



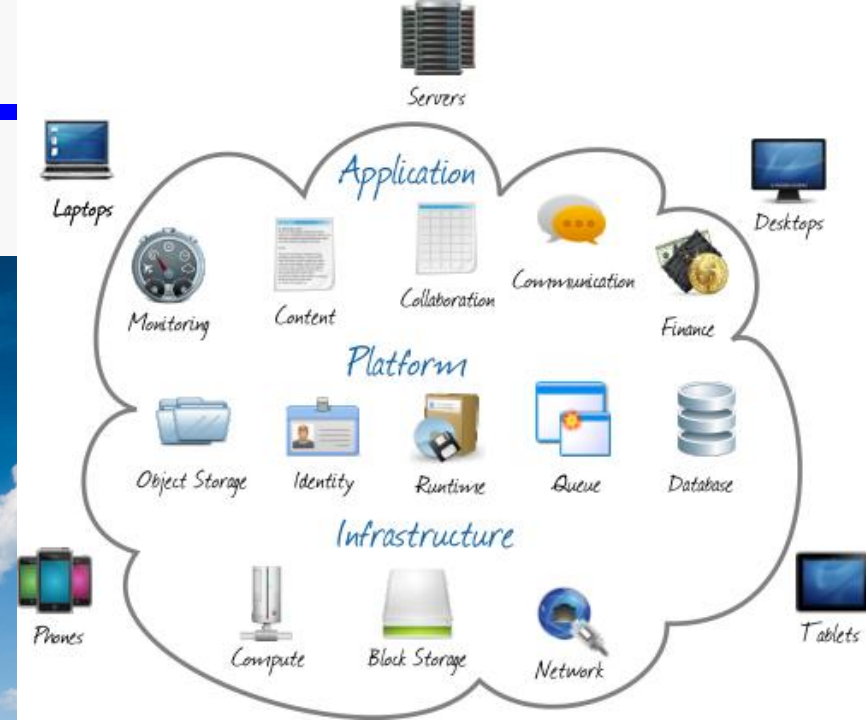
Cloud Networking (VITMMA02)

