



Cloud Networking (VITMMA02)

Markosz Maliosz, PhD

Department of Telecommunications and Media Informatics
Faculty of Electrical Engineering and Informatics
Budapest University of Technology and Economics

Spring 2018



Course Info

- » General subject info, requirements:
<https://portal.vik.bme.hu/kepzes/targyak/VITMMA02/en/>

- » Course homepage:
<http://www.tmit.bme.hu/vitmma02?language=en>

Cloud computing



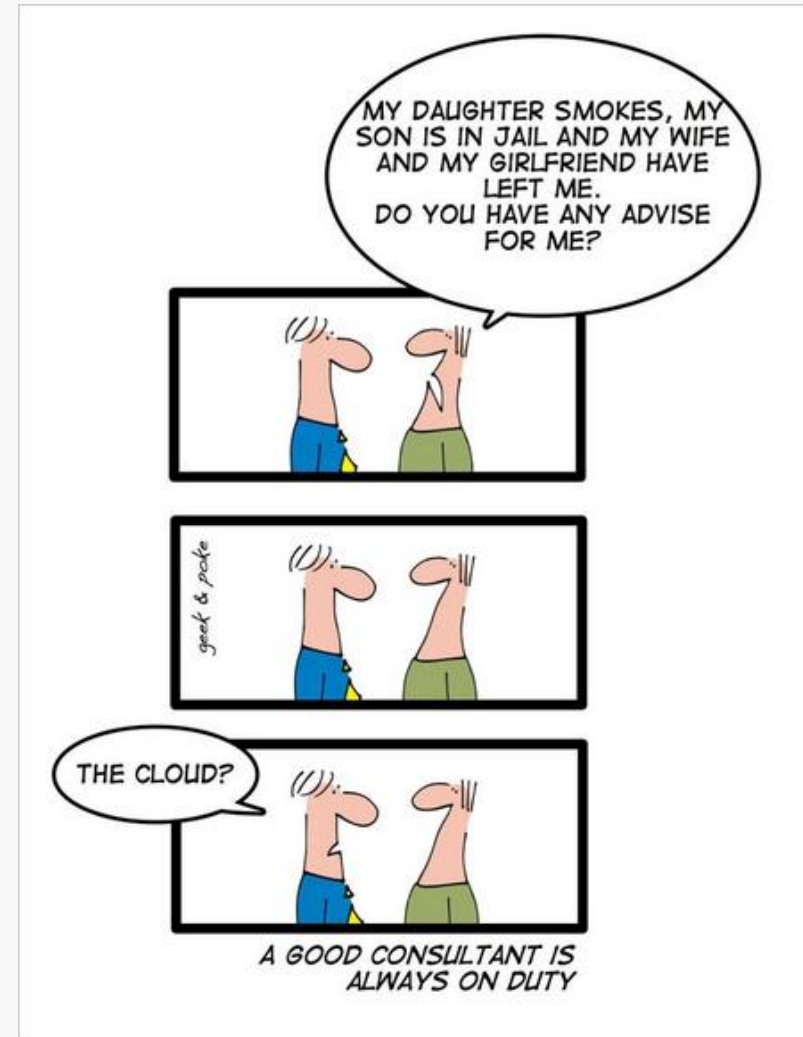


Definition of Cloud

- » Many characterizations, for example:
 - » using services and applications any time, from anywhere
 - » using information technology with usage based costs
 - » an overall virtualization model from the infrastructure to the applications
 - » using dynamically scalable virtual resources as a service over the Internet
- » Definition of National Institute of Standards and Technology (NIST) /2011. szept./
 - » „ Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.”
 - » 5 key properties + 3 service models + 4 deployment models
 - » on-demand self-service
 - » broad network access
 - » resource pooling
 - » rapid elasticity
 - » measured service
 - » Software as a Service
 - » Platform as a Service
 - » Infrastructure as a Service
 - » Private cloud
 - » Community cloud
 - » Public cloud
 - » Hybrid cloud

Is it a buzzword to solve everything?

- » “With the cloud, individuals and small businesses can snap their fingers and *instantly set up enterprise-class services.*” -Roy Stephan, 2011
- » Cloud computing is really a no-brainer for any start-up because it allows you to *test your business plan very quickly for little money.*” -Brad Jefferson, Animoto CEO. 2009.
- » Larry Ellison, CEO of Oracle
 - » in 2009: „What do you mean by “cloud computing”?...All the cloud is is computers on a network.
Our industry is so bizarre. They just change a term and they think they’ve invented technology....You can’t just come up with a [slogan] like “Let’s call that ‘cloud.’” [But] it sure beats innovation.
 - » in 2014: We think these three product areas — database, cloud applications, and engineered systems — will drive Oracle’s growth in calendar 2014.





