Mobile cloud business

Sakari Luukkainen

Introduction

- term "cloud" was first used as a metaphor for the Internet, based on the cloud drawing used to depict the Internet as an abstraction of the underlying infrastructure

- evolution from scientific grid computing

- new paradigm to offer ICT services to the market - **computing like electricity**

- cloud computing providers deliver **services online** that are accessed from Web browser over the Internet, while the software and data are stored on servers

- **outsourced** services produced in massive **centralized** energy efficient automated **datacenter ”factories”**

- cloud service **market expected to grow** fast (Gartner)

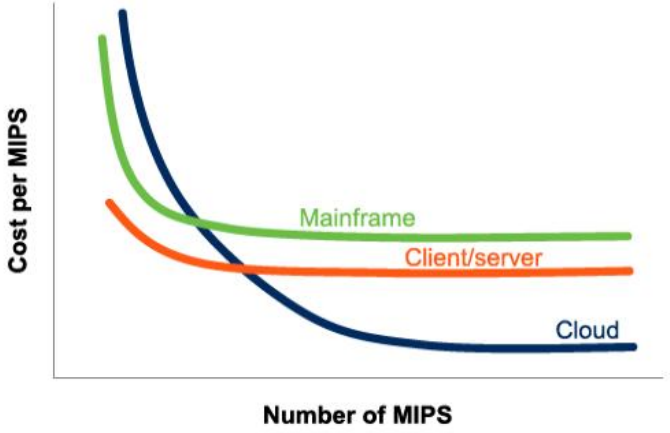
Characteristics of cloud computing

- elastical, scalable provisioning
- automatic management, self service
- provision from shared multitenant environment, better utilization rate of servers
- pay per use
- usage inpendent of terminal and location
- usage measurements
- high volume services

Economies of scale

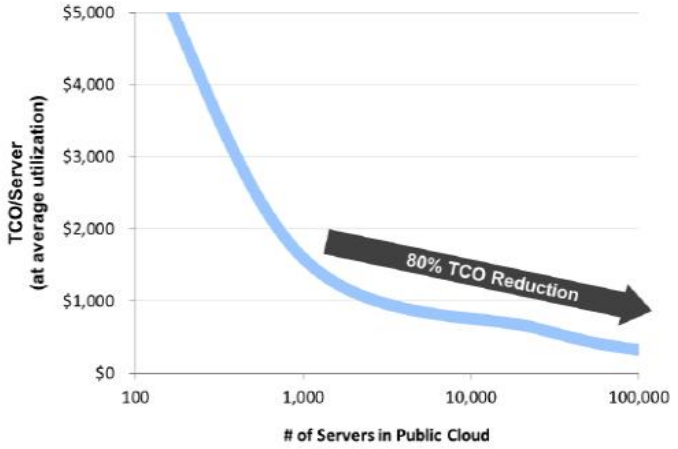
- Cheaper MIPS (5-7 times)
- Need for cost efficiency of servers, globally vacancy usage cost estimated to be16 B€ (Kelton Research)
- Better utilization of computing resources (5-10% to 60-80%)
- Multi-tenancy: one server can serve several customers
- Less admin people per server (from 1:100 up to 1:10 000)
- Worth 1$ IT requires 8$ admin costs

FIG. 4: ECONOMIES OF SCALE (ILLUSTRATIVE)



Source: Microsoft.

FIG. 15: ECONOMIES OF SCALE IN THE CLOUD



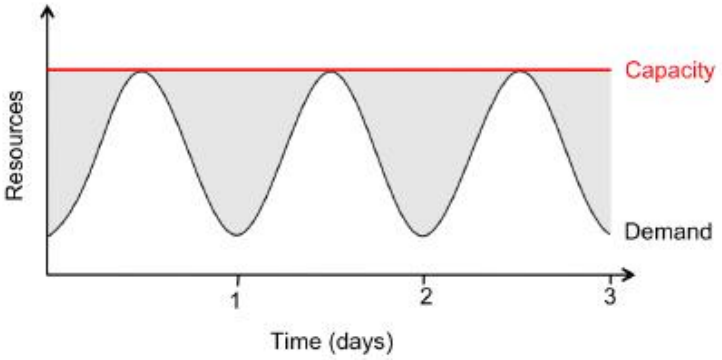
Source: Microsoft.

Source: Rolf Harms and Michael Yamartino: The Economics of the Cloud, Nov. 2010.

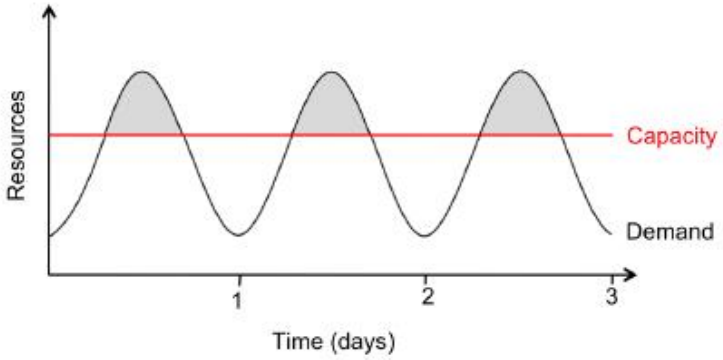
Economics of cloud

- centralized datacenters benefit from ecomies of scale – big companies can have over million servers
- by cloud usage some cost sources remain, but their relative share change
- from fixed to variable cost (CAPEX -> OPEX)
- cost sources: sw and hw investment and maintenance, telecommunication, delays, updates, breaks to business process, space, electricity, cooling, security, insurance, training, support
- commercial offerings are generally expected to meet quality of service (QoS) requirements of customers and typically include service level agreements (SLAs) with penalty