Dr. Markosz Maliosz

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

Spring 2017

Cloud computing





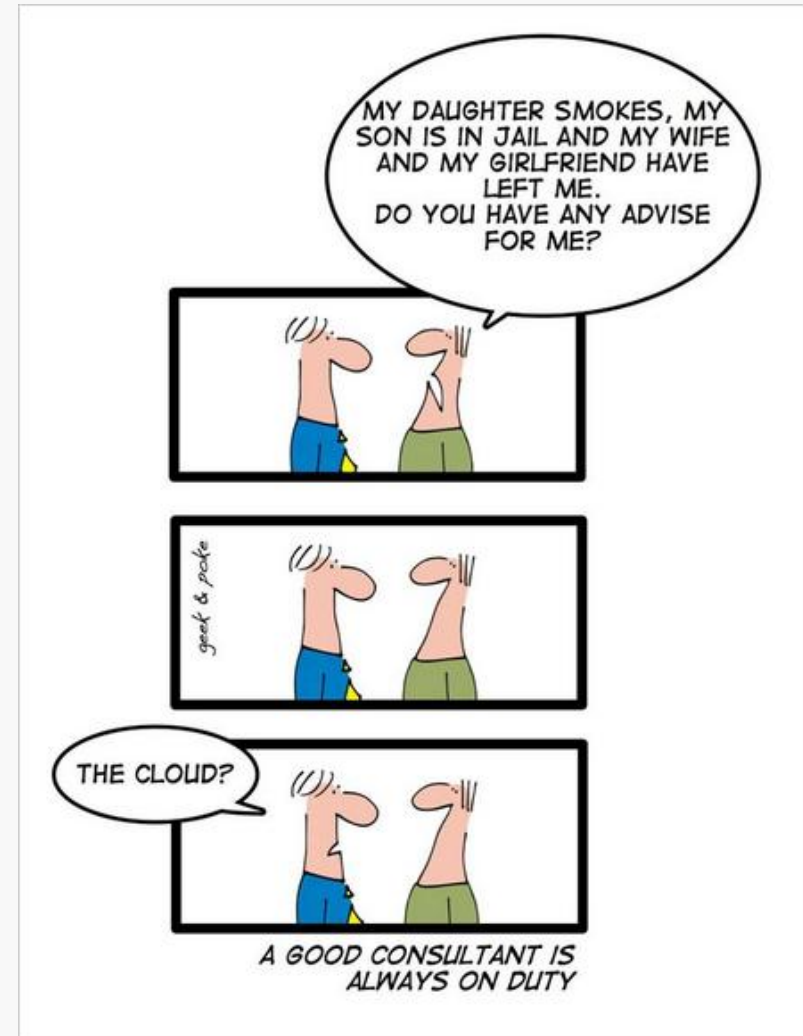
Definition of Cloud

- » 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

<ul style="list-style-type: none">» on-demand self-service» broad network access» resource pooling» rapid elasticity» measured service	<ul style="list-style-type: none">» Software as a Service» Platform as a Service» Infrastructure as a Service	<ul style="list-style-type: none">» Private cloud» Community cloud» Public cloud» Hybrid cloud
--	---	---

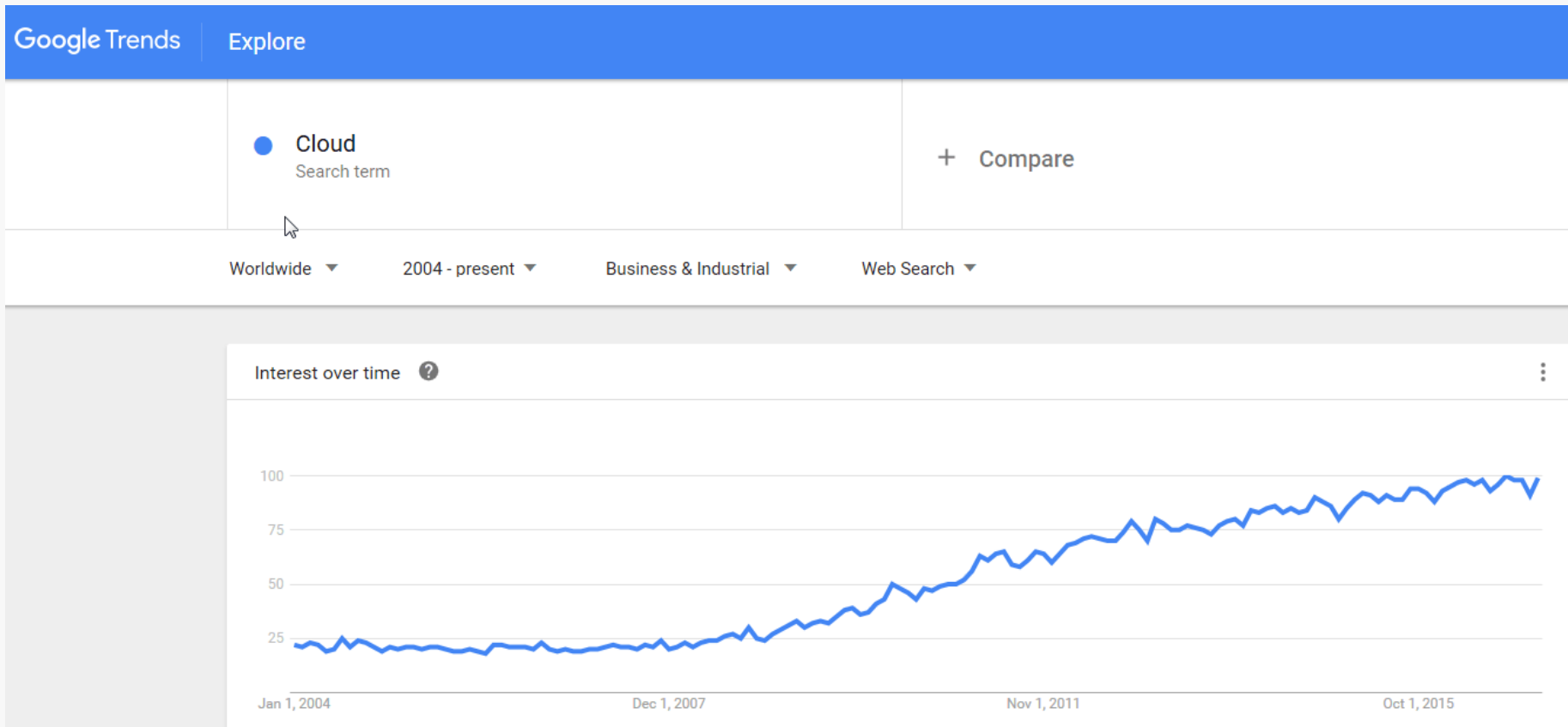
Is it a buzzword to solve everything?

