APPLICATION DEPLOYMENT IN FUTURE GLOBAL MULTI-CLOUD ENVIRONMENT

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These slides and audio/video recordings of this talk are at:

http://www.cse.wustl.edu/~jain/talks/apf_git.htm

Overview

- ❑ Recent Trends in Networking:
  - ➢ Trend 1: Computation in the Edge
  - ➢ Trend 2: Hierarchical Computation
  - ➢ Trend 3: Software Defined Inter-Cloud
  - ➢ Trend 4: Liquid Applications
- ❑ Solution: Generalized Application Delivery Networking

Trend: Content Distribution Networks (CDN) – Evolution of a Data-Centric Internet

❑ To serve world-wide users, latency was critical and so the data was replicated and brought to edge

Users

Distributed Content Caches
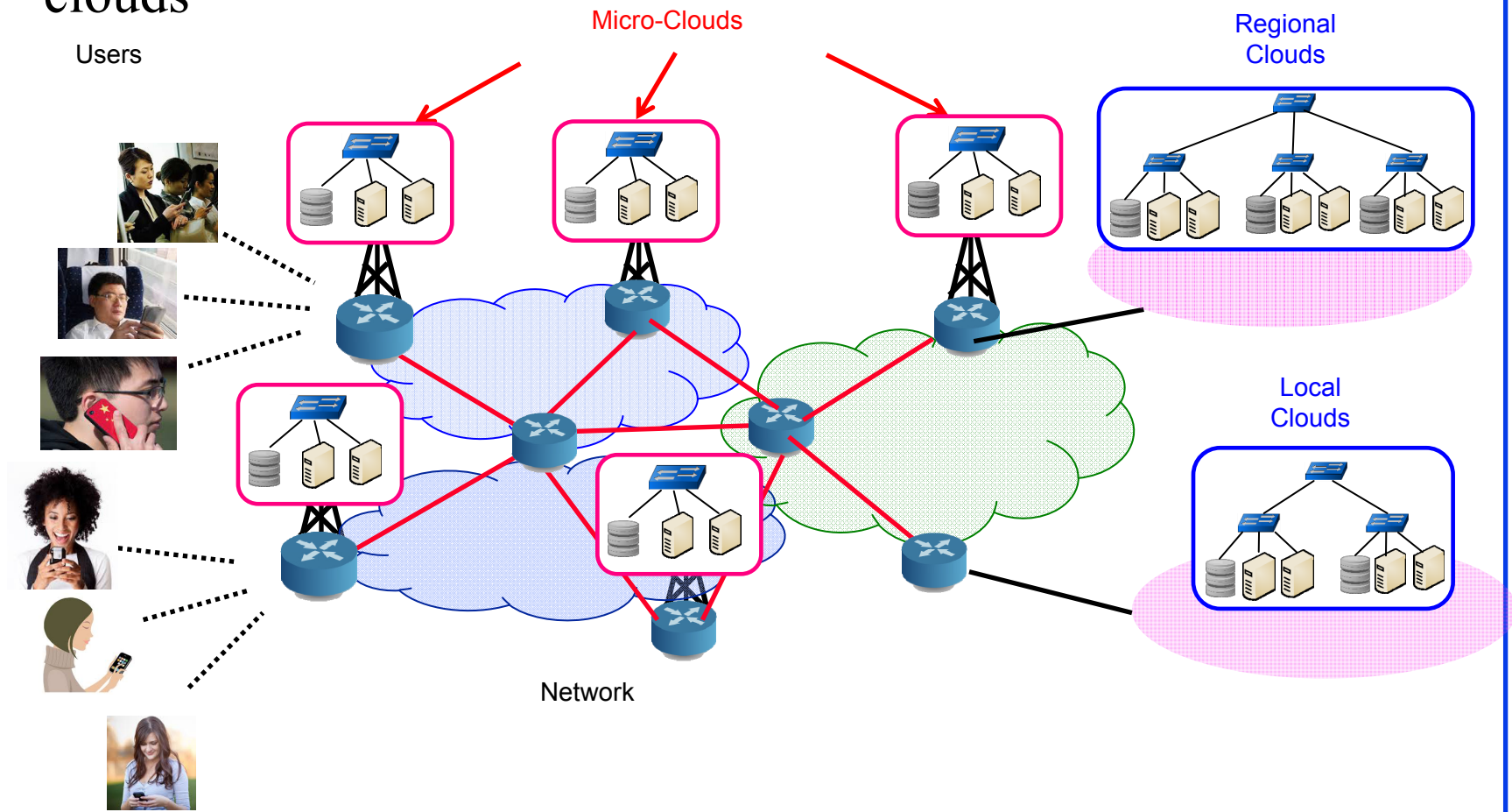
Network

Service/Content hosted on web servers
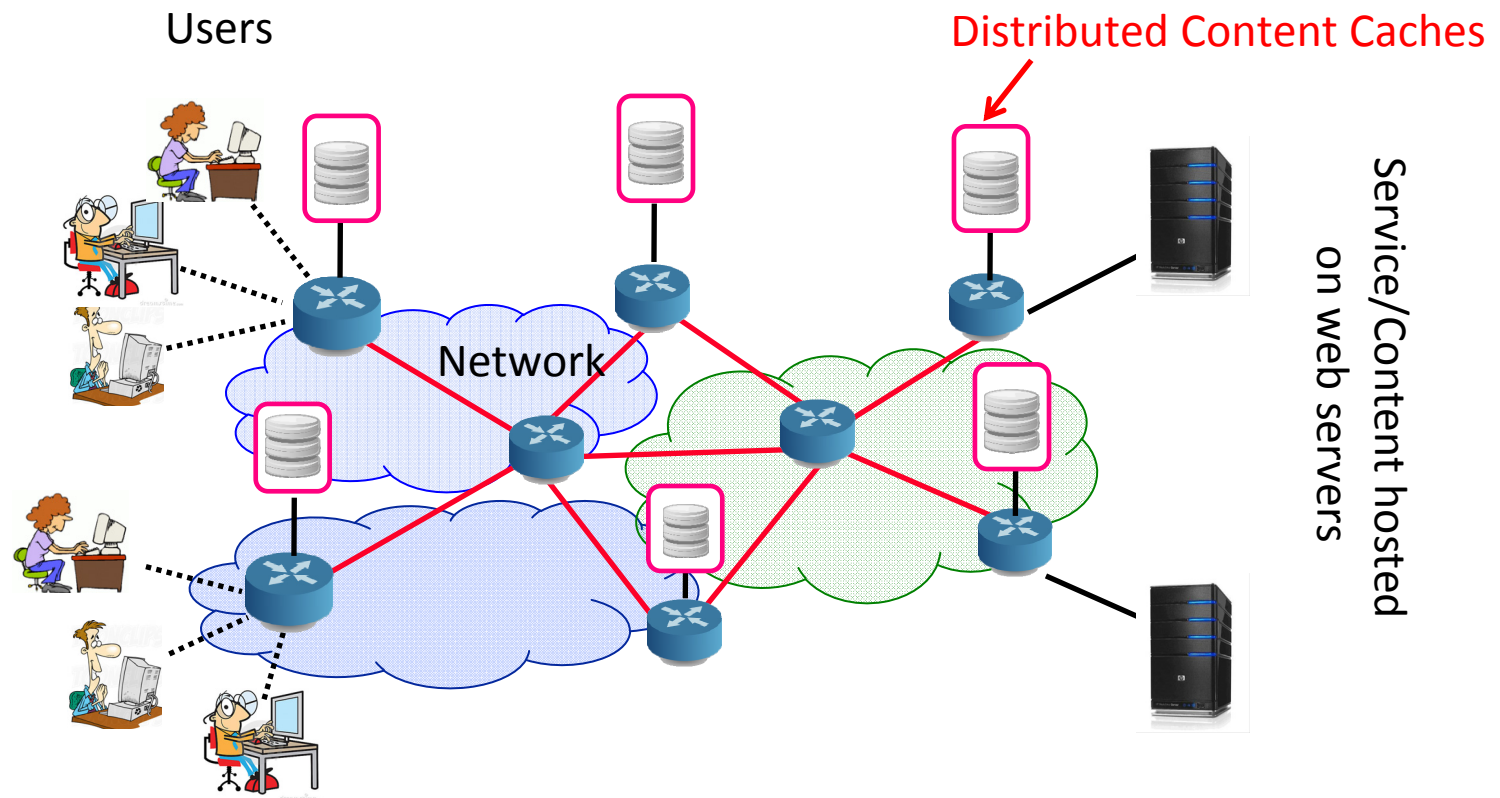
Trend 1: Computation in the Edge

❑ To service 5G smart phone users, the computation needs to come to edge $\Rightarrow$ Micro-cloud on the tower

