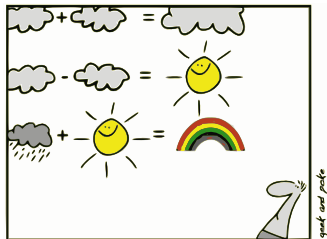# 3rd Slide Set Cloud Computing

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Agenda for Today

- What is Cloud Computing?
- Definition
- Why Cloud Computing?
- Organizational types of Cloud services
    - Public Cloud services
    - Private Cloud services
    - Hybrid Cloud services
- Categories of Cloud systems
    - Humans as a Service (HuaaS)
    - Software as a Service (SaaS)
    - Platform as a Service (PaaS)
    - Infrastructure as a Service (IaaS)
- Additional concepts (HuaaS, Cloud print, Cloud gaming, Cloud operating systems)
- Opportunities and risks of Cloud Computing

What is Cloud Computing?
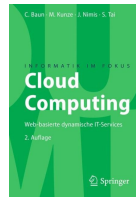
Image source: Pro7

Cloud Computing – Definitions

SIMPLY EXPLAINED – PART 17:
CLOUD COMPUTING

- Several definitions exist
- Not all are helpful
- Good definitions are extensive

„*By using virtualized computing and storage resources and modern web technologies, Cloud Computing provides scalable, network-centric, abstracted IT infrastructures, platforms, and applications as on-demand services. These services are billed on a usage basis.*"
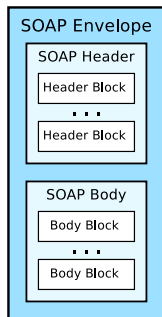
Is everything clear?

Cloud Computing – Focal Points by Definition

"By using virtualized computing and storage resources and modern web technologies, Cloud Computing provides scalable, network-centric, abstracted IT infrastructures, platforms, and applications as on-demand services. These services are billed on a usage basis."

- Part 1: Fundamental technologies – basis of Cloud Computing
  - **Virtualization** for shared and efficient resource utilization
  - **Web Services** (REST/SOAP) for communicating with the services
- Part 2: Cloud services and their characteristics
  - **IaaS, PaaS, SaaS**
  - **scalable** $\Longrightarrow$ "elastic"
  - **network**-centric $\Longrightarrow$ services/resources are accessible over the internet
  - **abstracted** $\Longrightarrow$ independent of the concrete hardware
  - **on-demand** $\Longrightarrow$ prompt request completion
  - **pay as you go**

Fundamental Technologies – Virtualization

- Allows an abstract, logical perspective of physical resources
    - Servers, storage, networks
- Isolates (hides) the physical hardware
- With virtualization,...
    1. the physical hardware can be used in a shared and transparent way
    2. heterogeneous hardware resources can be combined to create a homogeneous resource pool

- Some advantages:
    - Server consolidation $\implies$ cost reduction
    - Simplified (short-term) provisioning
    - Flexibility (different operating systems on the same hardware)

Fundamental Technologies – Web-Services

- Distributed systems often integrate heterogeneous resources
    - In theory, the these resources can be worldwide distributed
- Drawbacks of long distance connections compared to LANs
    - High response times
    - Low data transmission capacities
    - Potentially unreliable connections
- Web services enable **weakly coupled**, **asynchronous** and **messages-based** communication, based on HTTP and XML
- Most popular applications for web services:
    - Remote Procedure Calls
    - **SOAP** (originally defined as *Simple Object Access Protocol*)
    - **REST** (*REpresentational State Transfer*)

Web-Services – SOAP

- SOAP messages use the message format of the markup language XML
  - Usually, SOAP messages are stored in the body of a HTTP POST request and sent to an URL

```
SOAP Envelope
  SOAP Header
    Header Block
    . . .
    Header Block

  SOAP Body
    Body Block
    . . .
    Body Block
```

```xml
<?xml version="1.0" encoding="UTF-8" ?>
<env:Envelope xmlns:env="http://www.w3.org/2001/09/soap-envelope">
  <env:Header>
    <n:alertcontrol xmlns:n="http://example.org/alertcontrol">
      <n:priority>1</n:priority>
      <n:expires>2001-06-22T14:00:00-05:00</n:expires>
    </n:alertcontrol>
  </env:Header>
  <env:Body>
    <m:alert xmlns:m="http://example.org/alert">
      <m:msg>Mary um 14 Uhr von der Schule abholen</m:msg>
    </m:alert>
  </env:Body>
</env:Envelope>
```

Source: Tanenbaum, van Steen. Verteilte Systeme. Pearson Studium (2008)

- The message sends a text to a web service
- The message has a specific priority (1) and will be discarded, if it arrives after 2:00 pm at the web service

RESTful Web Services

- Requested via the **HTTP interface**
  - More simple way of interaction in contrast to SOAP (XML-based)
- **Stateless communication**
  - Each HTTP message contains all information to understand it
  - The server doesn't hold any status or session information about the client
  - Each request is an transaction, independent from other transactions
- 4 HTTP methods are enough to work with different **resources**

HTTP	CRUD Actions	SQL	Description
PUT/POST	Create	INSERT	Create or replace a resource
GET	Read/Retrieve	SELECT	Request a resource
PUT	Update	UPDATE	Modify a resource
DELETE	Delete/Destroy	DELETE	Erase a resource

- Further useful HTTP methods:
  - HEAD – requests metadata about a resource
  - OPTIONS – requests, which methods are supported by a resource

Cloud Computing – Services?

> *„By using virtualized computing and storage resources and modern web technologies, Cloud Computing provides scalable, network-centric, abstracted IT infrastructures, platforms, and applications as on-demand services. These services are billed on a usage basis."*

- Cloud computing is an umbrella term for different services

What is a **service**?

IT-Service – Service

- Service in the information technology (IT) area
- Provided by a service provider for one or more customers
- Offered like a product
- Should be defined via a service level agreement (SLA)
- Provided by company's own department ($\Longrightarrow$ **inhouse**) or by an external provider ($\Longrightarrow$ **outsourcing**)

How can Cloud services be distinguished in an **organizational** way?

Organizational Distinction of the Services

- **Public Cloud**
    - Customer and provider belong to different organizations
      $\implies$ Outsourcing
    - No cost for purchasing, operate and maintain of own hardware
    - Resources ready for use immediately, and (almost) unlimited available
- **Private Cloud**
    - Customer and provider belong to the same organization
    - Costs are similar to a non-Cloud-based architecture
- **Hybrid Cloud**
    - Public and private Clouds are used together
    - Application examples
        - Manage load peaks with public Cloud services
        - Store backup data in public Clouds,

How can Cloud services be distinguished according to their **functionality**?

