Date: 2015. 2. 5 Place: Seoul, Korea

Building Software-Defined Infrastructure with SDN/NFV/Cloud Integration

OpenStack Day in Korea 2015

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School of Information and Communications
Gwangju Institute of Science & Technology (GIST)

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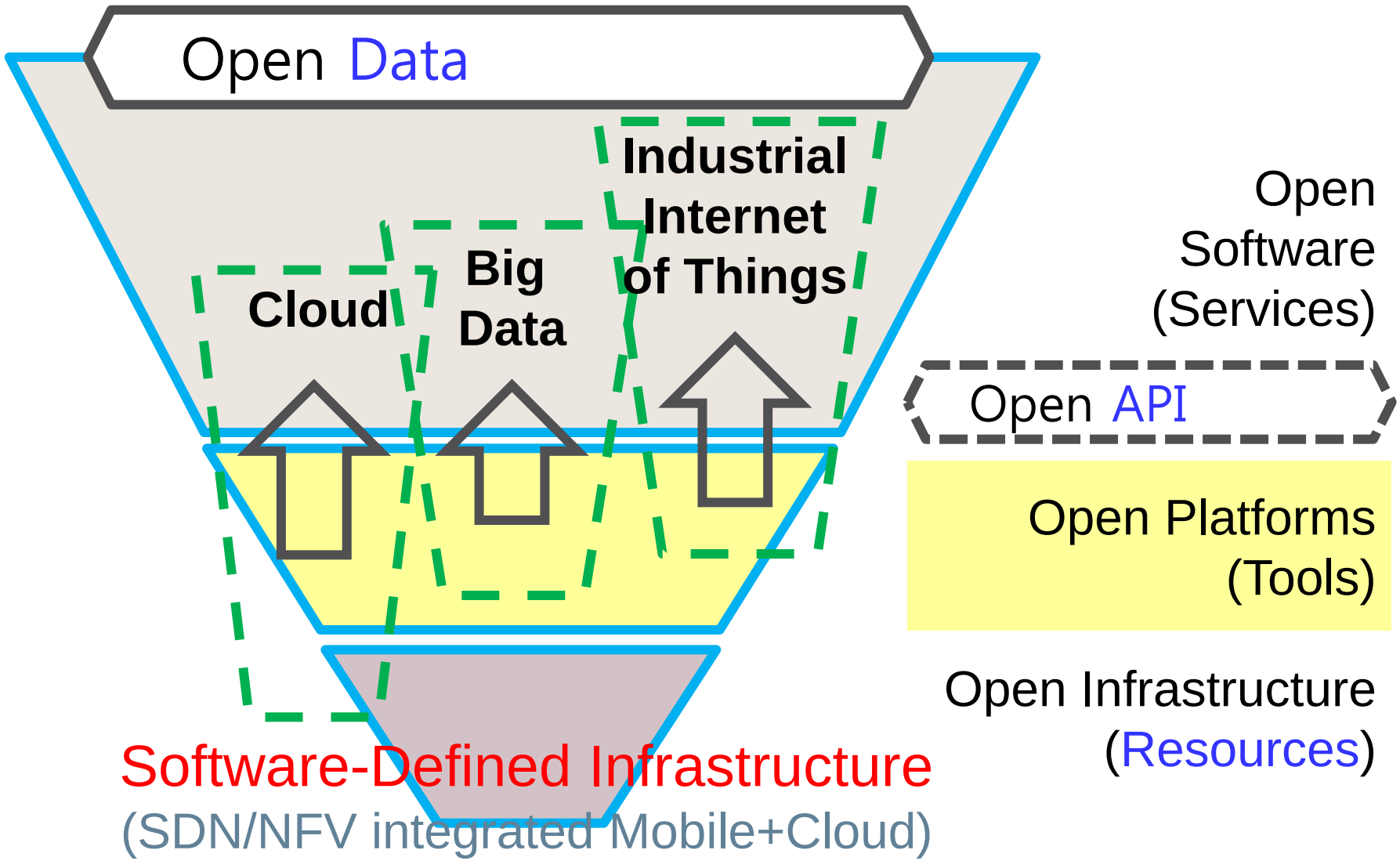
- Building Software-Defined Infrastructure with SDN/NFV/Cloud Integration & Hyper-convergent SmartX Boxes

- Realizing Smart Services with Provisioning/Orchestration/Governance

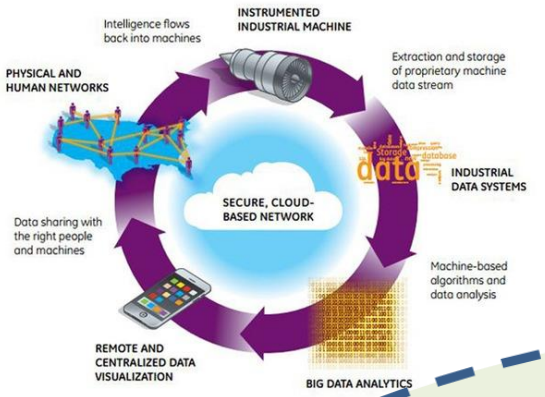
Building Software-Defined Infrastructure

with SDN/NFV/Cloud Integration & Hyper-convergent SmartX Boxes

Human-Defined Services over Software-Defined Infrastructure



Industrial Internet of Things (I^2oT)



Industrial Internet

- Smart Healthcare
- Smart City
- Smart Factory
- Smart Work / Gov.
- Smart Transportation
- Smart Home
- Smart Grid (Energy)

Smart Things => Smart X Service

Platform Challenges for Reliable, Safe, Agile, and Economic Services

Open, Software-Defined, Virtualized BIG Cloud Machines

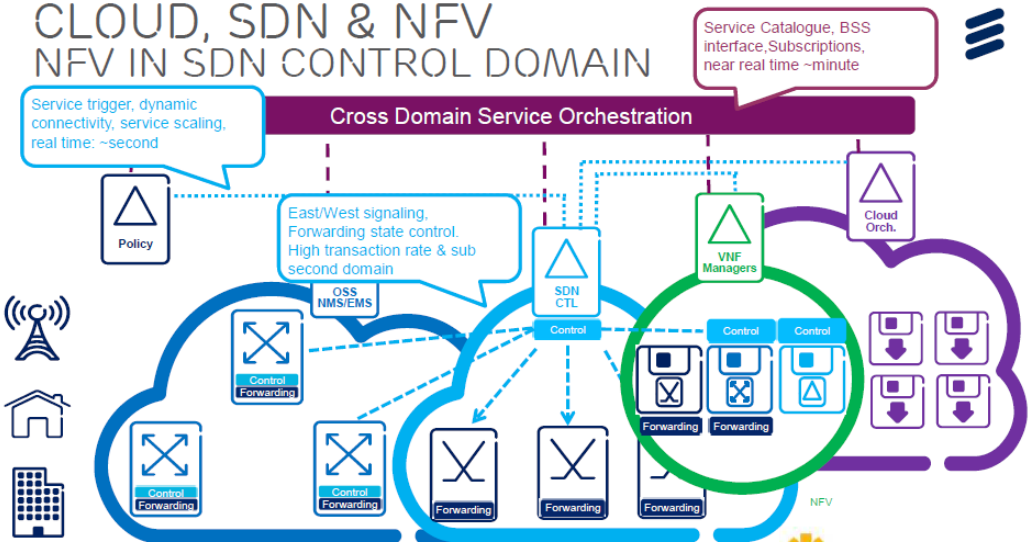
Continuous Integration

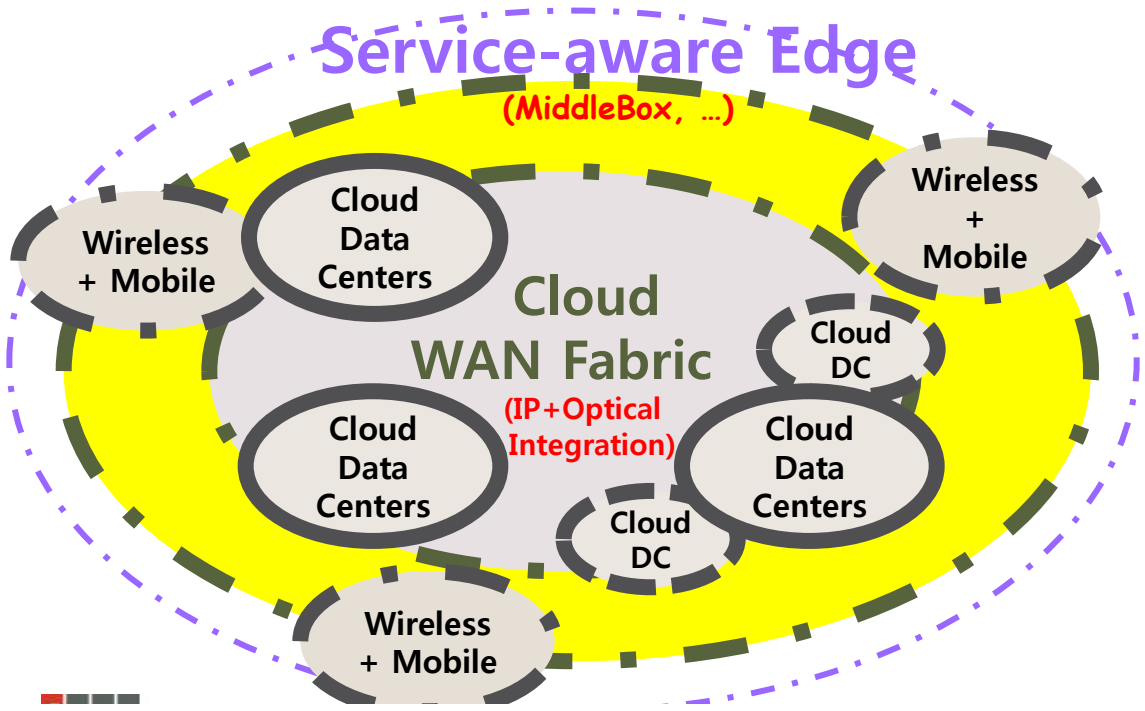
- Optical
- Mobile
- Data Center
- vNetworking
- vCompute
- vStorage

Virtualized Functions + Security

Convergent Software-Defined Infrastructure

(SDN/NFV/Cloud Integration)



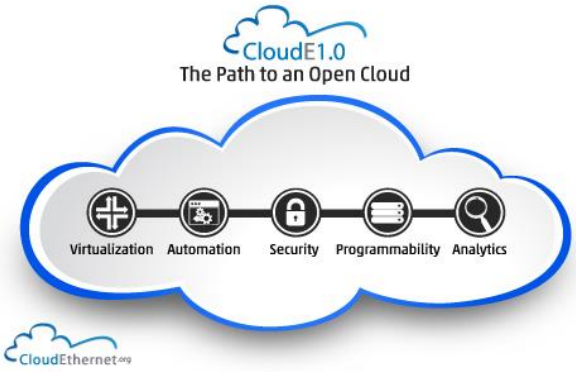


~~IP~~→??, More Switching + Simpler ~~Routing~~?

- **Amazon AWS**
- **Microsoft Azure**
- **Google Cloud Engine**
- VMware Hybrid
- **OpenStack** (**IBM, HP, Cisco, RackSpace, …**) + Network Operator Cloud (**AT&T. Verizon, NTT, …**)

Convergence @ Carriers

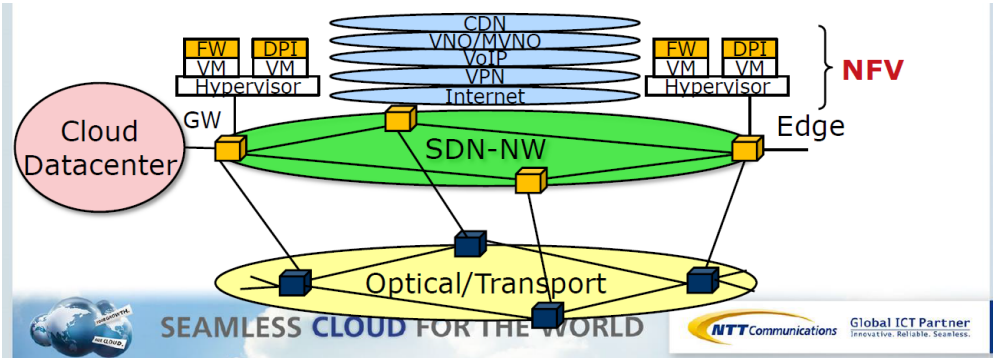
- AT&T Network Cloud (Domain 2.0, Open/Simple/Scale/Secure)
- NTT Seamless Cloud for the World
- Huawei SoftCom & Cloud Edge

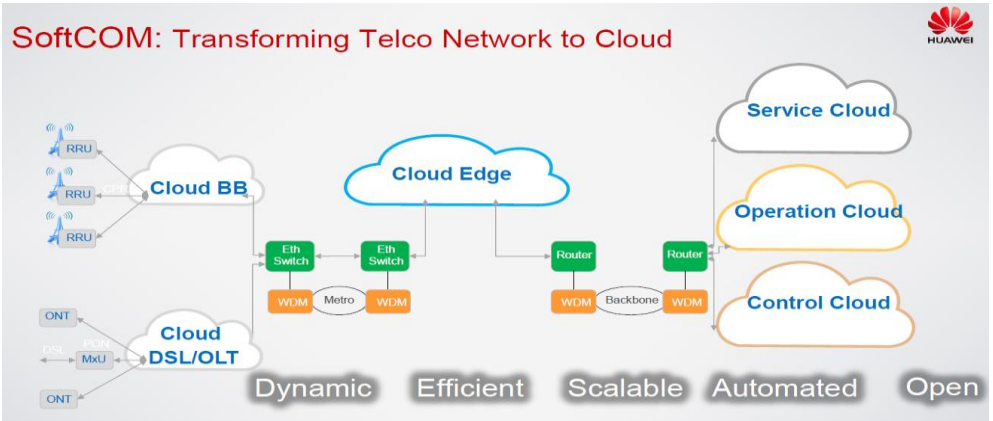


User-Defined Network Cloud

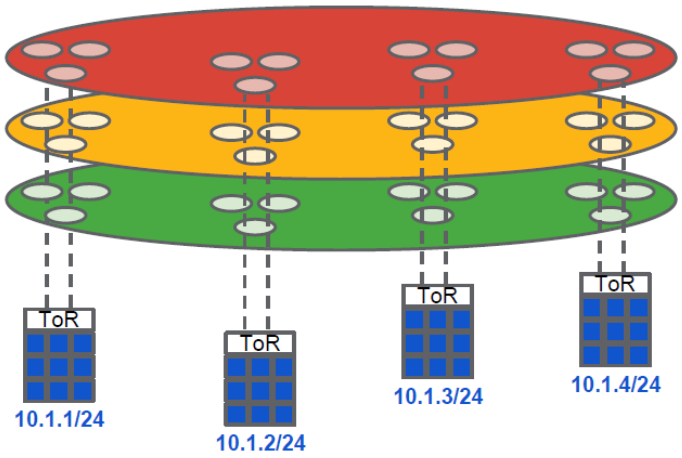
A multi-service, multi-tenant platform

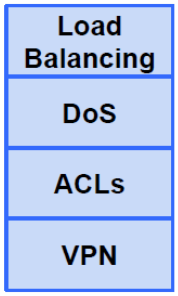
Network Function Virtualization [NFV]	+	Software Defined Networks [SDN]
Quickly update from almost anywhere		"Intelligent" network
Dynamically reroutes traffic		"Open" network
Adds capacity		Shifts control from hardware to software
Introduces new features		