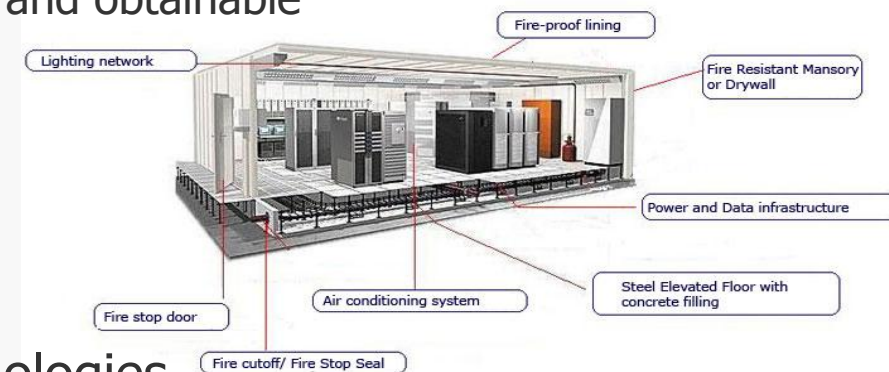
Cloud Applications

Cloud Application Usage By Company Size

	Small	Medium	Large
Business productivity	61%	58%	71%
Email	52%	64%	63%
Analytics/BI	45%	56%	59%
Collaboration	43%	55%	58%
Virtual desktop	41%	54%	57%
Web presence	43%	48%	53%
CRM	34%	49%	51%
HR management	33%	45%	50%
Help desk	30%	40%	44%
Expense management	27%	46%	33%
ERP	24%	34%	44%
Financial management	27%	29%	32%
Call Center	26%	33%	36%

Introduction

- » A clear trend: centralizing computing resources in big datacenters
 - » similarly to power-plants
- » Requirements
 - » commodity hardware: relatively cheap and obtainable
 - » place, building
 - » electrical power, cooling
 - » network
- » Cloud concept
 - » efficiency in cost and productivity
 - » remote network access
- » Re-used functions from legacy technologies
 - » parallel processing
 - » distributed systems
 - » usage-based pricing for computing (pay as you go)
- » Possible tasks for a cloud engineer
 - » regular checking and development of cloud infrastructure
 - » development, deployment and management of cloud applications
 - » creation, orchestration and operation of cloud services



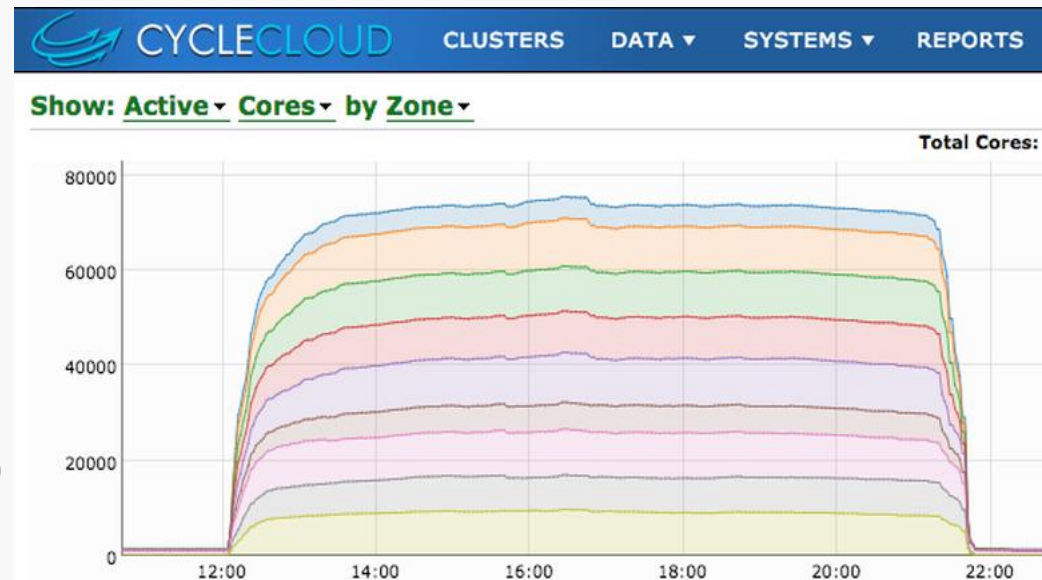


Properties of a Public Cloud Service

- » It is not owned by You
- » Details of service operation is hidden from the cloud user
 - » no maintenance tasks
 - » You cannot see it 😊
- » Usage-based billing (optionally free)
- » Dynamically scales according to the requirements
 - » scalable, elastic

Advantages

- » Quick server(cluster) creation
- » E.g. Amazon Web Services
 - » a fun cloud run: 70,980 cores on AWS for \$5,593.94 (<http://www.zdnet.com/article/a-fun-cloud-run-70980-cores-on-aws-for-5593-94/>)
 - » from 0 to 50 000 CPU cores: 23 min
 - » ~ 10 hours runtime
 - » 729 TeraFLOPS cluster
 - » ~ 63. supercomp.
 - » analysis and simulations (MatLab)