Functional Distinction of the Services

- **Software as a Service** (SaaS)
  - Provider runs web applications
  - Customers only need a browser
- **Platform as a Service** (PaaS)
  - Provider run scalable runtime environment(s)
  - Customers run their own web applications in the infrastructure of the service provider
- **Infrastructure as a Service** (IaaS)
  - Provider runs physical servers
  - Customers run VMs with (almost) any operating systems and unmodified applications
    - Customers have administrator privileges in their VMs and define the firewall rules themselves
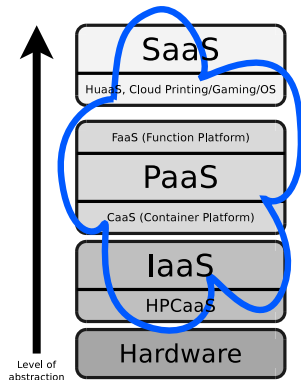
Software Service Examples

- (Free) solutions for building software services exist since > 10 years
  - Web server: Apache HTTP server, nginx,...
  - Application server for web applications: Apache Tomcat (Java), JBoss (Java), Zope (Python)
  - Scripting language for dynamic web pages: PHP
- Software services exist longer than the term „Cloud Computing"

Humans as a Service (HuaaS)

- Principle of crowdsourcing
- Human creativity is offered for low cost or donated from volunteers
- Interesting for. . .
    - Low-skilled jobs
    - Activities, which a computer cannot to, or requires an unreasonably high development time
- Possible applications are among others:
    - Image recognition
    - Personal Perspective (subjective) reviews for products
    - Translations
    - (Product) assignments to (product) categories
- Examples of public Cloud HuaaS
    - Investigation of the British expenses scandal by The Guardian in 2009
    - GutenPlag, VroniPlag
    - Marketplace for HuaaS: Amazon Mechanical Turk
- In the private Cloud area: HuaaS does not take place

Recommended literature to Crowdsourcing

Christian Papsdorf
WIE SURFEN
ZU ARBEIT WIRD
Crowdsourcing im Web 2.0
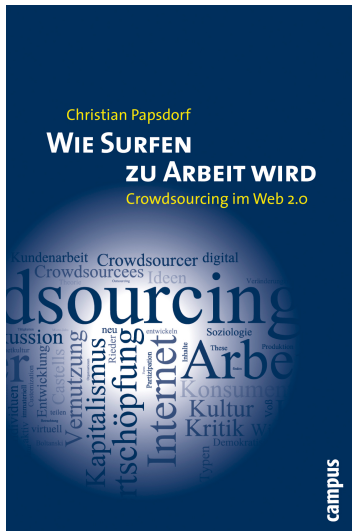
campus

- Christian Papsdorf. *Wie Surfen zu Arbeit wird*. Campus (2009)

- Consumer Write reviews, develop ideas, create logos,...

- These value-adding activities are of high economic significance

- Companies use the internet culture (participation, engagement, self-realization,...) to let the users mostly work for free

- Why do the consumers accept this and work for free?

Pril Competition

- On April 1st 2011, Henkel launched a crowdsourcing campaign
  - Despite the date, it was no joke!
- Everyone was able to crate a new design proposal for the 600ml bottle at http://mein.pril.de

- There were material prizes to win
- The two best designs should go on sale for a short time
- Users of Facebook were able to vote their favorite
- Huge feedback: > 30,000 proposals were submitted

Pril Competition – Outcome

- Not all proposals matched Henkel's expectation

- After a short time, 2 proposals of Peter Breuer (a professional advertising copywriter) became favorites
- The *chicken* proposal was ranked 1st place with several thousand votes ahead 2nd place
- Reaction of Henkel: They changed the rules
    - Now, proposals needed to be previously evaluated and release by a jury
    - Only after the jury evaluation, the users were allowed to vote for the proposal
- Result: Wave of anger

Pril Competition – Manipulation of the Outcome

- Things got even worse
    - Henkel erased comments of angry users
    - Henkel massively reduced the number of votes of several designs
    - Henkel stated they just „cleaned up" the results
- From this time, the affair went through the press
    $\implies$ Bad public relations work

Source: Jörg Breithut. Virale Werbefallen – Pril schmeckt nach Hähnchen. 12.4.2011
http://www.spiegel.de/netzwelt/web/0,1518,756532,00.html

Things do not necessarily need to end like this. . .

Otto Competition

- Otto organized a „model montest" in 2010
    - The winner with the most votes was planned to become the new face of the Facebook fan page

- Winner against 48,488 other participants: „Der Brigitte" (Sascha Mörs)
    - A 22 years old business administration student from FH Koblenz
- Otto was not unhappy about the result
    - Approximately 1.2 million votes were submitted

$\implies$ Great public relations work

Amazon's Mechanical Turk – Cloud Marketplace

- March 8th, 2006 - Sam Williams
- **Pennies for Web Jobs**

Speaking to a room filled with Internet developers at the O'Reilly
Emerging Technology Conference in San Diego this week, Luis Felipe
Cabrera, Amazon's vice president of software development, outlined a
project to **harness human intelligence for tasks that computers
can't handle well**, such as recognizing objects in images.
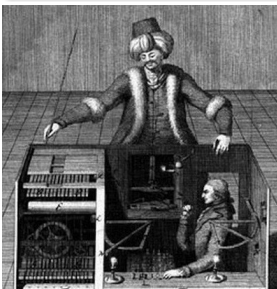
The backbone of the plan is a Web-services platform called
Mechanical Turk. It uses an **auction-style system** to **farm out
complex tasks – complex for a computer**, that is – such as
recognizing the difference between a human face and a nearby bush,
or **accurately transcribing** an audio recording. Cabrera likes to call
the platform „artificial artificial intelligence" – it's **computers asking
humans to do tasks, rather than the other way around**.

... Image source: Google image search

Source: http://m.technologyreview.com/web/16519/

Another Crowdsourcing Marketplace – Samasource

- http://www.samasource.org
- Founded in 2008
- Nonprofit project, which gives digital work to people in developing countries
    - *Workers* are in Haiti, India, Kenya, Pakistan, South Africa and Uganda
        - In these countries, school education includes for historical reasons a good basic education in the English language
        - But these countries don't have enough jobs
- Infrastructure is financed from donations
    - Donors are among others the Rockefeller Foundation and Google
- Wages of about \$300 are low from a European perspective, but in developing countries this is a desirable monthly income
- Example for a customer: Ask.com
    - Up to 50,000 requests from Ask.com are processed per month

Google Cloud Print

Image source: Google

- Provides printing via the Cloud
- Internet enabled devices such as netbooks, touchpads and mobile phones get more and more popular
- Connection of local printers is difficult
  - Printer drivers are missing
  - Some devices lack enough resources
  - Several operating systems (iOS, Android, Windows Phone, Blackberry...) exist
- Solution: Google Cloud Print (https://developers.google.com/cloud-print/)
- HP and Samsung offer compatible printers
  - Via an e-mail address, the devices can be identified and added as a Cloud printer inside Chrome OS
- The user sends his document to be print to the service, sets the printer settings and receives a feedback about the successful job execution

Google Cloud Print (2 Types of Printers)