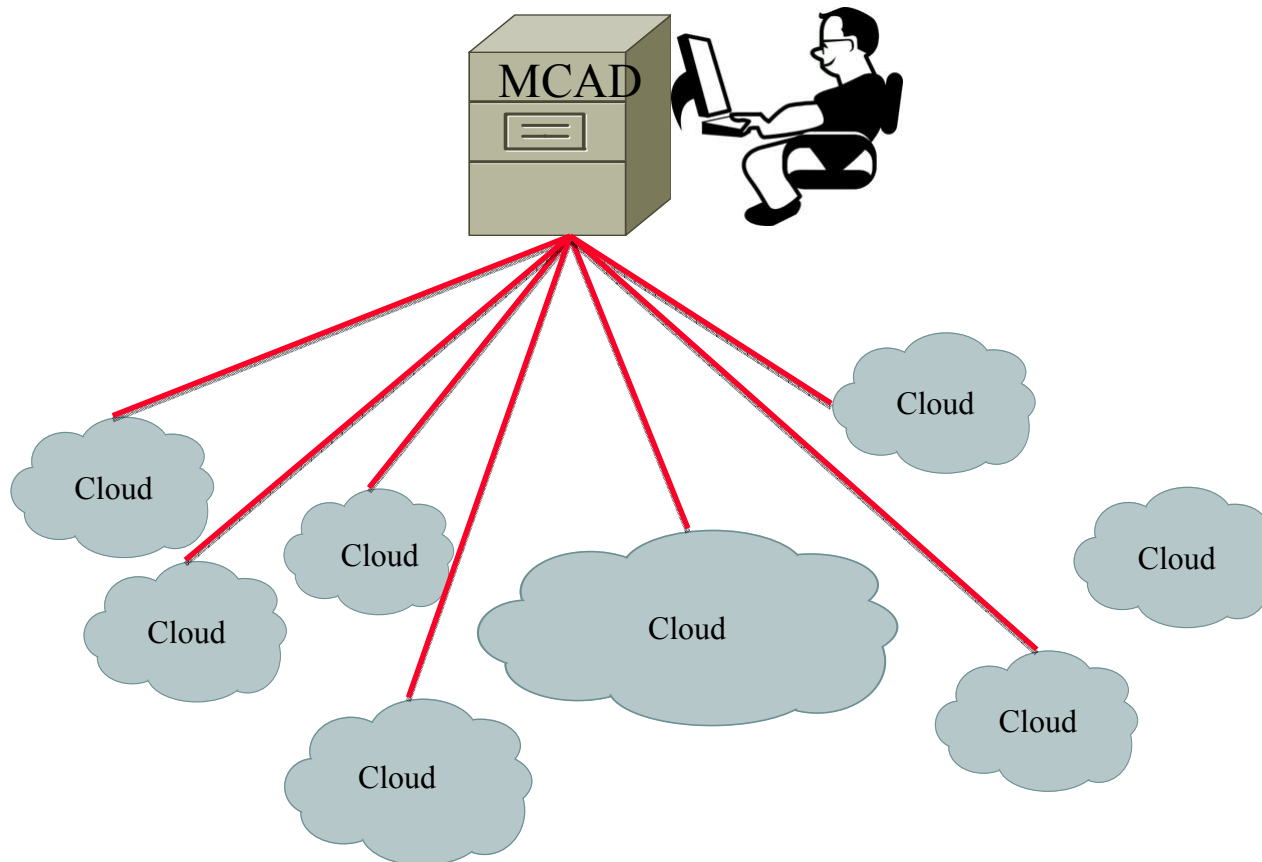Micro-Clouds

Users

Network
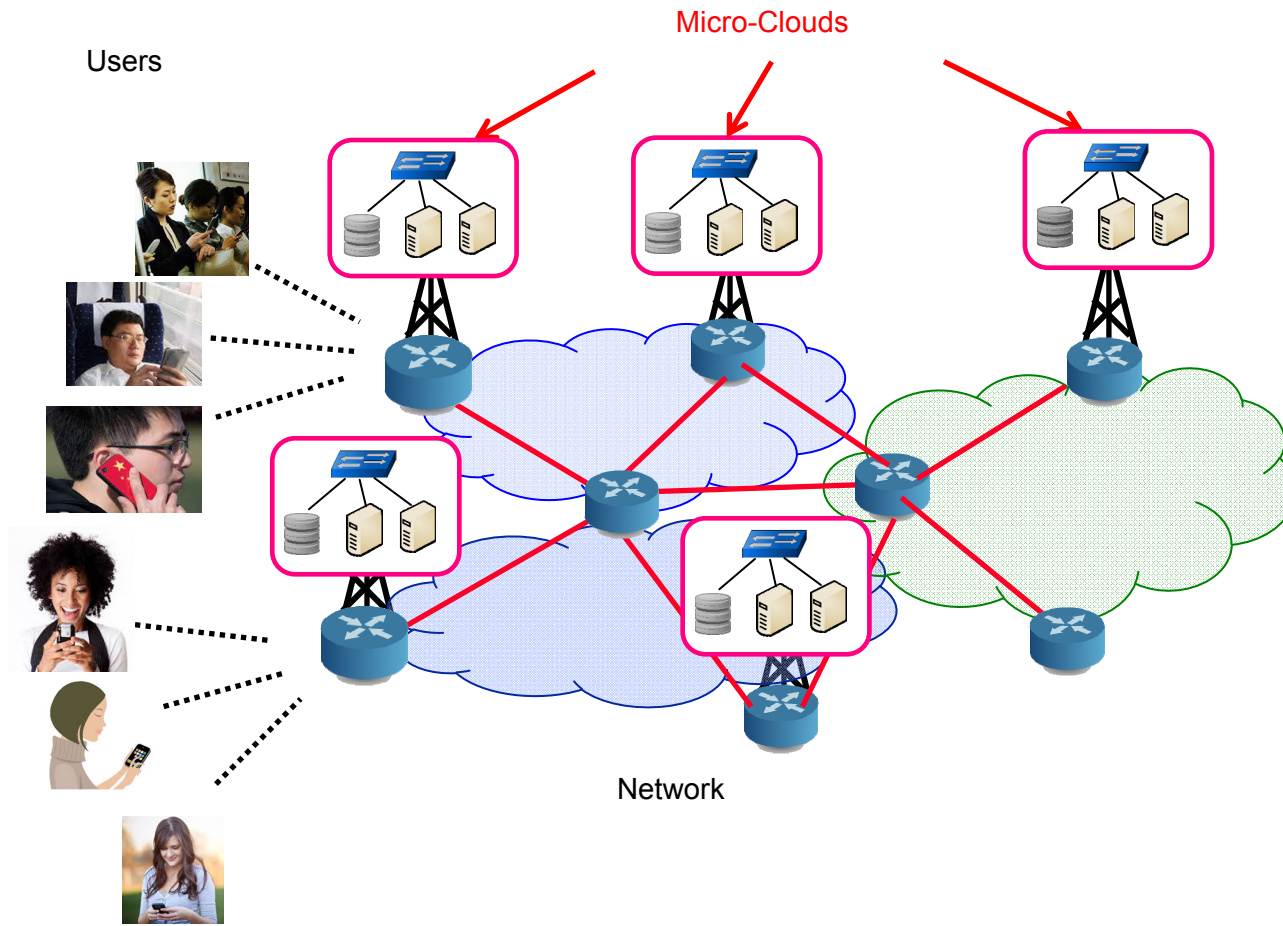
Trend 2: Hierarchical Computation

❑ Larger and infrequent jobs serviced by local and regional clouds

Trend 3: Software Defined Inter-Cloud

❑ Micro-Clouds, Local-Clouds, Regional Clouds
  ⇒ Need Mobile multi-Cloud Application Delivery (MCAD)

Trend 4: Liquid Applications

- Current networks designed for voice applications
  ⇒ Network function virtualization (NFV) is looking at functions that are designed for voice applications

