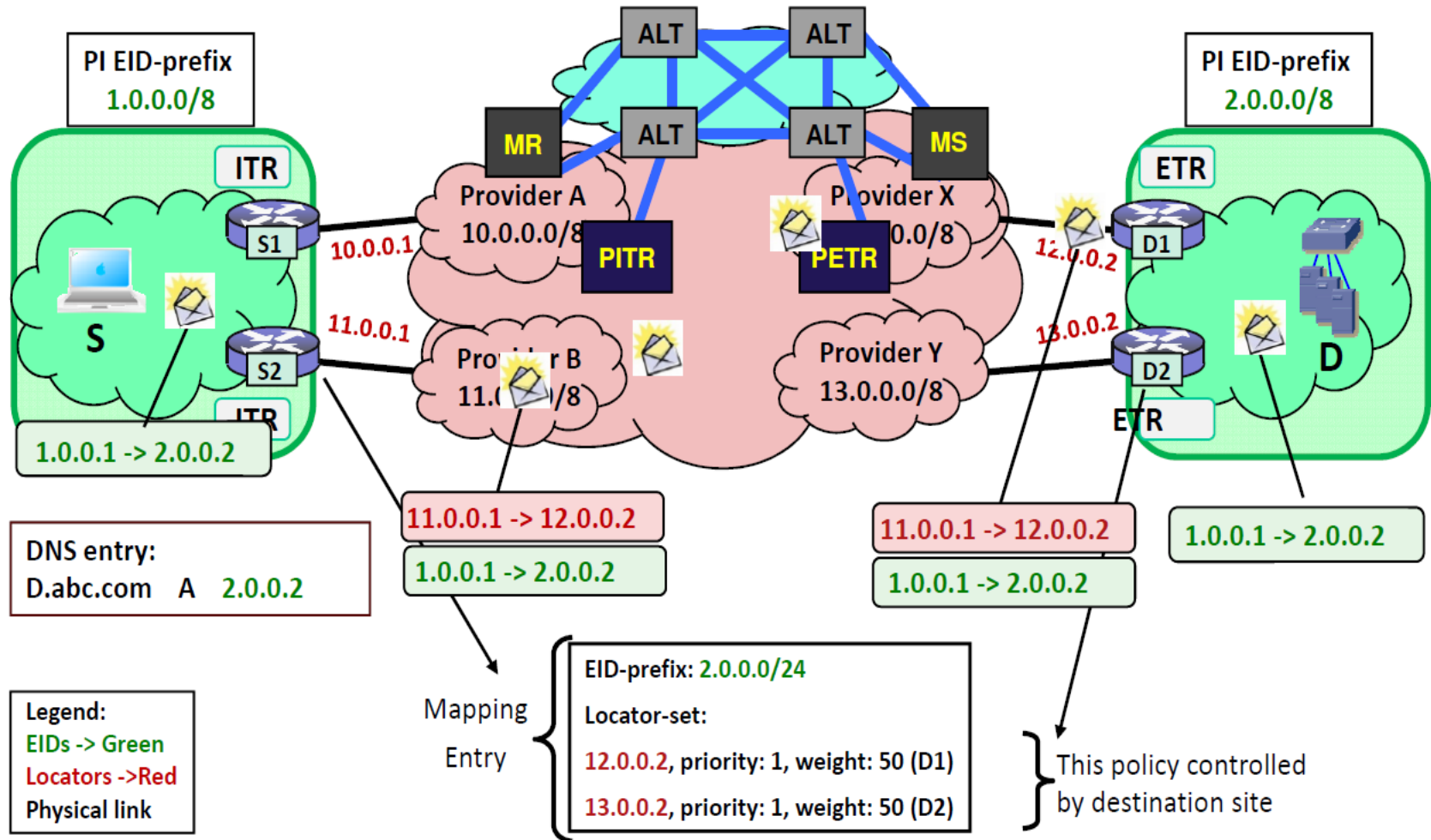
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# Open Source Implementation LISP

- **OpenLISP is a open source implementation of LISP**
  - Aims at providing an open and flexible platform for experimentation
  - FreeBSD based on the LISP draft (version 07)
  - Mapping sockets are created to support the mapping system to interact with the forwarding engine
- **LISP implementation for Linux 2.6**
  - Is also a open source implementation
  - Include kernel module, iproute, and lispd daemon