- **Google Cloud Print compatible network printer**
  - The printer is registered at the Service
  - Print jobs are sent to a service
  - The service prepares the print job and forwards it to the printer
- **Legacy printer** (not compatible with Google Cloud Print)
  - Locally attached printer (USB) or network printer
  - A proxy is installed on a local PC
    - The proxy registers the printer and sends print jobs to the service
    - Prepared print jobs are sent via the proxy to the printer
  - Drawback: The proxy computer must be switched on for printing
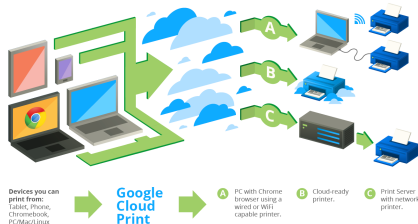
Cloud Gaming (1/4)

- Cloud gaming services make high-end video games available on low-end devices (older PCs, TVs, mobile phones)
    - The video games run at the servers of the provider
    - The users' devices are only used to display the games
    - The video output is transmitted as a compressed video stream
    - User input is sent to the provider and processed there
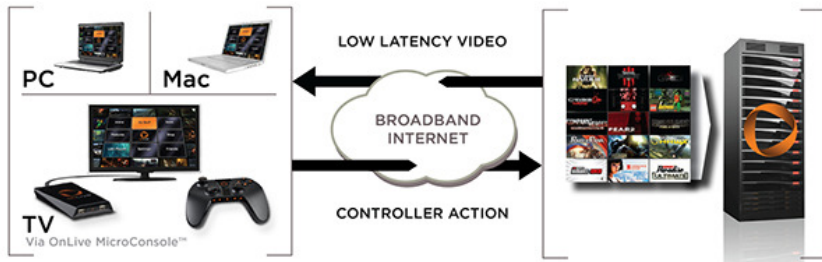
Cloud Gaming (2/4)

- Drawback: The required compression reduces the optical quality
- Problem: The network latency must be low because the user input is transmitted to a remote server and processed there
    - Period between the user input and results on the local display must be small in order not to disrupt the game flow
- Positive side effect for the providers: Pirate copies are impossible
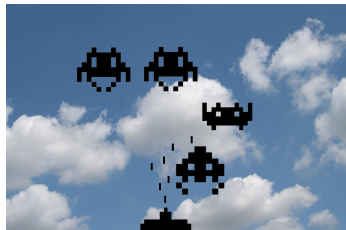
Cloud Gaming (3/4) – Providers

ONLIVE®

Free your games.
Free yourself.

OnLive delivers top-tier video games on demand to your TV, PC, Mac® or tablet —whatever you have on hand. Sign in. Play. It's that simple.

- http://www.onlive.com
- Available in the U.S. between June 17th 2010 and April 30th 2015
- Requirements:
  - Network link with low latency and $< 1000\,km$ distance to the OnLive data center used
- The service itself is no longer available

- http://www.gaikai.com
- Available since February 27th 2011
- July 2012: Sony buys Gaikai for \$380 million
- Is used to stream PS3 games to the PS4 and PC
- The service itself is no longer available
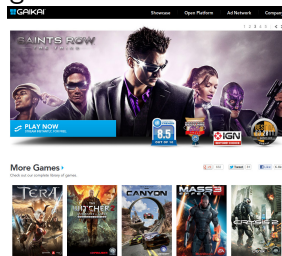
Cloud Gaming (4/4) – Nvidia Shield

Image source: NVIDIA

- http://shield.nvidia.com/
- Announced at CES January 2013
- Available since Q2 2013
- Android based

- Set top box for TV
- Offers 4K TV shows and movies
- Also as tablet and portable version

Latest News from November 1st 2017

https://**www.bit-tech.net**/news/gaming/apple/nvidia-launches-geforce-now-macos-beta/1/

Nvidia launches GeForce Now macOS beta

Written by Gareth Halfacree

November 1, 2017 // 9:52 a.m.

Nvidia has officially launched a macOS beta for its GeForce Now cloud gaming platform in Europe, allowing users of macOS 10.10 or newer to play previously Windows-exclusive titles on a Pascal-based dedicated graphics processor.

Based on the GeForce Grid platform announced back in November 2014, GeForce Now allows gamers on low-end platforms to play high-end games by pushing all the heavy lifting work onto remote data centres filled with dedicated GeForce graphics processors. As the client device only needs to process the audio-video stream and send back control commands, system requirements are light, but, as with any cloud gaming platform, the experience is heavily dependent on a low-latency internet connection with adequate bandwidth.

Another feature of cloud gaming is the possibility to unlock platform-exclusive titles, and that's something Nvidia is pushing heavily as it launches the European beta for GeForce Now on Apple's macOS platform. '*The [macOS] systems aren't powerful enough [for gaming]*,' Nvidia explains of the reason why macOS users should be interested in GeForce Now, '*and when they are, most top [Windows] PC games aren't available.*'

The macOS version of GeForce Cloud allows more than 100 games, listed in full here, to be installed on a virtual machine connected to a dedicated Pascal-based graphics processor claimed to be equivalent in performance to a GeForce GTX 1080 graphics card. The games themselves aren't free, however; users must already own the title before it's available to install.

The GeForce Now macOS beta requires an Apple device running macOS 10.10 or newer, with '*most Macs dating back to 2009* fully supported, along with an internet connection with at least 25Mb/s and preferably 50Mb/s of downstream bandwidth. Interested parties with compatible systems can sign up for the free beta now.

Cloud Operating Systems

Image source: eyeOS blog (Public Domain)
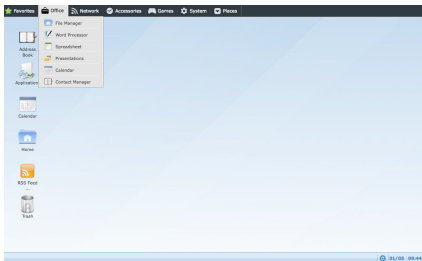
- Web desktops are also called Cloud operating systems
- Most popular product: eyeOS

> Last free software version: v2.5 (2011)
> https://en.wikipedia.org/wiki/EyeOS
> GNU Affero General Public License
> https://github.com/jonrandoem/eyeos
> Since 2014 a part of Telefónica

- The operating system, all installed applications and the user data are located on the servers of the provider
  - The users only need a browser and internet access
- The term Cloud operating system is misleading here
  - For using a Cloud operating system, a computer with a browser and therefore with an operating system too is required
  - The native operating system is not replaced
    - Only the applications and user data are outsourced

Cloud Cooking – the Future ?!