- Future 5G Mobile networks need a more general functional decomposition and architecture
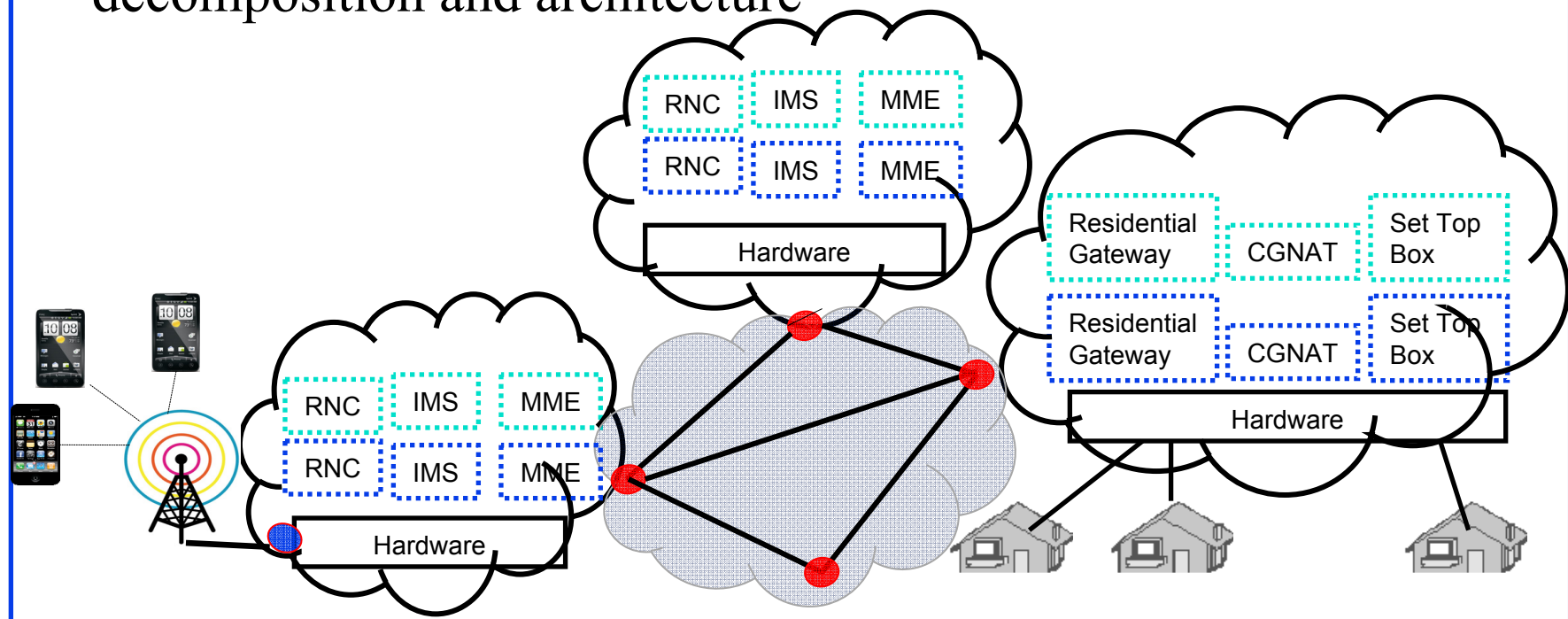
What can NFV do?

1. **Virtualization**: Use network resource without worrying about where it is physically located, how much it is, how it is organized, etc.

2. **Orchestration**: Manage thousands of devices

3. **Programmable**: Should be able to change behavior on the fly.

4. **Dynamic Scaling**: Should be able to change size, quantity

5. **Automation**

6. **Visibility**: Monitor resources, connectivity

7. **Performance**: Optimize network device utilization

8. **Multi-tenancy**

9. **Service Integration**

10. **Openness**: Full choice of Modular plug-ins

Note: These are exactly the **same** reasons why we need SDN.

Service-Infrastructure Separation

❑ With cloud computing, anyone can super-compute on demand.

  ➢ Physical infrastructure is owned by Cloud Service Provider (CSP). Tenants get virtual infrastructure

  ➢ **Win-Win** combination

❑ With virtualization, an ISP can set up all virtual resources on demand

  ➢ Physical Infrastructure owned by NFV infrastructure service provider (NSP) and tenant ISPs get virtual NFVI services

  ➢ **Win-Win** combination

High-Level Requirements

❑ Automatic provisioning and deployment

❑ Automatic runtime control

  ➢ Elastic load balancing

  ➢ Handling failures

❑ Dynamically change the application's distributed footprint

  ➢ Launch application on new sites

  ➢ Shutdown existing sites

High-level Challenges

❑ Massively distributed:

  ➢ Virtual resources distributed geographically

  ➢ Virtual resources from multiple providers

❑ Common platform for:

  ➢ Different device types – Application servers, middleboxes, routers, switches, etc.

  ➢ Different service types: Voice, Video, IoT, Gaming, Apps

Inter-Cloud is of interest in 5G as well as in other applications
  ⇒ Cisco announced $1B investment in inter-cloud

Ref: Network World, "Cisco pumping $1 billion more into Inter-Cloud," September 29, 2014,
http://www.networkworld.com/article/2688819/cloud-computing/cisco-pumping-1-billion-more-into-intercloud.html

Any Function Virtualization (FV)

❑ Network function virtualization of interest to Network service providers

❑ But the same concept can be used by any other industry, e.g., financial industry, banks, stock brokers, retailers, mobile games, …

❑ Everyone can benefit from:

  ➢ Functional decomposition of there industry

  ➢ Virtualization of those functions

  ➢ Service chaining those virtual functions (VFs)
    $\Rightarrow$ A service provided by the next gen ISPs