- » “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.





Google search statistics



Forrás: Google Trends



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%

CompTIA

Source: CompTIA's 5th Annual Trends in Cloud Computing | Base: 366 U.S. firms using cloud computing



Looking Ahead

» Basis of one of the Top 10 2017 technology trends (by Gartner)

» **Mesh App and Service Architecture**

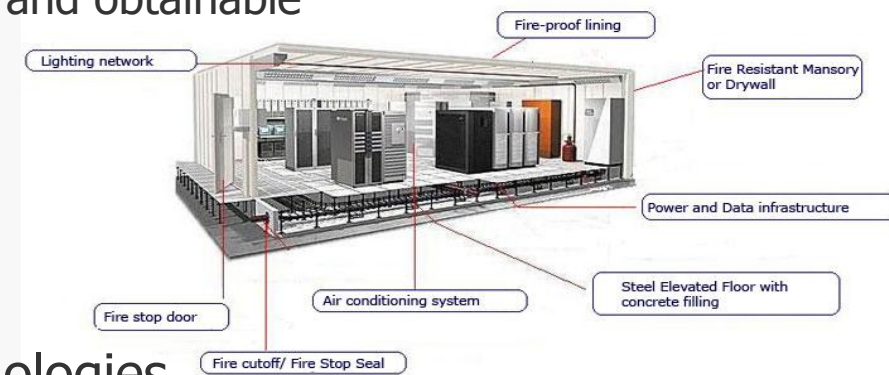
(The mesh refers to the dynamic connection of people, processes, things and services supporting intelligent digital ecosystems.)

The mesh app and service architecture (MASA) is a multichannel solution architecture that leverages cloud and serverless computing, containers and microservices as well as APIs and events to deliver modular, flexible and dynamic solutions.

Forrás: <http://www.gartner.com/smarterwithgartner/gartners-top-10-technology-trends-2017/>