Image source: Heise Zeitschriften Verlag

Platform Service Examples – App Engine

- Customers can run their own web applications, implemented in Python, Java, Go and PHP, in the Google infrastructure
- Automatically scales on Demand
- Applications can use various infrastructure and storage services
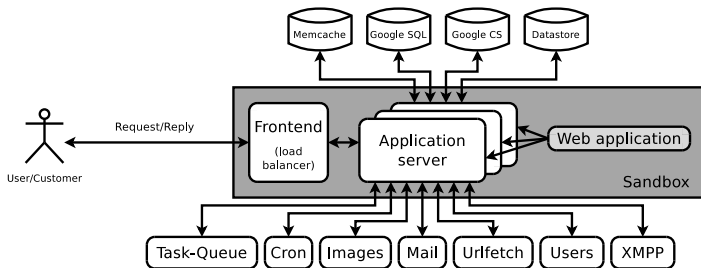
Platform Services (PaaS)

Image source: Google image search

- Examples of public Cloud PaaS

- Examples of private Cloud PaaS
  - AppScale and typhoonAE
- The GAE is the most popular platform service and the use is under some of quantity limitations (quotas) free of charge
- AppScale and typhoonAE are free re-implementations of GAE
  - Allow the construction of an GAE-compatible platform services
  - The existence of these solutions is a unique selling point of the GAE

- Google App Engine $\implies$ slide set 5
- AppScale and typhoonAE $\implies$ slide set 6

Function as a Service (FaaS)

Image Source: AWS

- Is a category of PaaS
- Customers can run their own functions in the infrastructure of the service provider
    - Typically the services support JavaScript (Node.js), Python and/or Java
- Functions may run inside multiple instances if required $\implies$ they scale
- Functions are triggered by external requests or events
    - e.g. HTTP request, appearance/modification/erasing of an object inside a S3 bucket, reception of an Email, modification inside a DB table,...
- The backend is *invisible* for the customers $\implies$ **serverless architecture/computing**

- Examples of public Cloud PaaS
    - AWS Lambda, Google Cloud Functions, MS Azure Functions, IBM Cloud Functions
- Examples of private Cloud PaaS
    - Apache OpenWhisk, OpenFaaS

Working with AWS Lambda

EVENT SOURCE   FUNCTION   SERVICES (ANYTHING)

Changes in data state
Requests to endpoints
Changes in resource state

Node
Python
Java
C#
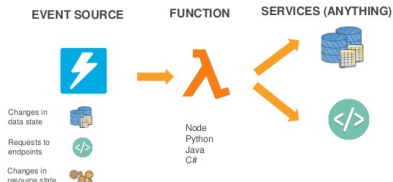
Infrastructure Service Example – Amazon Web Services

- Collection of public Cloud services
- Services of the AWS are among others

Elastic Compute Cloud (EC2)	⟹	Infrastructure service for virtual servers
Simple Storage Service (S3)	⟹	Storage service for web objects
Elastic Block Store (EBS)	⟹	Storage service for virtual storage volumes
Elastic Load Balancing (ELB)	⟹	Service for virtual load balancers
CloudWatch	⟹	Service for monitoring AWS resources
Auto Scaling	⟹	Service for scaling EC2 capacities

Take the Risk Factor out of Capacity Planning
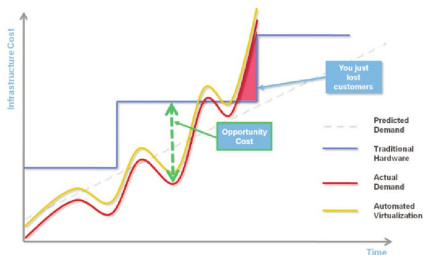
Source: Amazon Web Services

- Application examples:
  - Implementation of virtual data centers
  - Building up an elastic infrastructure (e.g. for a startup)
  - Acquire resources within a short time

Infrastructure Service Example – Amazon S3

- Simple Storage Service (S3)
- Data is stored as **(web-)objects** (1 byte to 5 TB)
- Each object is assigned to a **bucket**
    - Buckets have unique names and contain no other buckets
      $\implies$ Folders are impossible
- Objects are accessible online
    - http://s3.amazonaws.com/bucket/objekt
- Access to buckets and objects is done via REST or SOAP
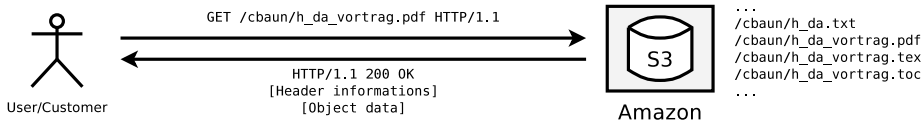
- April 2013: 2 trillion objects stored in S3, 1.1 million requests per second

(https://aws.amazon.com/de/blogs/aws/amazon-s3-two-trillion-objects-11-million-requests-second/)

Infrastructure Services

- Examples of public Cloud infrastructure services

- Examples of private Cloud infrastructure services
  - Eucalyptus, OpenNebula, OpenStack ad Nimbus
- Eucalyptus is a free software to build up AWS-compatible infrastructure services on Linux clusters
  - OpenNebula, OpenStack and Nimbus offer similar functionality

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- Amazon Web Services $\Longrightarrow$ slide set 4
- Eucalyptus and OpenNebula $\Longrightarrow$ slide set 6

Performance Computing as a Service (HPCaaS)

- Belongs to the infrastructure services too
- For HPCaaS, the network latency between the virtual machines, and thus the physical location of the nodes is important
- Only few private Cloud solutions support the grouping of nodes
  - OpenNebula and CloudStack
- Some private Cloud solutions offer absolutely no localization of the virtual machines
  - Eucalyptus
- Public Cloud HPCaaS offerings exist
  - Cluster Compute Instances inside Amazon EC2
- HPCaaS is not suited for all HPC problems
  - It is suited just for trivial parallel problems

Functional Types of Clouds

Level of abstraction

SaaS (Software as a Service)

HuaaS/Crowdsourcing, Cloud Printing, Cloud Gaming, Cloud Operating Systems

PaaS (Platform as a Service)

Functions as a Service

IaaS (Infrastructure as a Service)

High Performance Computing as a Service (HPCaaS)

Hardware
(Server, Networks, Storage, Compute power)
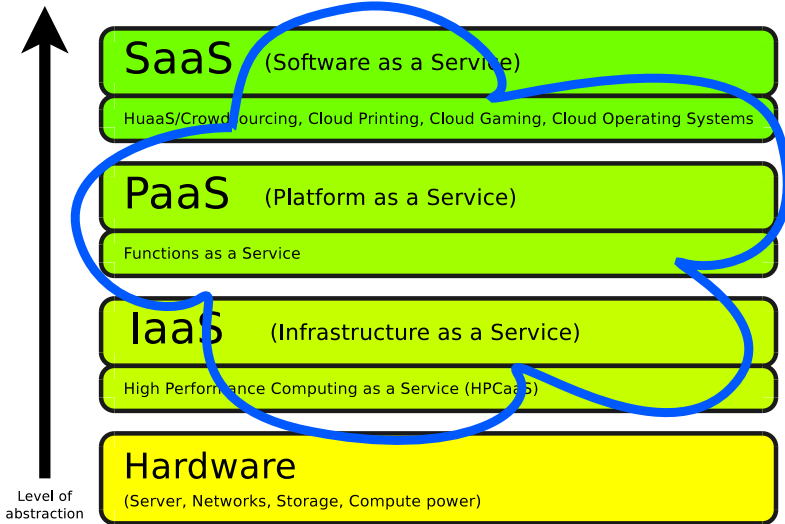
Aversion to Cloud Computing?