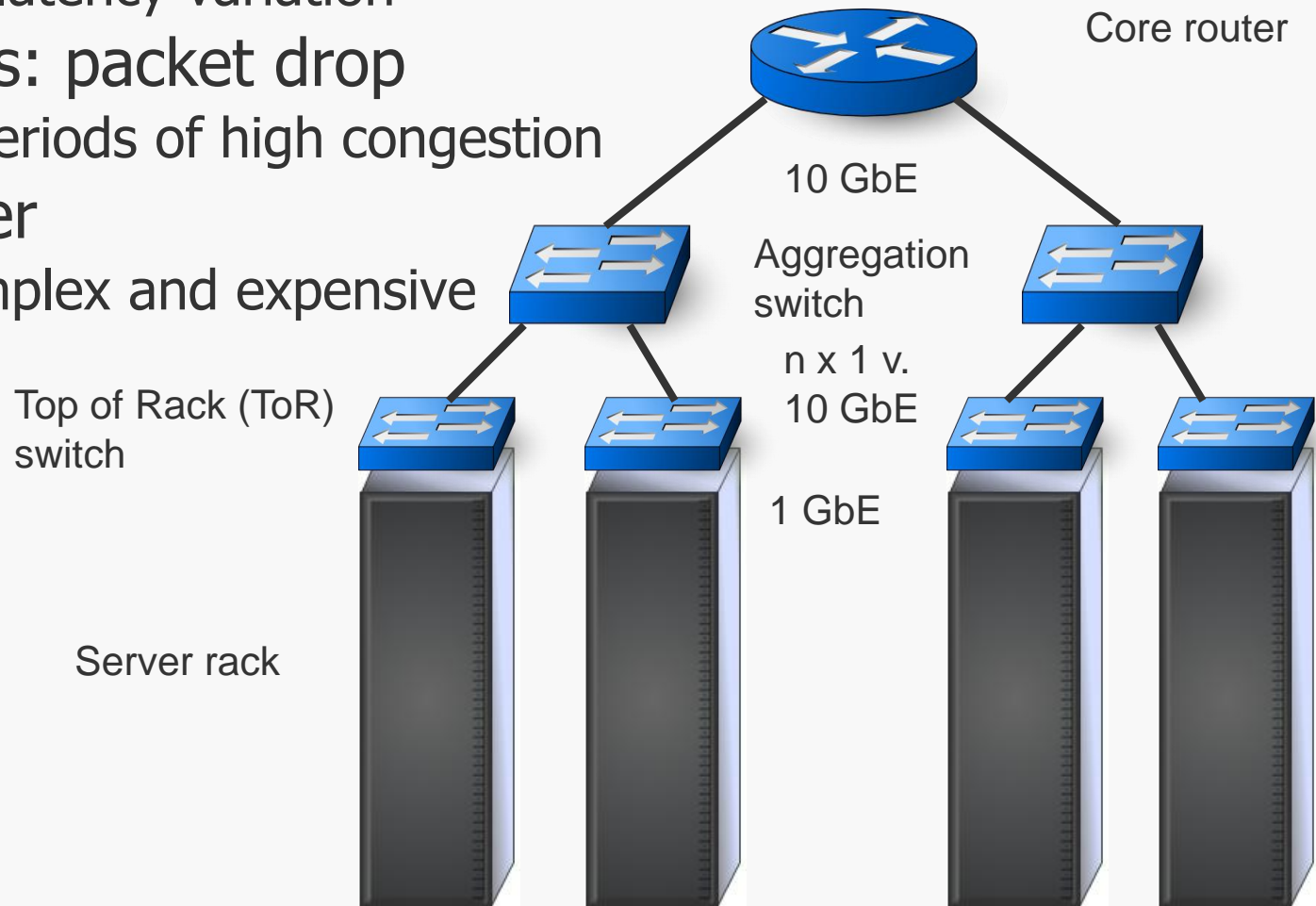
Generations of Technologies

- » Or: what is new in cloud systems?
- » Data Center Evolution
 - » mainframe era: ~ from the 1960s
 - » 1 mainframe computer: centralized compute and storage, time sharing
 - » punch card, printer, later teletype
 - » thin client
 - » minicomputers connected with LAN, later servers + LAN connects clients too: from 1980s
 - » terminals and servers
 - » distributed compute and storage
 - » enterprise data centers (1990s)
 - » servers in racks
 - » cloud data centers
 - » commodity hardware
 - » horizontal scaling (scale out)