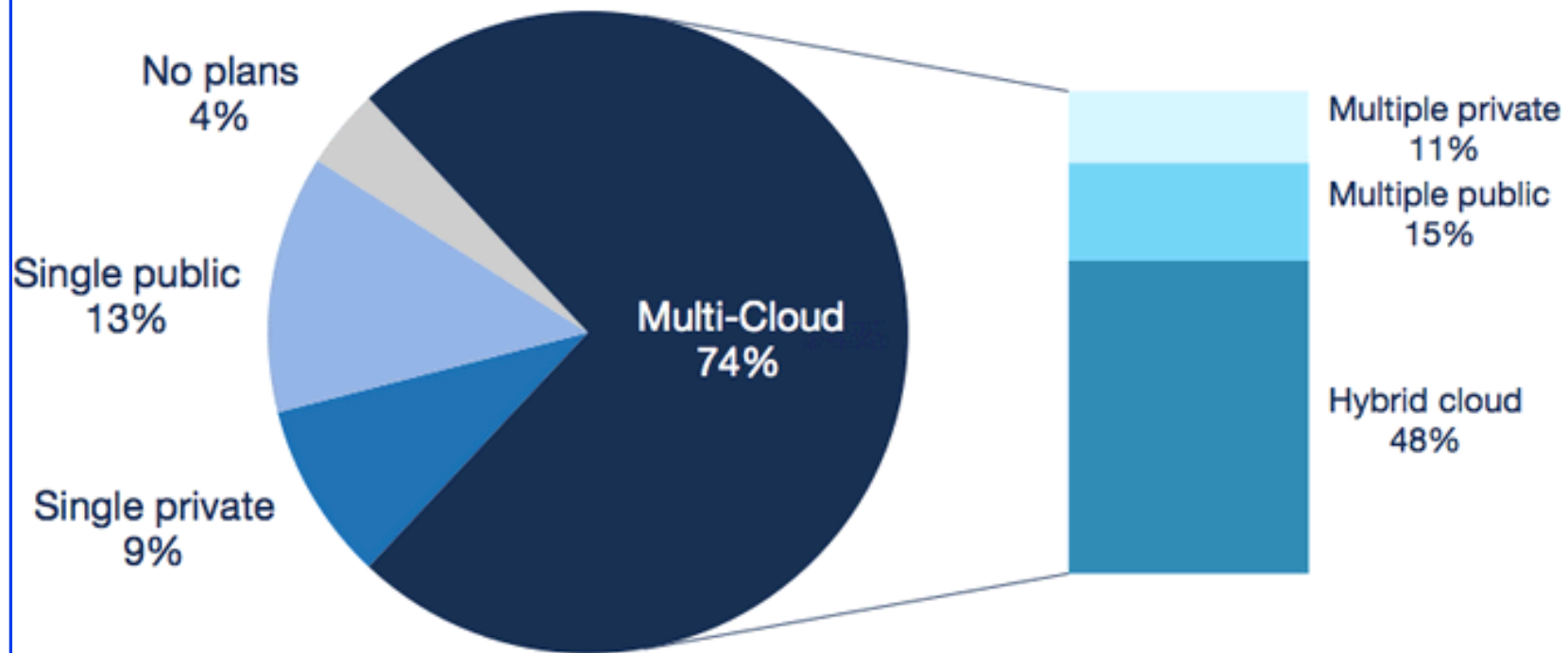# Carrier App Market: Lower CapEx

Virtual IP Multimedia System

Available on the App Store

amazon.com and you're done.™ App Store

ANDROID

200,000 AVAILABLE APPS

Trend: Multi-Clouds

Enterprise Cloud Strategy
1000+ employees

No plans 4%

Single public 13%

Single private 9%

Multi-Cloud 74%

Multiple private 11%

Multiple public 15%

Hybrid cloud 48%

Source: RightScale 2014 State of the Cloud Report

❑ Most companies use more than one cloud.
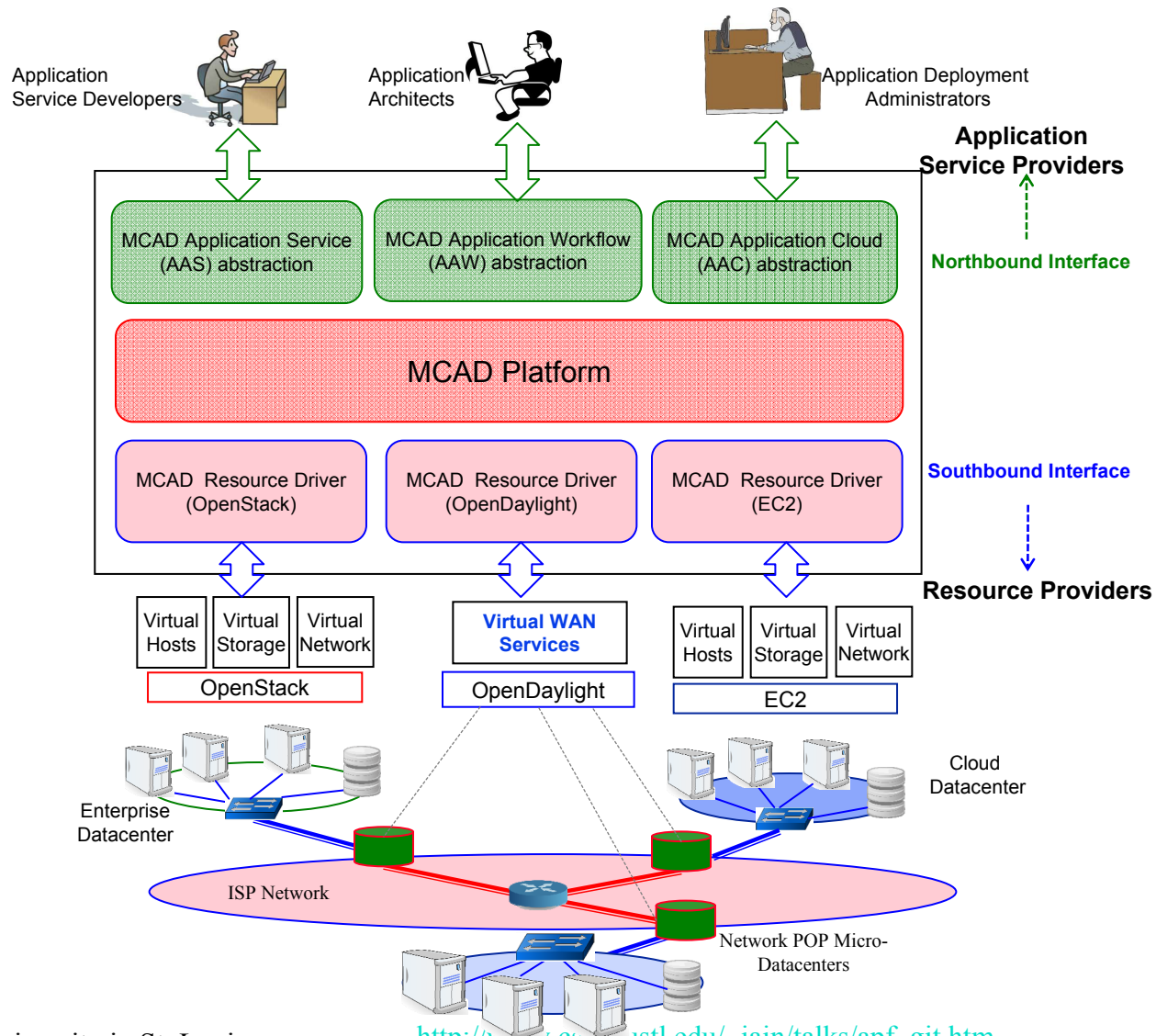
Ref: http://www.rightscale.com/blog/cloud-industry-insights/cloud-computing-trends-2014-state-cloud-survey