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



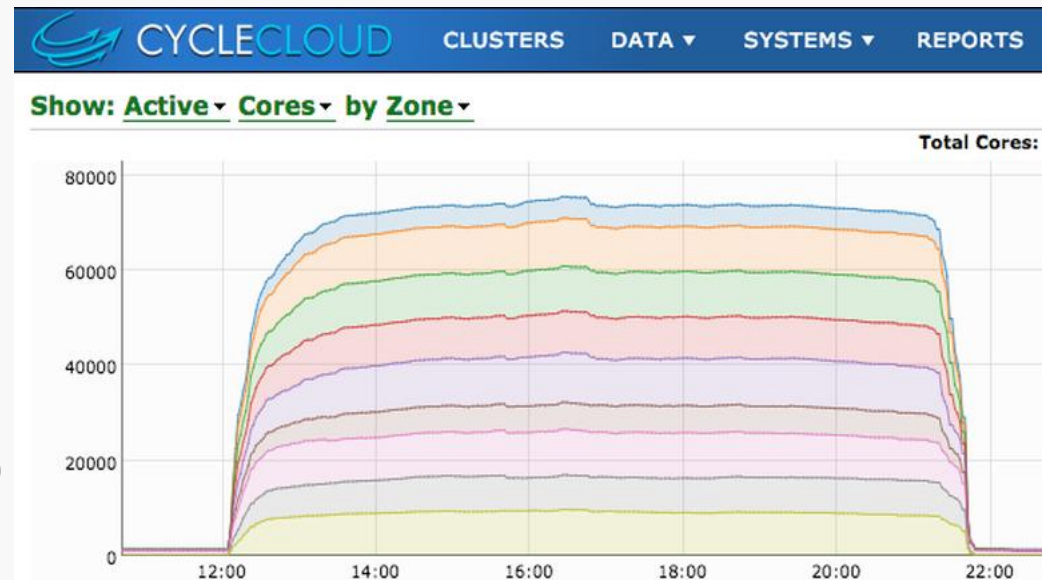


Properties of a cloud service

- » 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)