- Some reasons for aversion to Cloud Computing:
    - Hardware is *sexy*
    - (As much as possible) own hardware is impressive on the open house day
    - Difficult to describe feeling of insecurity
        - Storing own data outside the home, generates an *uneasy* feeling
    - *On my hardware I am the boss*
    - Administrators love their hardware
        - Despite all the work and frustration
        - Stockholm syndrome?!
    - Loss of hardware = loss of power and influence?
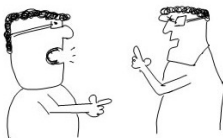
Someone must call a Doctor. . .

Why Cloud Computing? No Hardware...

Everything great, isn't it?

What Risks are Real?

- What is the availability of the data and services?
- Can data loss happen?
- Is data in Cloud services secure against unauthorized access?
- Can Cloud services be used to cause damages?
- Are the Cloud service providers trustworthy?

Cloud Computing
00000000000

SaaS, PaaS and IaaS
0000000000000000000000000000

Opportunities and Risks
00000●0000000000000000000

Current Situation
000000000000000000

Risks of Cloud Computing (2009)

November 10th, 2009, 10:48 GMT · By Lucian Constantin

Botnet Command and Control Server Hosted on Google App Engine

Security researchers have discovered a botnet that queried a rogue application hosted on Google's App Engine platform for commands. Its command and control server instructed infected computers ⧉ to download and install a backdoor component.

ENLARGE

The unusual piece of malware was discovered by researchers from network security company ⧉ Arbor Networks, who tracked its connections to a Google App Engine application. "The app in question is being used to feed URLs to the zombies for them to download," Jose Nazario, manager of security research at Arbor, explains.

The Google App Engine allows developers to run the Web applications on Google's infrastructure. Hosting an application that does not require more than 500 MB of storage space and five million page views per month is free. So far, the platform features a Java Runtime Environment ⧉ and a Python interpreter.

Google has been notified of the abuse and has taken the rogue application offline. Researchers were not able to uncover much of the specific commands that this botnet C&C server was able to give as they did not obtain access to the code hosted on Google App Engine.

The only relevant malicious behavior they noticed was the command to download a file called aa.exe from a third-party URL. This file is actually an installer for a backdoor component known as PCClient.

Another URL of the application appears to have been used to count visits to it, which might indicate the number of infected computers comprising the botnet. The monthly count at the time when the app was analyzed was 587.

This is not the first C&C server to be hosted on a public service ⧉. Several such sightings have been reported in recent months, beginning with a Twitter feed that was being used to relay commands to bots. Security researchers from Symantec later discovered a botnet that was using a Google group for a similar purpose.

Risks of Cloud Computing (2010)

06 April 2010, 12:46   « previous | next »

GhostNet 2.0 espionage network uses cloud services

Espionage network GhostNet, first identified about a year ago, is much larger and more sophisticated than previously assumed. This is according to a study entitled "Shadows in the Cloud", released today (Tuesday) by the Munk Centre for International Studies, the Information Warfare Monitor, the SecDev Group and the Shadowserver Foundation. GhostNet is essentially a botnet for distributing and controlling spyware.

In March 2009, whilst investigating a computer system belonging to the Tibetan government-in-exile in India, researchers at the Toronto-based Munk Centre for International Studies discovered the largest computer-controlled espionage network ever seen. The network, which they dubbed GhostNet, was controlled almost exclusively by computers located in China and had infiltrated 1,295 computers in 103 countries over a two year period.

Google's email service wipes entire email accounts of 150,000 Gmail users

- February 28th 2011

- http://www.dailymail.co.uk/sciencetech/article-1361334/

  Googles-email-service-wipes-entire-accounts-150-000-Gmail-users.html

About 150,000 Gmail users have had their accounts deleted, including every email, application, contact and calendar information, Google confirmed today.

. . .

One frustrated user wrote: „I have lost ALL on my emails/folders etc from Gmail. Why would this happen? How can I restore everything?"

Another said: „All my account settings, email, labels, contacts etc has just disappeared."

. . .

Back online? Google said it has already fixed the fault for some users and restored the missing data

„A firm believer in the concept of cloud computing, it never occurred to me that my Gmail account could one day disappear."

. . .

Reliability of of Cloud Services? (Similar Case)

Es war die schlimmste Erfahrung seines Berufslebens. „**Zwei Tage lang war unsere Firma komplett lahmgelegt**", sagt Bernhard Bahners, Gründer und Prokurist des Internet-Start-ups Radio.de. „Sie können sich gar nicht vorstellen, was hier los war!" Los war Folgendes: Niemand in der ganzen Firma konnte mehr auf irgendein internes Dokument zugreifen; Kunden wunderten sich, dass ihre E-Mails unbeantwortet blieben; **48 Stunden lang war die Firma ohne Daten und Büro-Software**. Dabei war an den beiden Standorten von Radio.de in Hamburg und Innsbruck technisch alles in Ordnung, die Computer liefen, die Datenleitungen funktionierten. Der Grund für den Totalausfall im vergangenen Dezember: ein **Fehler im Bezahlsystem von Google**.

Weil ein Rechnungsbetrag von wenigen Hundert Euro nicht abgebucht werden konnte, hatte der kalifornische Gigant der deutschen Firma kurzerhand den Zugang zu ihrer Büro-Software und den zugehörigen Unterlagen gesperrt. Ohne Vorwarnung. „Am liebsten hätte ich das Geld in einen Umschlag gepackt und persönlich hingetragen", sagt Bahners. Aber er habe nicht einmal gewusst, wohin. Für mittelständische europäische Kunden ist die Google-Niederlassung in Dublin zuständig, **telefonisch erreichbar ist sie jedoch nicht**. Und jene Hilferufe, die der entsetzte Bahners per E-Mail schickte und ins Formular auf der Google-Website eintrug, blieben zunächst unerhört.

Source: Dirk Asendorpf, Die Zeit, 17. Februar 2011, S.39

- Such things should not happen!

Availability

- For S3, Amazon guarantees 99.9% availability per month

	Downtime (HH:MM:SS)		
Availability	per day	per month	per year
99.9%	00:01:26	00:43:49	08:45:56
99%	00:14:23	07:18:17	87:39:29

- If availability falls below that, the customer gets a refund
- http://aws.amazon.com/s3-sla/

Monthly Uptime Percentage	Service Credit Percentage
Equal to or greater than 99% but less than 99.9%	10%
less than 99%	25%

Will a refund help any further, if the service fails and thus the own data is not available (or gone)?

Cloud Computing
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SaaS, PaaS and IaaS
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Opportunities and Risks
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Current Situation
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Amazon's US-Cloud Disturbed

gizmodo.com/5794420/when-the-amazon-cloud-goes-down-your-favorite-internet-time-sucks-go-with-it

When the Amazon Cloud Goes Down, Your Favorite Internet Time Sucks Go With It

Adrian Covert
Filed to: AMAZON   4/21/11 12:06pm

Amazon's EC2 cloud storage service had some problems while we were all sleeping last night (Read: IT CRASHED), causing a few websites we've come to know and love to take a brief nap (Read: THEY CRASHED).

EC2 is Amazon's scalable data center, which lets companies pay for more server storage and bandwidth on the fly, as they need it, which is especially useful for young, rapidly

manage their own servers. But when things like this happen, resolving the problem isn't entirely in their control. Affected in this whole mess are/were sites, apps and services such as Foursquare, Reddit, Cydia, Discovr and Scvngr.