http://www.cse.wustl.edu/~jain/talks/apf_git.htm

Services in a Cloud of Clouds

Application Service Developers

Application Architects

Application Deployment Administrators

Application Service Providers

MCAD Application Service (AAS) abstraction

MCAD Application Workflow (AAW) abstraction

MCAD Application Cloud (AAC) abstraction

Northbound Interface

MCAD Platform

MCAD Resource Driver (OpenStack)

MCAD Resource Driver (OpenDaylight)

MCAD Resource Driver (EC2)

Southbound Interface

Resource Providers

Virtual Hosts	Virtual Storage	Virtual Network

OpenStack

Virtual WAN Services

OpenDaylight

Virtual Hosts	Virtual Storage	Virtual Network

EC2

Cloud Datacenter

Enterprise Datacenter

ISP Network

Network POP Micro-Datacenters

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MCAD Features

❑ **Automate** the entire process of creating new workflows and installing them, managing them during runtime, uninstalling them as necessary

> ➢ Allow **Deployment Administrators** specify policies for quantity and location of resources inside various clouds.

❑ Workflow creation includes virtual networks, computers, storage inside the clouds as well as the network between the clouds

❑ **WAN bandwidth** and latency is the key to placement. Allows manual approval and override.

❑ Physical infrastructure owners keep complete control over their resources while the tenant service providers can deploy their applications according to their desired policies

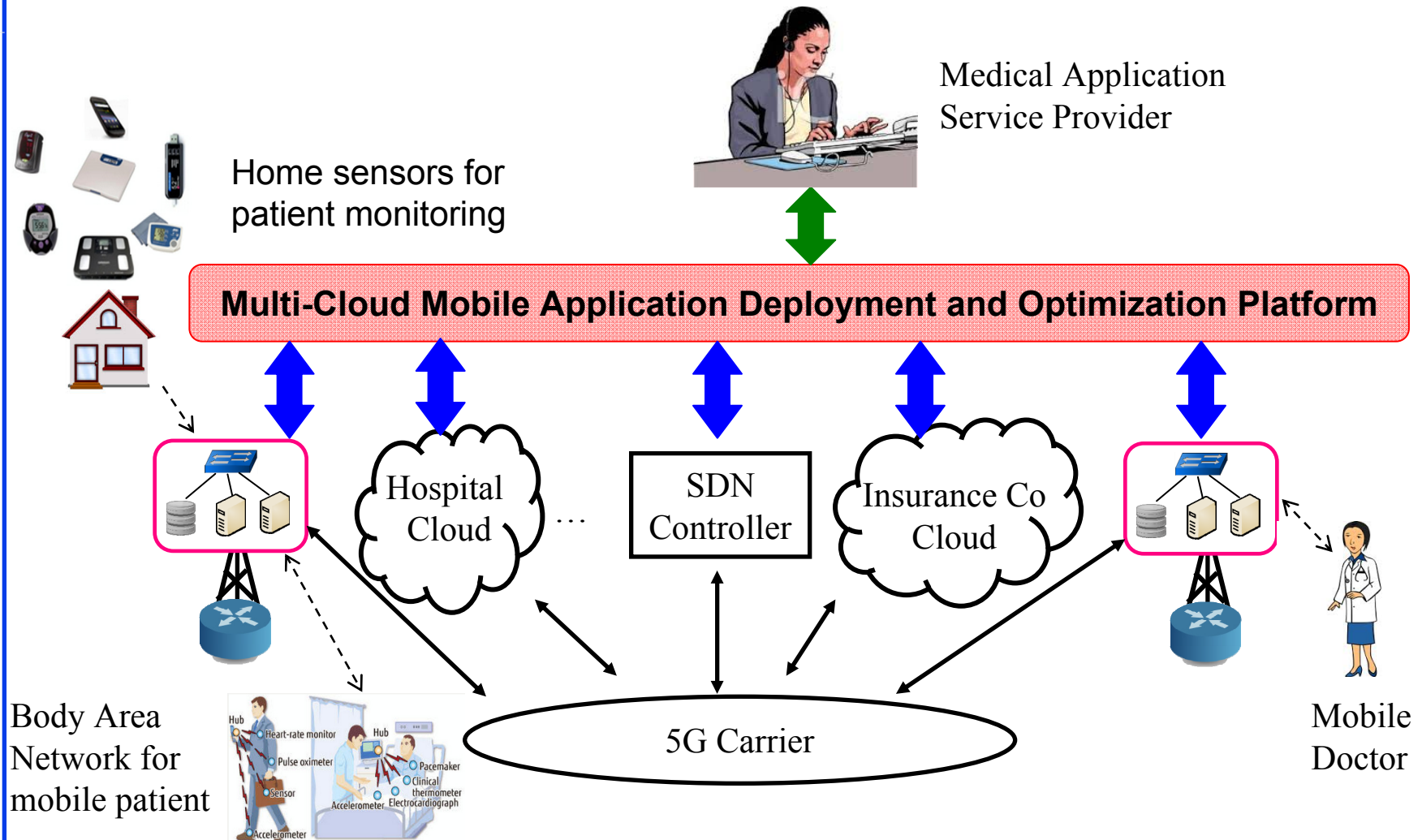❑ All communication is via APIs. All interfaces initially XML based. GUI based in future.