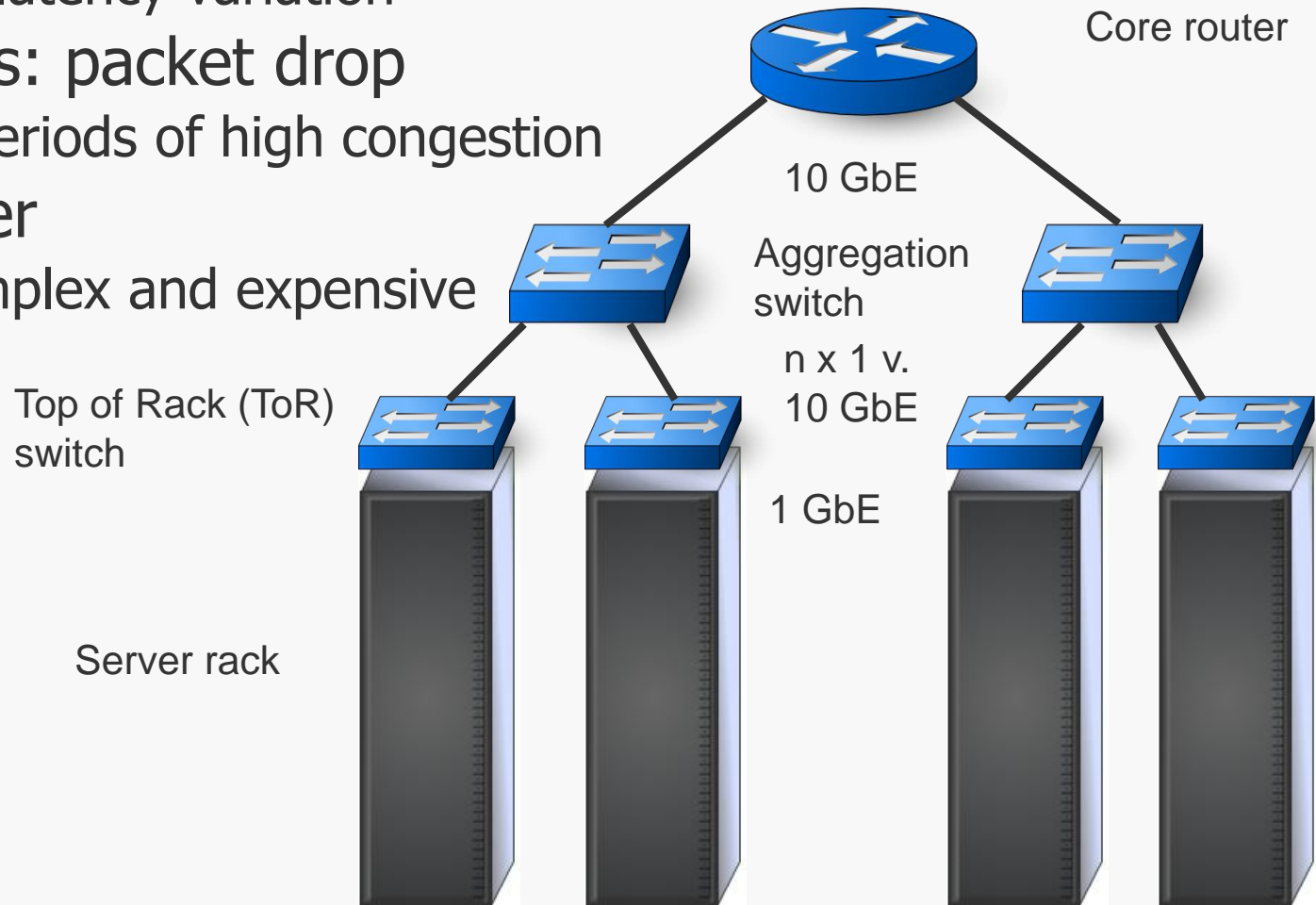
Generations of Technologies

- » 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)