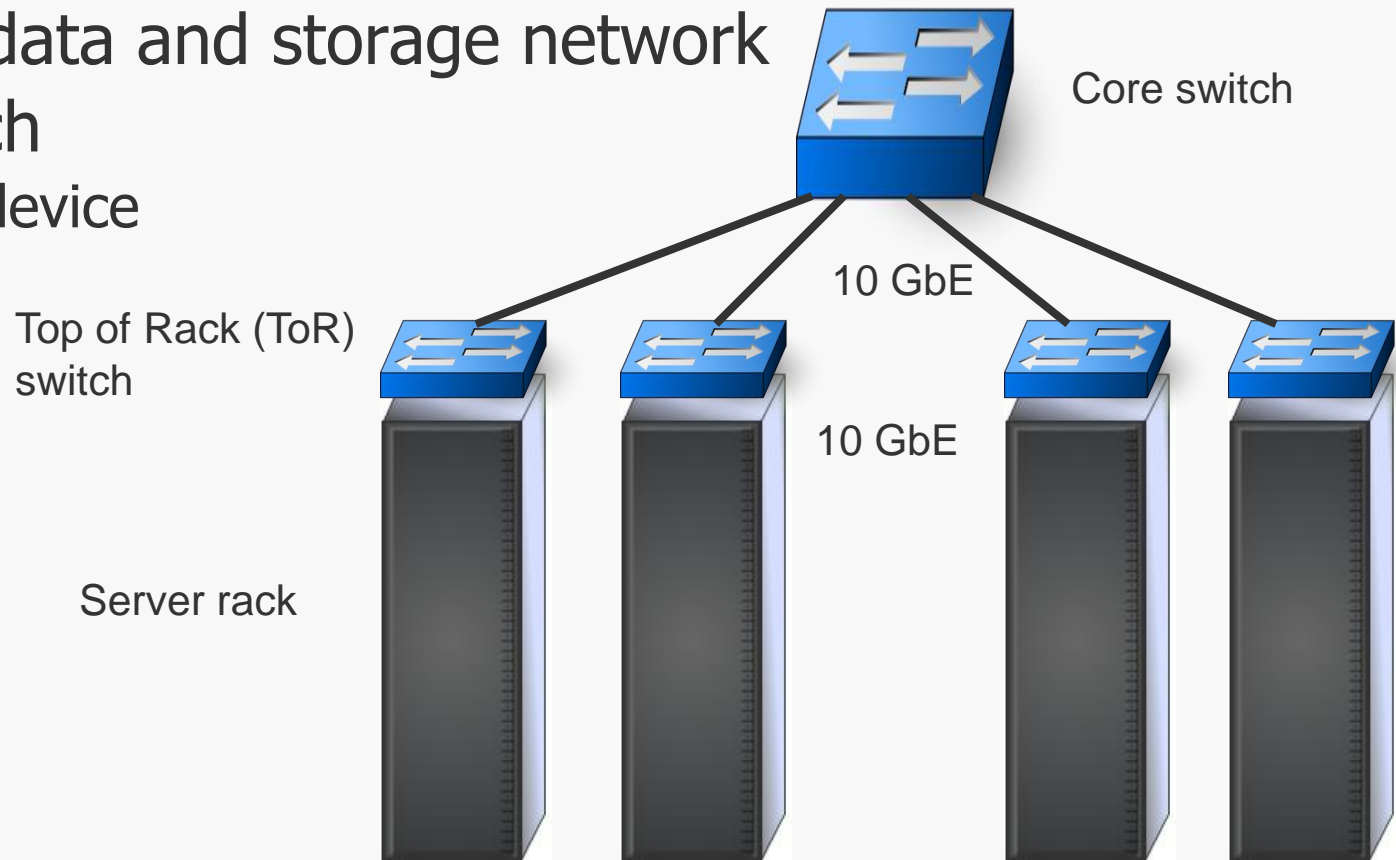
Enterprise Data Center

- » Traffic between servers over multiple hops
 - » latency, latency variation
- » Traffic loss: packet drop
 - » during periods of high congestion
- » Core router
 - » very complex and expensive