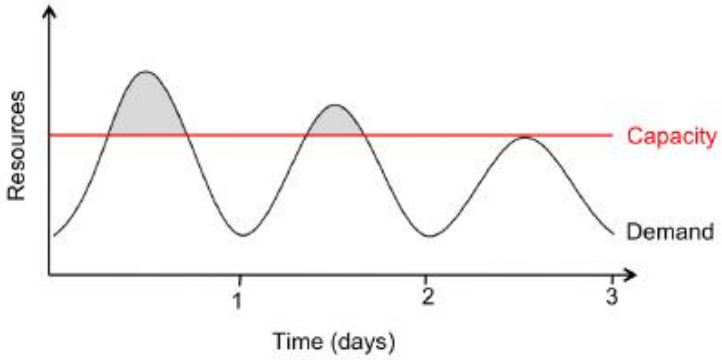
Elasticity



(a) Provisioning for peak load



(b) Underprovisioning 1



(c) Underprovisioning 2

Source: Ambrust et al, Above the Clouds: A Berkeley View of Cloud Computing, Feb 2009

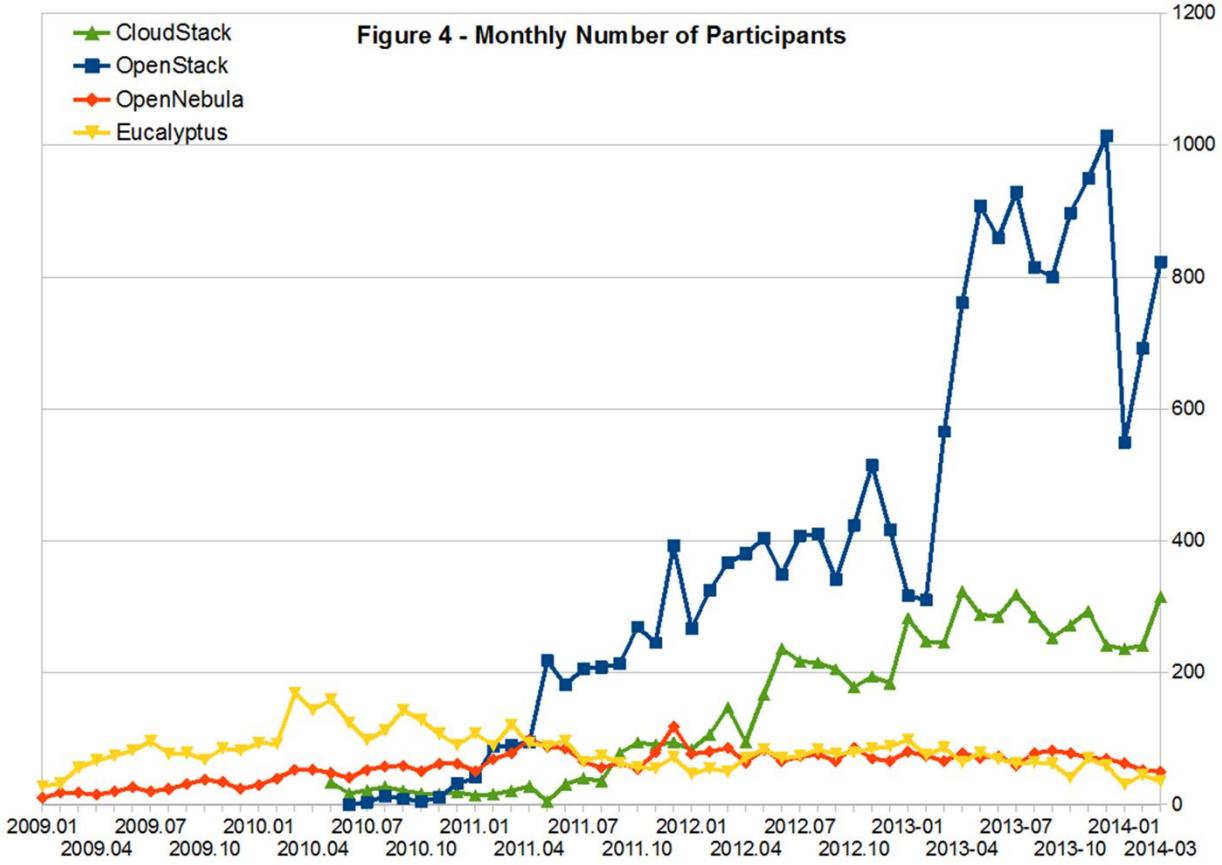
Server virtualization

- To avoid **vendor lock-in**, the preferred way is to select an open-source cloud platform
- **Open technologies** allow the network provider to implement custom modifications to the platform
- Multiple options exist for open source IaaS cloud stacks: OpenNebula, Eucalyptus, CloudStack and OpenStack
- There are differences in **licensing policy** : Eucalyptus has the GNU General Public License version 3. The others have Apache License version 2. Apache License does not require releasing the modifications to the public.
- Other notable difference is the **size, activity and governance** of the community behind the project

Server virtualization

- Eucalyptus and OpenNebula have smaller communities and are controlled by a single institutes. CloudStack's community is larger, but it still largely consists of Citrix employees. OpenStack has the largest and active community, which is distributed over different institutions.
- Large and diverse community reduces the risk of the project being directed in a harmful direction. The positive effects are visible in, for example, the amount of supported hypervisors and networking technologies.
- **OpenStack** is widely used: in addition to smaller private clouds owners, many commercial public cloud service providers, such as Rackspace, have adopted it as their platform