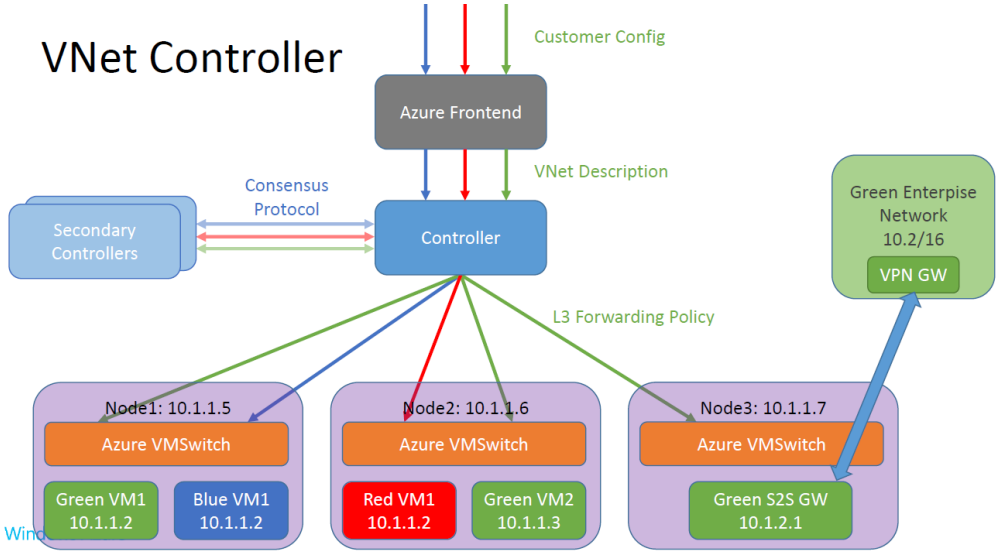
Convergence @ Hyper-scale Cloud DCs



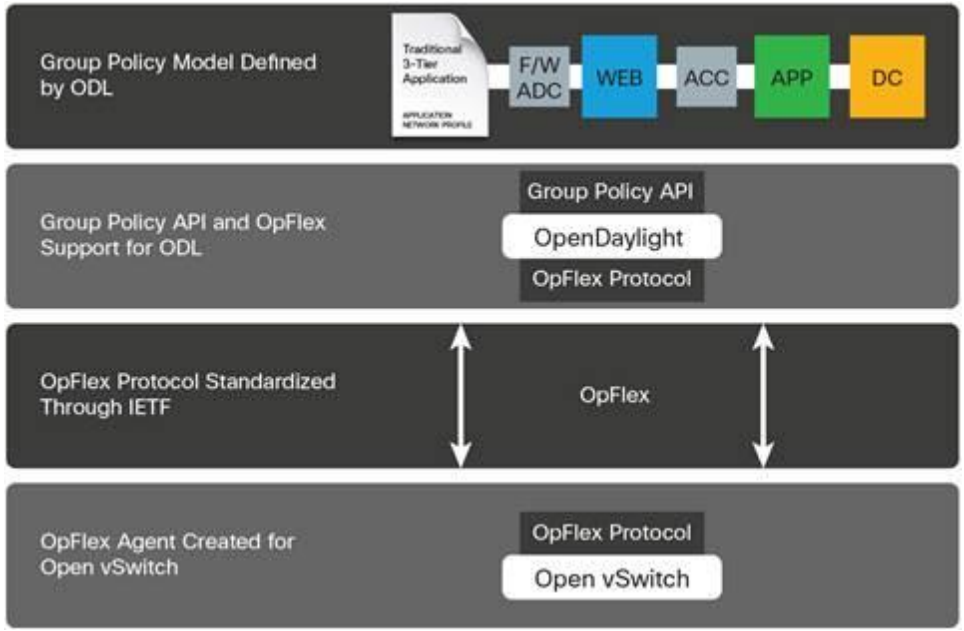


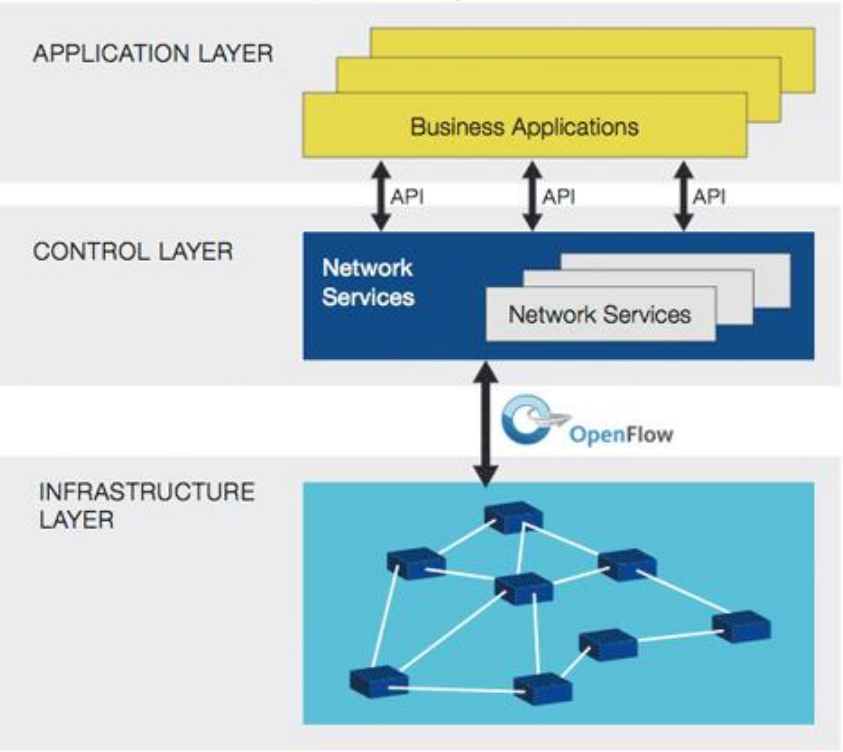
Google Virtualized SDN: Andromeda

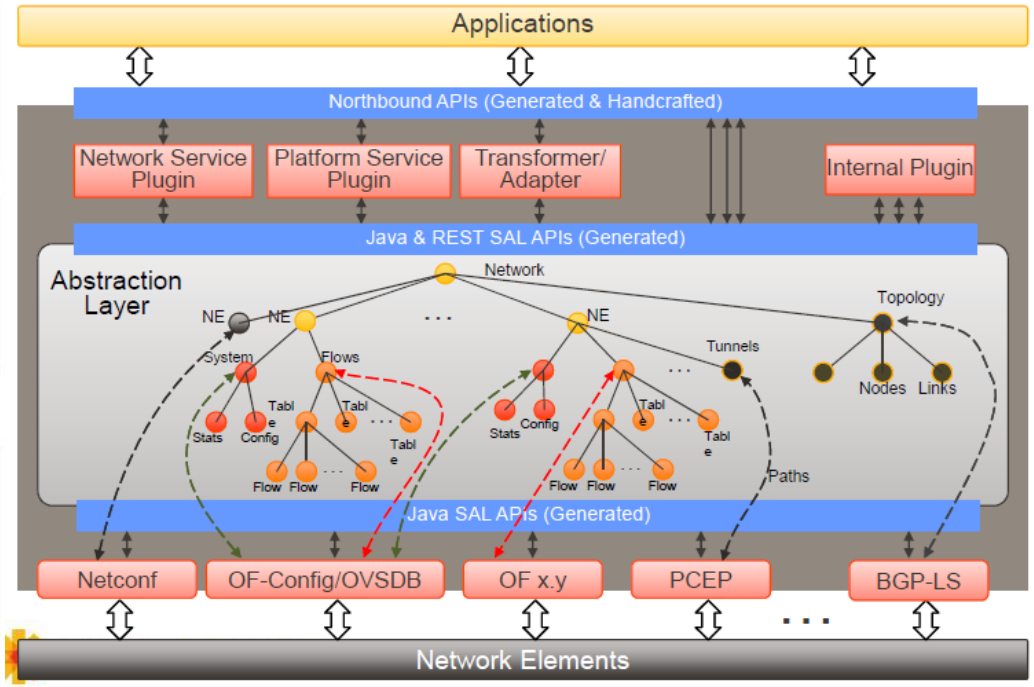
Microsoft Host SDN



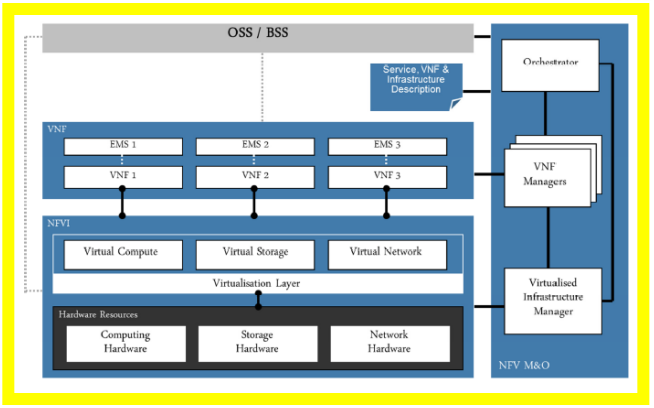
SDN: OpenFlow-based SDN and Others



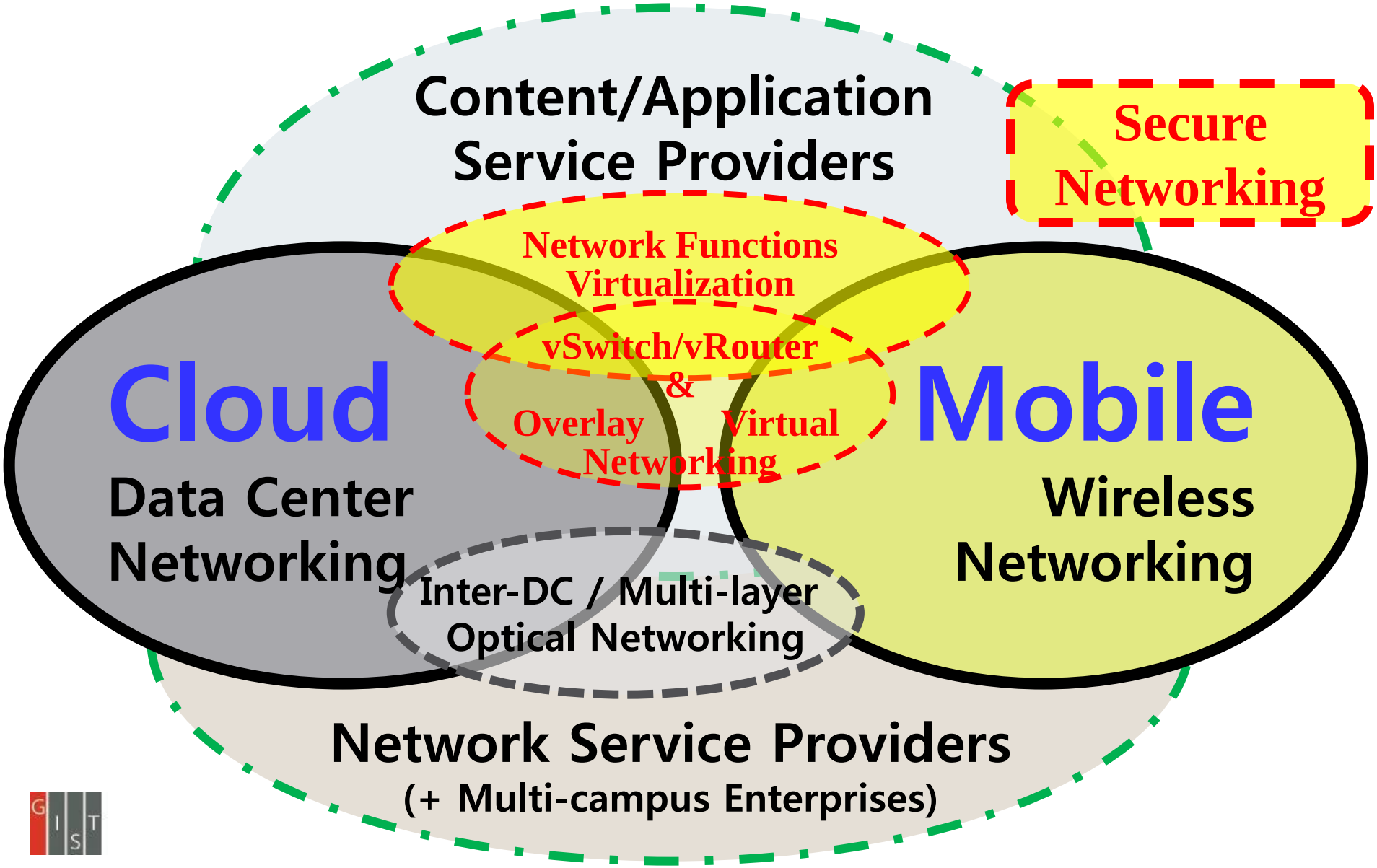




NFV Architecture Framework & Use Cases



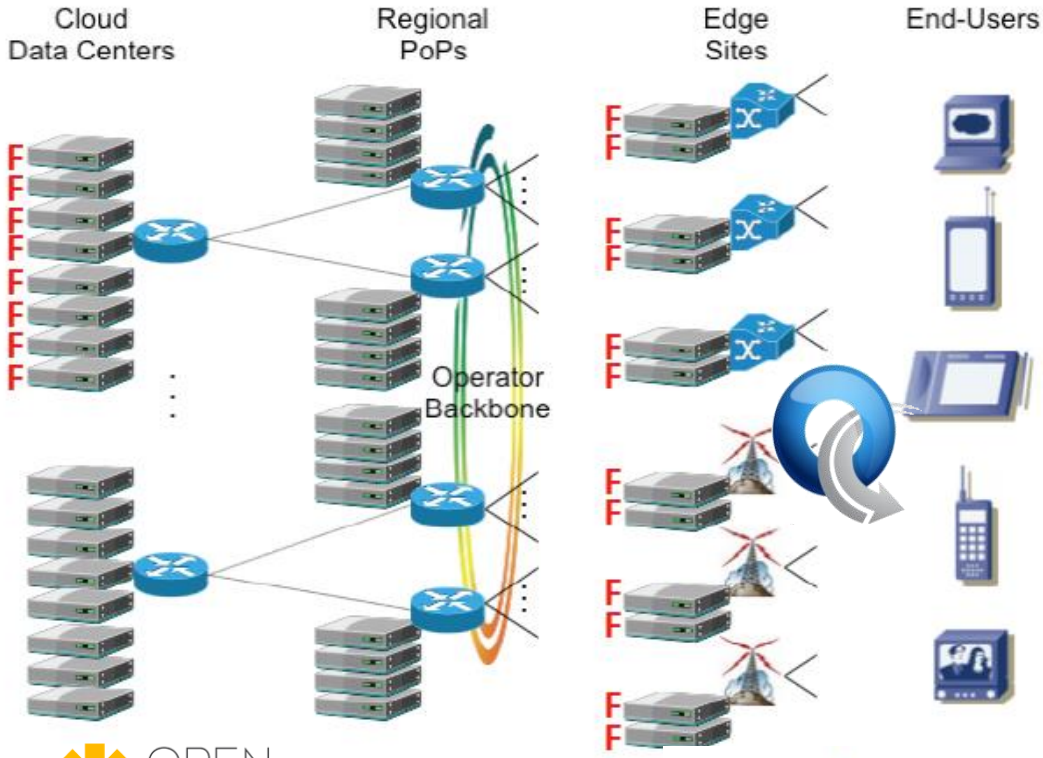
Mobile + Cloud: SDN/NFV/Cloud Integration



Convergent Software-Defined Infrastructure

F =

openstack™



OPEN DAYLIGHT

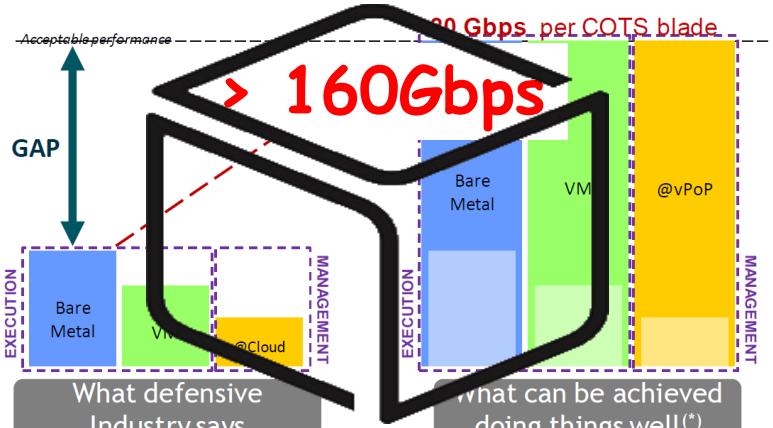
OPNFV

onos

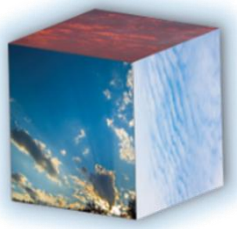
Nines	% Available	Downtime per year	Downtime per month	Downtime per week
one nine	90%	36.5 days	72 hours	16.8 hours
two nines	99%	3.65 days	7.20 hours	1.68 hours
three nines	99.9%	8.76 hours	43.2 minutes	10.1 minutes
four nines	99.99%	52.56 minutes	4.32 minutes	1.01 minutes
five nines	99.999%	5.26 minutes	25.9 seconds	6.05 seconds
six nines	99.9999%	31.5 seconds	2.59 seconds	0.605 seconds

Carrier-Grade NFV? Five 9's

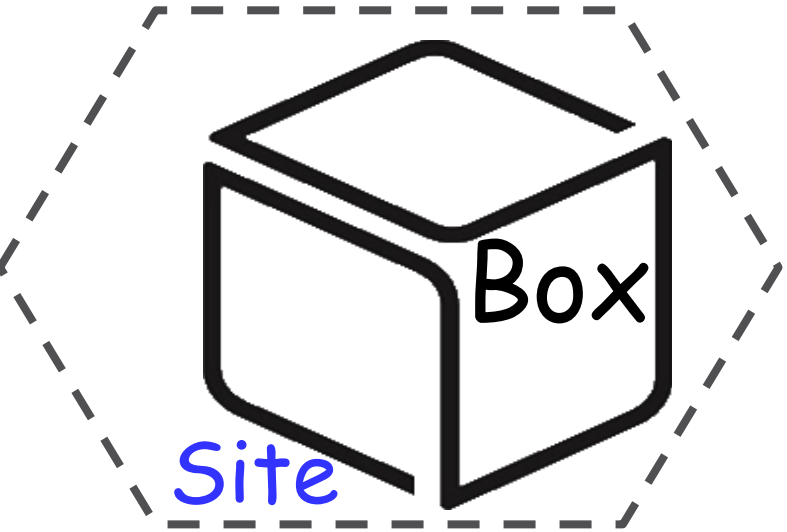
Small VNF Paradigm assisted by "magical" virtual networking of distributed flow-steering at scale

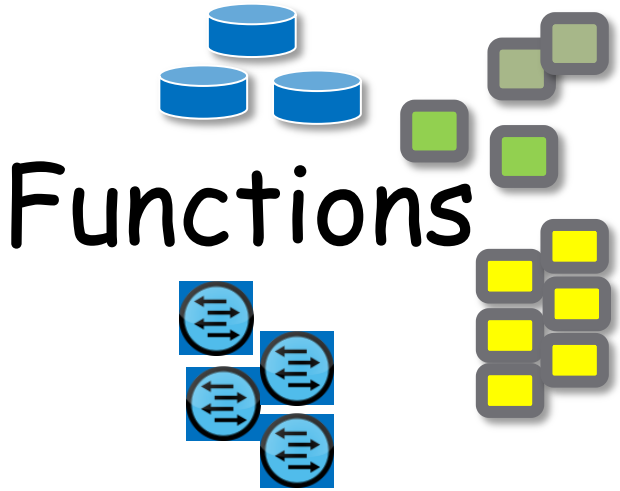


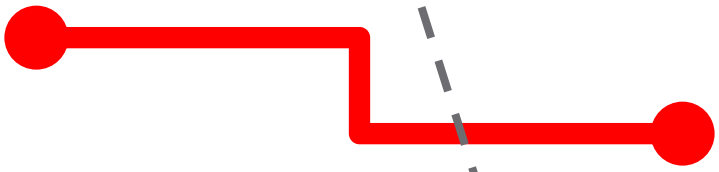
SmartX Box: Inter-Connected Functions inside Boxes/Sites



Resources - Workloads - Services



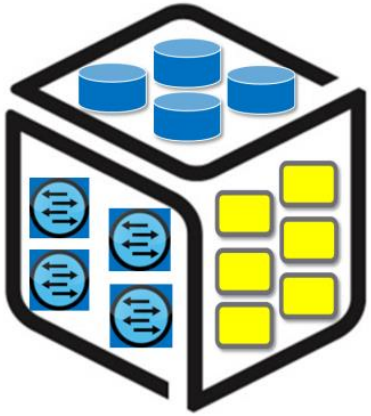


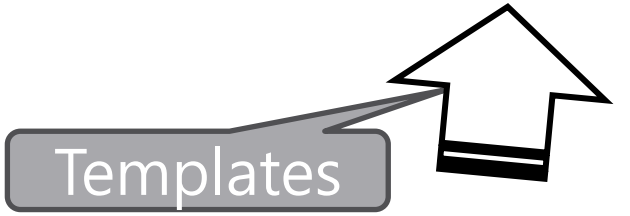


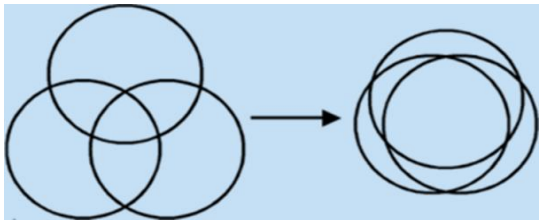
Inter-Connect

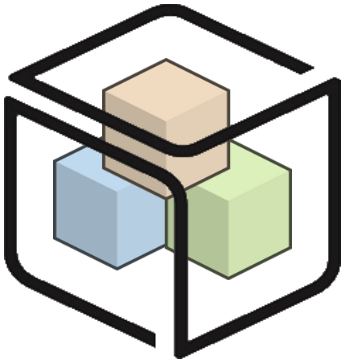
Convergent Software-Defined Infrastructure:

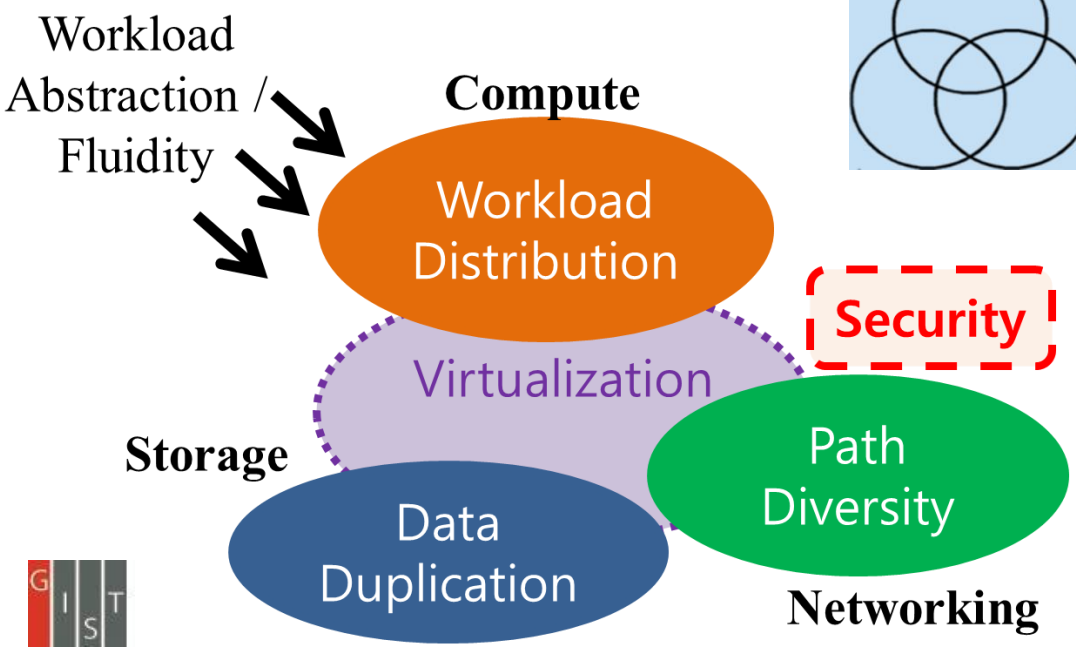
Programmable, Virtualized, Hyper-convergent SmartX Boxes