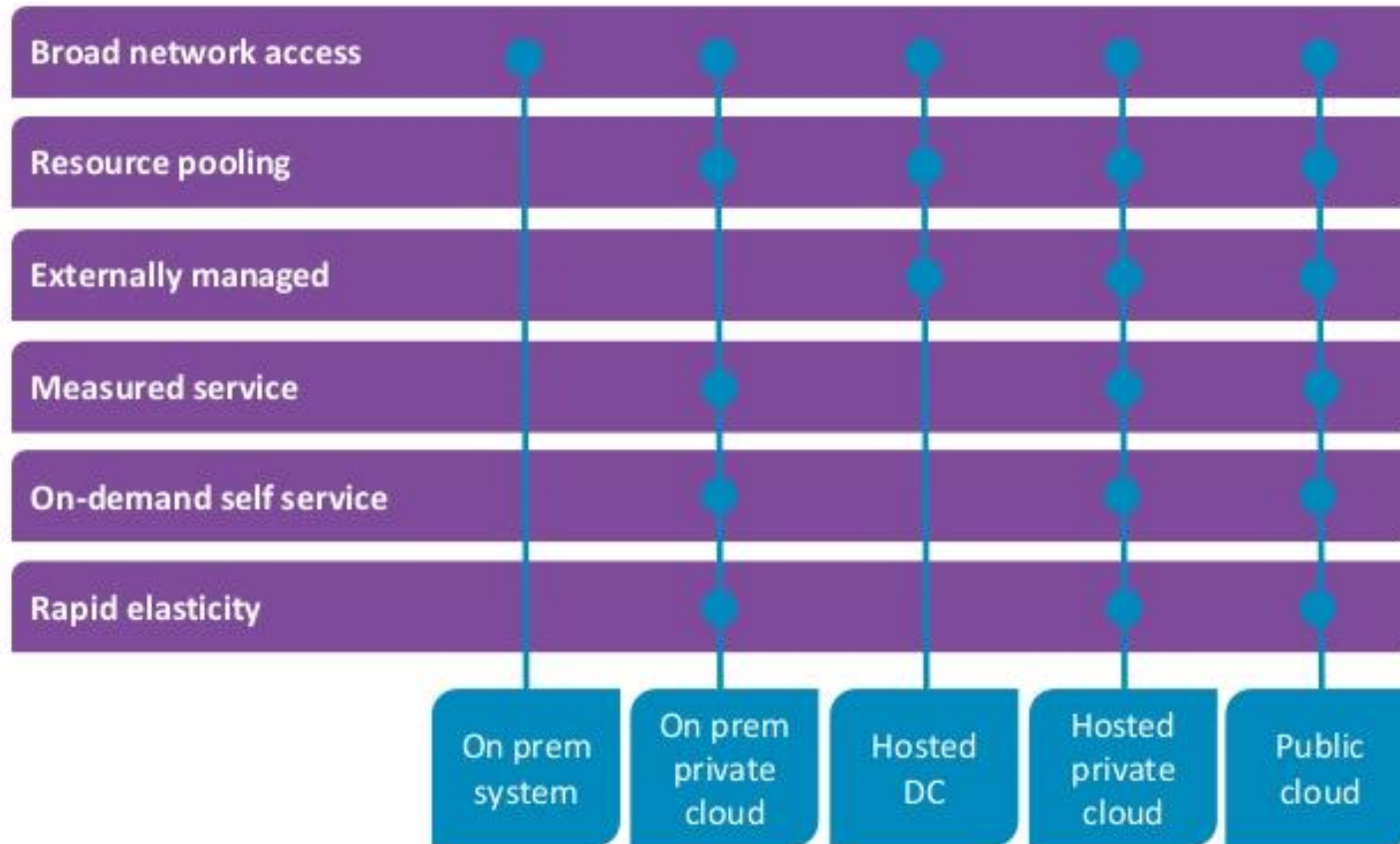
Cloud Data Center

- » Traffic between servers over few hops
 - » flat(ter) network topology
 - » lower latency and latency variation
- » Common data and storage network
- » Core switch
 - » simpler device





Characteristics of Typical Computing Models



CompTIA

Source: CompTIA



Driving Forces

- » Technology
 - » web services and service oriented architecture (SOA)
 - » low server utilization \Rightarrow virtualization
 - » PCs, servers: 10%-50%
 - » storage: 50%
 - » high speed networks
- » Economies of scale: bulk of devices – lower cost
 - » CPU
 - » servers
 - » storage
- » costs
 - » electrical power
 - » cooling
 - » network access
- » environment-friendly, a.k.a green
 - » consolidation of workloads to avoid idle servers
 - » concentrated energy consumption
- » considered as the first milestone: 2006 opening the access to Amazon web services for outside developers
- » outsourcing processes and information using cloud resources



Similar Concepts

- » Cluster computing
 - » similar (or identical) computers
 - » in the same place, connected by LAN
 - » operating as powerful supercomputer
- » Grid computing
 - » independent, usually different computers
 - » even at different physical locations
 - » operating as a distributed system
- » Cloud computing
 - » similar (or identical) computers
 - » usually at different physical locations
 - » resources provided as services



Comparison of Similar Concepts

Cluster

- » tightly coupled, identical systems (HW and OS)
- » centralized task management and scheduling
- » dedicated low latency and high speed network
- » for solving a specific task

Grid

- » loosely coupled, different systems (HW and OS)
- » autonomous components with own resource management, distributed control
- » a large task is divided among the components
- » powerful computers
- » connected over the Interneten

Cloud

- » identical or different systems
- » independent components, resources are managed by a hypervisor (virtual machine manager)
- » numerous different applications running in the same time
- » dedicated low latency and high speed network

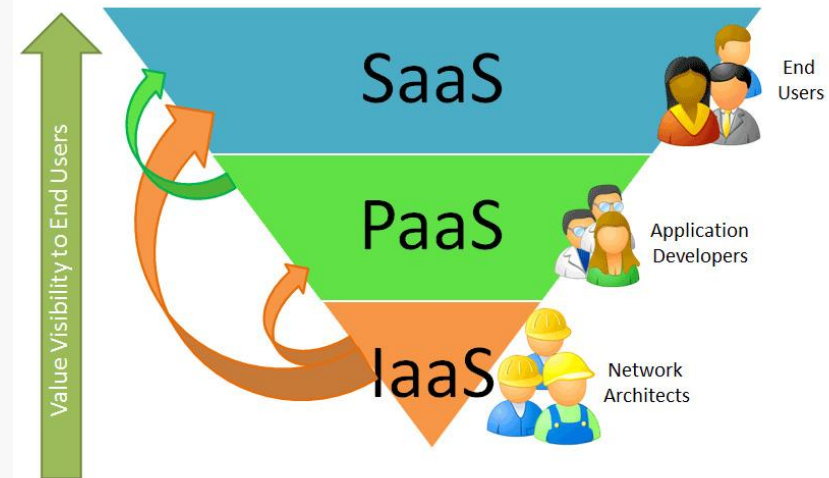
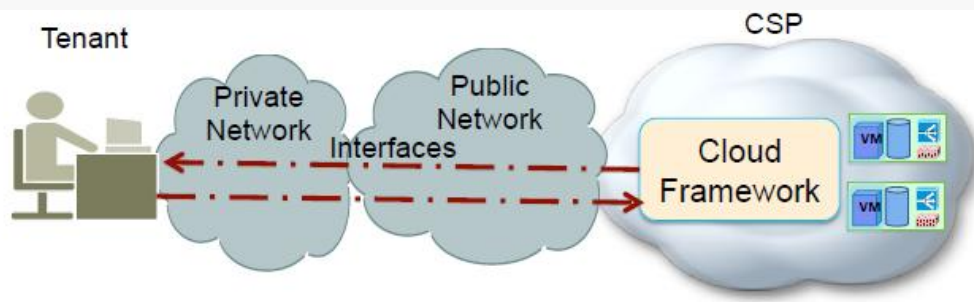


Cisco Global Cloud Networking Survey 2012

- » applications and services
 - » email and web services
 - » virtual desktop
 - » collaboration tools
 - » storage
- » migration to cloud is getting more and more accepted
 - » cost savings
 - » flexibility
 - » less operational tasks