Open source virtualization - OpenStack



Server virtualization

Case: 311 servers datacenter, 180 can be virtualized, otherwise 135 new has to be bought in 3 years, 0,4 KW / server, 0,08 € / KWh

Traditional

CAPEX (135)	542 295 €
OPEX	160 650 €
Total	702 945 €

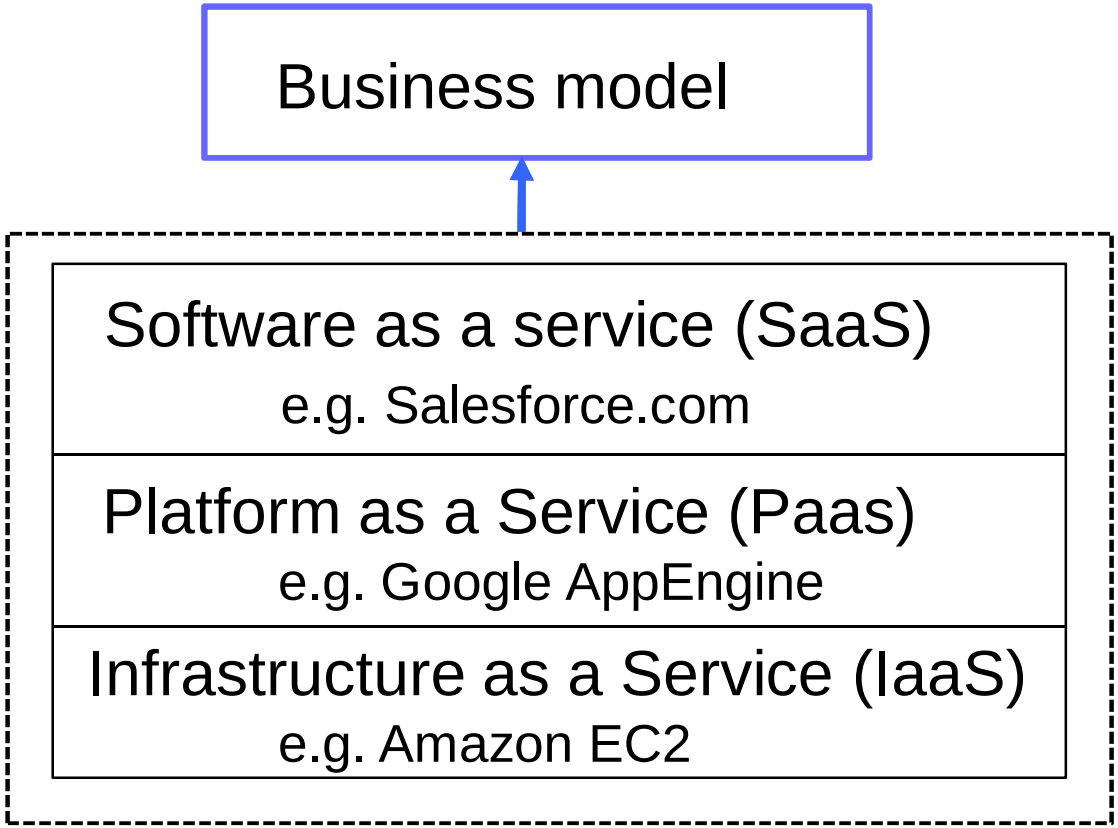
Virtualized

CAPEX	220 500 €
OPEX	103 736 €
Total	324 236 €

ROI 217 %, savings 378 709 €, savings in electricity 412 070 €

Source: Heino 2010

Classification of cloud services



Infrastructure as a Service (IaaS)

- evolved from virtual private server offerings
- customer buys computing resources from service provider as service
- offereded capacity capacity virtualized, scaled and automated
- pay per use, self service
- customer takes care of installing own applications, updates, load balancing and security

Platform as a Service (Paas)

- tools for developing, testing and maintaining applications are provided
- service provider use own or external IaaS environment
- easier and faster application development, most rutines as ready modules
- scalability of ready application
- cost efficiency, enables new entrants to application market
- lock-in to service provider, new competence required and security as disadvantage

Software as a service (SaaS)

- customer buys plain application as service
- application provided through browser, no maintenance and updating required by customer - focus on **business process development**
- reliability, trustworthiness and security as disadvantage, less lock in
- service provider use own or external IaaS/PaaS environment
- customer gets own reporting and management consol by which is possible to monitor application and to add/abolish users
- pay per use, pay per users, flexibility in cyclical business trends
- larger customer base for application provider, efficient updates and deliveries – focus on application development
- Example salesforce.com CRM applications, Gmail, YouTube, Netflix

Public, private and hybrid cloud

- in **public cloud** is services are dynamically provided over the Internet by a third-party provider like Amazon

- **private cloud** is a virtualized computing infrastructure created and managed by an organization for own internal use

- **hybrid cloud** is a cloud computing environment in which an organization produces some services in-house and buys others from public cloud

Cost evaluation

	traditional	public cloud	hybrid	private
CAPEX	0	3	6,1	7
OPEX	77,3	22,5	28,9	31,1
Total cost	77,3	25,5	35	38,1
BCR	-	15,4	6,8	5,7

Case existing traditional non virtualized datacenter, 1000 servers, cost M$ in 2 years investment and 12 years usage timeframe
BCR=Benefit-to-cost ratio