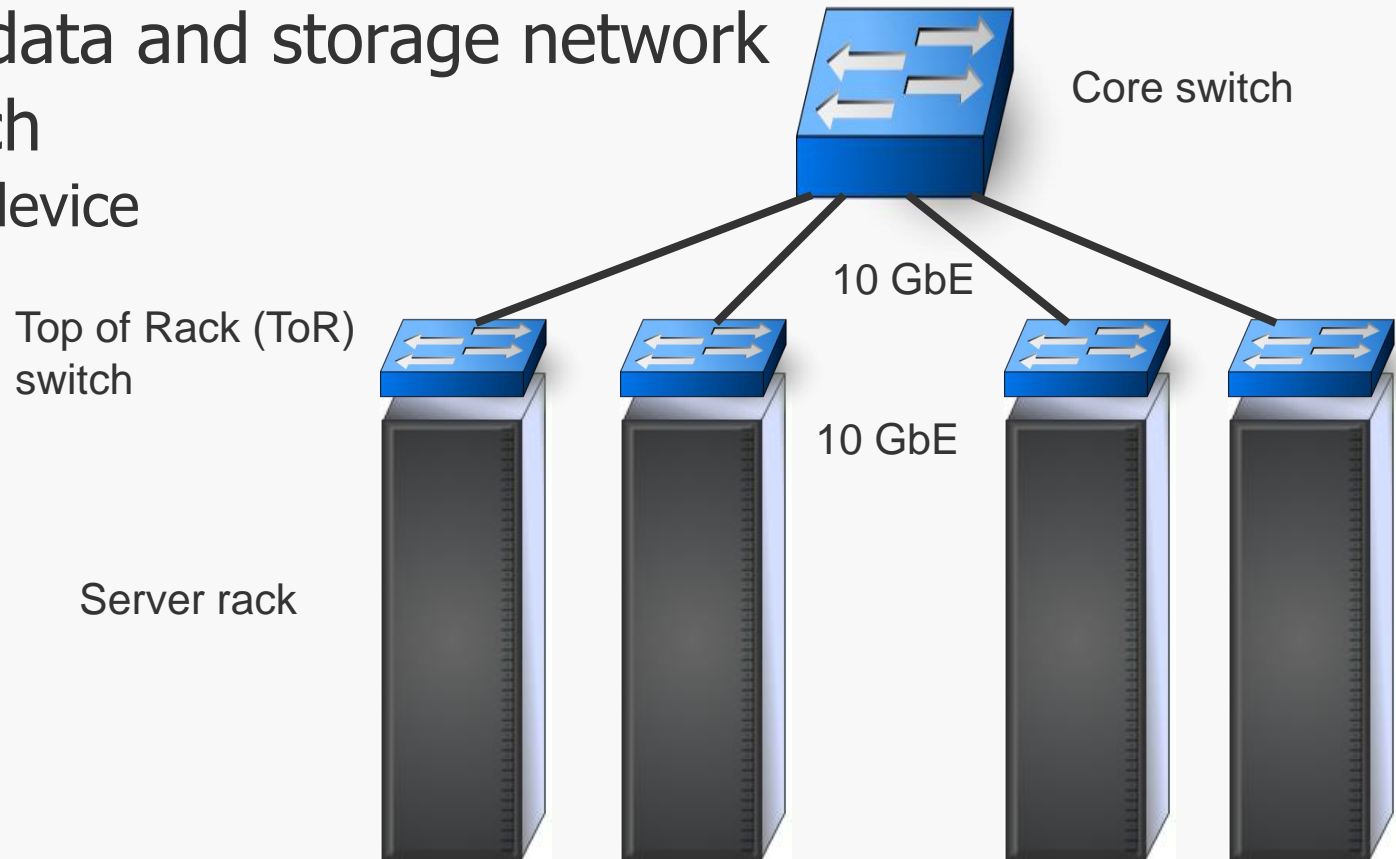
Enterprise Data Center

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



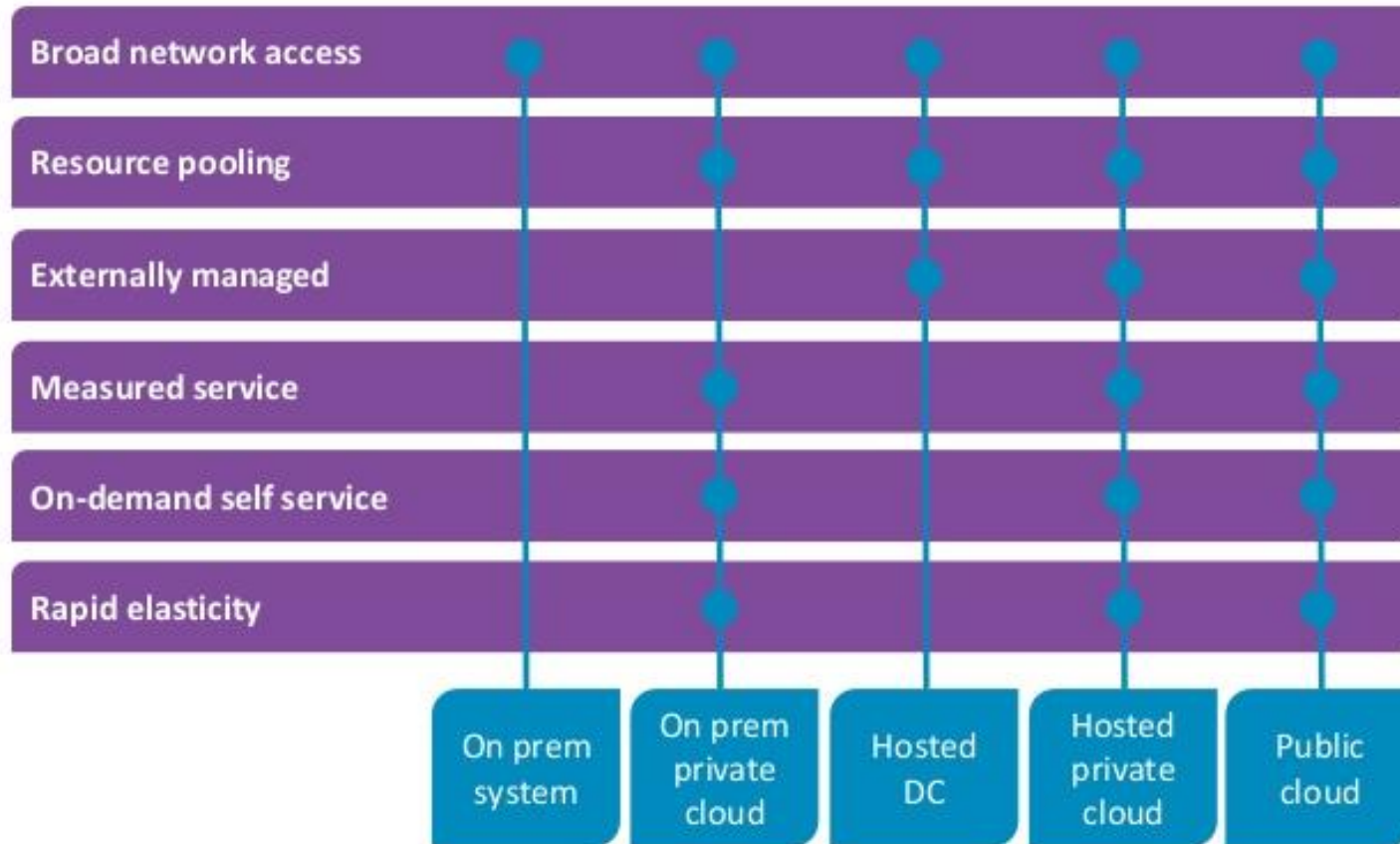