Roles

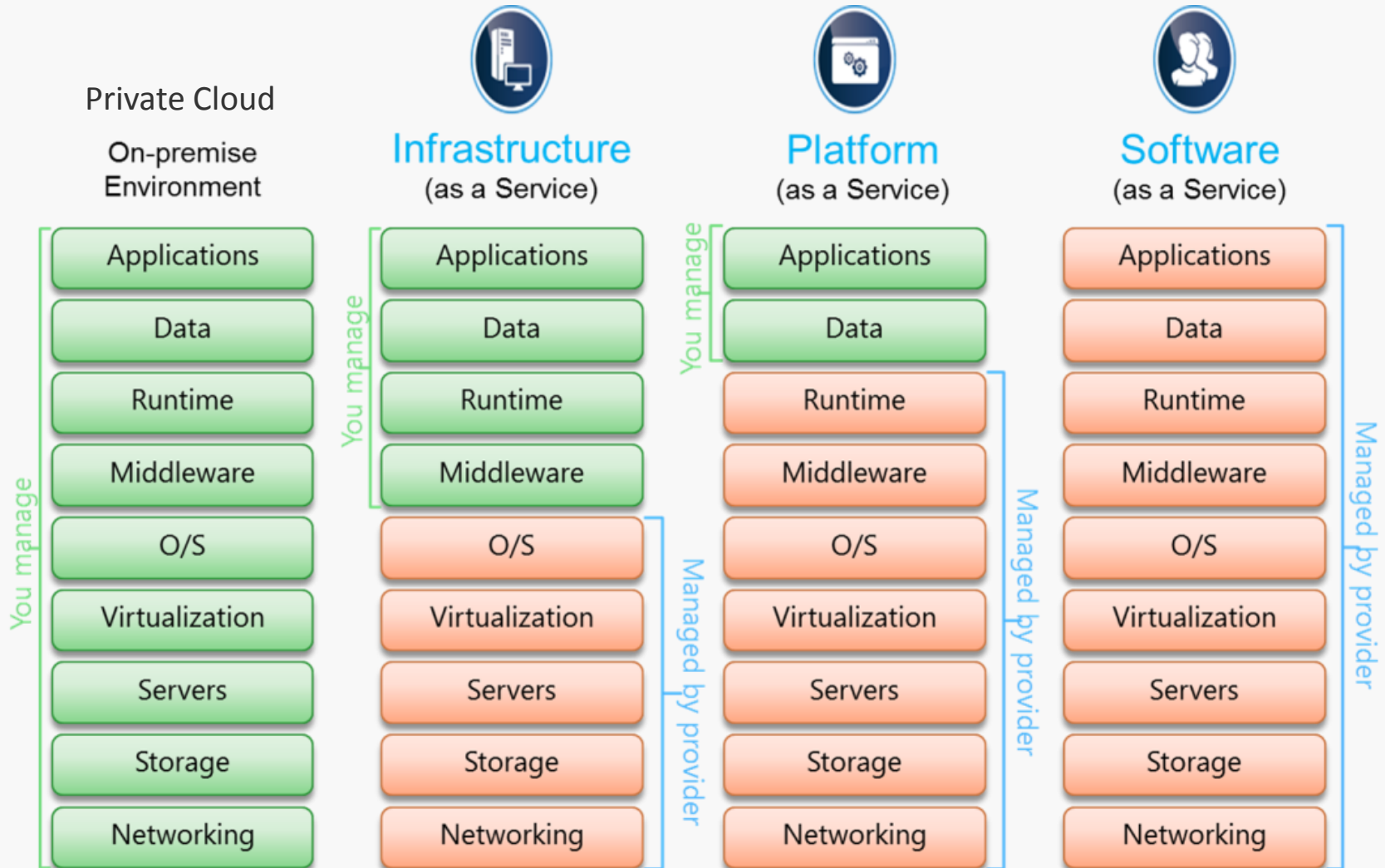
- » Cloud Service Provider – CSP
- » Cloud end-user, tenant, consumer
- » Cloud (networking) designer/engineer/architect
- » Cloud application designer/engineer/architect
- » Cloud administrator, operator



Forrás: <https://jaymanalotoibm.wordpress.com/2013/11/03/delivering-ibm-tririga-from-the-cloud/>



Responsibilities



Source: <https://www.simple-talk.com/cloud/cloud-development/a-comprehensive-introduction-to-cloud-computing/>



IaaS

- » Infrastructure aaS: „Hardware“ as a Service
- » Managed environment for existing applications and services
- » Components
 - » server (physical or virtual) – compute resource
 - » storage: disk drive
 - » network + network devices: firewall, load balancer, etc.
⇒ network architect
- » Providers: e.g. Amazon EC2, S3; Rackspace, Microsoft Azure, Google Compute Engine, etc.