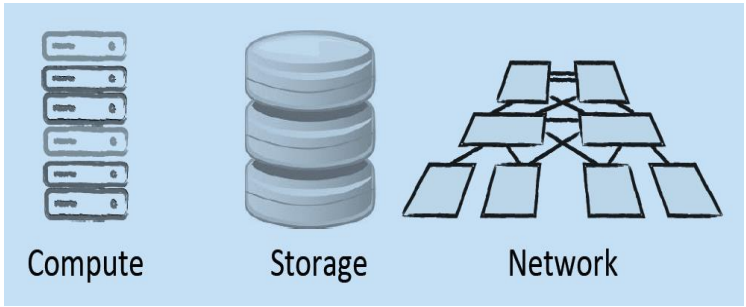




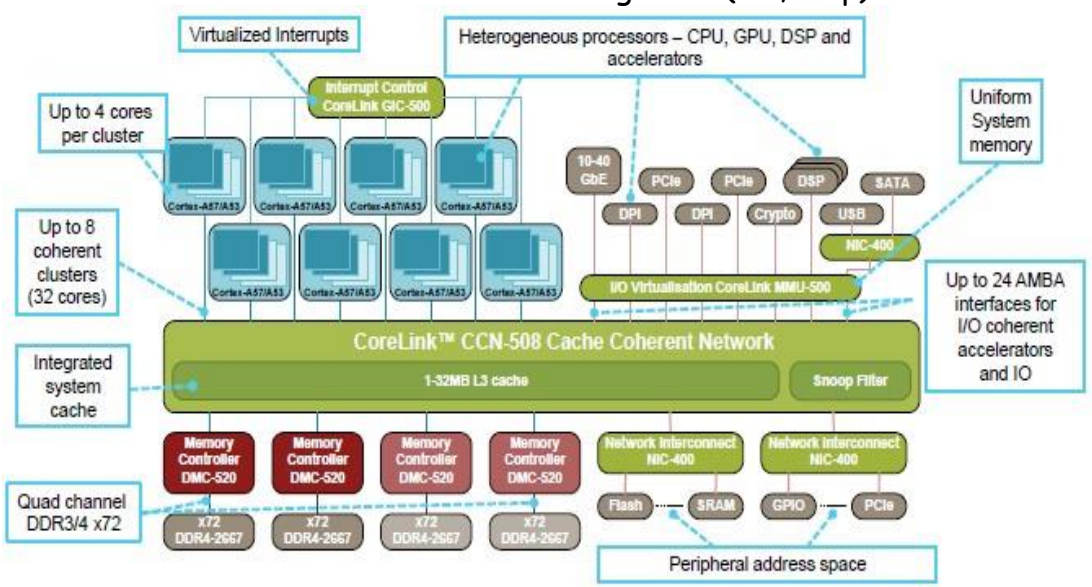


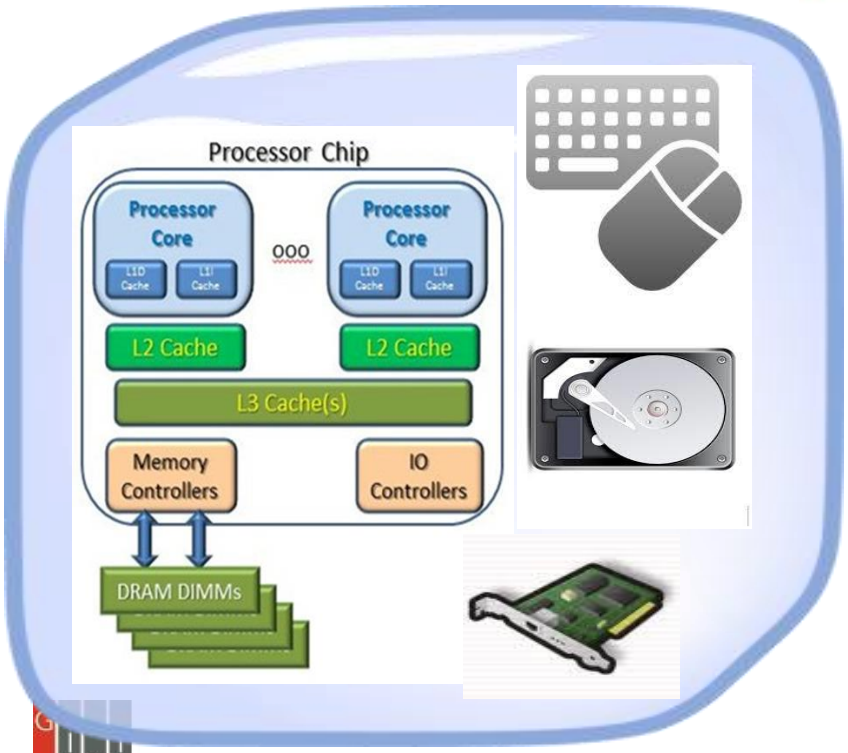


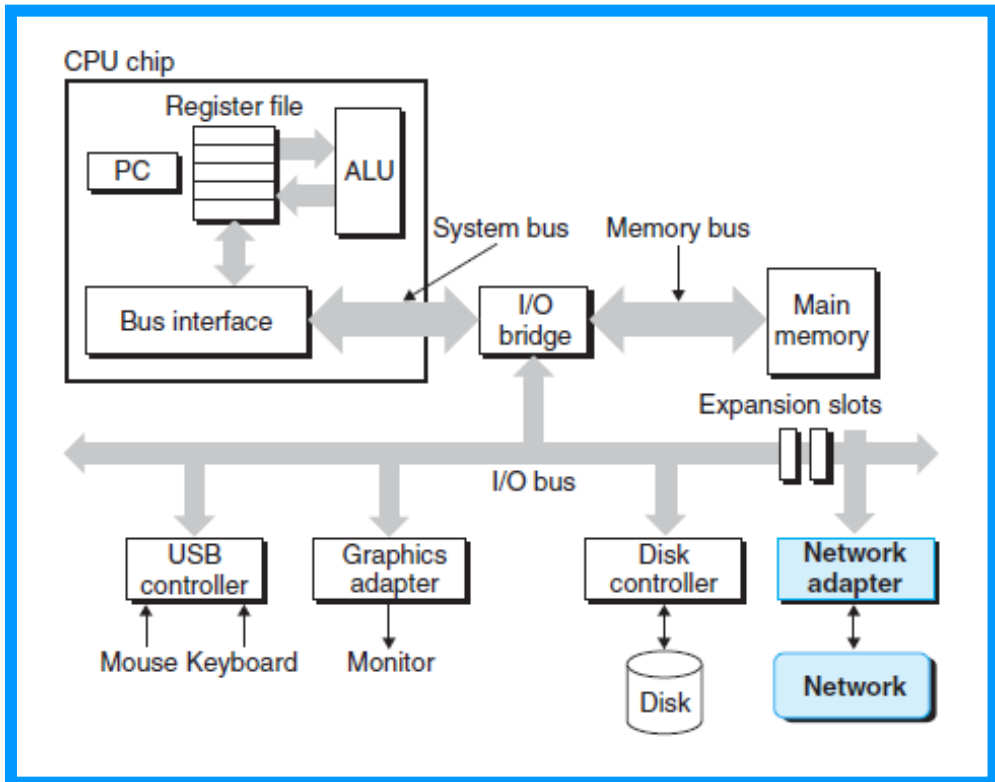




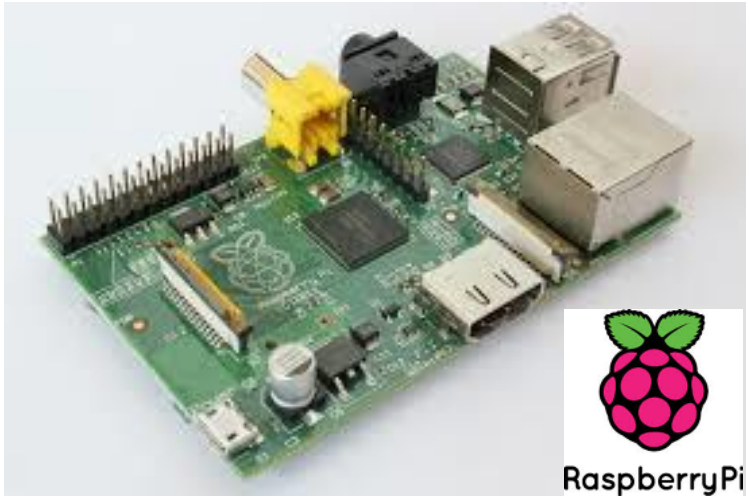
Computer Systems ➔➔ Boxes?



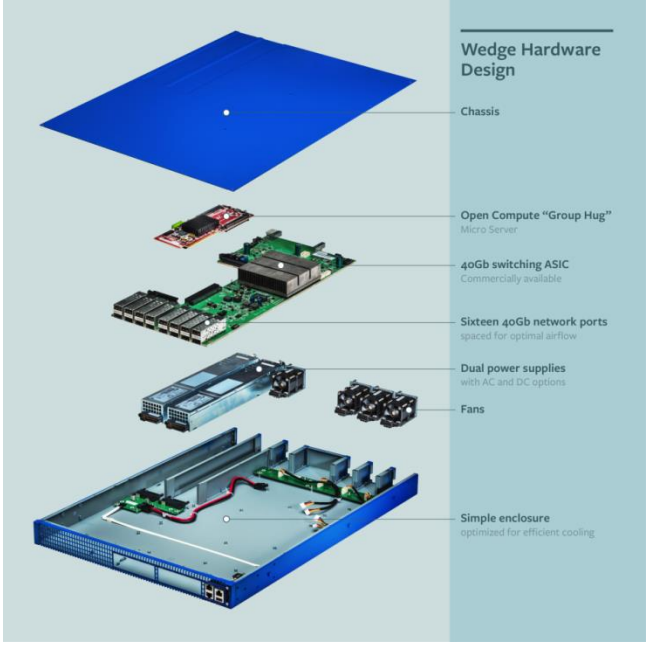




Open-Source Hardware
(Computers, Switches, …)



RaspberryPi



OPEN Compute Project

routerboard

ARDUINO

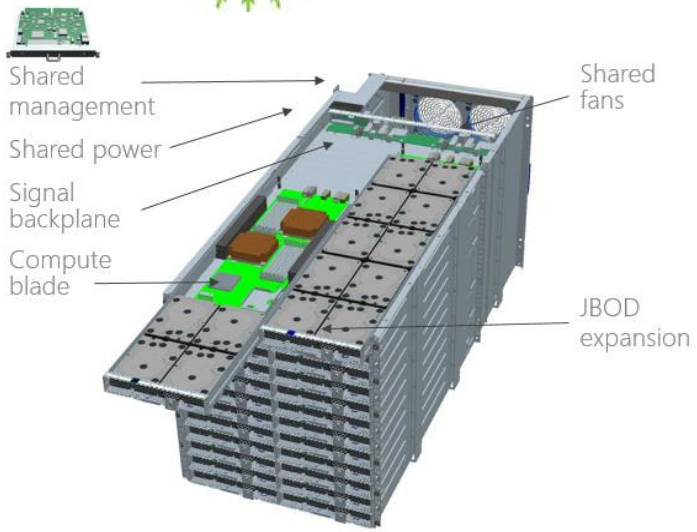
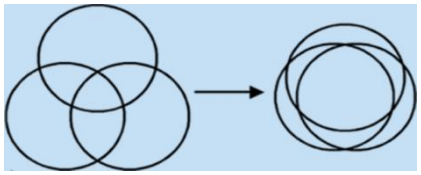
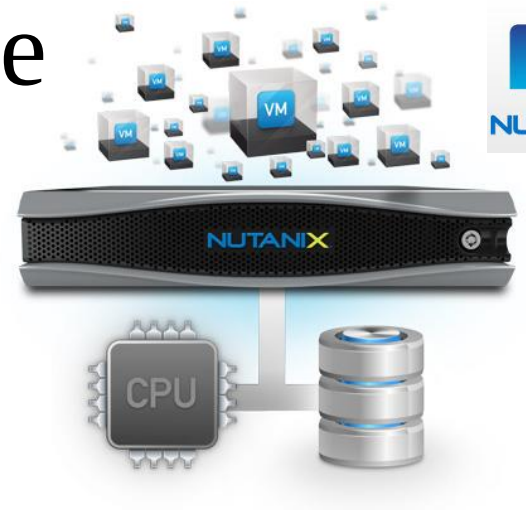


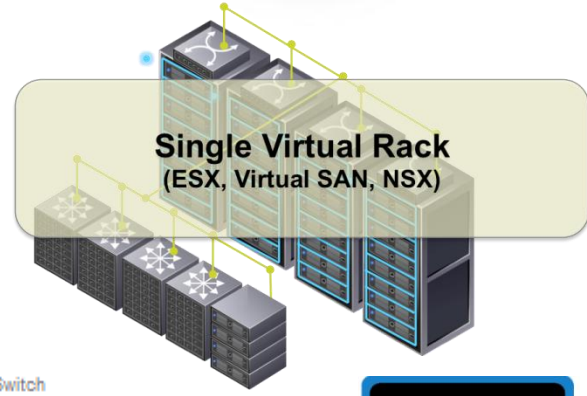
Diagram: Microsoft cloud server specification



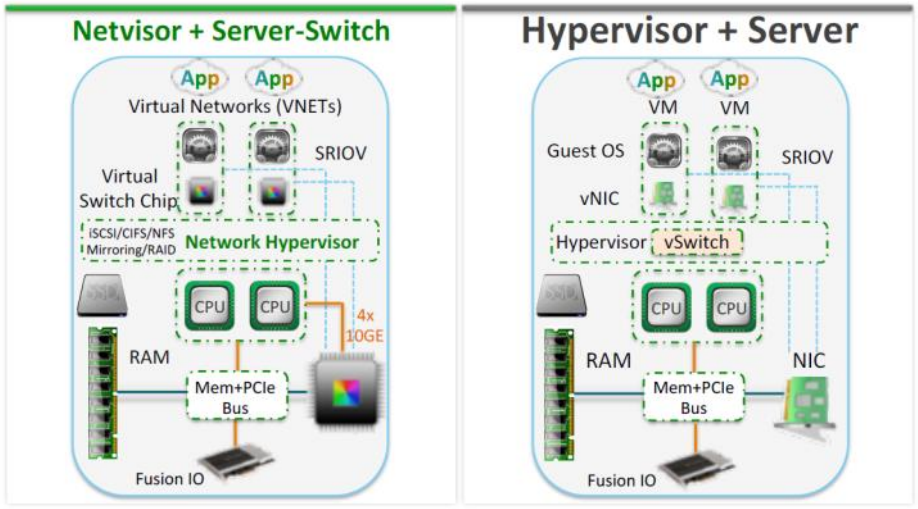
Hyper-Convergence Boxes

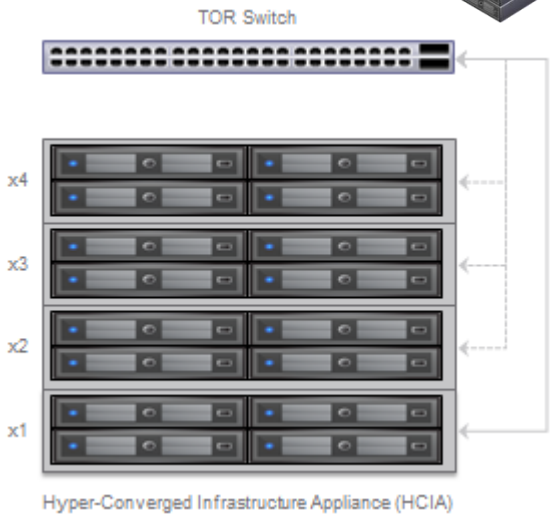


- Nutanix, Simplivity, …
- Pluribus Freedom Server-Switch
- VMware Project Mystic ➔
  Evo: Rails, Evo: Racks



PLURIBUS NETWORKS

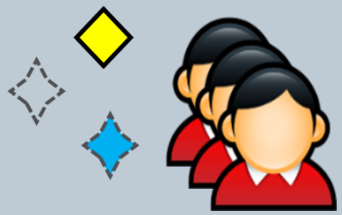




vmware EVO TECH PREVIEW RACK

vmware EVO RAIL™

Realizing Smart Services with Provisioning / Orchestration / Governance



Cloud Platforms

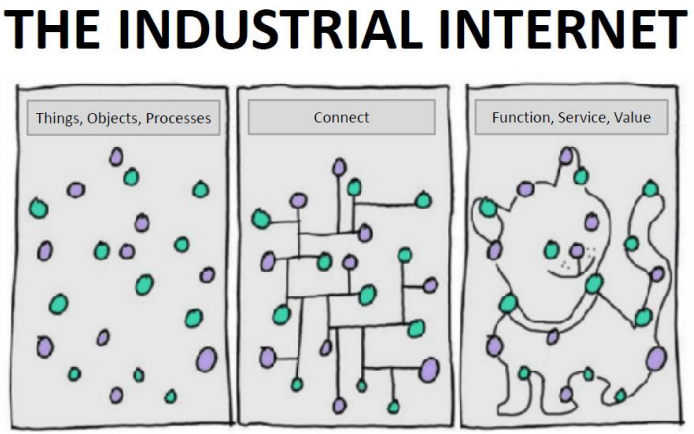
(+ BigData + IoT + ...)

Mobile

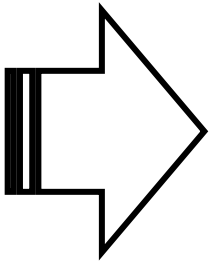
SmartX

Things

Prepare SmartX Boxes & Realize Smart Services



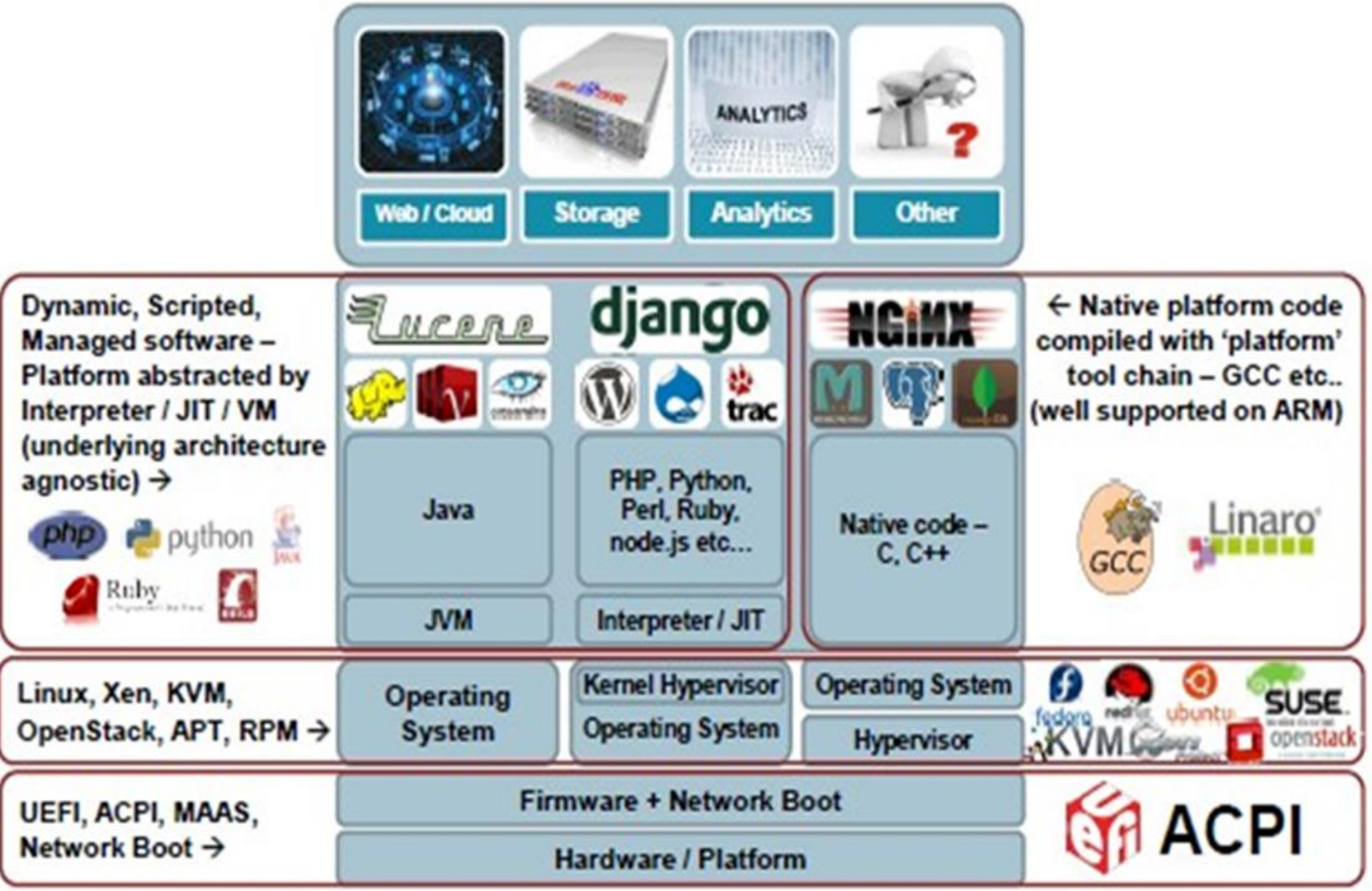
Build Open APIs with Inter-connected Functions



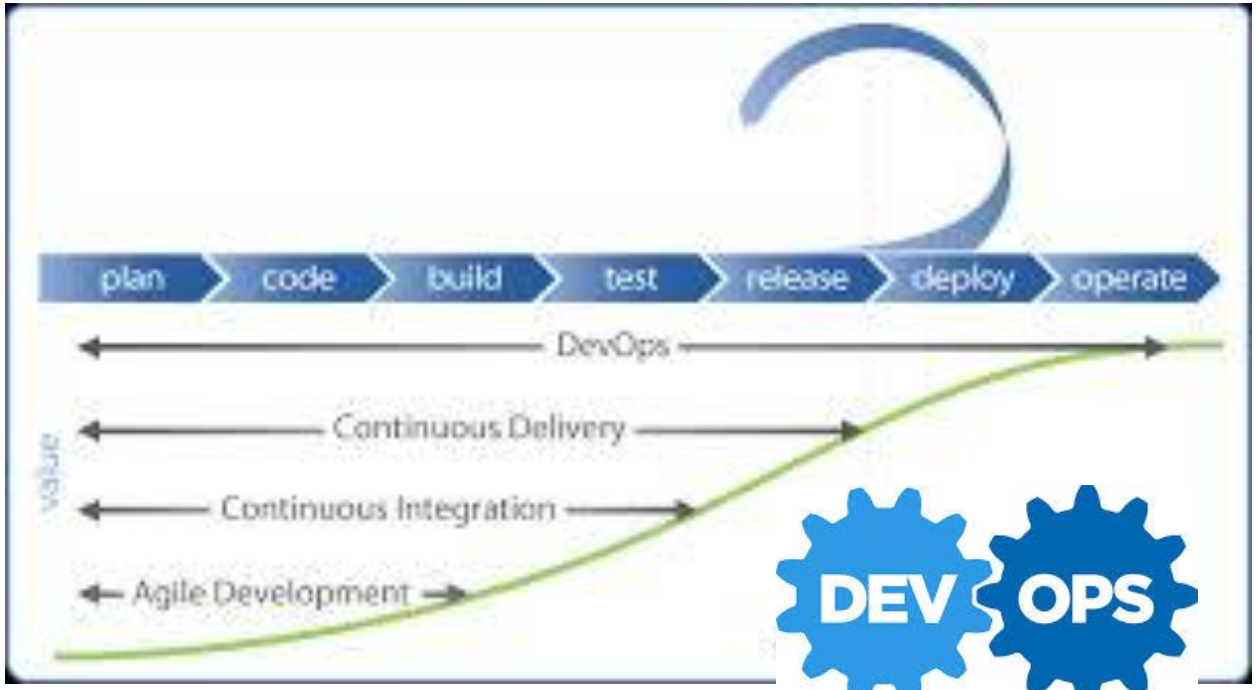
Architecture Your Smart Things with **API Tools**