Resource Control

❑ Tenants keep complete control of their data.
NSP does not have to look at the **application data** to enforce application level policies

❑ NSPs keep complete control of their equipment.
tenants communicate their policies to NSP's control plane

❑ **VFs and Middle boxes** can be located anywhere on the global Internet
(Of course, performance is best when they are close by)

❑ Tenants or NSPs can **own** OpenADN modules.
NSPs can offer "Service Chaining" **service**

Application Delivery for the Enterprise

❑ MCAD is of interest to 5G Mobile carriers

❑ But the same concept can be used by any other industry, e.g., financial industry, banks, stock brokers, retailers, mobile games, …

❑ Everyone can benefit from:

➢ Functional decomposition of their industry

➢ Virtualization of those functions

➢ Service placement of those virtual functions (VFs)
   $\Rightarrow$ A service provided by the next gen ISPs

Mobile Healthcare Use Case

Medical Application Service Provider

Home sensors for patient monitoring

Multi-Cloud Mobile Application Deployment and Optimization Platform

Hospital Cloud ... SDN Controller Insurance Co Cloud

5G Carrier
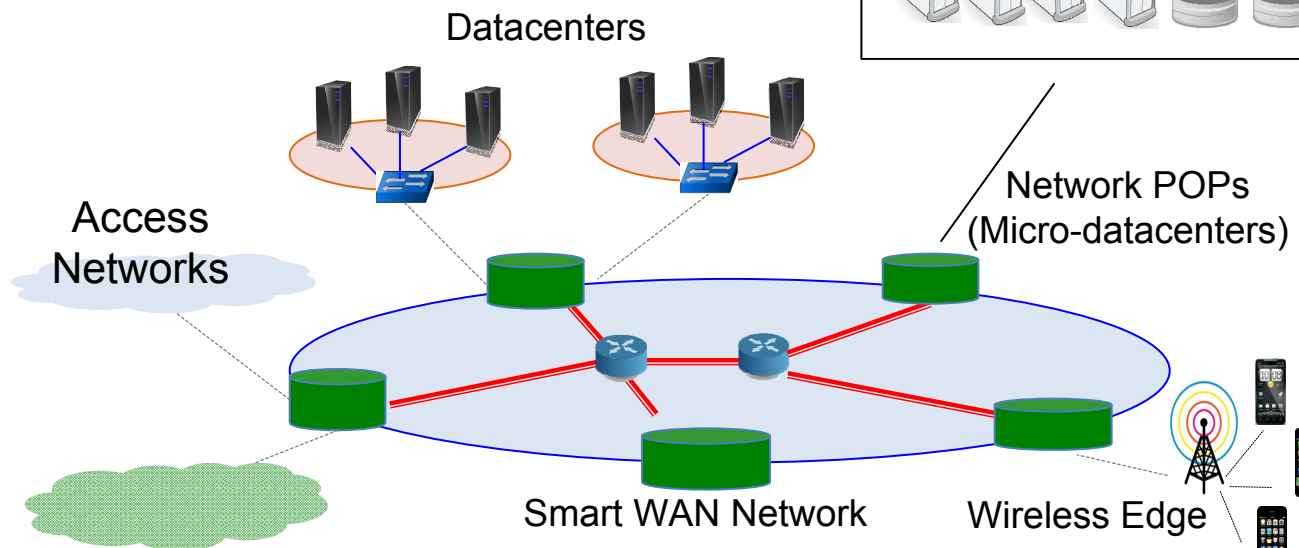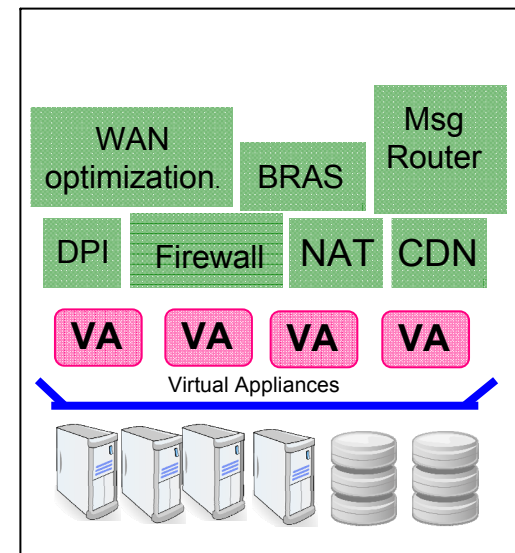
Body Area Network for mobile patient