Source: Booz Allen Hamilton

Cloud computing market

- The increasingly perceived vision of cloud computing as utility like electricity creates great challenges to the development of the emerging market structures
- The history has shown that separation of network and service has increased competition, in former monopoly, energy and telecommunications industries
- The markets perform in these industries more efficiently because of increased interoperability and **lower switching costs**
- The public cloud computing market is still dominated by services based on **proprietary platforms and customer interfaces**

Cloud computing market

- Under these kind of circumstances the customer expose **switching costs and lock** in to the cloud service provider
- Other observed problem, which hinders the proliferation of cloud computing, is related to **trust** issues between service providers and their customers.
- SaaS providers can easily lose their reputation, if the underlying IaaS infrastructure creates QoS or privacy problems
- Currently there are significant efforts to **standardize** customer interfaces of public cloud in order to realize **interoperability and competition between various clouds**
- The interoperability problems can also be outsourced to brokers such as RightScale and CloudSwitch

NFV – Network functions virtualization

Network functions implemented as software modules in cloud – hence “virtualised”

Can run on standard hardware

- COTS hardware (Commercial Off the Shelf)
- as opposed to current vendor specific hardware

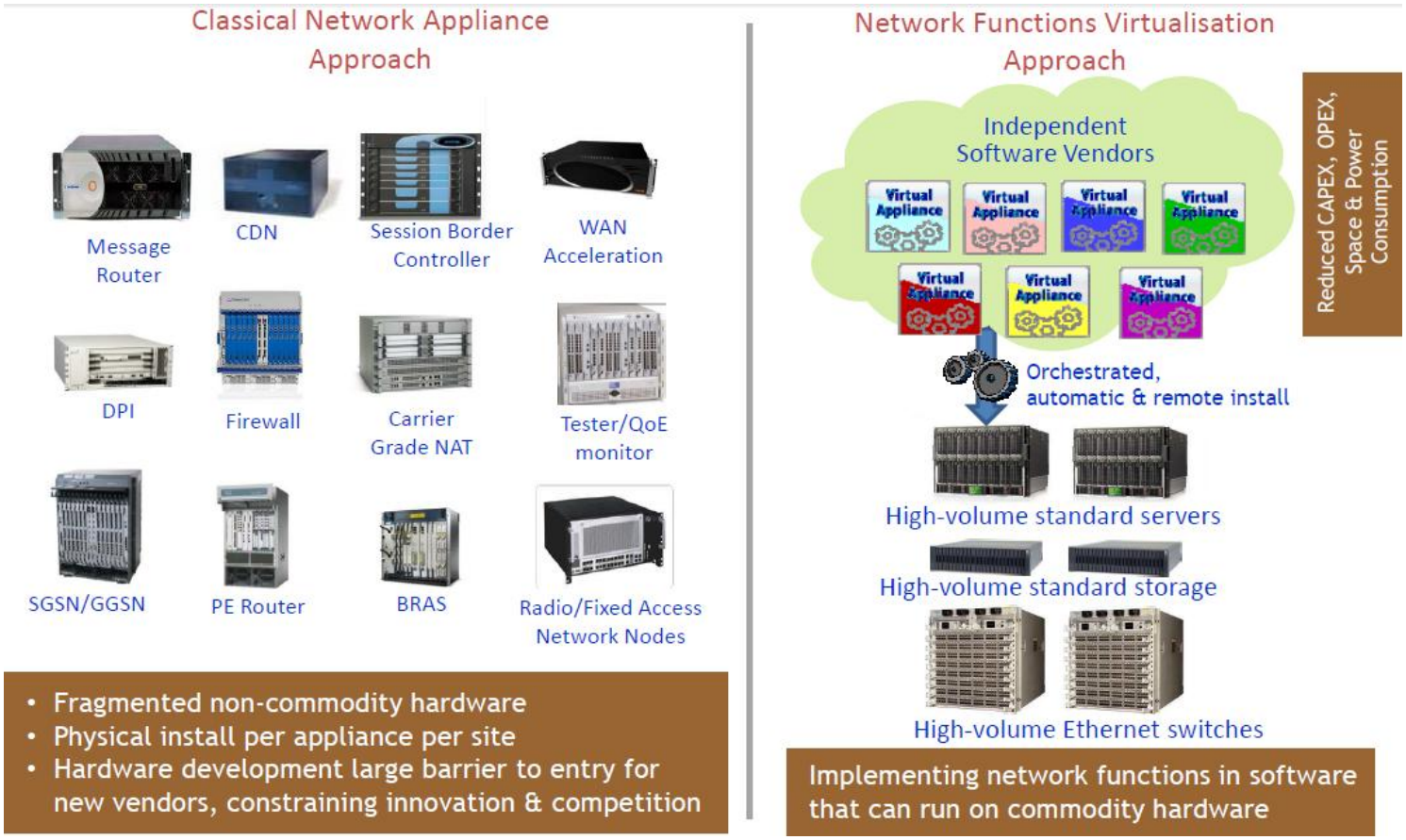
Driven by ETSI and operators

- *NFV ISG – decide business & technical requirements*
- *Active involvement of network operators worldwide*

White papers and specifications

- *Two white papers (October 2012, November 2013)*
- *First set of specifications released*