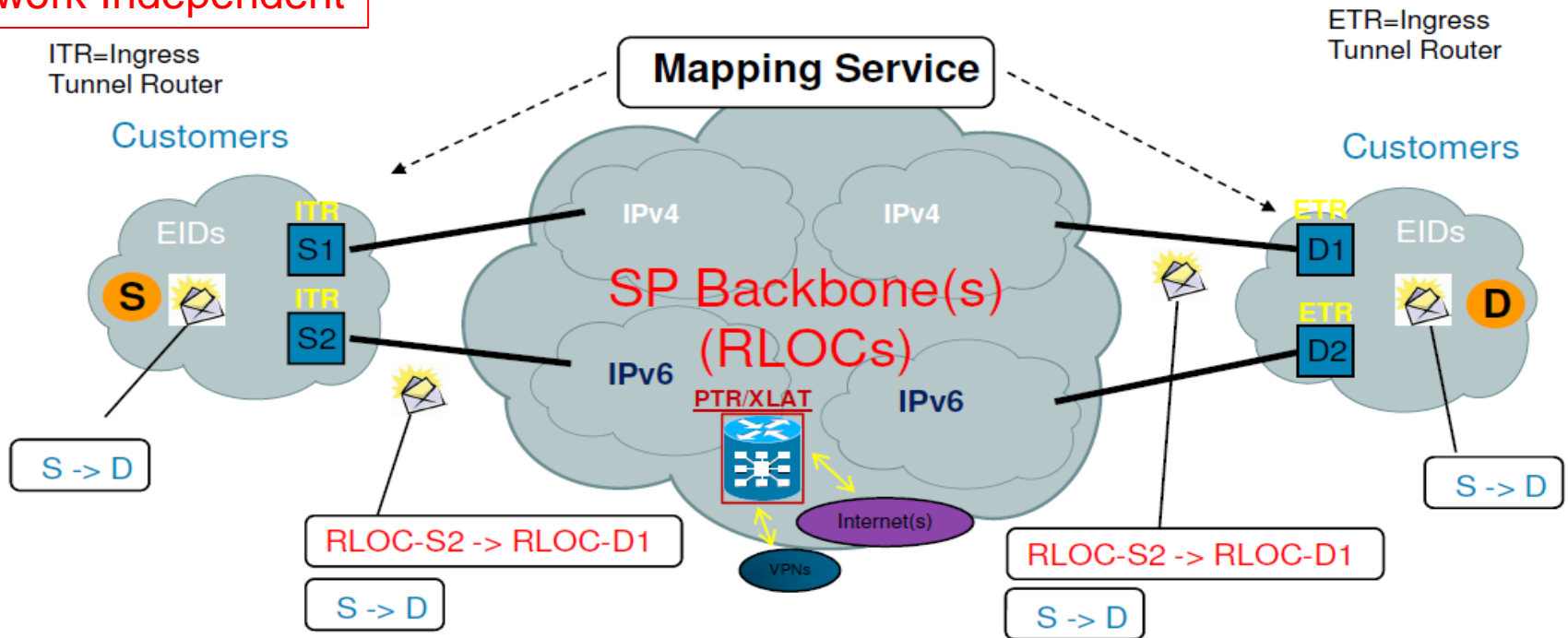
# Cisco LISP Operation (Router-based)

How does LISP operate?



# LISP for IPv6 Transition (Router-based)

Network Independent



- Scales SP Backbone/Internet routing by “tunneling” PI Customer space (EID) across aggregated SP Backbone/Internet routing space (RLOC)
- Customers – EIDs are PI IPv4 or IPv6 address families; Completely separated from SP RLOC address families
- Tunnel Routers – attach customer EID networks to Internet, encaps/decaps EID packets in RLOC headers based on mappings
- Mapping Service – manages EID-RLOC mappings on Tunnel Routers