Cloud Data Center

- » 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

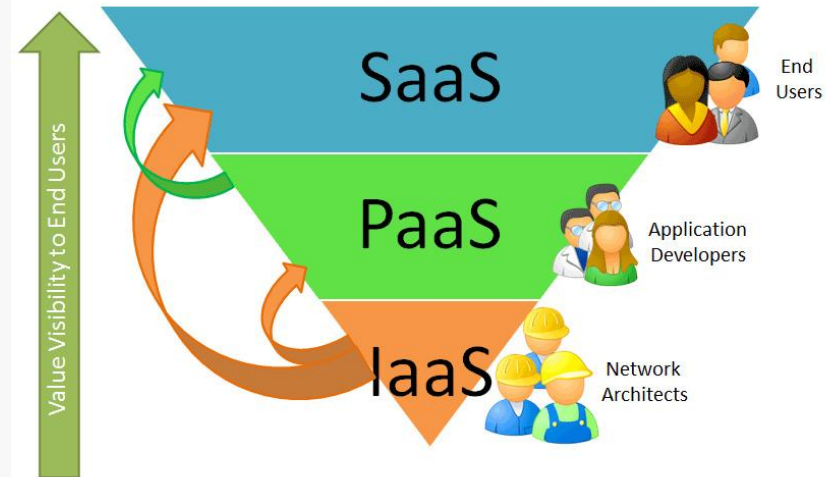
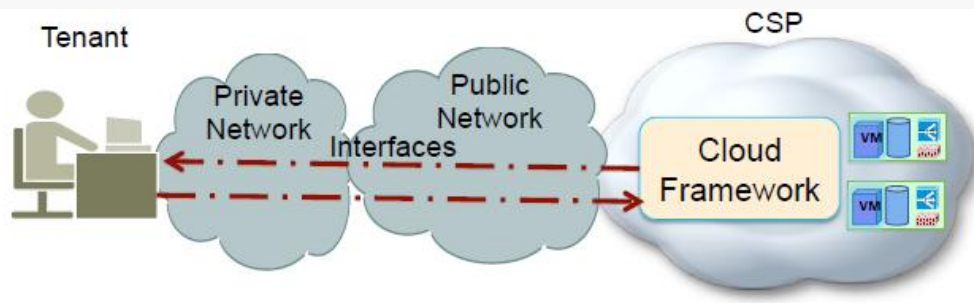