NFV – Network functions virtualization

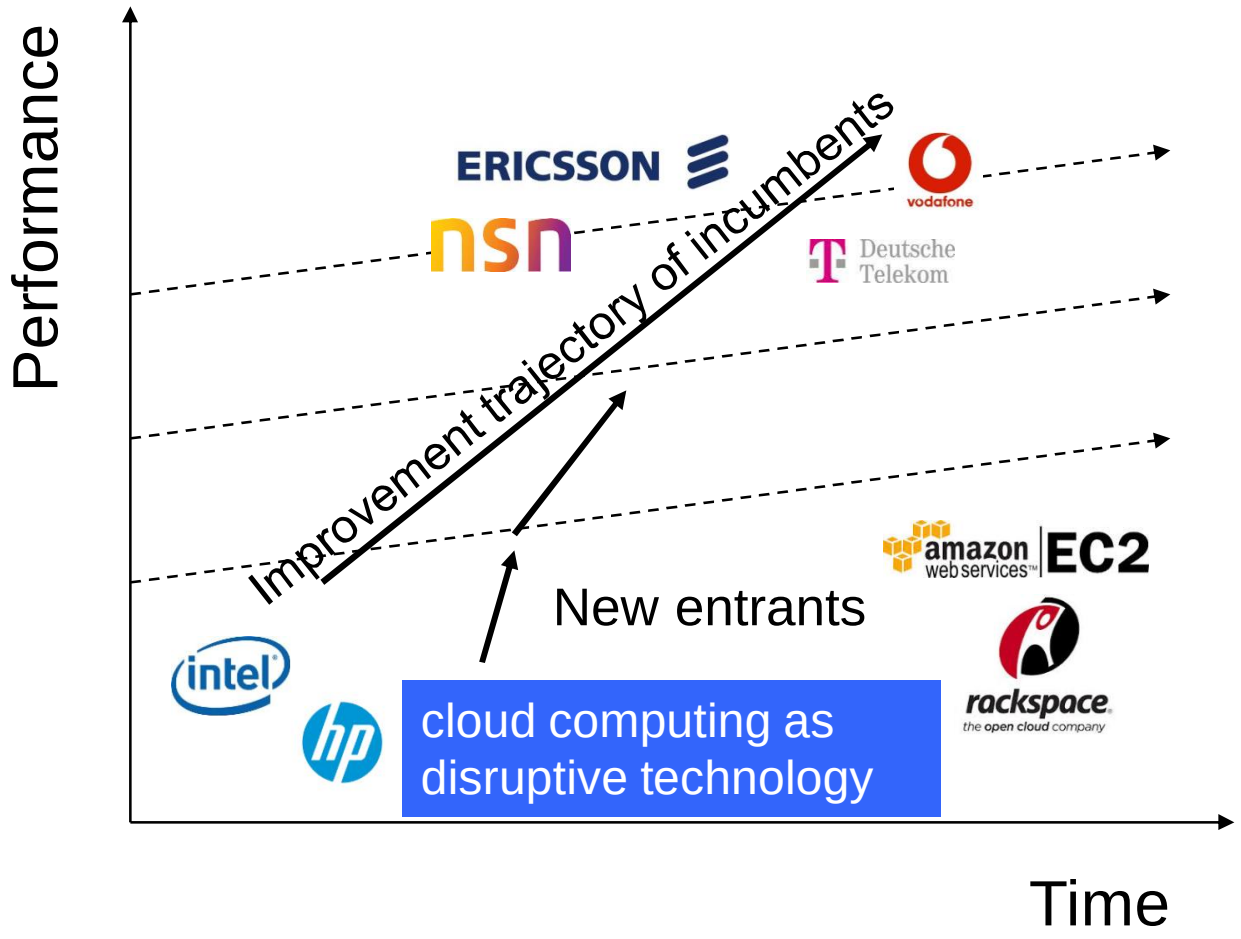


Source: ETSI

Key benefits for mobile operator

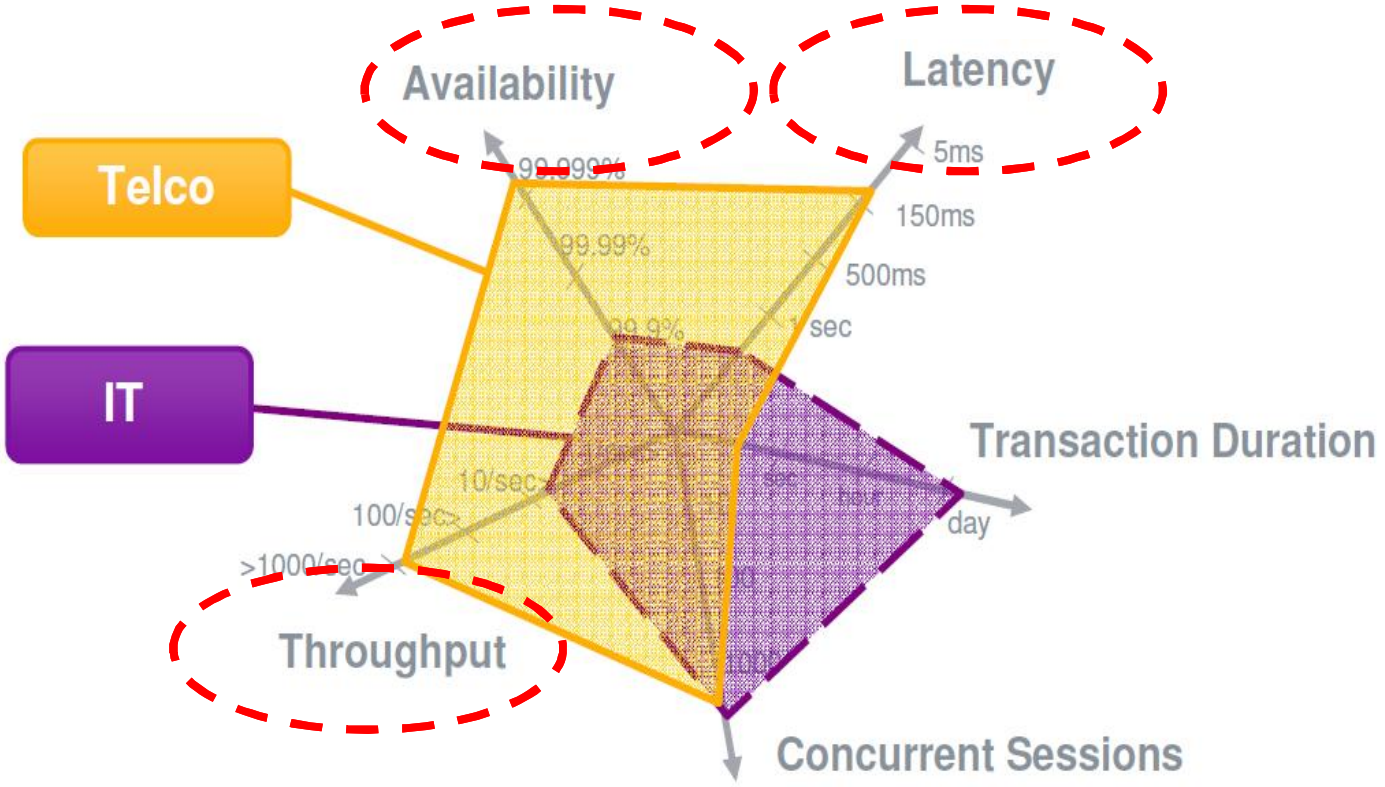
- Less revenue from mobile data – need for reduced equipment, space costs and power consumption
- Elastic capacity provisioning
- Improved operational efficiency through automatization
- Reduced time to market with minimal hardware dependency
- Ability to run production, test and reference facilities on the same infrastructure
- Ability to support targeted local service-introduction
- Complementarity with SDN/LTE
- Easy to experiment new innovations – lower entry barriers of challengers of incumbents