No Explanation for the Failure of Amazon's Cloud Services

- 26.04.2011 14:14
- http://www.golem.de/1104/83028.html

Nach einem mehr als dreitägigen Ausfall sind die US-Cloud-Angebote von Amazon zwar wieder online - eine **Erklärung für die Defekte gibt es jedoch nicht**. Unter Onlineanbietern in den USA regt sich Unmut, einige Betreiber weisen zudem darauf hin, dass man sich **nicht allein auf Cloud-Dienste verlassen** dürfte.

Große Teile von Amazons Cloud-Angeboten mit dem Namen Amazon Web Services (AWS) sind über die Osterfeiertage in Nordamerika ausgefallen. Wie sich der Statusseite von AWS entnehmen lässt, begannen die Schwierigkeiten am 21. April 2011 und wurden erst am 24. April weitgehend behoben. Betroffen war den Statuseinträgen zufolge ein Rechenzentrum für den Dienst Elastic Compute Cloud (EC2) im US-Bundesstaat Virginia.

Aus diesen Einträgen geht jedoch nicht hervor, was die Probleme ausgelöst hat. Nur von Verbindungsproblemen zu den Webservern und den Datenbankservern untereinander ist die Rede. **Hunderte von Webseiten sollen dadurch offline gewesen sein**...

Permanent Loss of the Customer's Data

www.businessinsider.com/amazon-lost-data-2011-4

BUSINESS INSIDER   Tech   Finance   Politics   Strategy   Life   Entertainment

Amazon's Cloud Crash Disaster Permanently Destroyed Many Customers' Data

HENRY BLODGET
APR. 28, 2011, 7:10 AM   94,707   75

In addition to taking down the sites of dozens of high-profile companies for hours (and, in some cases, days), Amazon's huge EC2 cloud services crash permanently destroyed some data.

The data loss was apparently small relative to the total data stored, but anyone who runs a web site can immediately understand how terrifying a prospect any data loss is.

(And a small loss on a percentage basis for Amazon, obviously, could be catastrophic for some companies).

Um...

Amazon Explains its Cloud Server Failure

- 29.04.2011 16:51

- http://www.golem.de/1104/83140.html

Ein **Routingfehler** im Rahmen eines Netzwerkupgrades ist für den Ausfall von Amazons
Cloud-Servern verantwortlich. Der kleine Fehler führte zu einer Kettenreaktion, **langen Ausfällen**
und bei einigen Kunden sogar zu **Datenverlust**.

Eine Sache können auch die Amazon-Kunden machen, um die Auswirkungen solcher Ausfälle auf
ihr Geschäft zu verringern: Amazon bietet die Möglichkeit, **Dienste über mehrere
Verfügbarkeitszonen zu verteilen**. Wer das getan hat, sollte im aktuellen Fall **kaum Auswirkungen
gespürt** haben, da die Problematik weitgehend auf eine solche Verfügbarkeitszone beschränkt war.
Allerdings ist die Nutzung mehrerer Verfügbarkeitszonen mit etwas Aufwand auf Applikationsseite
verbunden. Das will Amazon künftig reduzieren, damit mehr Kunden ihre Angebote auf mehrere
Zonen verteilen können.

Kunden, deren Server oder Datenbanken auf EBS-Volumes in der betroffenen Zone zugegriffen
haben, gewährt Amazon **zehn Tage kostenlose Nutzung**, ganz gleich, ob ihre Server oder
Datenbanken von den Problemen direkt betroffen waren oder nicht. (ji)

...

Dropbox Security Bug Made Passwords Optional For Four Hours

- June 20th 2011
- http://techcrunch.com/2011/06/20/dropbox-security-bug-made-passwords-optional-for-four-hours/

This morning a post on Pastebin outlined a serious security issue that was spotted at Dropbox: for a brief period of time, the service allowed users to log into accounts using any password. In other words, you could log into someone's account simply by typing in their email address. Given that many people entrust Dropbox with important data (one of the service's selling points is its security), that's a really big deal.

We've now confirmed with Dropbox that the service did have this issue yesterday — Dropbox says that it began after a code push at 1:54 PM PDT and was fixed at 5:46 PM PDT (they had the fix live five minutes after they discovered it). So, in total, the bug was live for around four hours.

The question now is how many people were affected. The company will be announcing that „much less than 1 percent" of users logged in during this time, and that all sessions have now been logged out as a security precaution. The team is now investigating if any accounts were improperly accessed, and says that anyone who was impacted will be notified.

. . .

U.S. Authorities are Allowed to Access Cloud Data in Europe

- June 28th 2011
- http://www.zdnet.com/blog/igeneration/microsoft-admits-patriot-act-can-access-eu-based-cloud-data/11225

Summary: Microsoft's U.K. head admitted today that no cloud data is safe from the Patriot Act, and the company can be forced to hand EU-stored data over to U.S. authorities.

LONDON, U.K. – At the Office 365 launch, Microsoft U.K.'s managing director Gordon Frazer, gave the first admission that cloud data, regardless of where it is in the world, is not protected against the Patriot Act Act.

After a year of researching the Patriot Act's breadth and ability to access data held within protected EU boundaries, Microsoft was the first cloud provider to openly admit it.

The question put forward: „Can Microsoft guarantee that EU-stored data, held in EU based datacenters, will not leave the European Economic Area under any circumstances – even under a request by the Patriot Act?"

Frazer explained that, as Microsoft is a U.S.-headquartered company, it has to comply with local laws (the United States, as well as any other location where one of its subsidiary companies is based).

Though he said that „qustomers would be informed wherever possible," he could not provide a guarantee that they would be informed – if a gagging order, injunction or U.S. National Security Letter permits it.

He said: „Microsoft cannot provide those guarantees. Neither can any other company."

While it has been suspected for some time, this is the first time Microsoft, or any other company, has given this answer.

Any data which is housed, stored or processed by a company, which is a U.S. based company or is wholly owned by a U.S. parent company, is vulnerable to interception and inspection by U.S. authorities.

Microsoft previously opened up its Online Services Trust Center which explained in great detail how data was managed, handled and if necessary, handed over to the authorities.

Risks of Cloud Computing

- Main differences between the Cloud services:
    - Functionality
    - Availability / quality
    - Price
    - **Interface** ⟸ is often considered not important
- Risks of Cloud Computing:
    - Privacy and security
        - Solutions exist and not everything must be stored in the Cloud
    - Parental Computing
        - Contrast to personal computing
    - **Lock-in** (!!!)
        - Services and tools of the service providers only implement their own API

Risk of Lock-in

- If a customer decides to use a public Cloud service, he also decides to use a specific interface
- Potential issue: **Lock-in**
    - A dependency between the user and the provider of the service exists
- Scenarios: Price increases, provider bankruptcy, change of service offering (functionality),...
- A consequence of switching the provider is the **loss** of the infrastructure (**services**) and possibly even the **data**
    - Consequences for customers (especially companies) may be fatal
- If a customer uses a service for long term, he **invests** is in this service
    - The own business model is focused on the service
    - Employees are trained
    - Services are *refined*

Impact of the Lock-in for Dropbox

- Web service, started in 2007
- Provides a network file system for the synchronization of files between different computers and users
- Stores the users' files inside S3 (**see latest news on slide 61**)

Where does Dropbox store everyone's data?