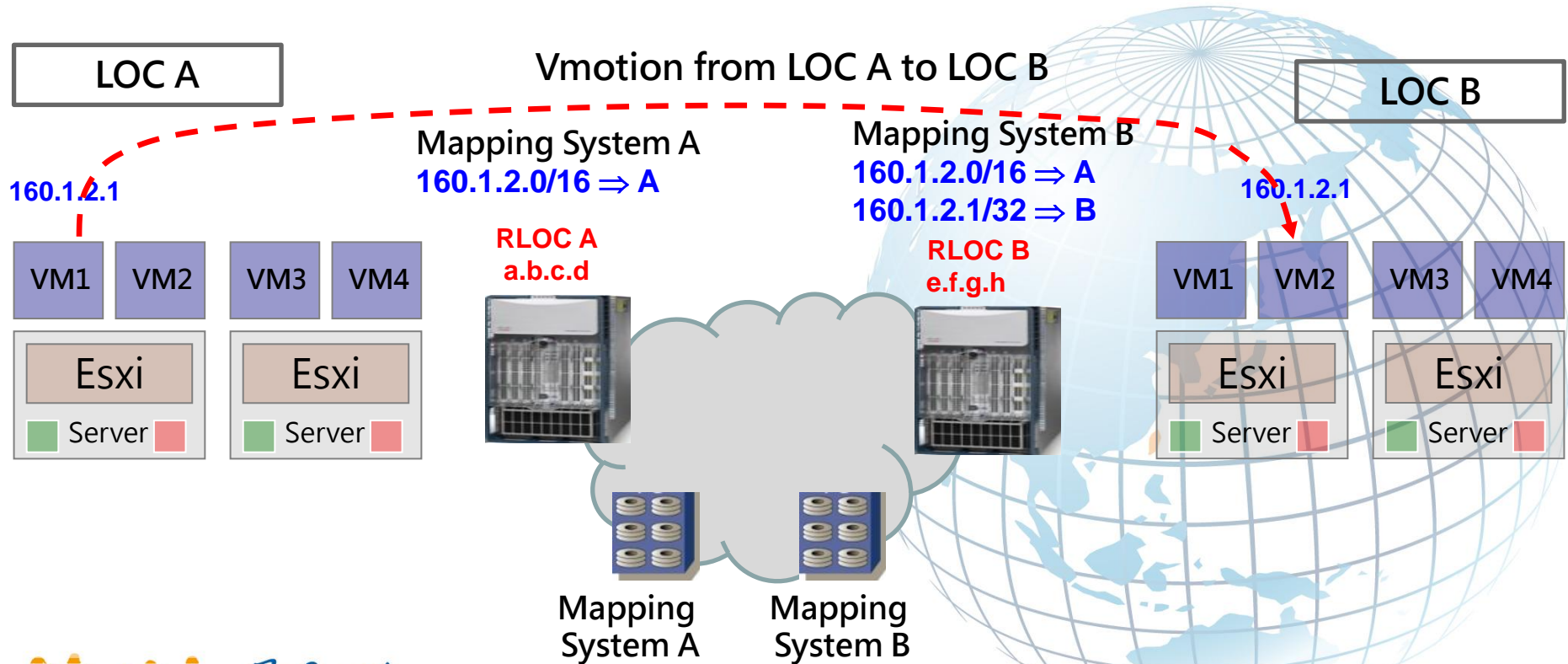


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Source: Cisco Locator ID Separation Protocol (LISP)

# LISP support VM Mobility

- VM1 (IP address 160.1.2.1) motion from LOC A to LOC B
  - IP address reserved
- No Layer 2 connectivity between LOC A and LOC B



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# Future Cloud Computing Services

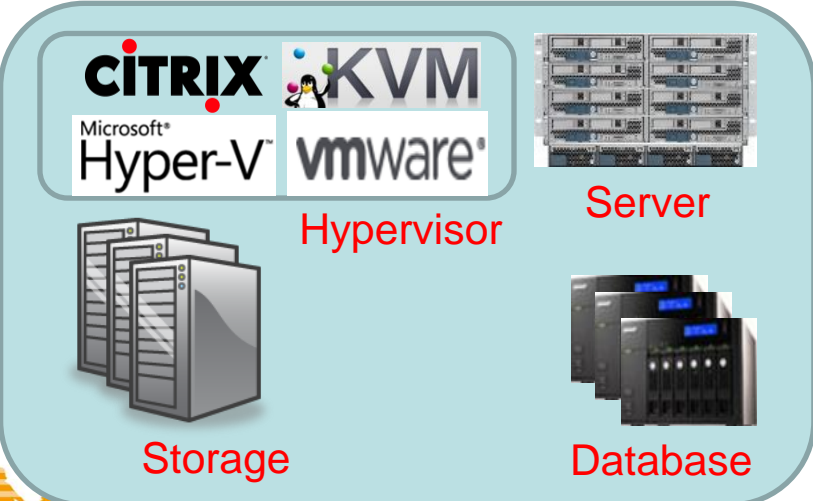
I/P/S as a Service  
(Computing, Storage, IPTV, Web, Hadoop...)