Disruptive technology



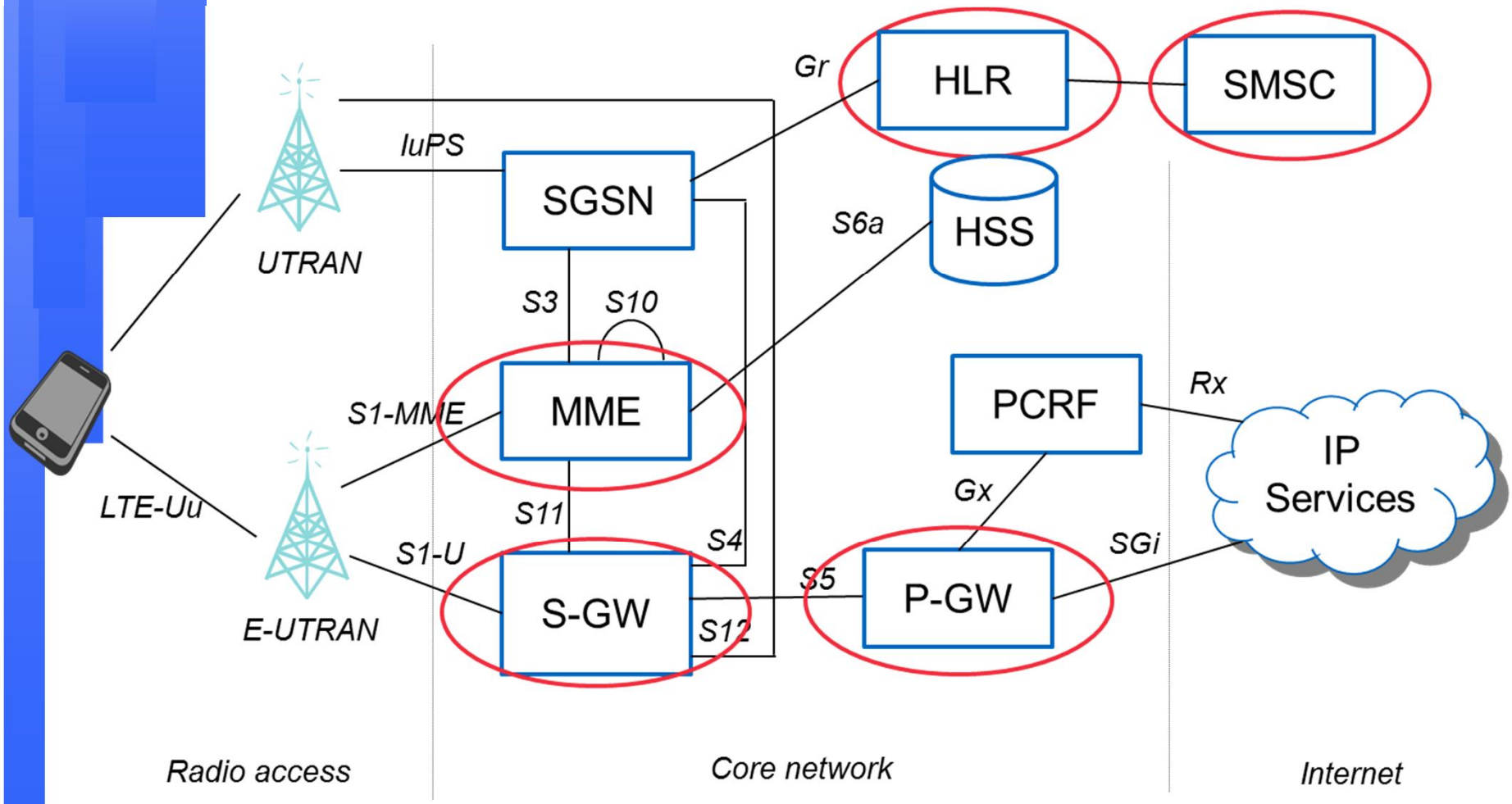
Source: adapted from Christensen, 1997

Performance?