Converged (C/N/S) **SmartX Box** with Program-mable & Virtualized Resources

Learning & Playing with Open-Source Hardware/Software Building Blocks



Software Lifecycle and CI (Continuous Integration) / CD (Continuous Deployment)



DEV OPS
Automation Service

Master Software Coding (for Cloud OS Kernel + Service Frameworks and Tools) and Execute Continuous Integration for Agile and Economic Service Realization

Software Lifecycle: Development ➔ Testing (Staging) / QA ➔ Production / Deployment

Testbed: Wild & Organized Playground

DevOps

Play (Experiment)
- Configuration
- Control
- Visibility

(Power Users)

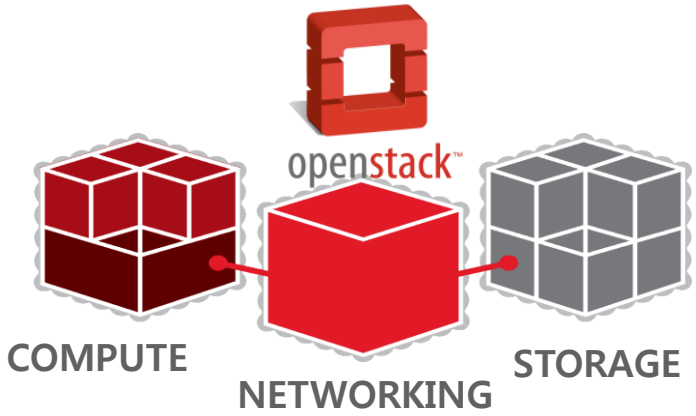
Provide Playground with Resources

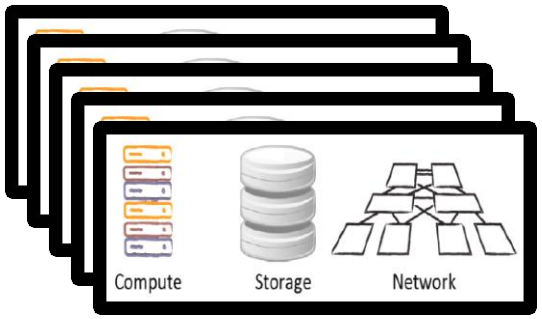
(Provider)

SmartX Box: Design and Prototyping with SDN/NFV/Cloud Leverage

Simplified SmartX Rack

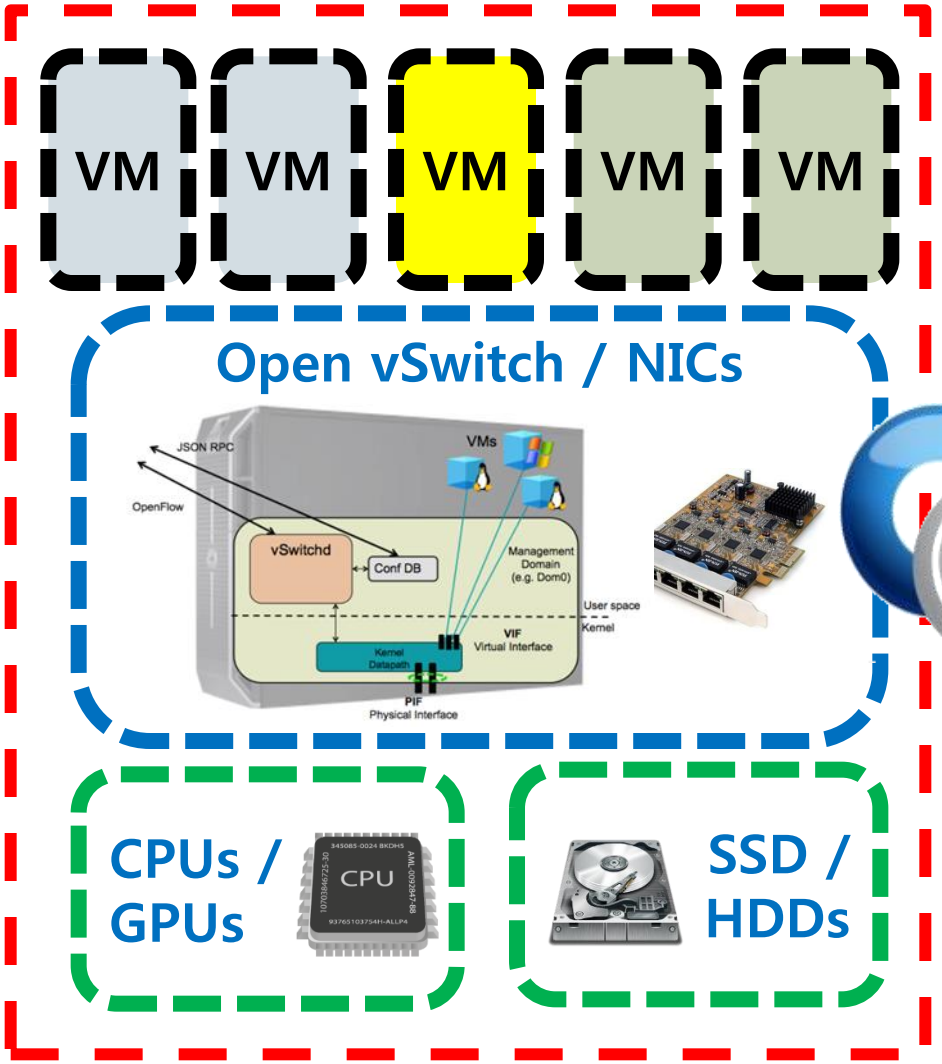
➔ SmartX Box



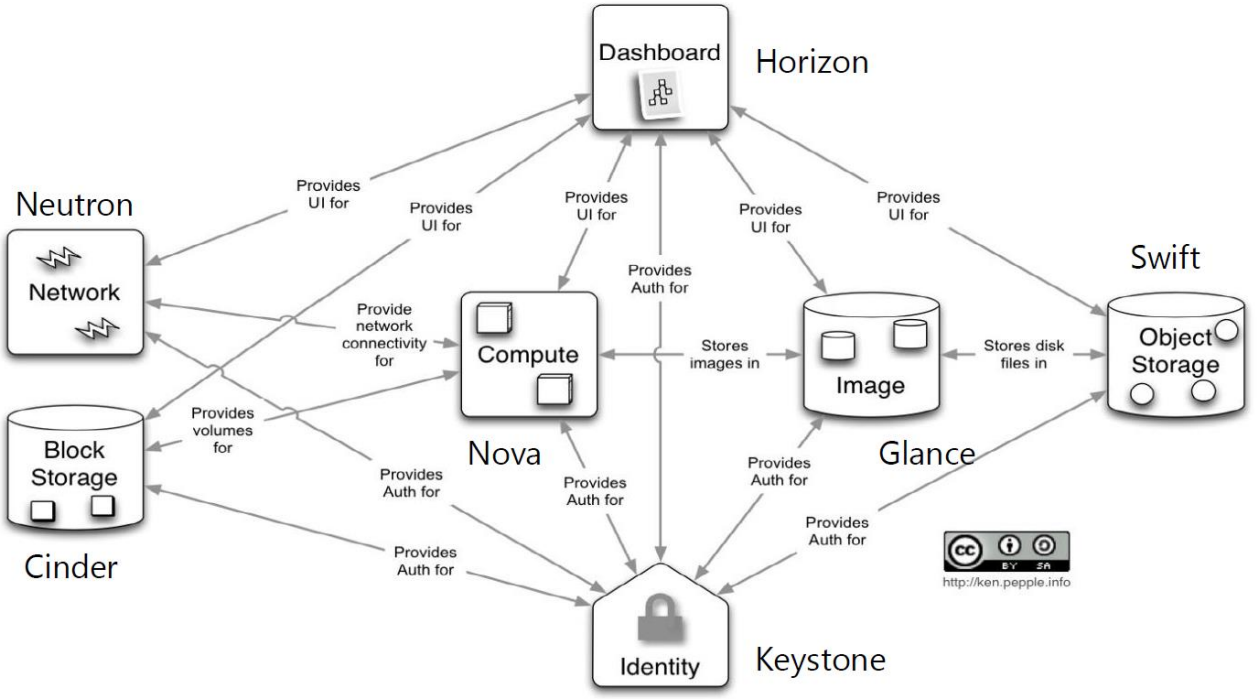


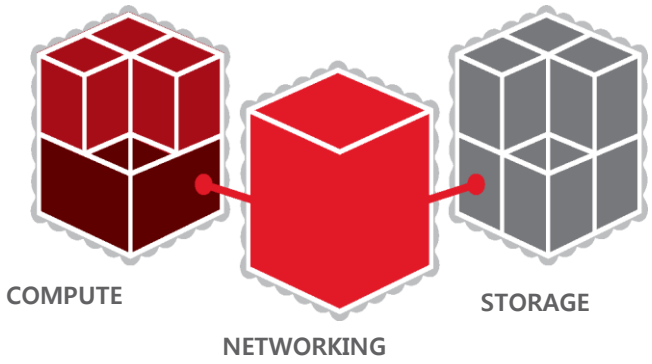
Pools of SmartX Boxes:

Massive scalability and pay-as-you-grow flexibility



openstack™





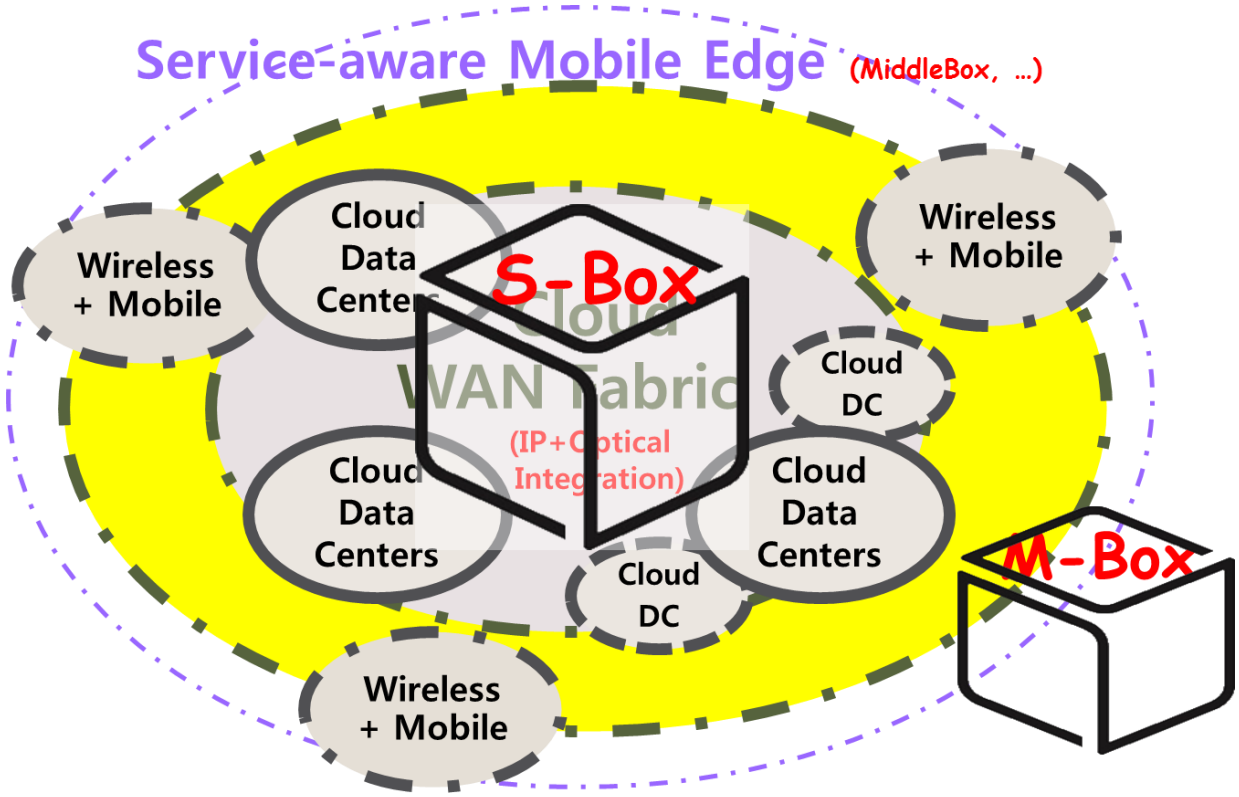
CISCO openstack
vmware openstack
ORACLE

Vendors will co-opt and fragment OpenStack

HP Helion openstack
IBM openstack
DELL & openstack
redhat. openstack
Azure openstack
ALYPTUS openstack

GIST

Playing with Converged Software-Defined Infrastructure (SDN/NFV/Cloud)



SmartX Automation Center

Configuration

Control

Visibility

FIF Future Internet Forum

SmartFIRE www.eukorea-fire.eu

KOREN KOREA ADVANCED RESEARCH NETWORK

TEIN COOPERATION CENTER

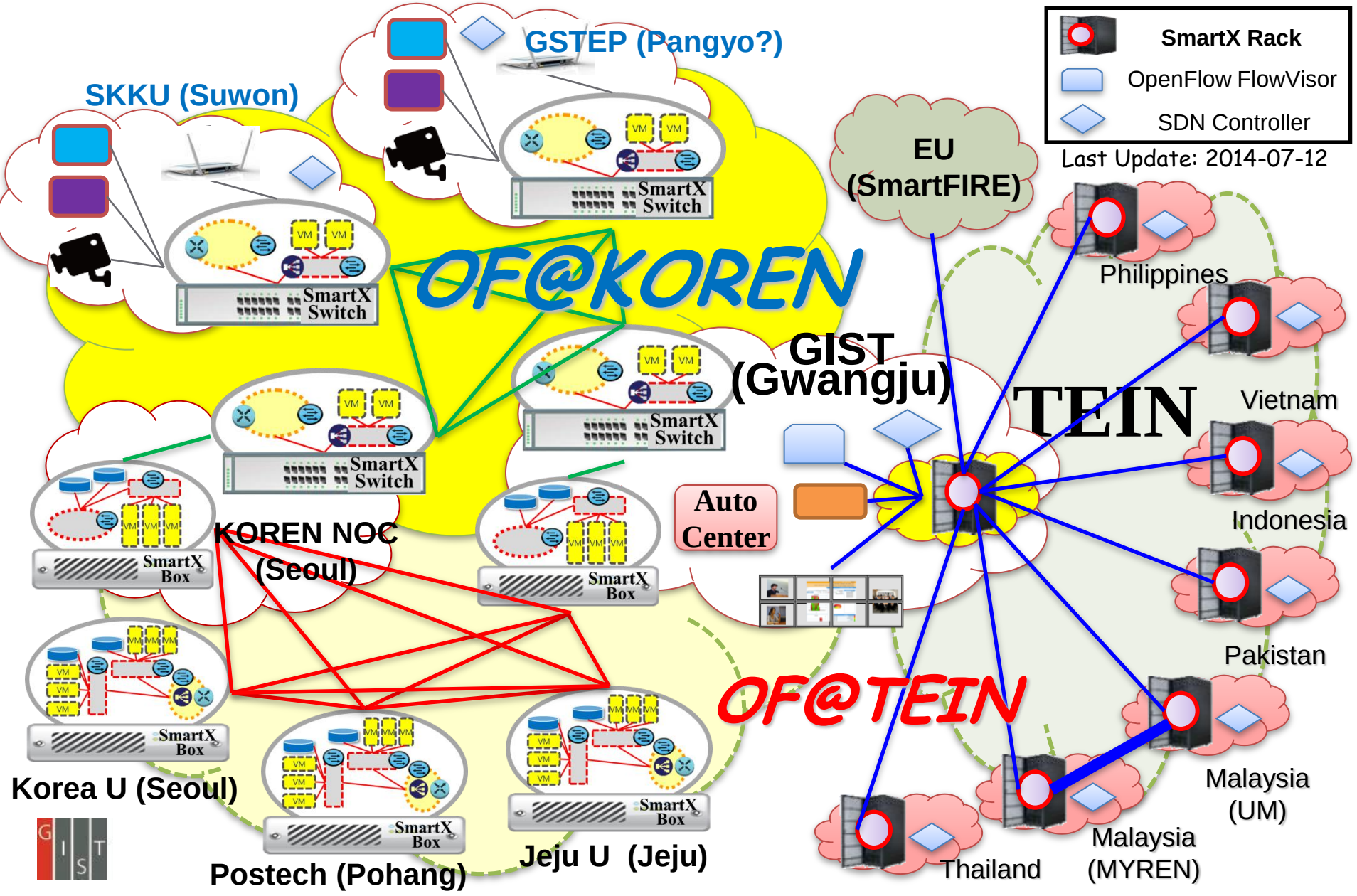
GIST

SMEC (주)스맥

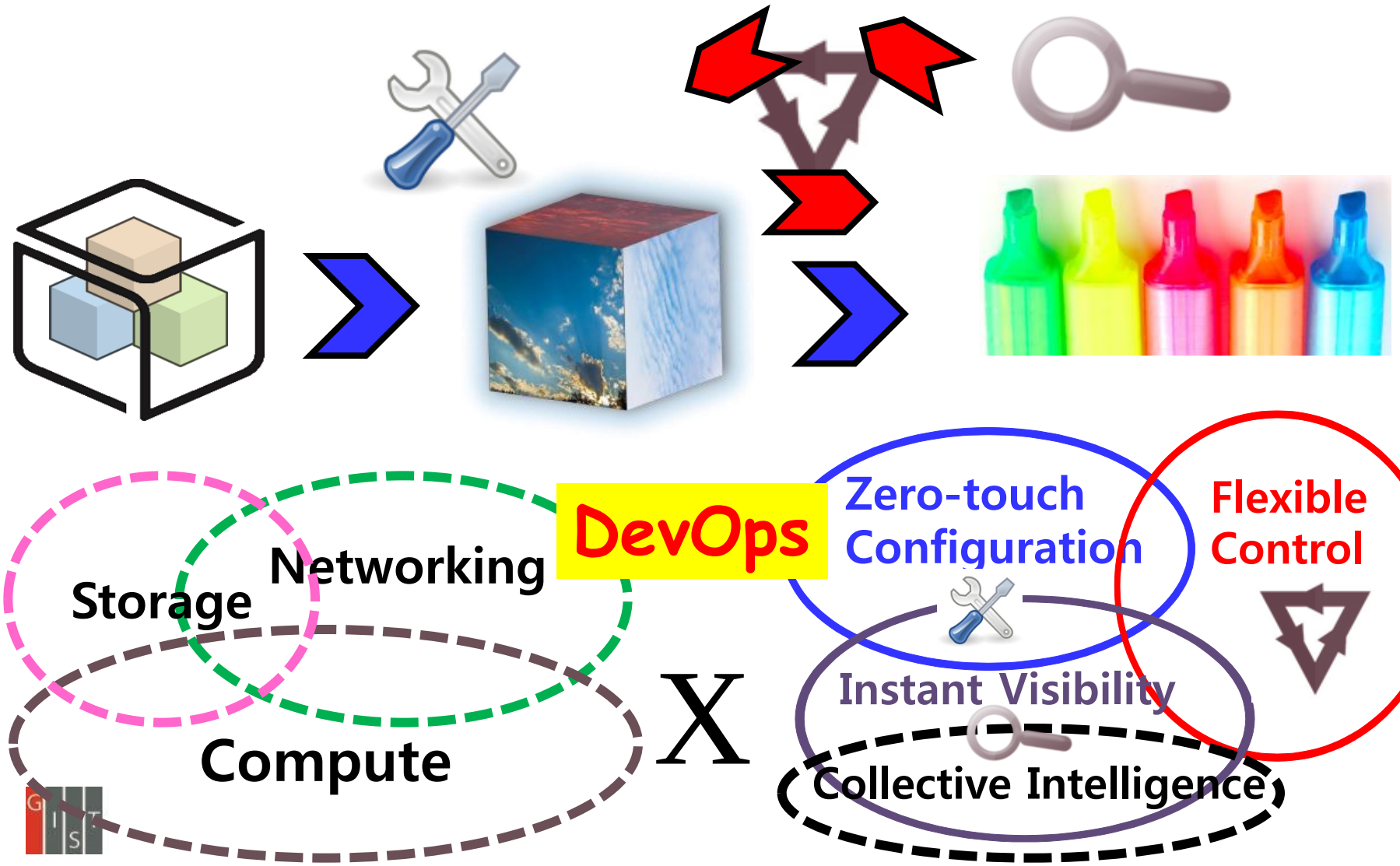
Atto Research

gstep Gyeonggi Institute of Science & Technology Promotion

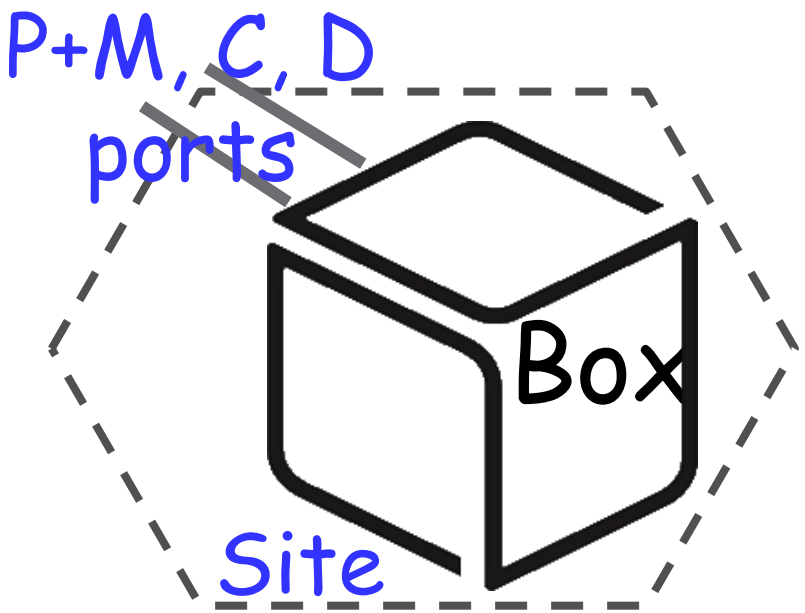
OF@KOREN & OF@TEIN (2012~2014)