Mobile Doctor

Use Case 1: Internet of Things

❑ Computing everywhere or Fog computing.
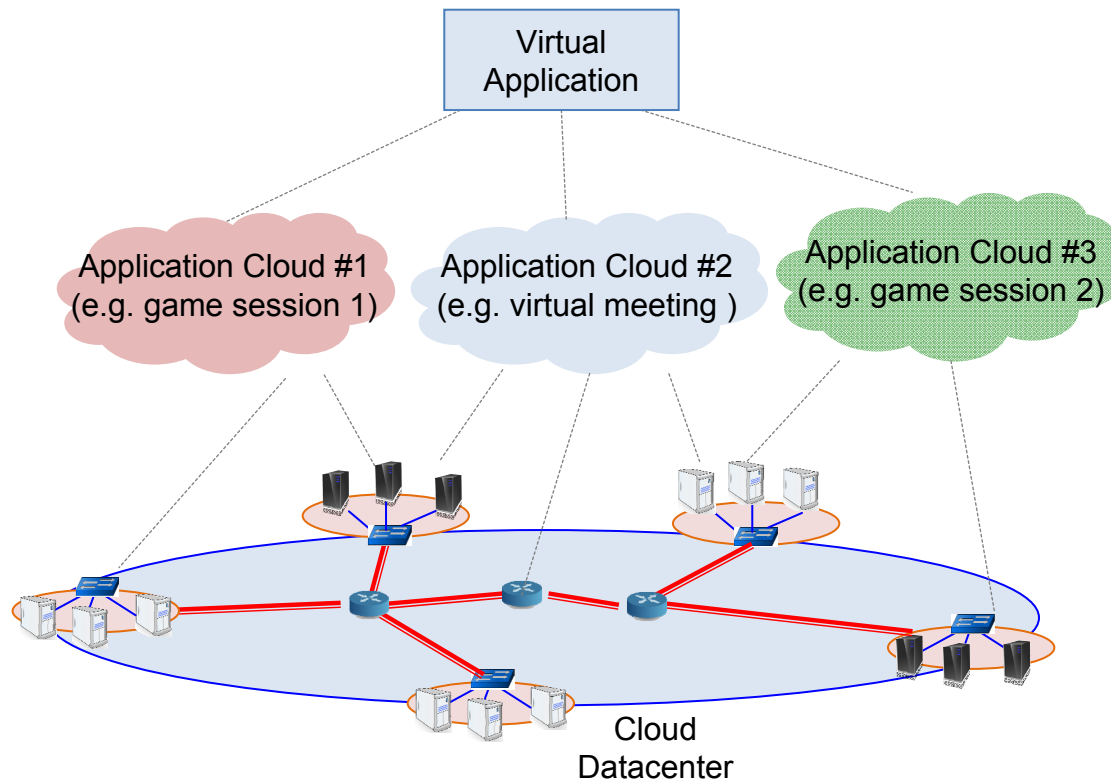
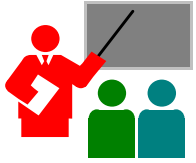❑ Data aggregation and analytics at various levels
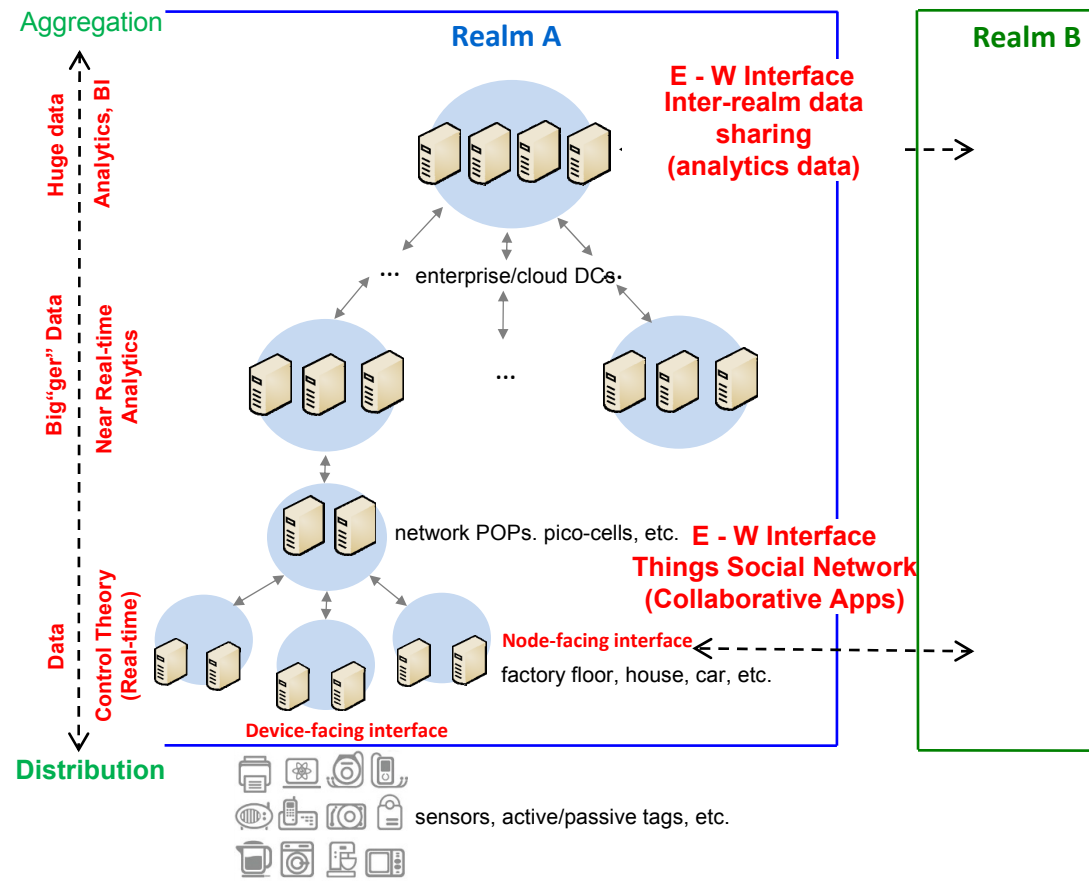
Use Case 2: Smart WANs

- Service Chaining
- Message-level Middleboxes
- Packet-level Middleboxes
- Dynamically place services at POPs based on application topology
- Provide differentiated transport
- Contextual mapping of messages to transport QoS

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Use Case 3: Massively Distributed Apps

❏ Online games

Virtual Application

Application Cloud #1 (e.g. game session 1)

Application Cloud #2 (e.g. virtual meeting)

Application Cloud #3 (e.g. game session 2)

Cloud Datacenter

Summary

1. To meet the quality of experience (QoE) for future 5G mobile applications, the computation will need to come to edge. Computation will be hierarchical with micro-Clouds on Towers, Local Clouds, and Regional Clouds

2. Need software defined inter-cloud management and ability to create/deploy/move applications and functions among clouds while maintaining the required QoE

3. Mobile multi-Cloud Application Delivery (MCAD) platform will solve the problem of optimal application placement. **WAN link capacity, utilization, and latency** are key to the placement of VMs.

4. Infrastructure owners keep complete **control** over their resources. Tenants keep complete control over their traffic.

5. Same solution is application to numerous other applications such as enterprises, internet of things, and apps.

References

- Raj Jain and Subharthi Paul, **"Network Virtualization and Software Defined Networking for Cloud Computing - A Survey**," IEEE Communications Magazine, Nov 2013, pp. 24-31, http://www.cse.wustl.edu/~jain/papers/net_virt.htm