Once a file is added to your Dropbox, the file is then synced to Dropbox's secure online servers. All files stored online by Dropbox are encrypted and kept securely on Amazon's Simple Storage Service (S3) in multiple data centers located across the United States.

Source: `https://www.dropbox.com/help/7/en/`

- Business model: **Refine a Cloud service**

- 🔴 What would be the impact on Dropbox, if S3 would double the price or close down?
- 🔴 What would be the impact on the customers of Dropbox and S3?
- 🔴 Is there anything which can be done against the risk of a lock-in?

Ways to avoid the Lock-in

- **Competitors**
  - Offer public services with the same functionality and API
    - For S3: Google Cloud Storage, HP Cloud Object Storage (†2016) , Connectria CS, Host Europe CS (†2014), Nirvanix (†2013), Dunkel Cloud Storage, Cloudian,...

- **(Free) implementations**
  - Running private Cloud services with the same functionality and API
    - For S3: Eucalyptus Walrus, Nimbus Cumulus, OpenStack Swift, Riak CS, Minio

Competitors and (free) solutions with compatible interface open up a lot of opportunities

Karlsruhe Open Application for cLoud Administration

- Users interact directly with infrastructure and storage services
  - Tools of providers normally only support few services
    $\implies$ Services are mostly isolated solutions

  - Wanted: **Marketplace portal** $\implies$ KOALA
    - Service, which integrates public and private services from different providers
  - Developed for the Google App Engine
    - Runs in a private context too
  - Challenges during the development:
    - Features of the (private) services
    - Quality of documentation

Project: https://github.com/christianbaun/koalacloud
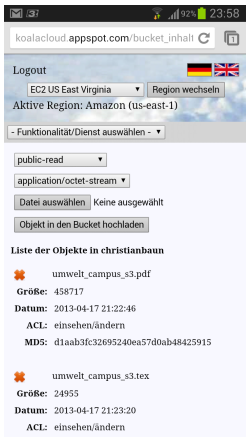
The KOALA Cloud Manager - **Cloud Service Management the Easy Way**. *Christian Baun, Marcel Kunze, Viktor Mauch*. Proceedings of the IEEE Cloud 2011 4th International Conference on Cloud Computing in Washington. ISBN:978-0-7695-4460-1
The KOALA Cloud Management Service - **A Modern Approach for Cloud Infrastructure Management**. *Christian Baun, Marcel Kunze*. Proceedings of the 1st International Workshop on Cloud Computing Platforms (CloudCP) that was part of the EuroSys 2011 in Salzburg. The Association for Computing Machinery (ACM). ISBN:978-1-4503-0727-7

Octopus Cloud Storage System
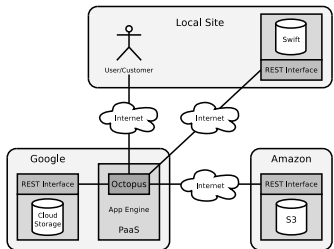
- Service, which connects S3-compatible storage service to a RAID 1
- Benefits:
    - Better availability of the data
    - Independence of individual providers
- Developed for the Google App Engine

- Copies files to the storage services and monitors the synchronicity via MD5 checksums
- Challenges of the development:
    - Behavior of services is not 100% identical

Project: https://github.com/christianbaun/octopuscloud
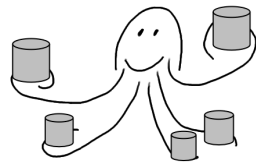
Octopus - A Redundant Array of Independent Services (RAIS). *Christian Baun, Marcel Kunze, Denis Schwab, Tobias Kurze*. Proceedings of the 3rd International Conference on Cloud Computing and Services Science (CLOSER 2013) in Aachen. SCITEPRESS. ISBN: 978-989-8565-52-5, P.321-328

And what does Dropbox? – They leave the Amazon Cloud

- *The Epic Story of Dropbox's Exodus From the Amazon Cloud Empire*

  Cade Metz, March 14th, 2016

  Source: https://www.wired.com/2016/03/epic-story-dropboxs-exodus-amazon-cloud-empire/

Over the last two-and-a-half years, Dropbox built its own vast computer network and shifted its service onto a new breed of machines designed by its own engineers, all orchestrated by a software system built by its own programmers with a brand new programming language.

. . . some companies get so big, it actually makes sense to build their own network with their own custom tech and, yes, abandon the cloud. Amazon and Google and Microsoft can keep cloud prices low, thanks to economies of scale. But they aren't selling their services at cost. . . . „There is some margin somewhere." If you're big enough, you can save tremendous amounts of money by cutting out the cloud. . . Dropbox says it's now that big.

The irony is that in fleeing the cloud, Dropbox is showing why the cloud is so powerful. It too is building infrastructure so that others don't have to. It too is, well, a cloud company.

Transition IT into the Era of Industrialization

- Carr describes the changes in IT, caused by inexpensive and highly available Cloud services and compares this changes with the industrial revolution 100 years ago
- Change in the economy and society have been caused by always available electrical energy
- Energy production in large power plants was cheaper than building bigger water wheels to self produce the energy
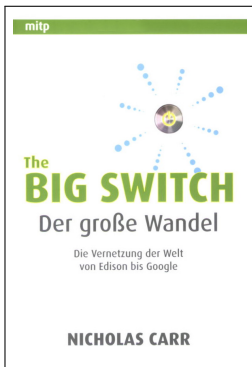
- A power grid arose and the transport of energy over long distances became possible
- This allowed to build up factories everywhere and not only near rivers
- Incorporating a companies became simplified by inexpensive energy. In Cloud Computing, it is similar
- Until now, most companies and universities operate their IT services themselves
- The consolidation in large-scale computing and data centers is less expensive and will become standard in the long term
- New business segments arise
- The impact on the business models of current IT market leaders such as Microsoft, IBM and SAP is immense

U.S. government closes nearly half of their Data Centers

Interview of the NYT with Vivek Kundra, Chief Information Officer of the Obama administration

...The federal government is the largest buyer of information technology in the world, spending about $80 billion a year. The Obama administration, in plans detailed Wednesday, is taking aim at some of that by closing 800 of its sprawling collection of 2,000 data centers. The savings, analysts say, will translate into billions of dollars a year and acres of freed-up real estate....

... the data center consolidation was part of a broader strategy to embrace more efficient, Internet-era computing. In particular, the government is shifting to cloud computing, in which users use online applications like e-mail remotely, over the Internet. These cloud services can be provided by the government to many agencies or by outside technology companies....

...But government officials say the federal agencies are moving faster than the initial plans, with a total of 195 closings now scheduled by the end of 2011. That would help lift the total to 373 data centers by the end of 2012.....

....„In an era of massive deficits, the federal government has to figure out ways to get more efficient. The data center consolidation is part of that process."