Network as a Service  
(Dynamic Network Provision)

Portal

OpenStack 

Openflow Controller 



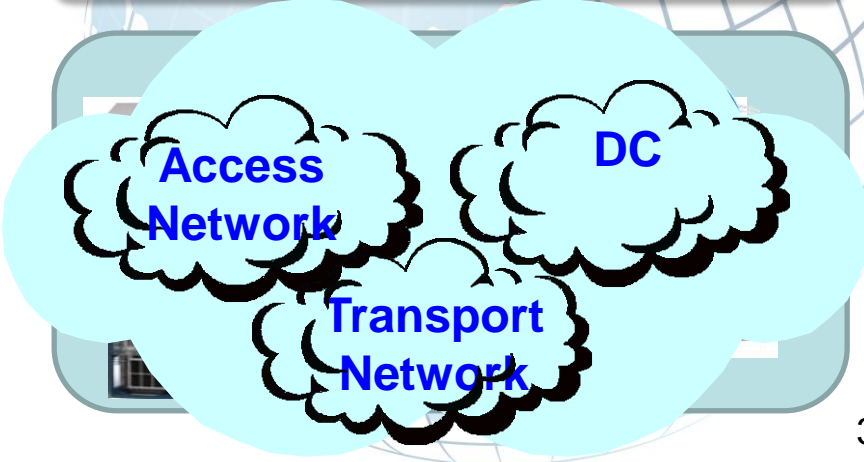
**CITRIX** **KVM**  
**Microsoft Hyper-V** **vmware**