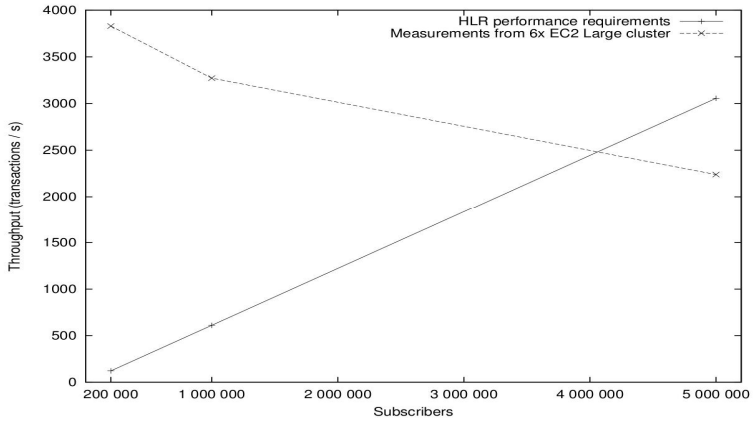


Source: M. Murphy, ”Telco Clouds”, Cloud Asia 2010

3 - 4 G data networks



HLR in Amazon EC2 public cloud



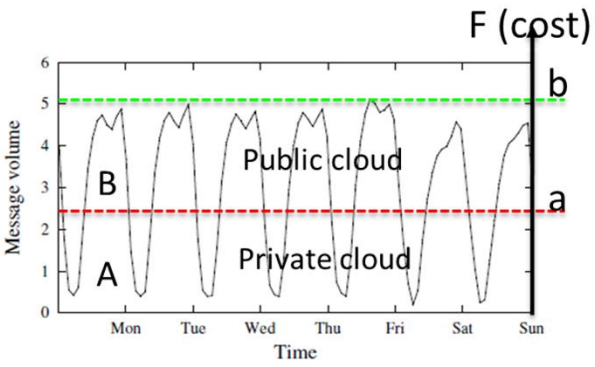
Latencies below 50 ms

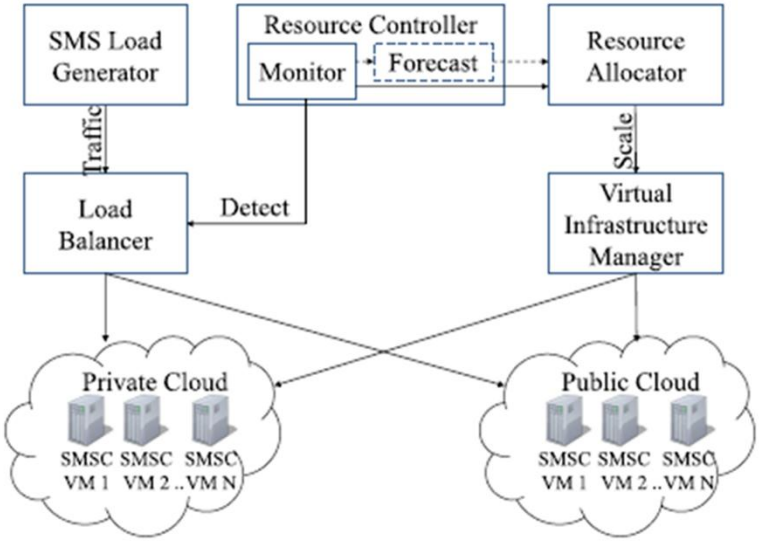
6x EC2 cost ca. 15 k€ / year

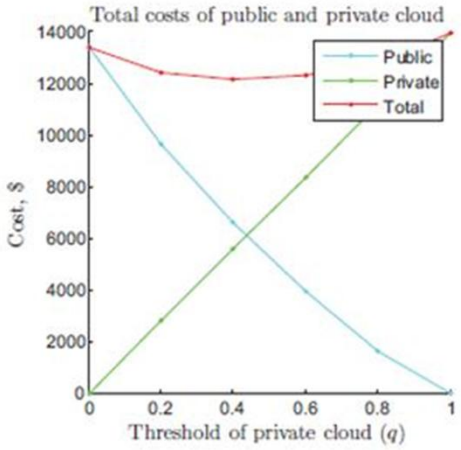
SLA	Carrier grade	6 EC2 Large VMs
Availability	99.999 %	99.95 % one zone 99.9999 % two zones
Latency	< 150 ms	< 50 ms (EU zone)
Throughput	> 1000 msg/s	>1000 msg/s