PaaS

- » Services
 - » „solution stack“: developer, test and runtime environment
 - » OS, developer tools, databases, application servers, webservers all-in-one
- » Access via API (App. Programming Interface)
- » For cloud application developers
 - » full development cycle: source code repository and control, compile, build, test, etc.
- » Built on IaaS
- » Providers: e.g. Microsoft Azure PaaS, Google App Engine, Red Hat OpenShift, Cloud Foundry, Heroku
- » typically not portable between different PaaS providers



SaaS

- » Software application as a Service
 - » a complete solution, product
 - » usually business applications
 - » e-mail, calendar, CRM, office suite, project management, helpdesk, etc.
 - » software licensing model, subscription fee
- » SaaS provider maintains hardware and software
 - » reducing IT operating costs
- » Only few customization options



*aaS

» Generalization

» Network as a Service

» e.g. Content Delivery Network

» Data as a Service

» access to analytical data

» Communication as a Service

» VoIP, IM, videoconference service operated on third party managed HW and SW, e.g. remote PBX

Public and Private Clouds

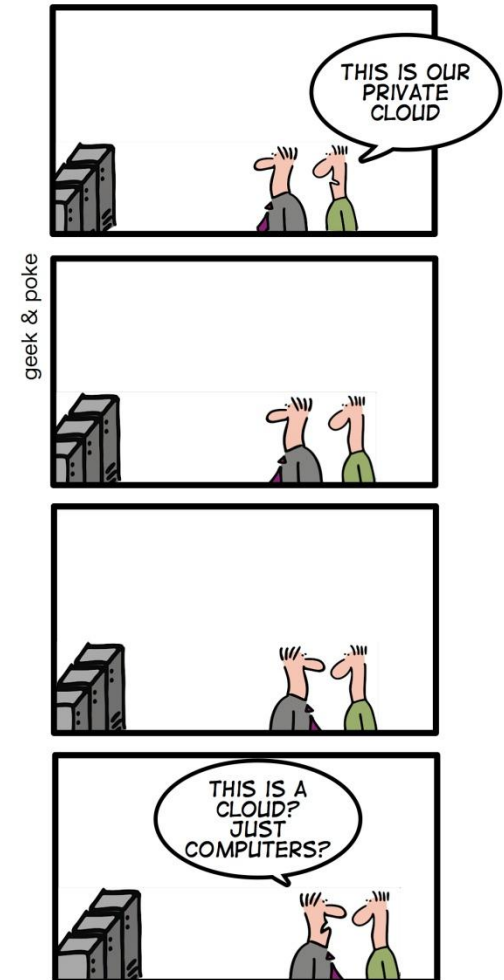
» Public

- » shared infrastructure, public access
- » running on devices owned by a provider
- » perceived as unlimited resources
- » accessible via the Internet

» Private

- » dedicated to an organization, company
- » dedicated ownership of devices
- » flexible, but limited resources
- » not necessarily connected to the Internet

HOW TO DISILLUSION YOUR BOSS





Vendors and Providers

Cloud Marketplace	
Cloud Broker Platform	
Cloud Management	
SaaS	
PaaS	
IaaS	
Cloud Platform	
Virtualization Software/Mgmt	
Hardware	

Source: Gravitant, Inc from Cloud Technology Spectrum
 (<http://blog.gravitant.com/2012/07/27/cloud-technology-spectrum/>)
 More examples: <http://www.clouds360.com>



Bursting

- » Cloudbursting
 - » if the private resources are exhausted, outsources the workload to the public cloud
 - » the critical tasks remain in the private cloud
- » Bursting in the cloud
 - » automated data center
 - » on-demand control and management of devices
 - » coordination



Standardization Organizations

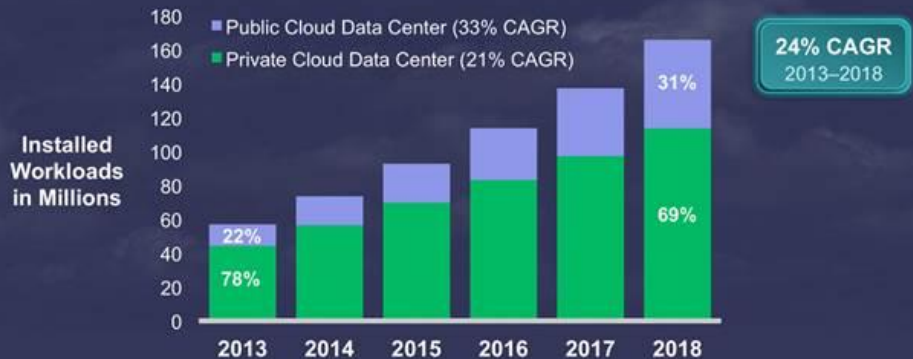
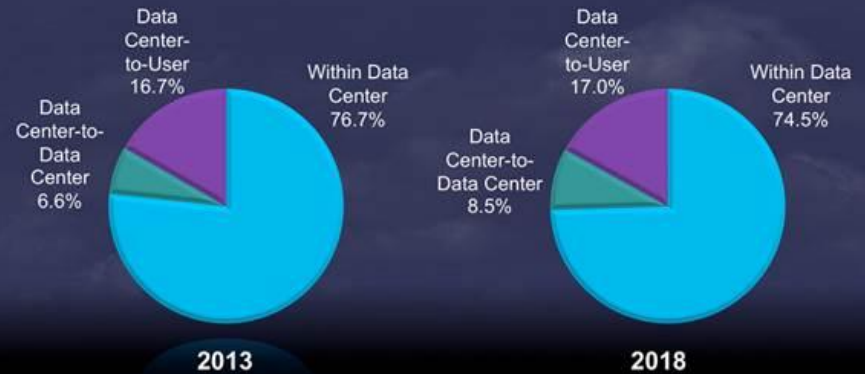
- » National Institute of Standards and Technology (NIST)
- » Cloud Standards Customer Council
- » Distributed Management Task Force (DMTF)
- » Global Inter-Cloud Technology Forum (GICTF)
- » Open Grid Forum (OGF)
 - » Open Cloud Computing Interface (OCCI) Working Group
- » Open Cloud Consortium (OCC)
- » The European Telecommunications Standards Institute (ETSI)
 - » TC CLOUD
- » International Telecommunication Union (ITU)