Hypervisor

Server

Storage

Database



Access Network

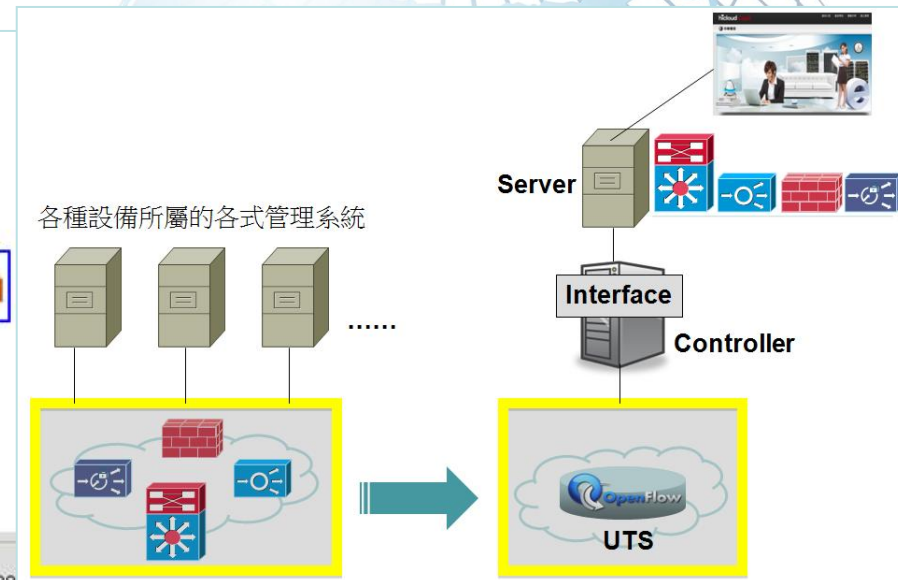
DC

Transport Network



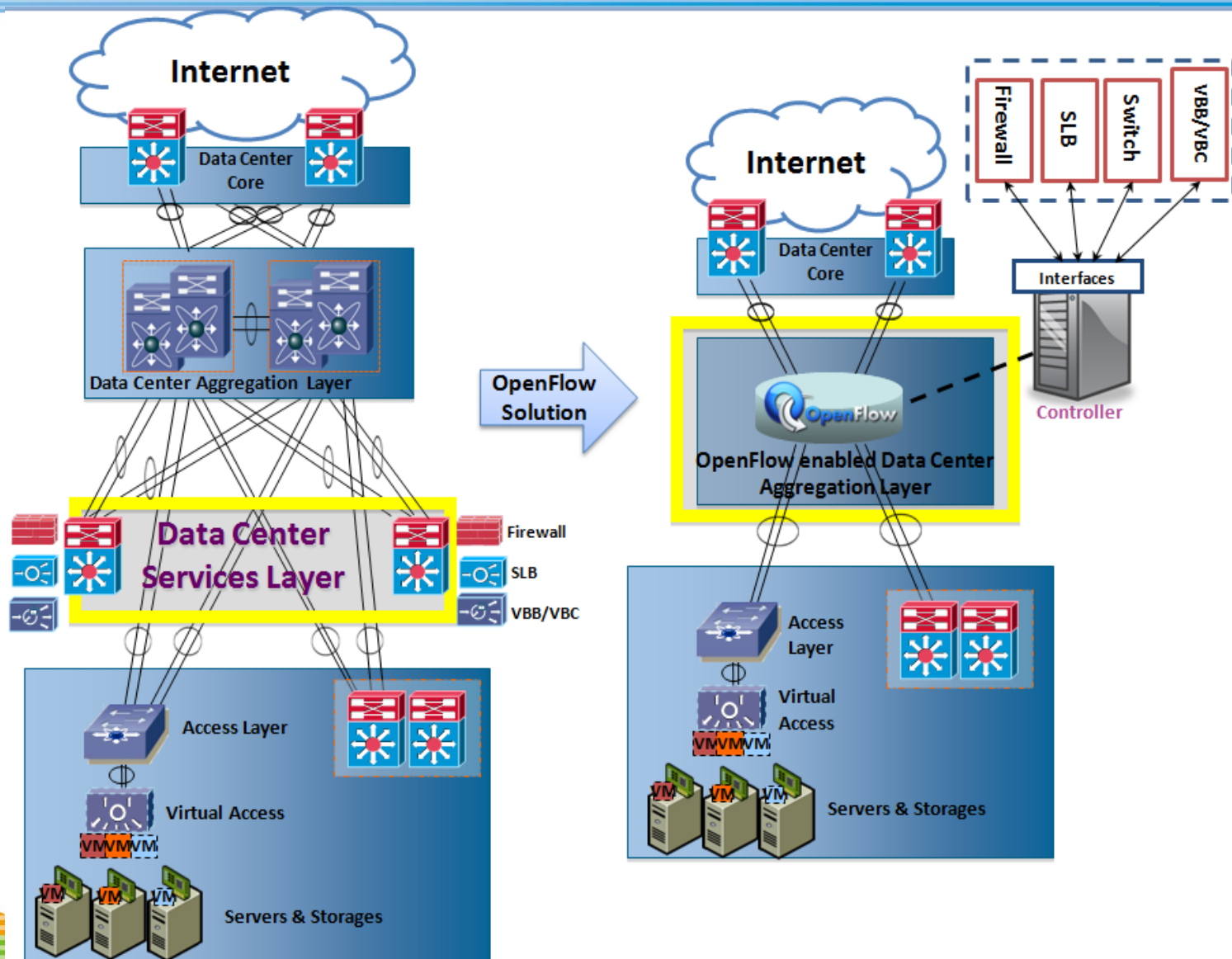
# CHT's Experience on SDN

- POC for Network as a Service (NaaS)
- Universal Transport Switch (UTS)係利用OpenFlow Switch同時扮演下列四種角色
  - **Firewall**: L2/3/4 ACL, NAT, Virtual FW
  - **IPS (Intrusion Prevention System)**: DDoS defendor
  - **SCE (Service Control Engine)**: flow control & Billing
  - **Switch**: L2/L3/L4





# Data Center Network Transformation



your life

# Future Work

- **Testing over OpenFlow Testbed @ Taiwan**
  - Live Migration
  - Storage vMotion
  - VM interoperation
- **Hypervisor Mode SDN Implementation**
  - Home Gateway
  - VM interoperation





# Thank You

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## Q&A



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