Cisco Global Cloud Networking Survey 2012

- » 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

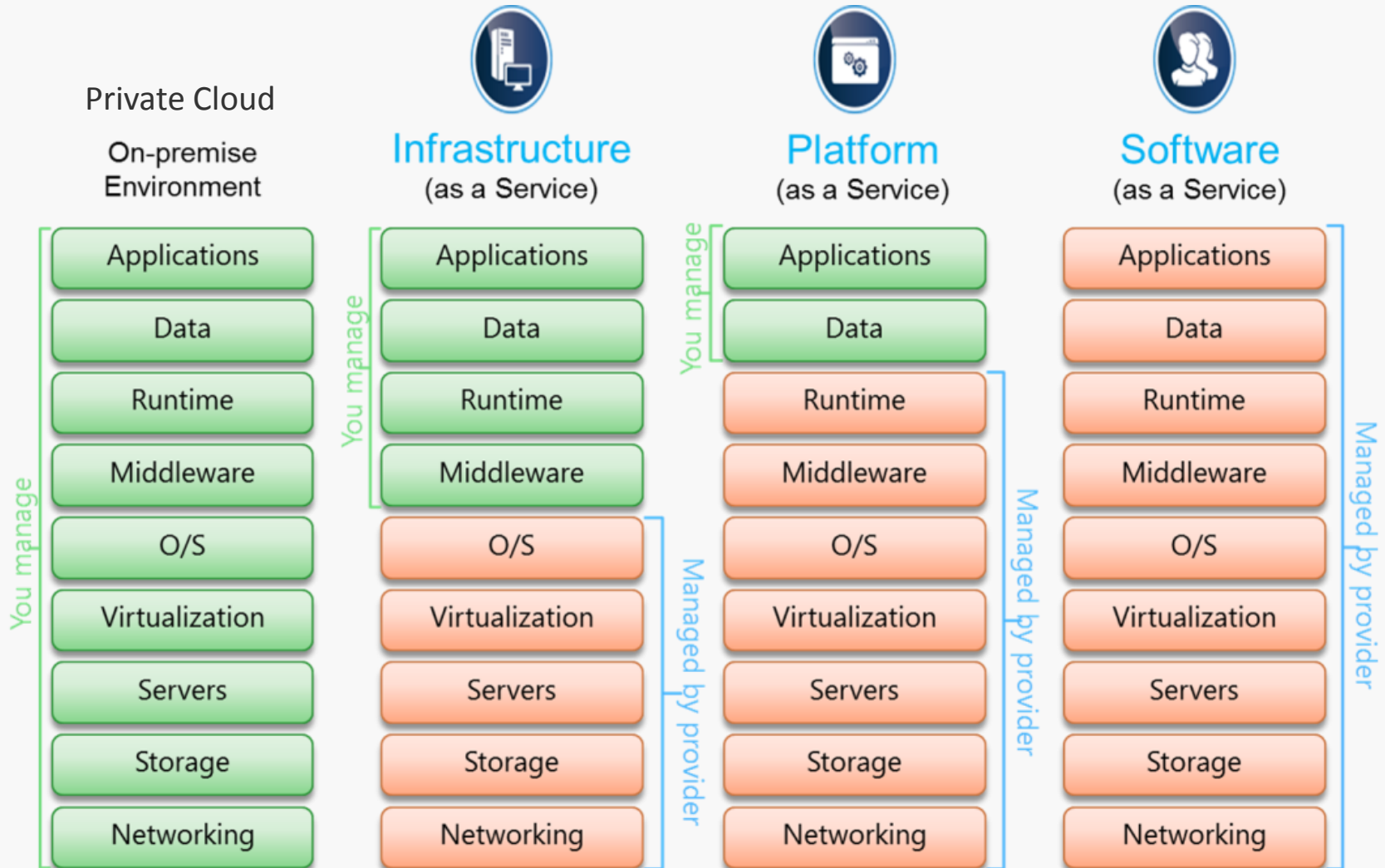
- » Cloud Service Provider – CSP
- » Cloud end-user, tenant, consumer
- » Cloud (networking) designer/engineer/architect
- » Cloud application designer/engineer/architect
- » Cloud administrator, operator



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



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



Our Focus

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