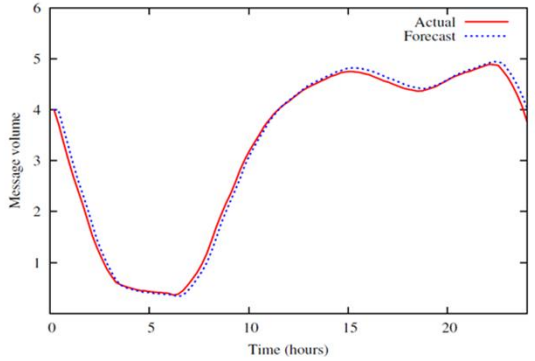
Source: Raivio, Päivärinta 2011

SMSC in hybrid cloud

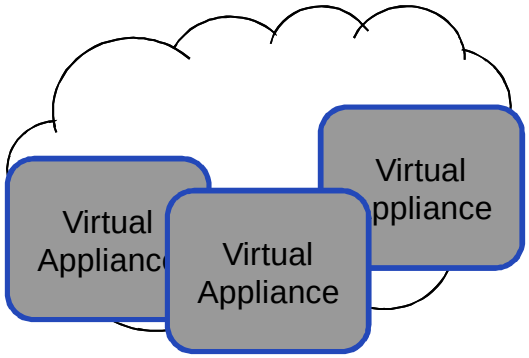




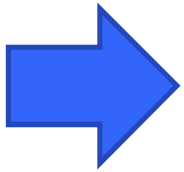




NFV in 4 G / vEPC

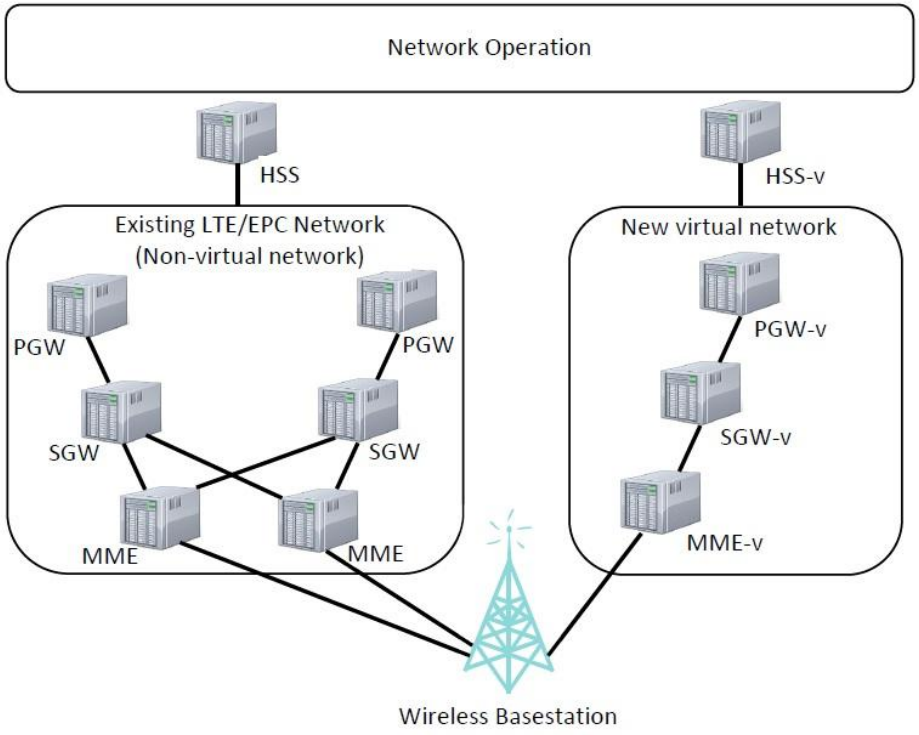


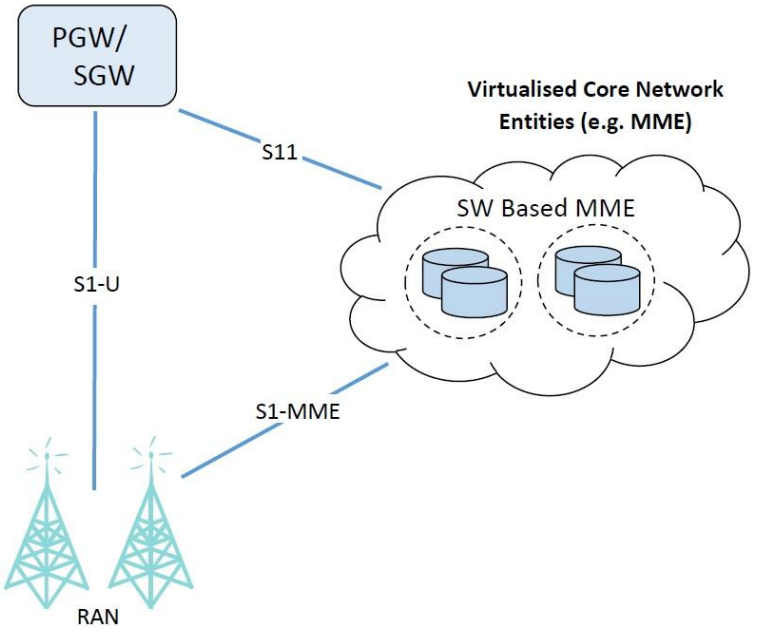
MME S-GW P-GW



High volume compute, storage and Ethernet

Realising NFV in 4 G / EPC





Co-existence of virtualised network and non-virtual packet core network

Co-existence of virtualised and non-virtualised nodes

Source of images: GS NFV 001, Network Functions Virtualisation (NFV); Use Cases, Version 1.1.1. Specification, ETSI, 2013

Conclusion

- **Cost** savings and **elasticity** in transformation of mobile infrastructure to the cloud
- From dedicated telecom hardware to open based computer platforms, role of **OpenStack** critical
- Telco grade can be achieved
- New entrants can enter to the telecommunications by using cloud computing in network infrastructure and operator markets – **disruption potential is high**
- History of Linux in mobile terminals… – huge renewal is required from incumbent network vendors in order to stay competitive
- Main target is in 5G which design will be influenced strongly by cloud computing