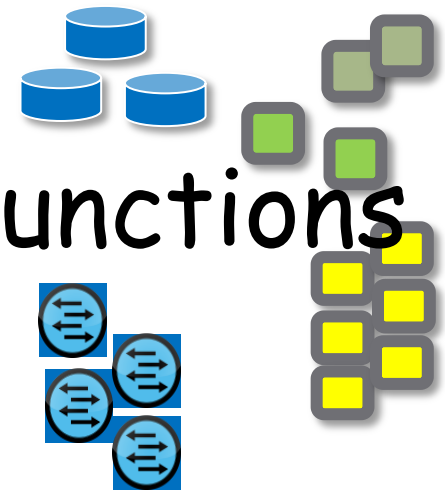


SmartX Provisioning: Configuration / Control / Visibility Challenges

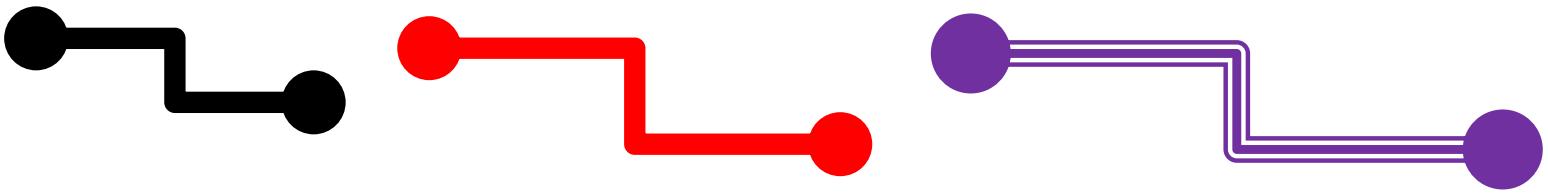


SmartX Provisioning: Inter-Connected Functions inside Boxes/Sites



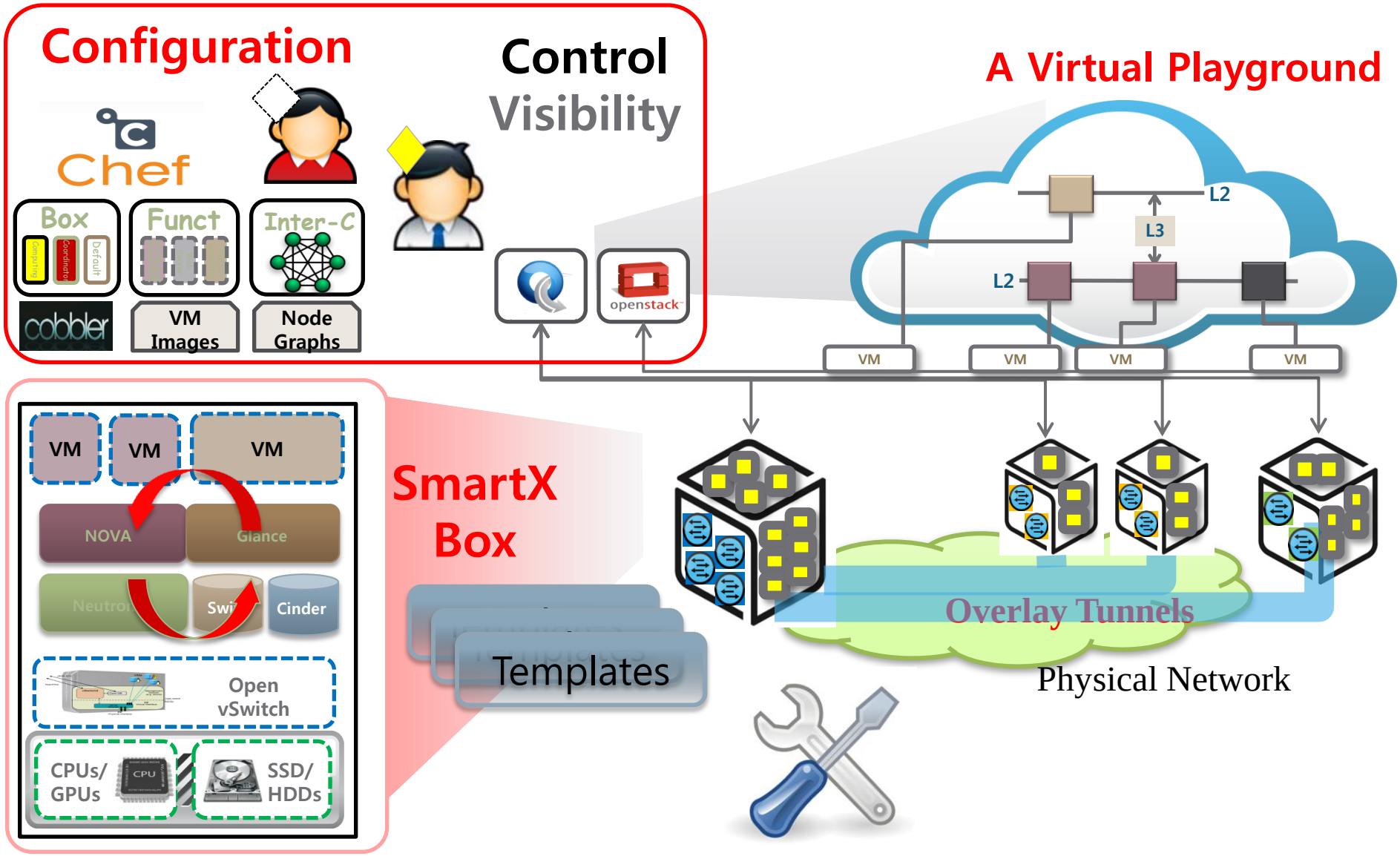


Inter-Connect

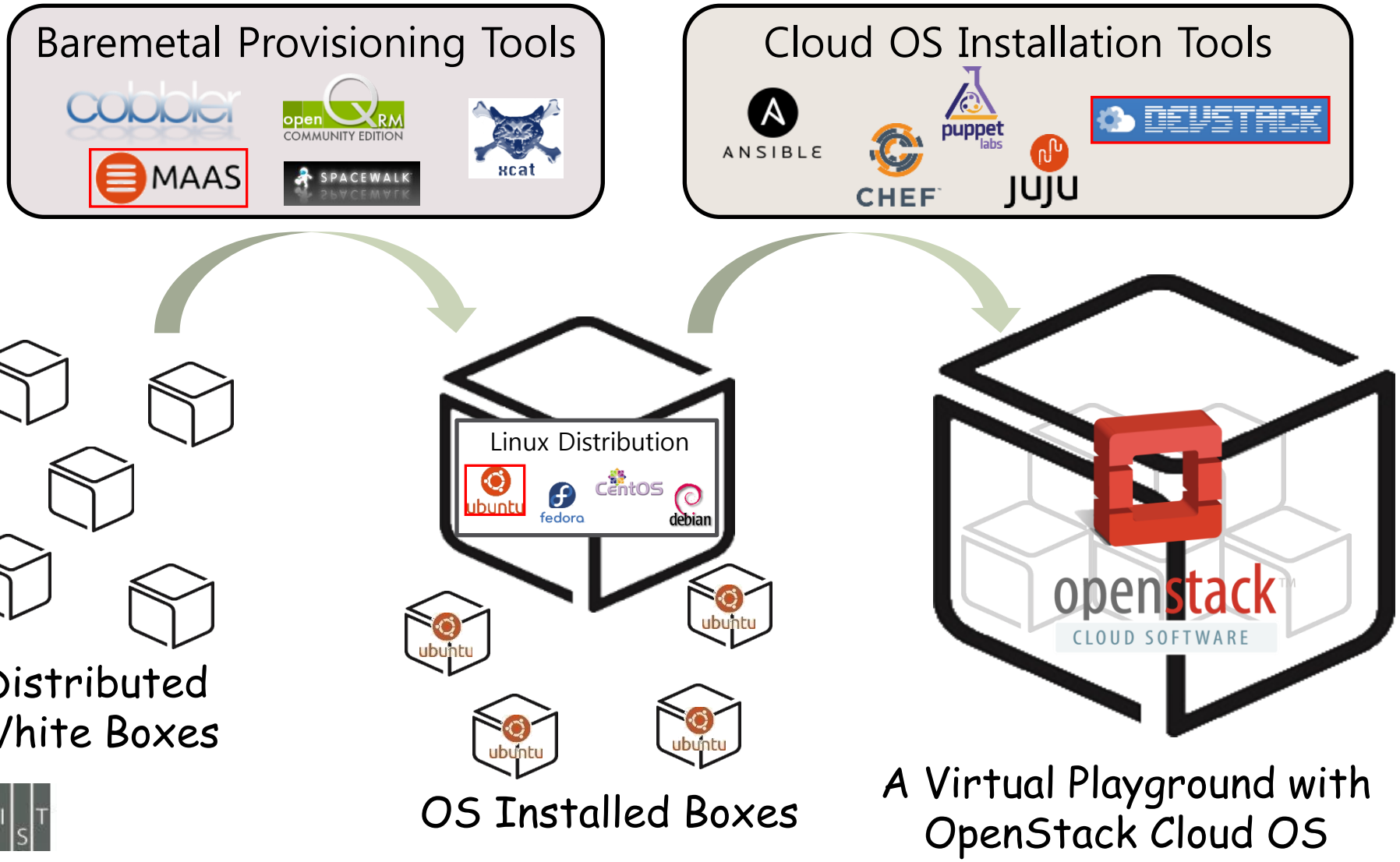


Normal → Secured → Tag/Steer/Mapped

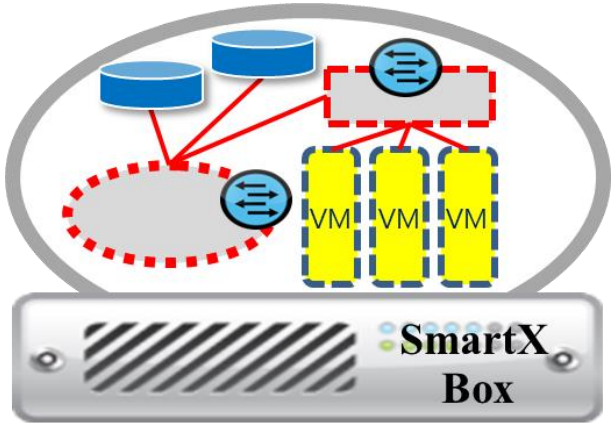
SmartX Provisioning: Virtual Playgrounds via Automated Zero-touch Configuration



SmartX Provisioning: Automated Configuration Tools for SmartX Boxes



SmartX Provisioning: Automated Configuration of SmartX Boxes



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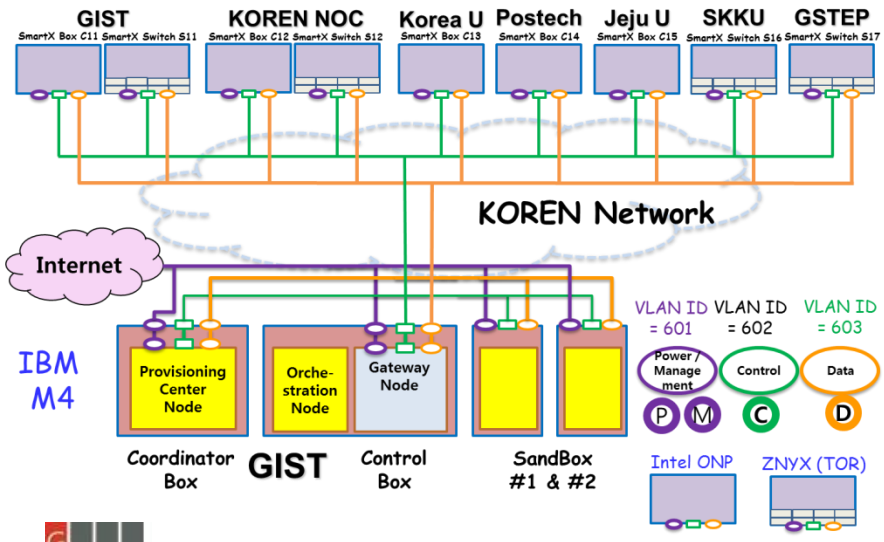
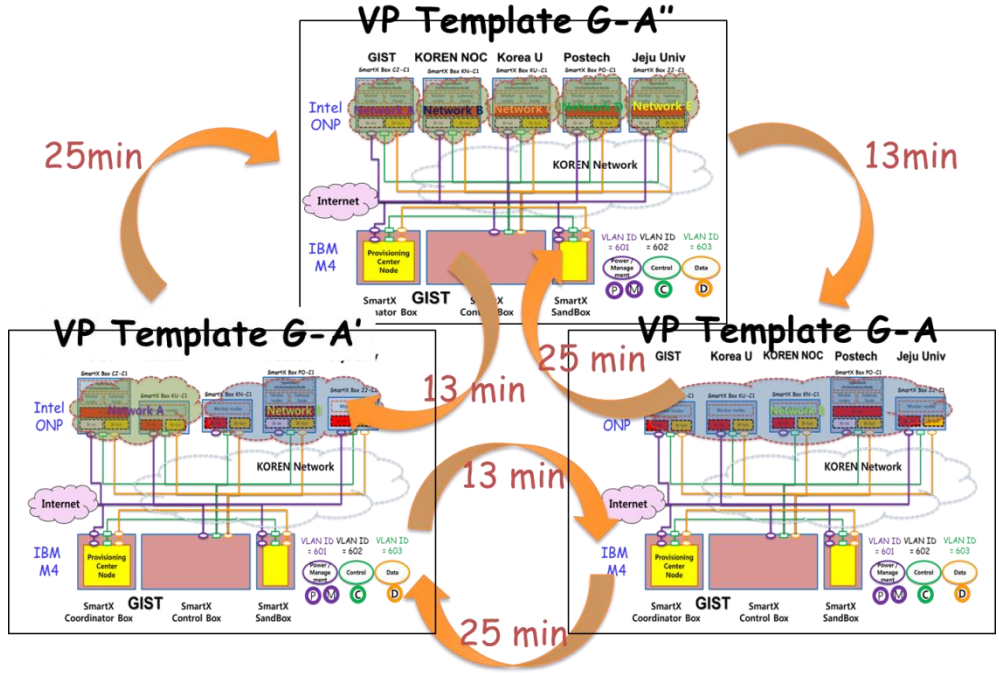
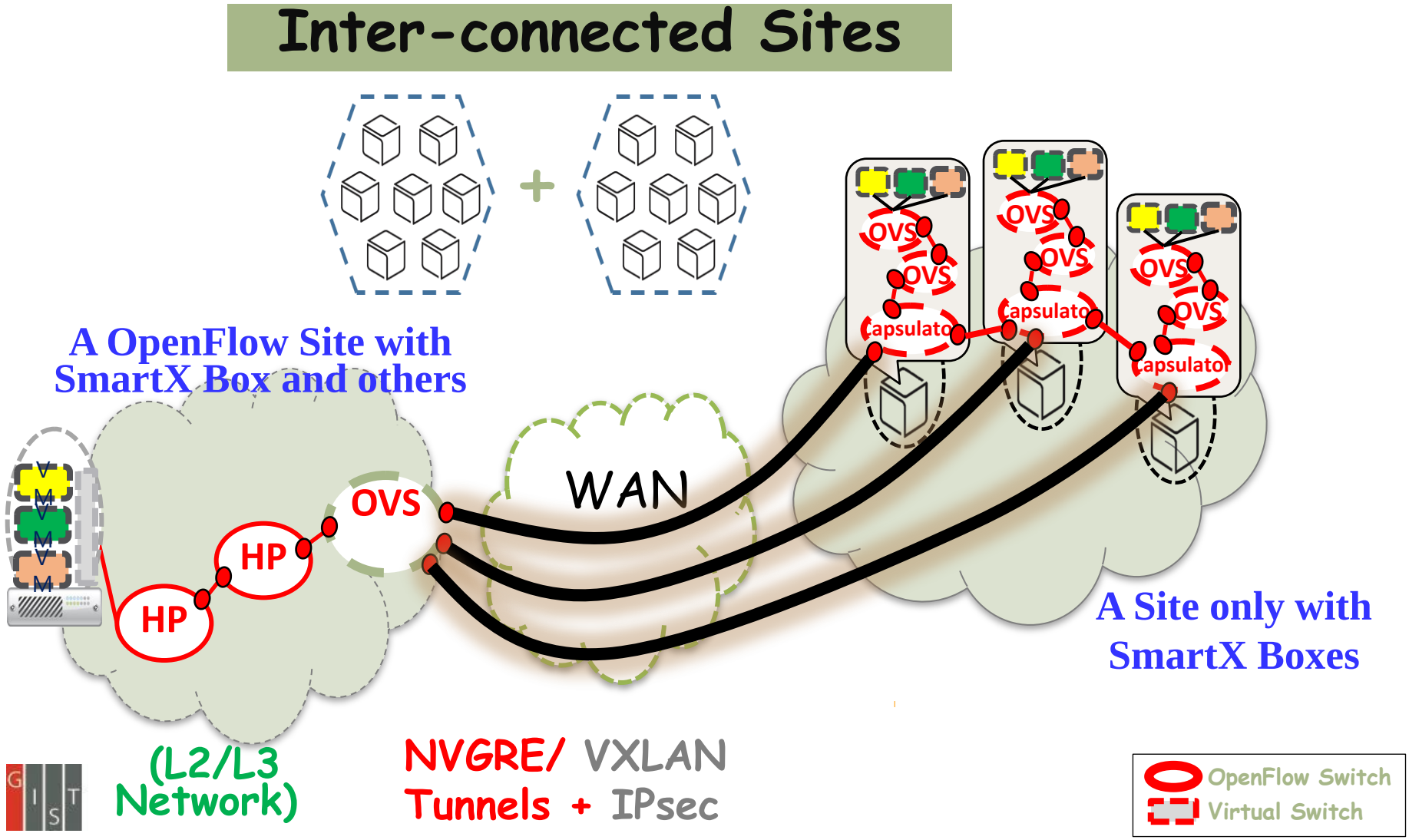
CLOUD SOFTWARE