Source: <http://cloud-standards.org/wiki/>



Forecasts

- » Cisco Global Cloud Index: Forecast and Methodology, 2013–2018
 - » Cloud Data Center Traffic Growth
 - » exa: 10^{18} , zetta: 10^{21}
 - » Global Data Center Traffic by Destination
 - » Public vs. Private Cloud Growth

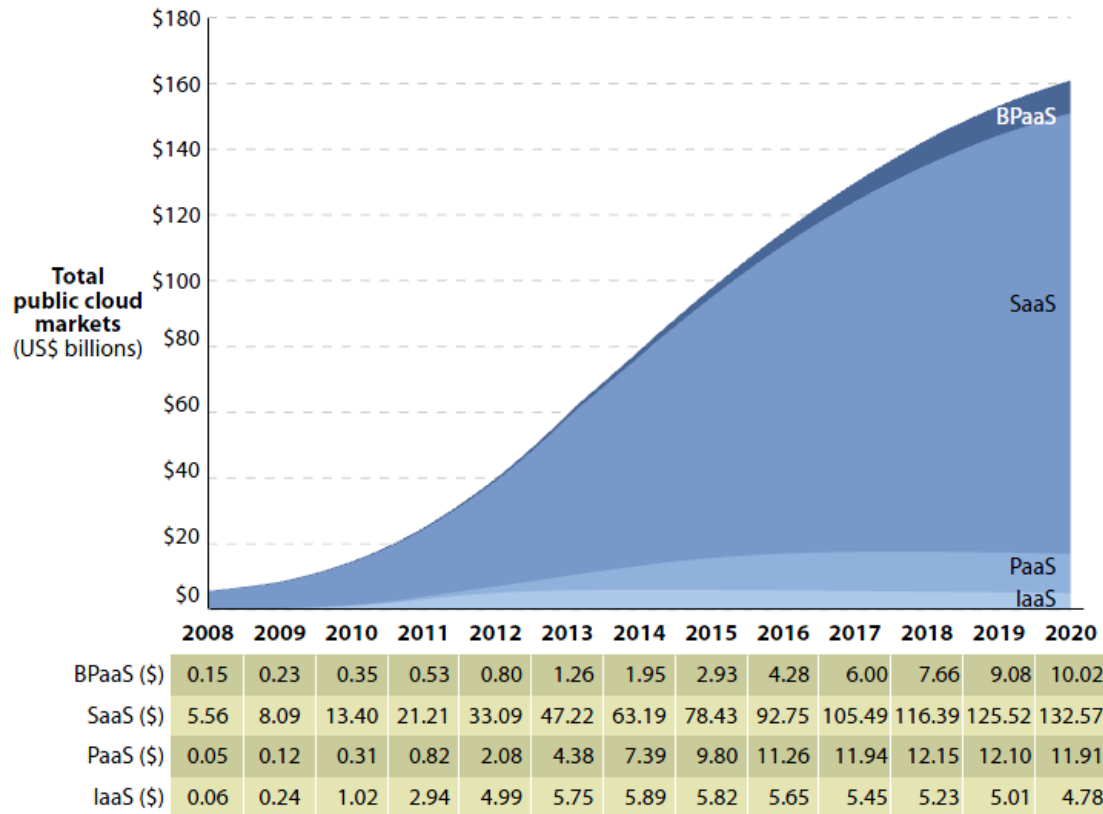




Cloud Market

Figure 3 Forecast: Global Public Cloud Market Size, 2011 To 2020

The spreadsheet detailing this forecast is available online.



CL(U) BUDGET ALLOCATIONS

- 45%** Software-as-a-Service (SaaS)
- 30%** Infrastructure-as-a-Service (IaaS)
- 19%** Platform-as-a-Service (PaaS)
- 6%** Other as-a-service models*

*Such as Backup-as-a-Service, Storage-as-a-Service

Source: International Data Group, Inc., Cloud Computing Survey, 2016



Inter-cloud

- » Cloud of clouds
- » Global Inter-Cloud Technology Forum (GICTF)
 - » 2009 Japan
 - » „...standardization of network protocols and the interfaces through which cloud systems interwork with each other...”
- » Cisco Intercloud (Fabric)
 - » globally connected (hybrid) cloud platform
 - » using OpenStack (avoiding lock-in)
 - » March 2014: commitment to invest in the next two years \$1 billion into cloud area
 - » 2015: 60 partners more, than 350 data center in 50 countries
 - » April 2017: End-of-Life, recommended alternative: Cisco CloudCenter



Future of Cloud?

- » *“...combination of cloud based software products and on premises compute to create a hybrid IT solution that balances the scalability and flexibility associated with cloud and the security and control of a private data center.”* Michael Corrado, World Wide Marketing Manager with Hewlett Packard Enterprise
- » multi-cloud
- » serverless, Function as a Service
- » Cloud to the Edge



Our Focus in this Course

- » IaaS
 - » OpenStack
- » Network
 - » no cloud without network