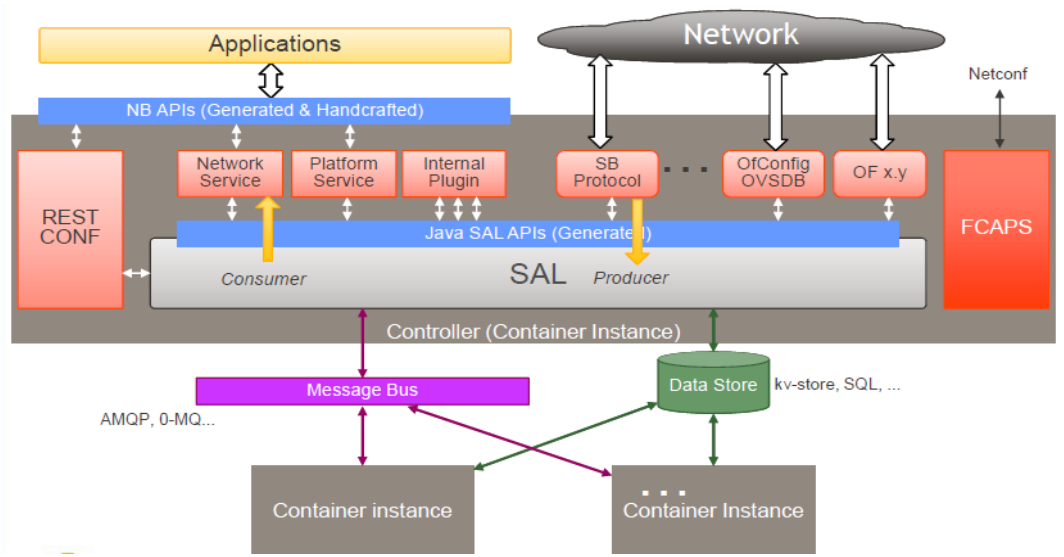


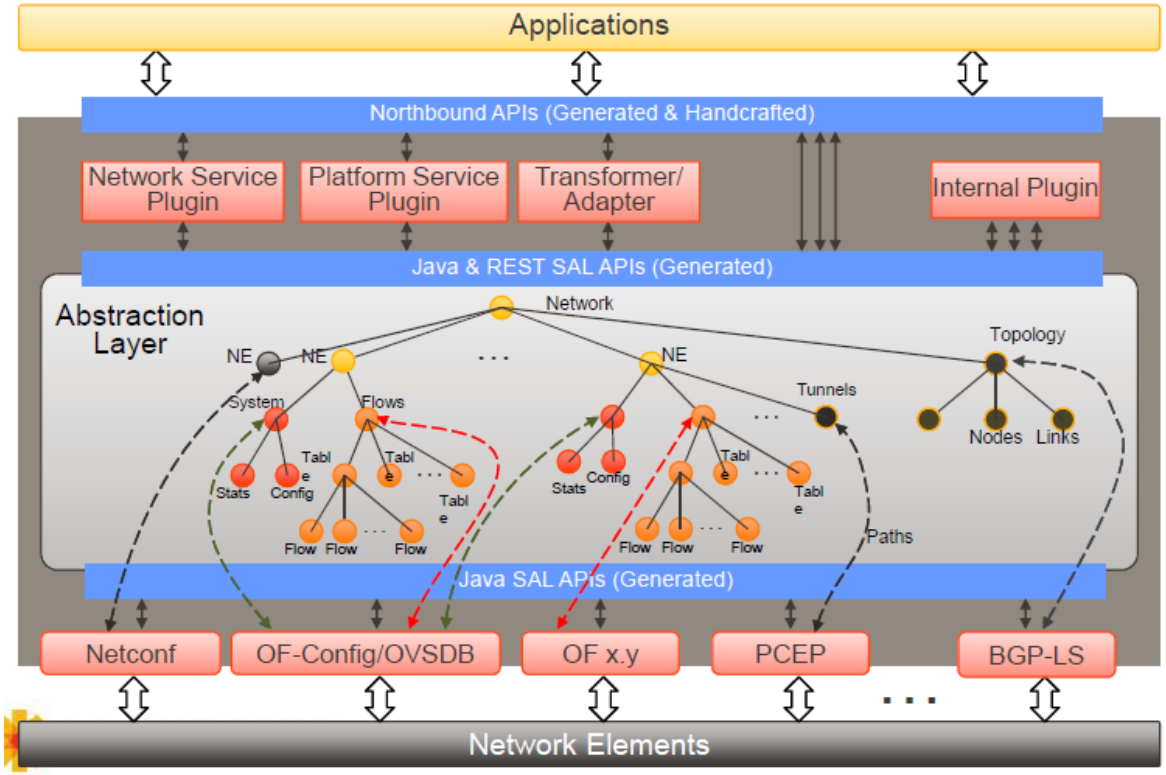


SmartX Provisioning: Configuration of Inter-Connected SmartX Sites (Boxes)

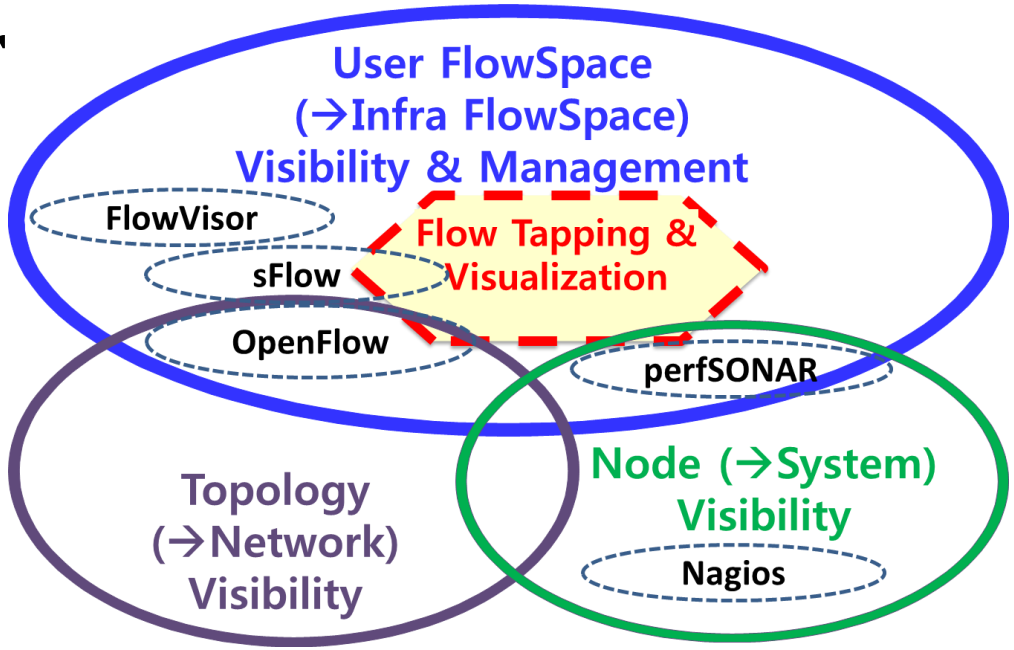


Enable Flexible Control with Diverse SDN Controllers



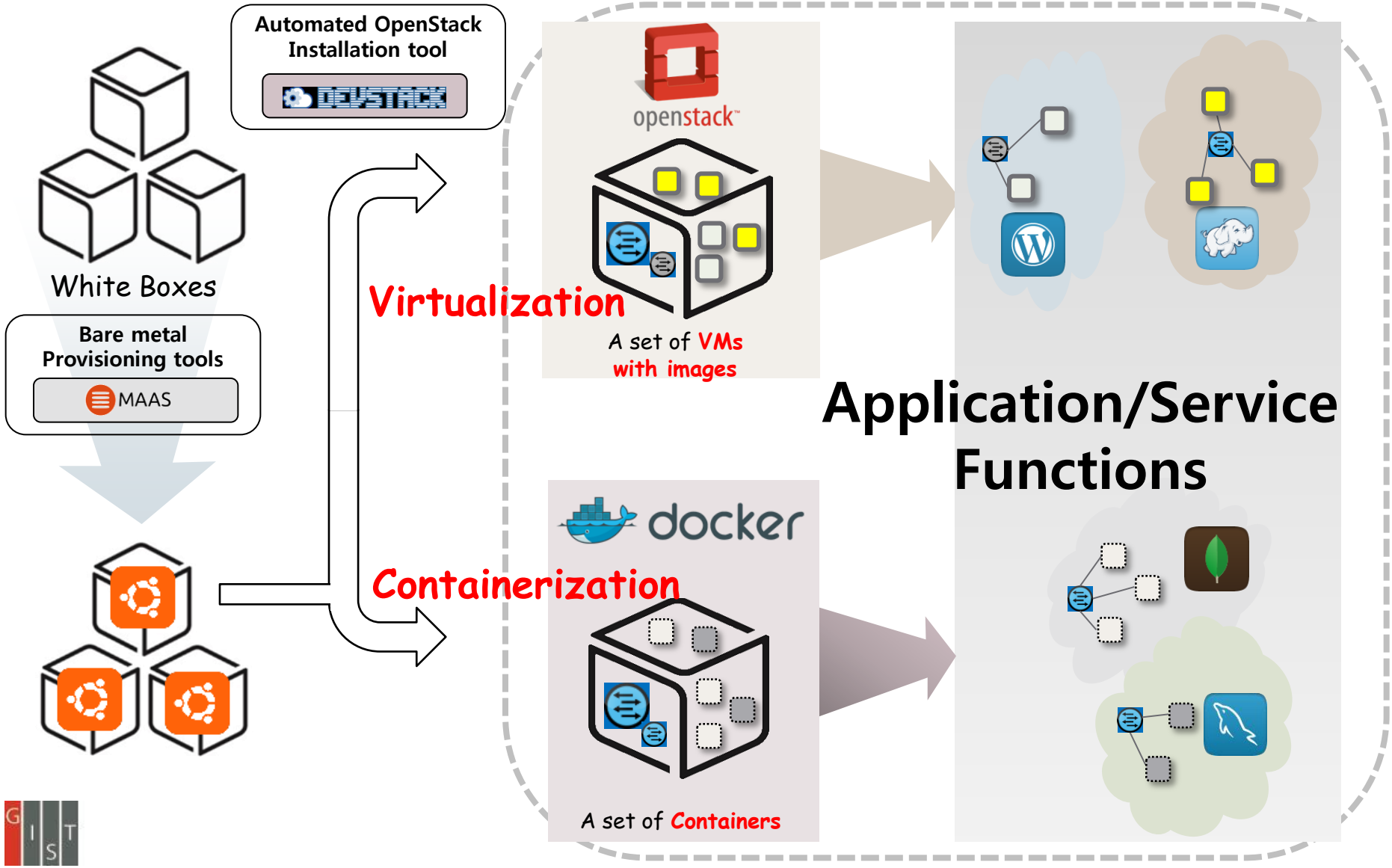


Instant Visibility for SDN-enabled Infrastructure & SDN-coordinated Services

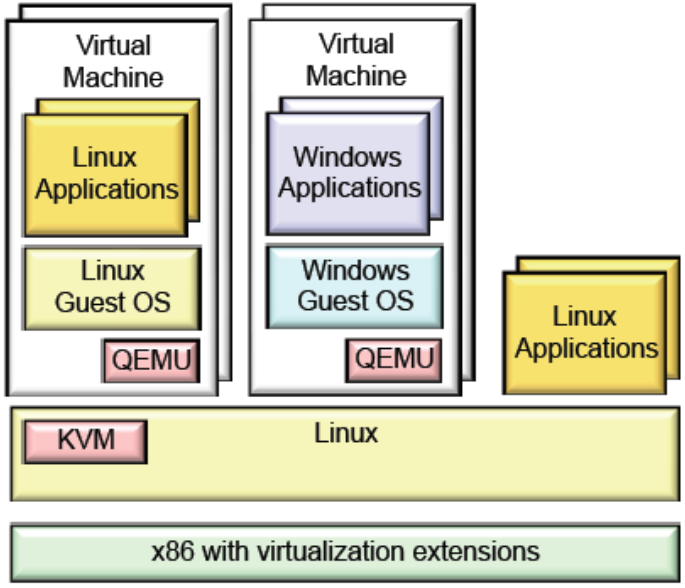


- Application Visibility
  - Resource-awareness for Service Composition ➔ Application Performance Management
  - Service Metric Visibility; Workload Benchmarking & Profiling;
- System/Network Resource Visibility
  - Underlay-awareness for Overlay Virtual Networking
  - Instantaneous Micro/Macro Benchmarking of Resource Capability

Placing Application/Service **Functions** with Virtual Machines & Containers

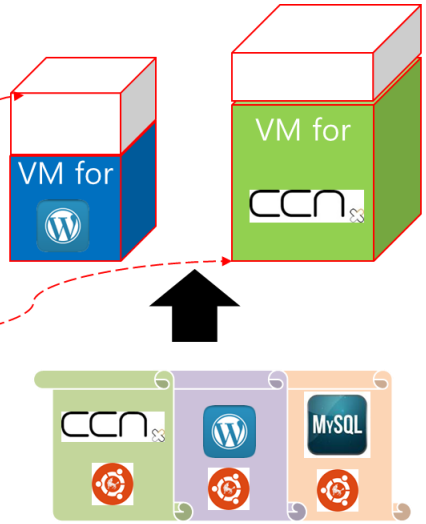


VM Functions with Hyper-visor-based Virtualization



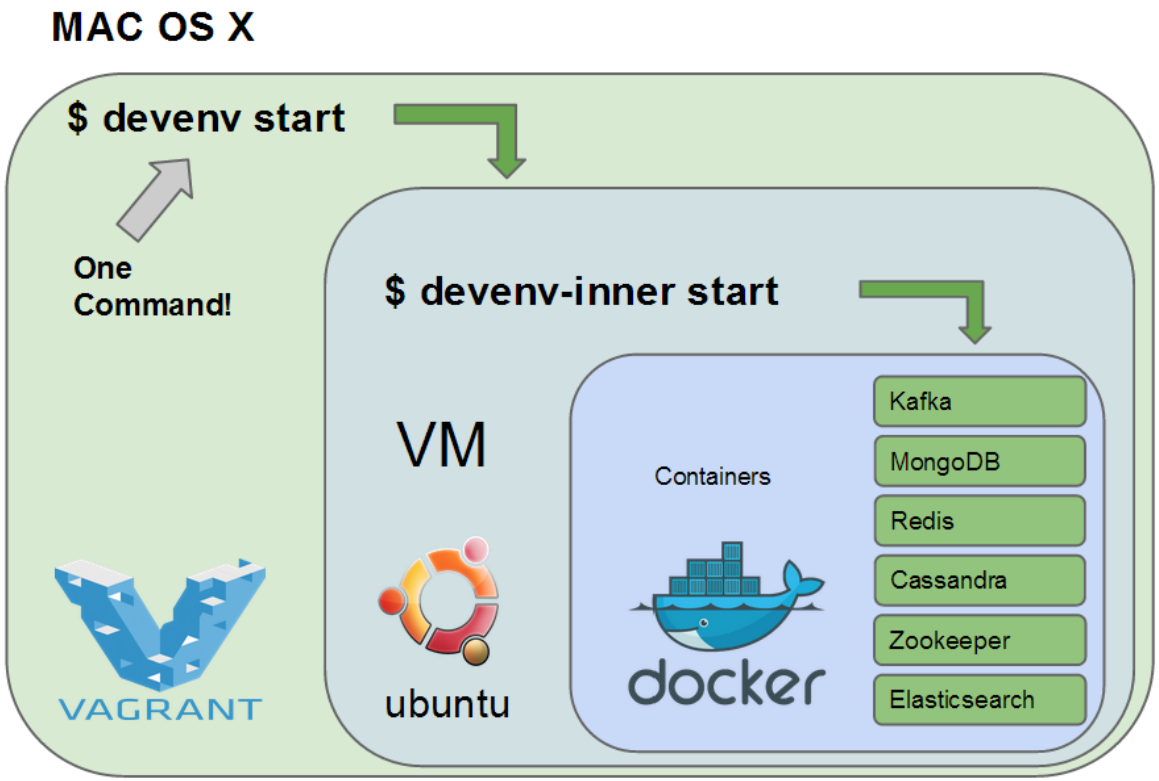
Name	vCPU	RAM	Root Disk
Nano	1	64 MB	0 G
Micro	1	128 MB	0 G
Heat	1	512 MB	0 G
Tiny	1	512 MB	1 G
Small	1	2048 MB	20 G
Medium	2	4096 MB	40 G
Large	4	8192 MB	80 G
X large	8	16384 MB	160 G

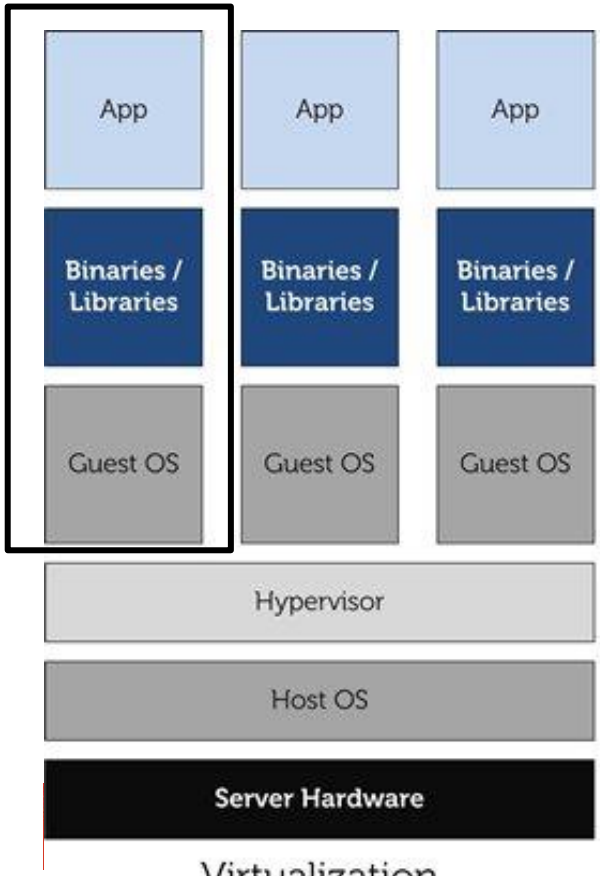
Selected VM Flavors

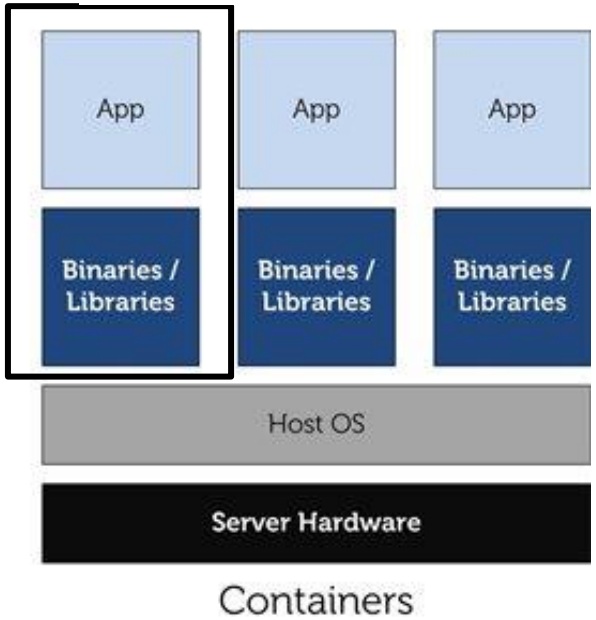


VM images with preinstalled Functions

Container Functions: Docker, Rocket, …

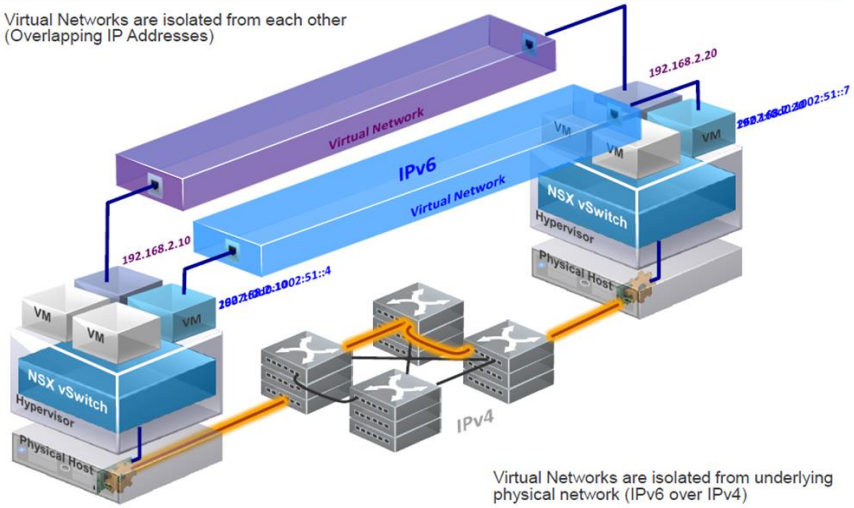


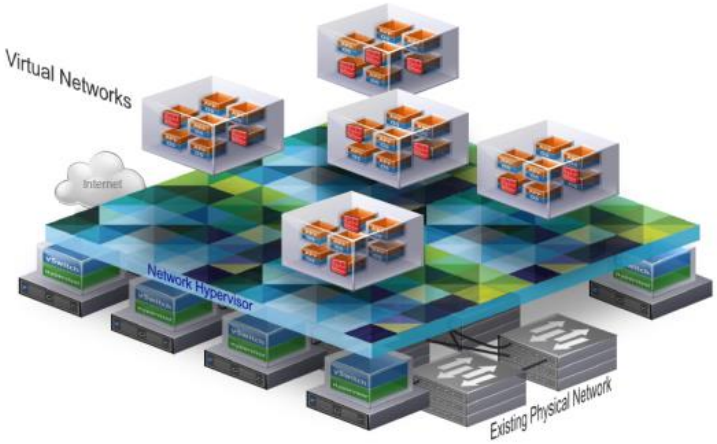


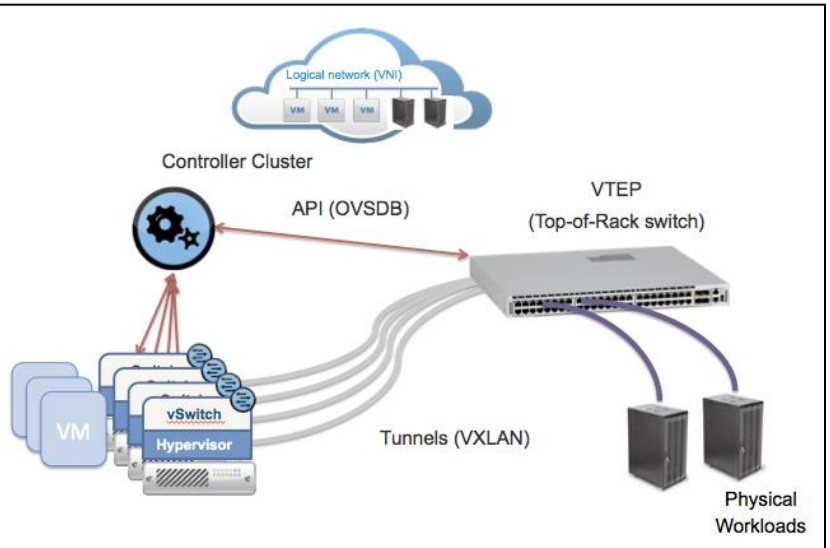


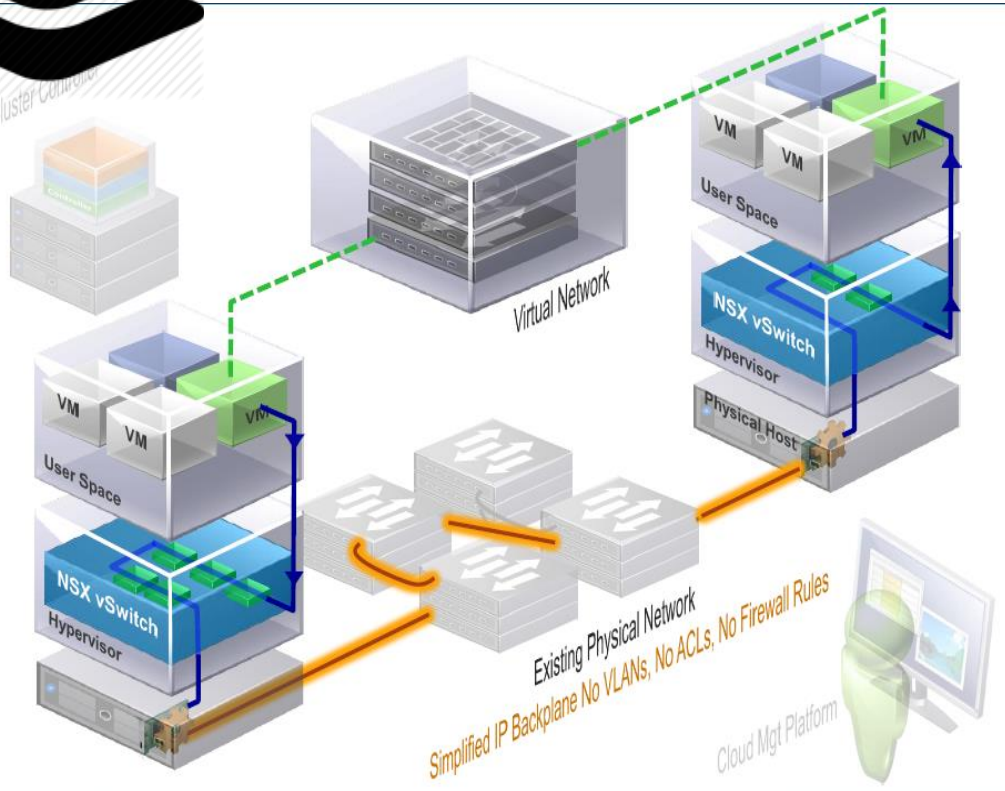
Lightweight packaging for workloads & Scaling …

Inter-Connecting VM Functions via Overlay vNetworking

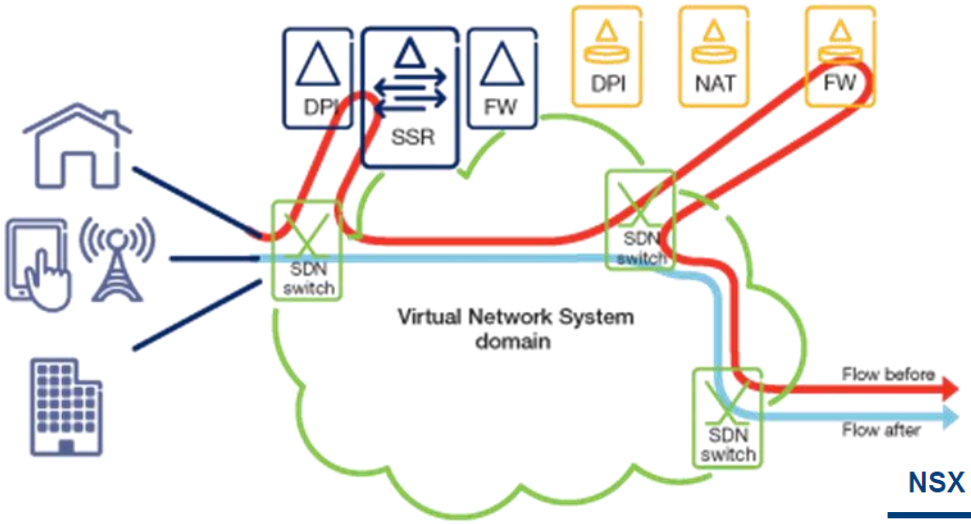


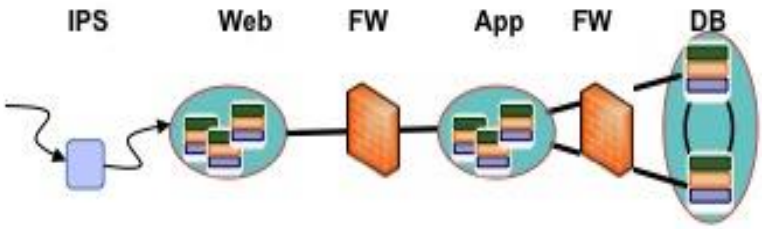






SDN-coordinated End-to-end Inter-connection for Mobile Cloud Services

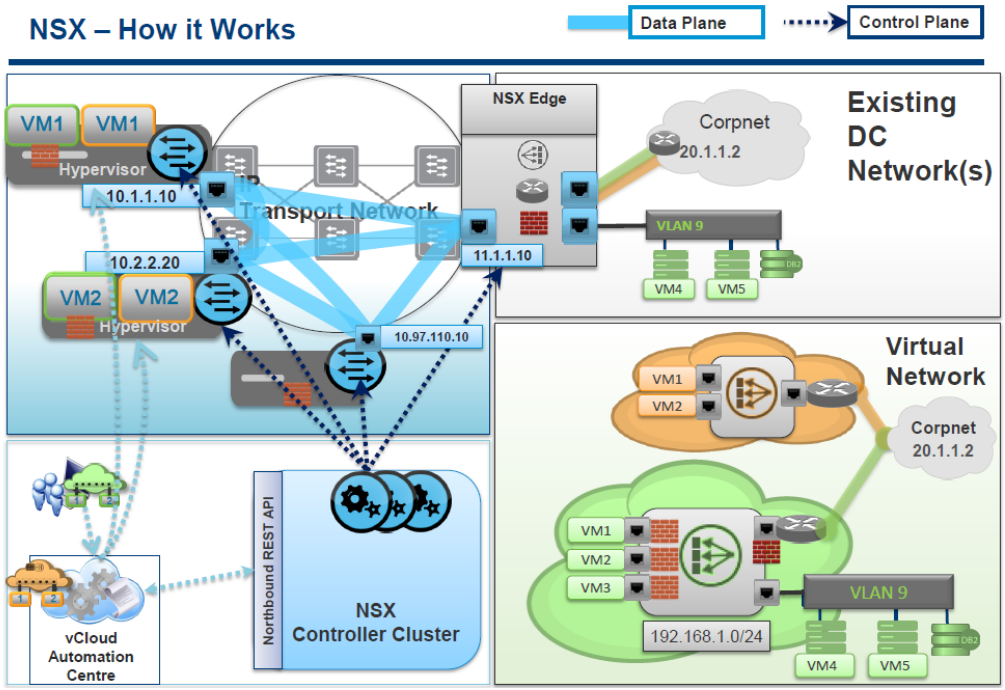




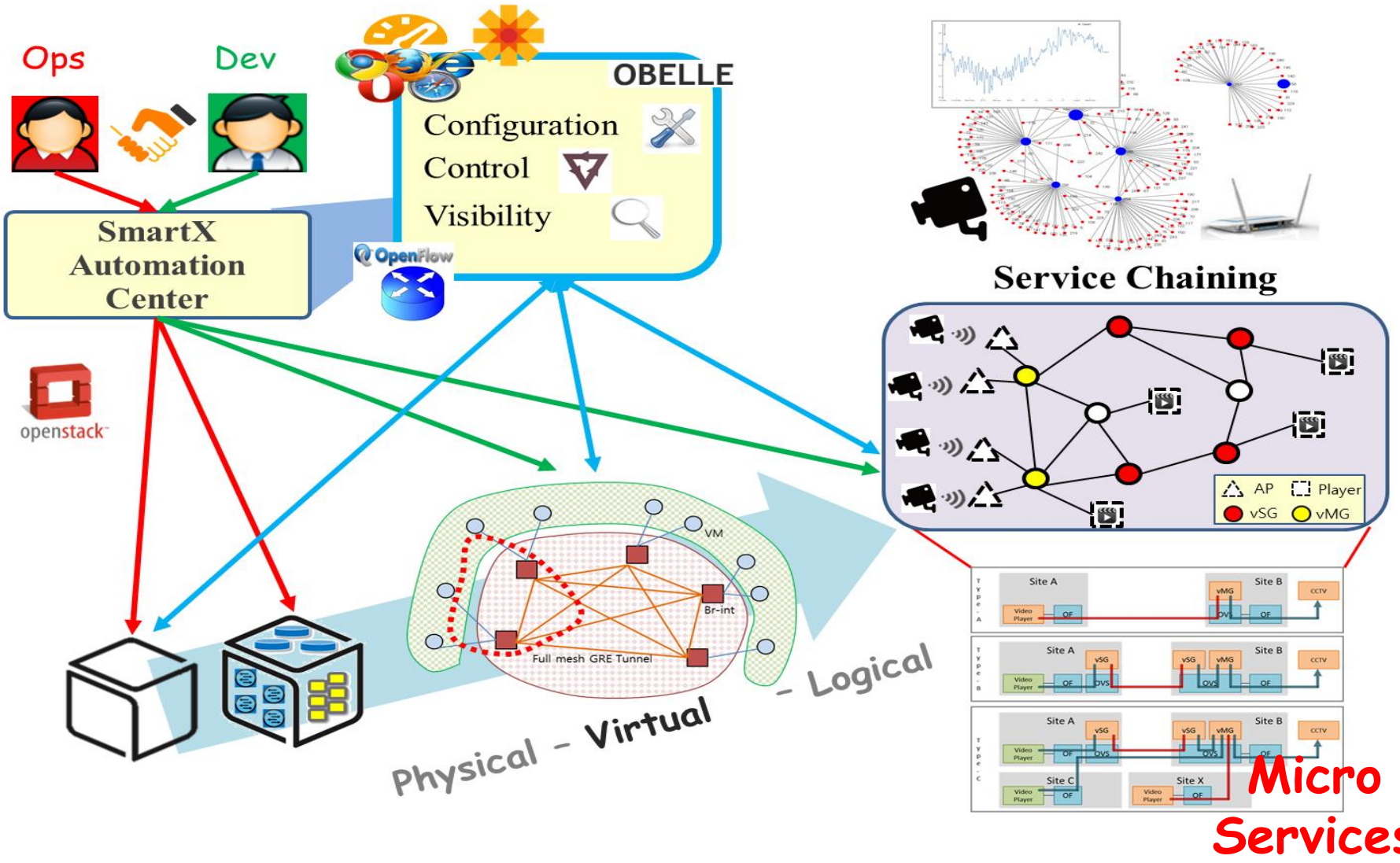
Overlay vNetworking @ DC

SDN-Coordinated Flow Steering with NFV @ Edge

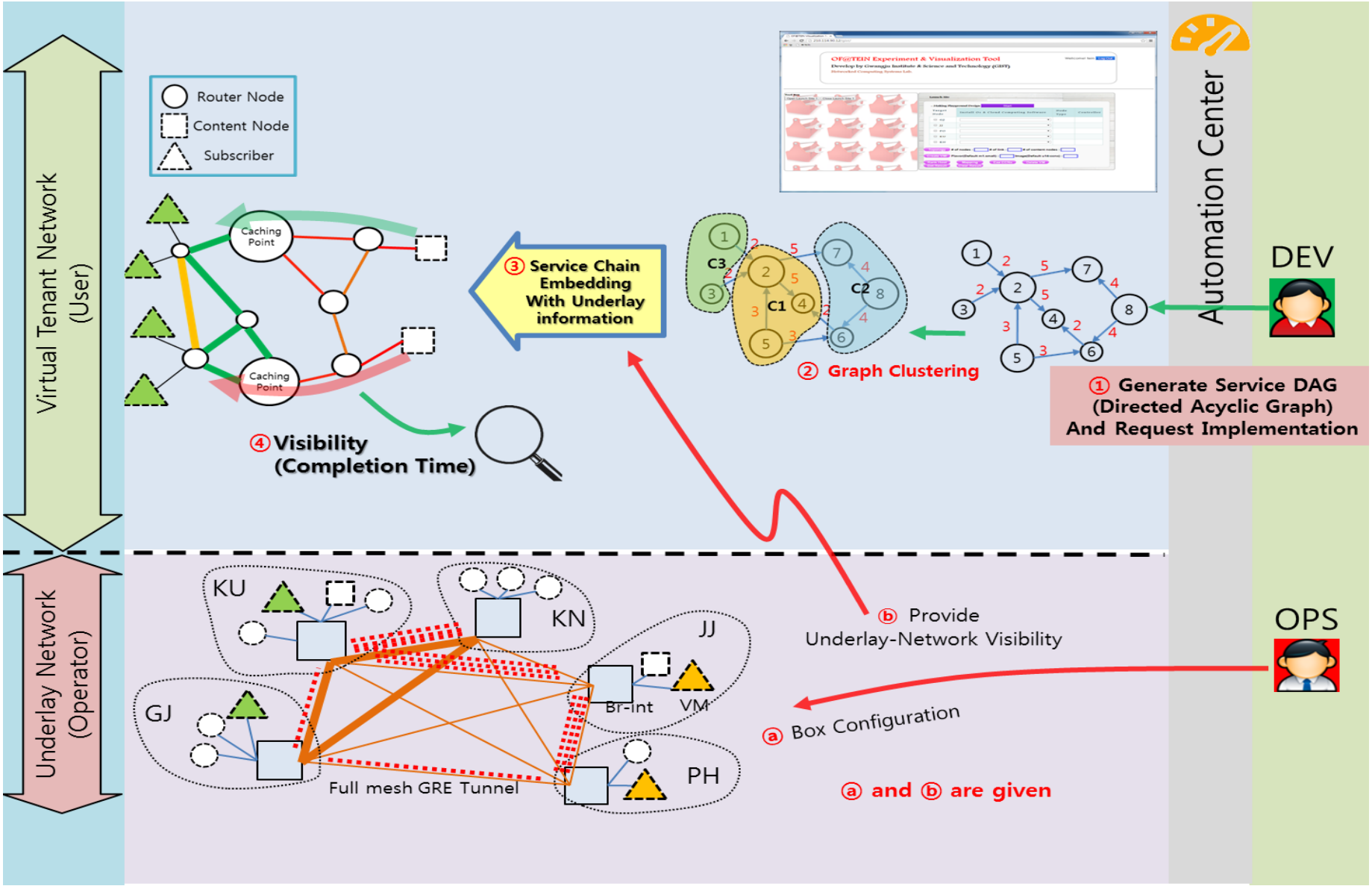
Flow Tag/Steer/Map



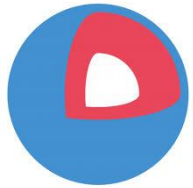
SmartX Orchestration: Service Function Chaining



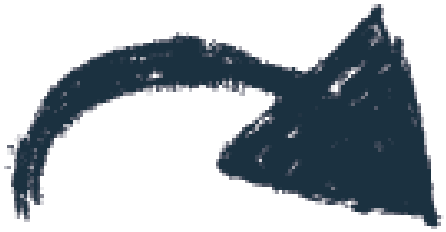
SmartX Orchestration: Resource-aware Service Function Chaining

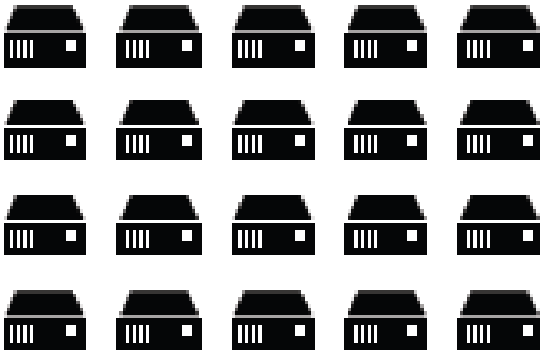


SmartX Orchestration: Distributed Resource Scheduling

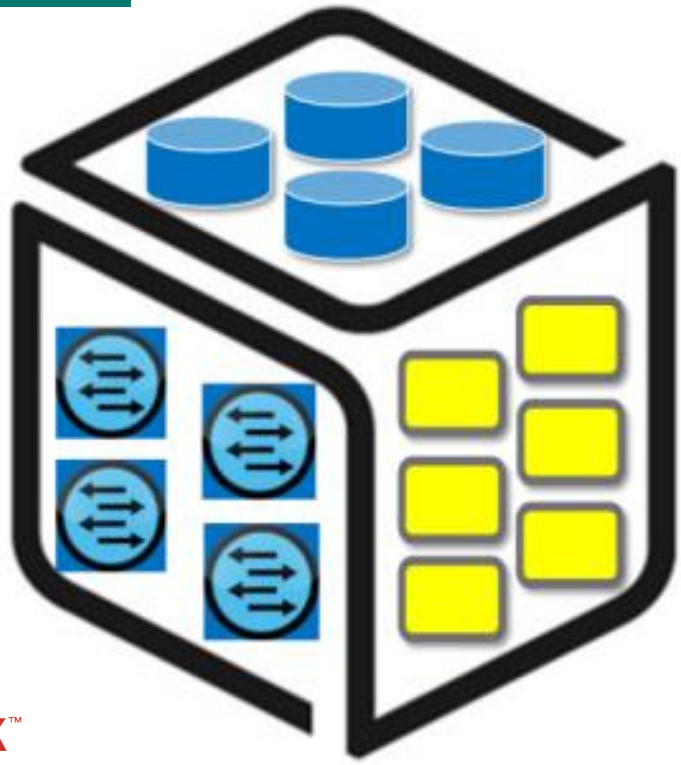


DATACENTER

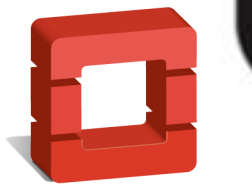




Google



Cloud Datacenter as a BIG Computer



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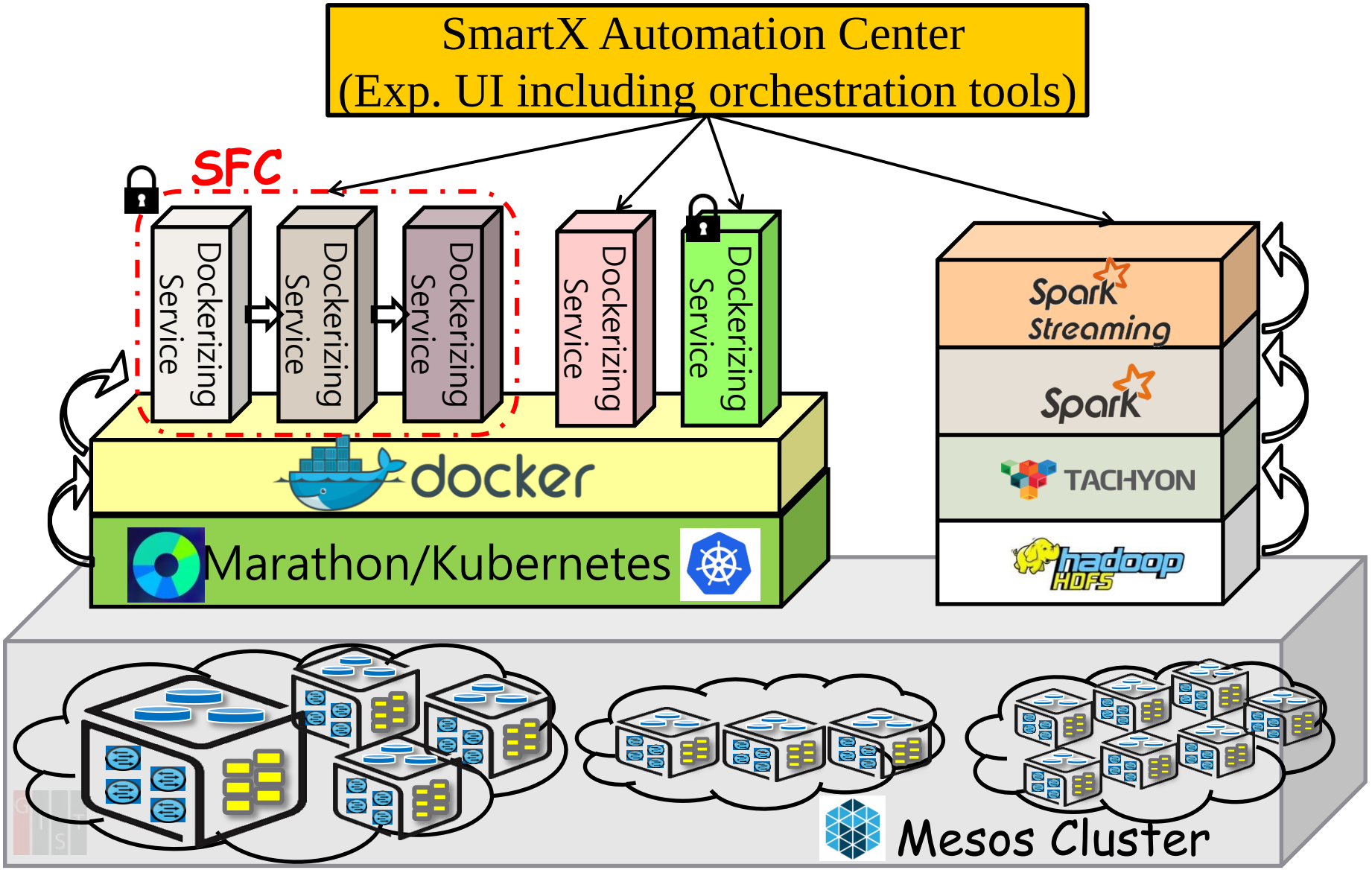
SmartX Orchestration: Container-based Services over Resource-shared Clusters



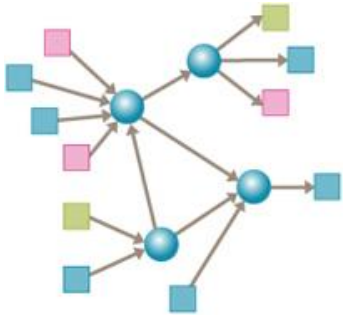
SmartX Provisioning & Orchestration:

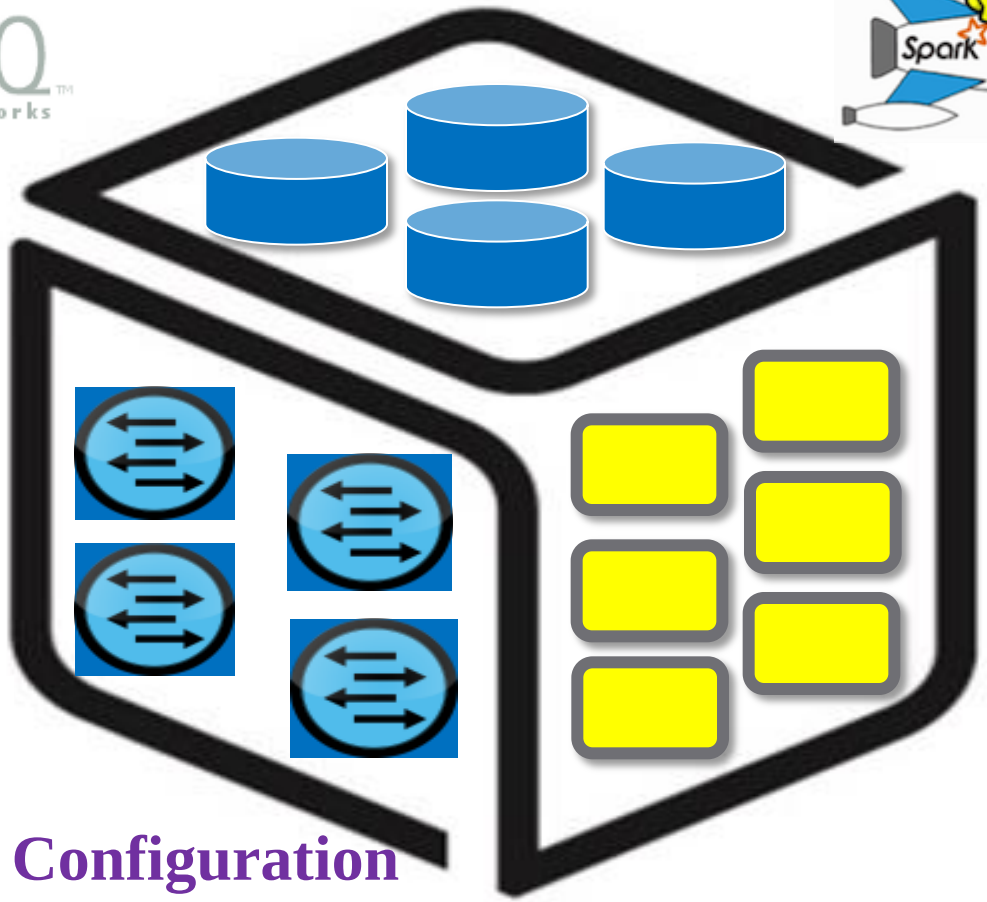
Converged Resources - Workloads – Diversified Functions

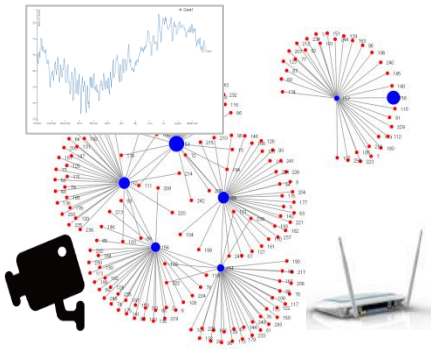
Auto Scaling

Continuous Integration

Instant Visibility







Flexible Control

Service Chaining

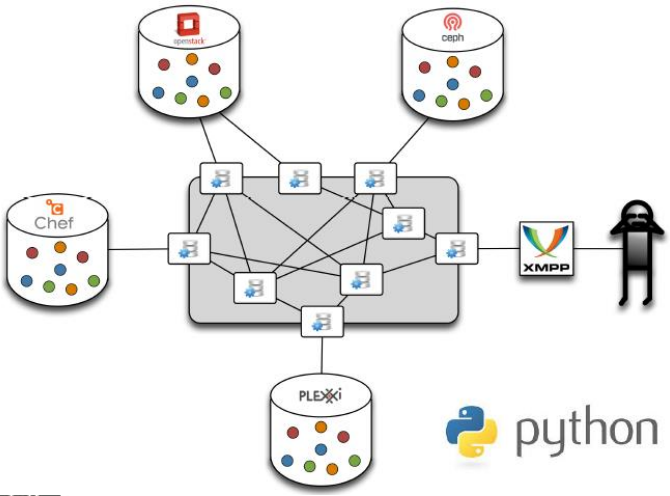
Zero-touch Configuration

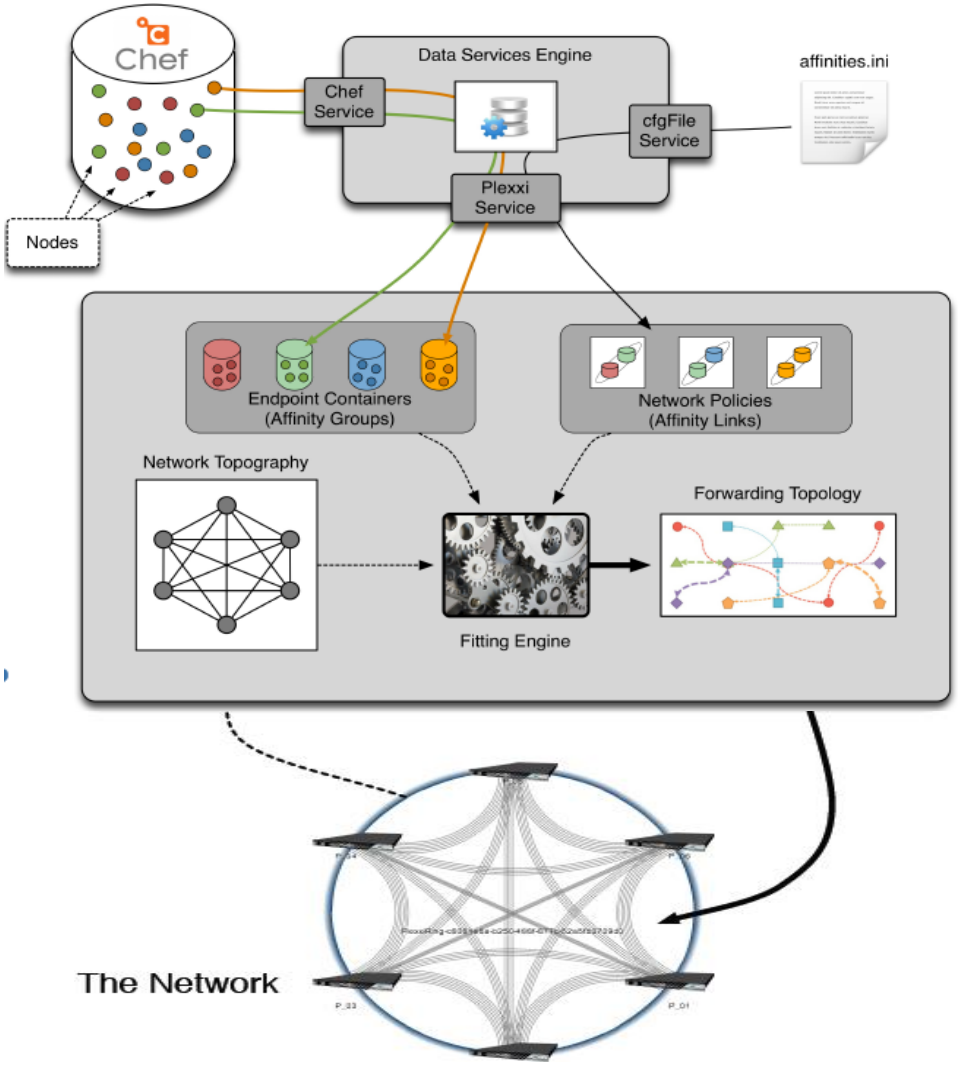
Governing Service Realization:

Data (Policy – Service – Function) & Resource (Converged, Programmable, Virtualized)

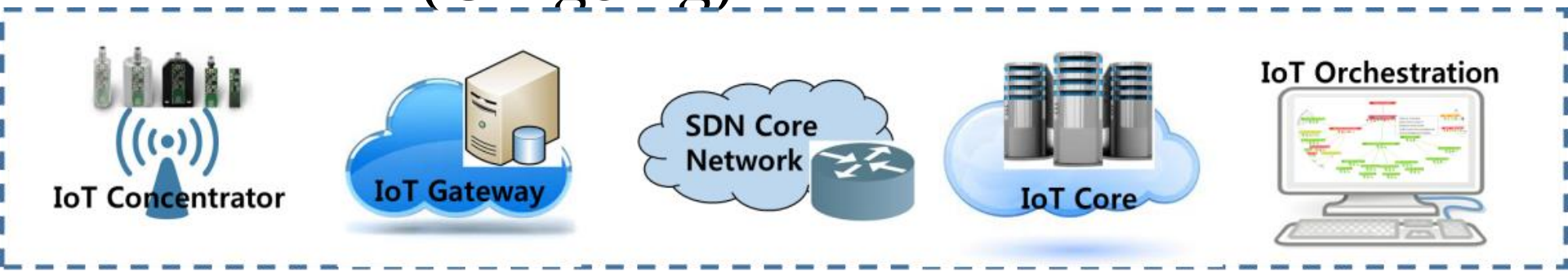
Data Model

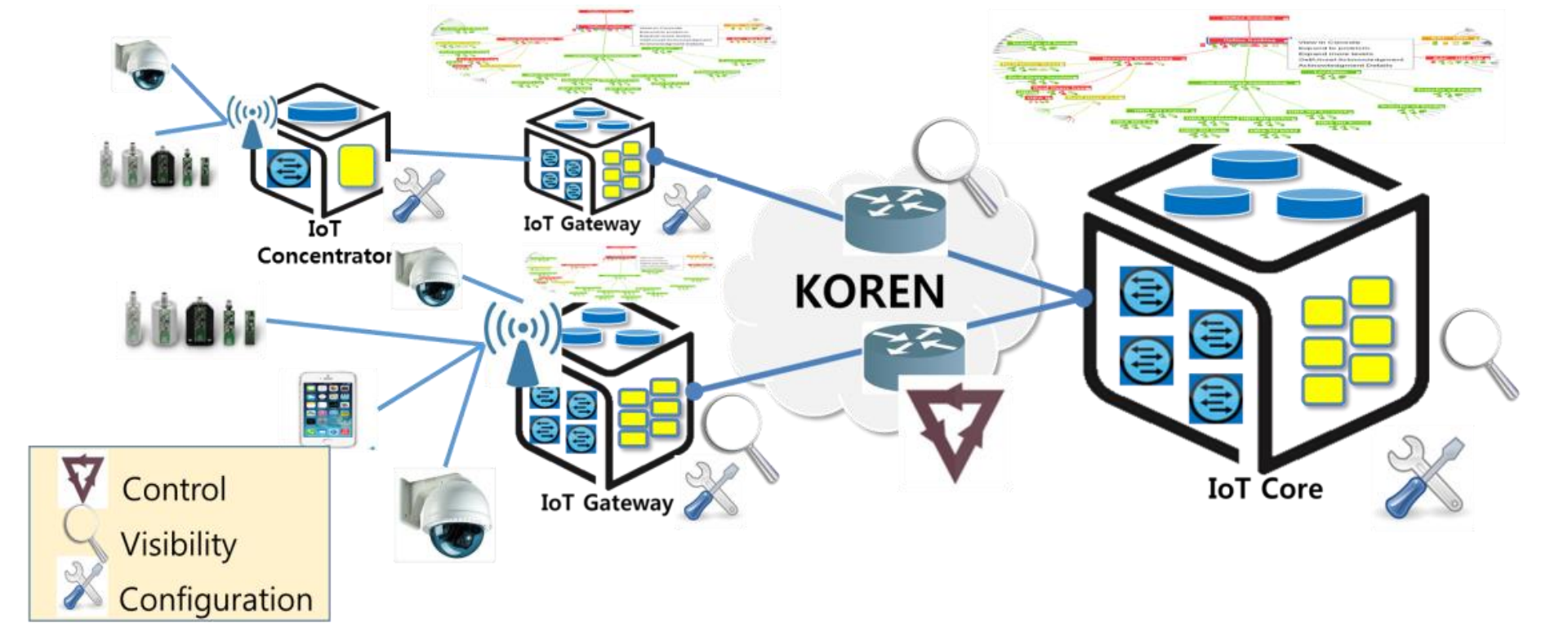
Data Service Engine





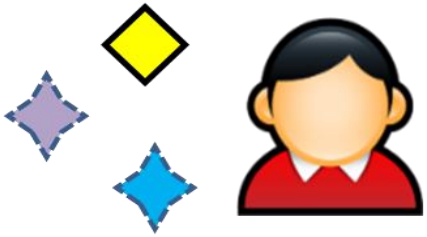
Preparing Virtual Playgrounds for Industrial Internet of Things (On-going)





Human-Defined Services over Software-Defined Infrastructure

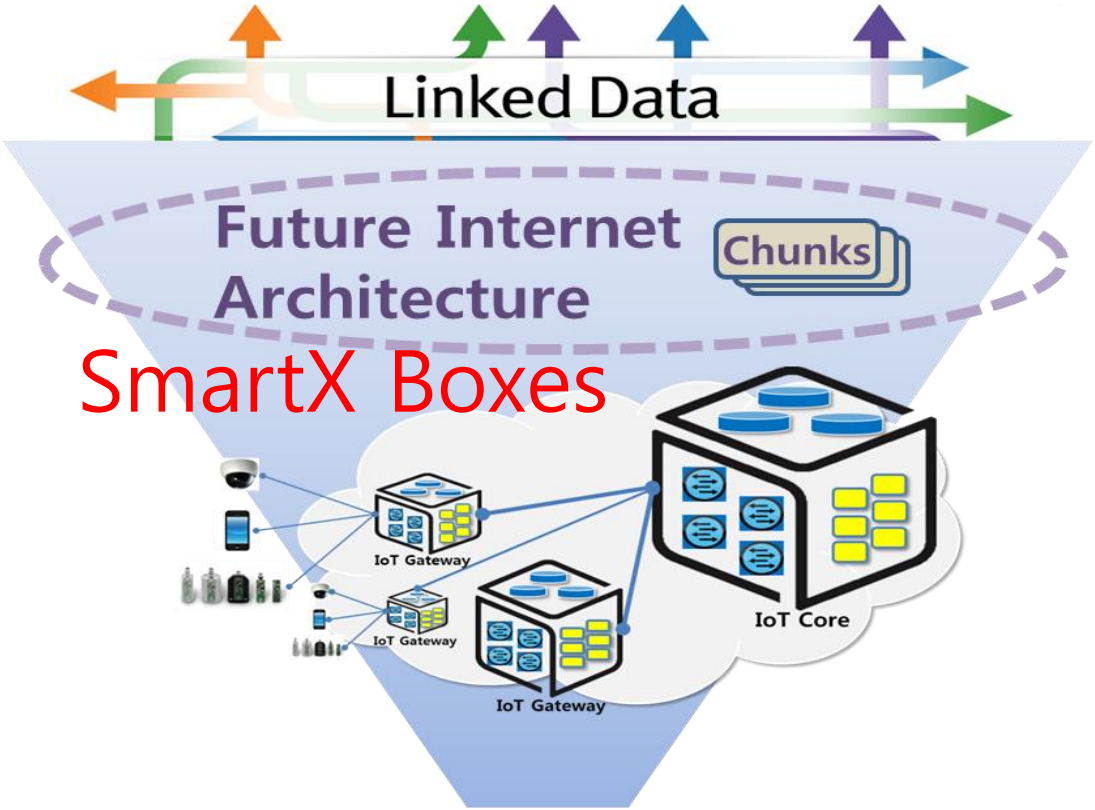
Human-Defined Services



Policy-based Security & Lifecycle Safety

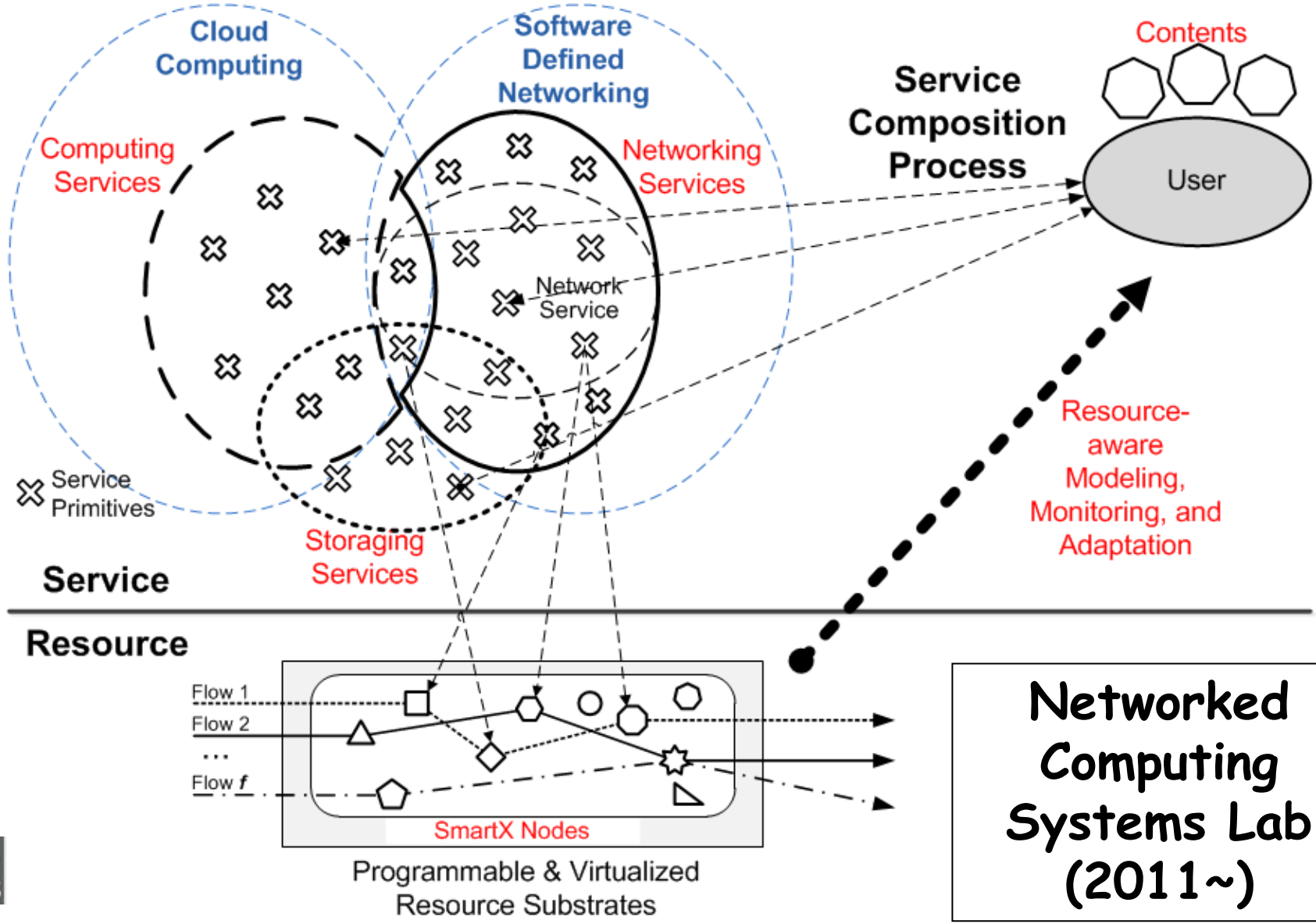
Automated Scaling & Continuous Integration

Distributed Real-time Intelligence from Multi-level Connectivity



Software-Defined Infrastructure

Balanced Service Composition based on Programmable (*and Virtualized*) Resources



Networked Computing Systems Lab (2011~)

Gwangju Institute of
Science & Technology

Thank you!

jongwon@gist.ac.kr