„The shift to modernized computer services has already started. For example, nearly 140,000 employees at the General Services Administration and Department of Agriculture have moved to cloud-based e-mail, Mr. Kundra said, saving about $42 million a year. Google provides the cloud e-mail for the G.S.A, while a Microsoft cloud service is used by the Agriculture Department.

Source: http://www.nytimes.com/2011/07/20/technology/us-to-close-800-computer-data-centers.html

Industry reacts by offering specialized Services

Is Cloud Computing still a Hype?

- Is Cloud Computing still a topic, which is helpful to apply for funding?
- Is Cloud Computing still a Hype?
    - Or is it an established and fully developed technology?
- 2 ways to check the „hype status" of a technology
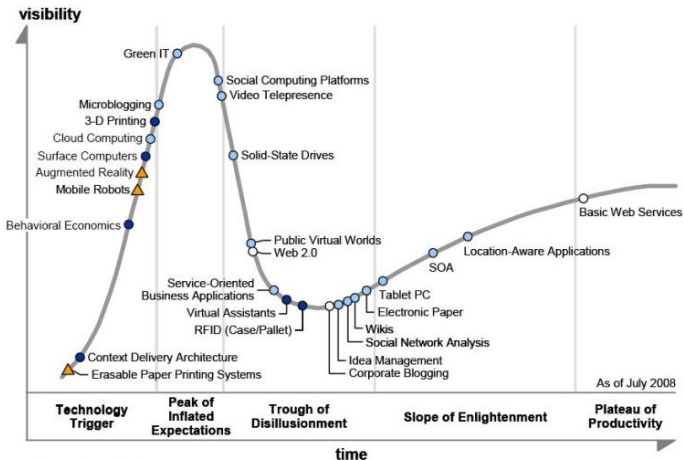   - **Gartner Hype Cycle** for Emerging Technologies
    - **Google Trends** (http://www.google.de/trends/)

Cloud Computing
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SaaS, PaaS and IaaS
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Opportunities and Risks
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Current Situation
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Gartner Hype Cycle

Image source: Wikipedia
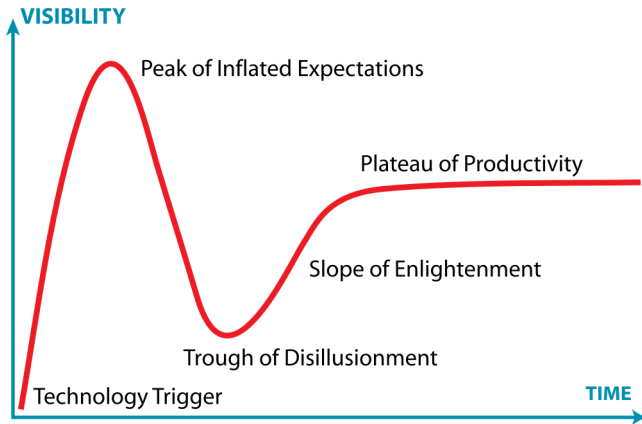
- Phases of public attention during the introduction of a new technology

Gartner Hype Cycle 2008

Figure 1. Hype Cycle for Emerging Technologies, 2008

Gartner Hype Cycle 2009

Figure 1. Hype Cycle for Emerging Technologies, 2009
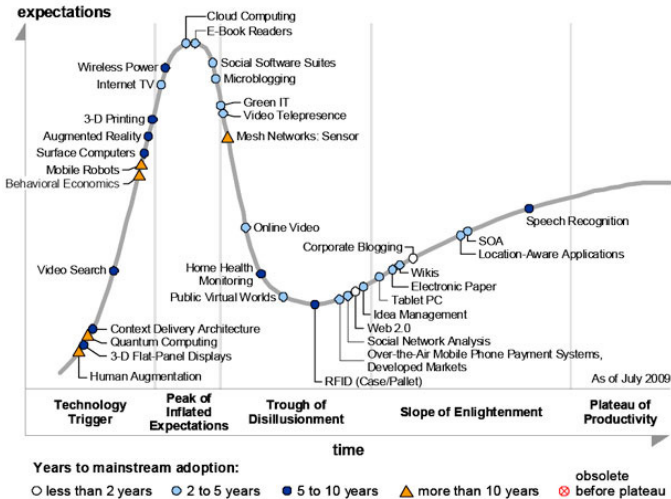
Gartner Hype Cycle 2010
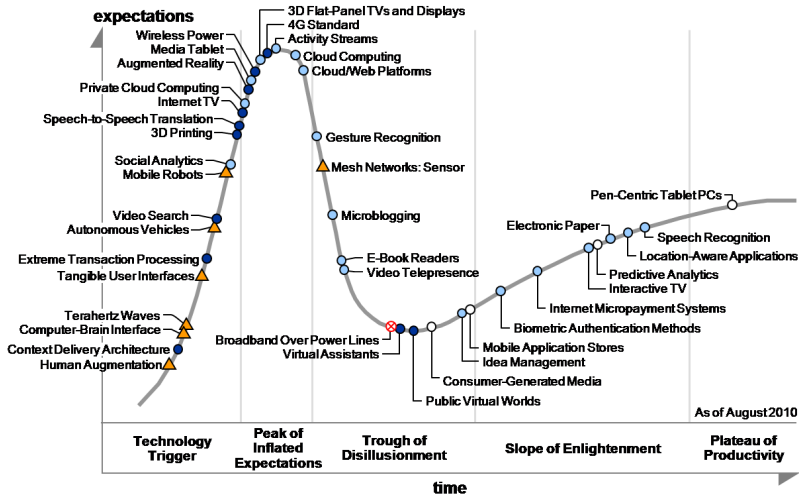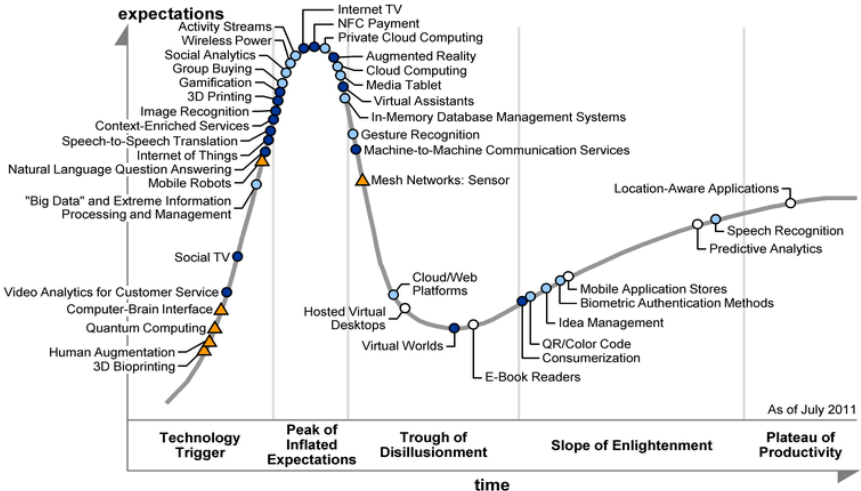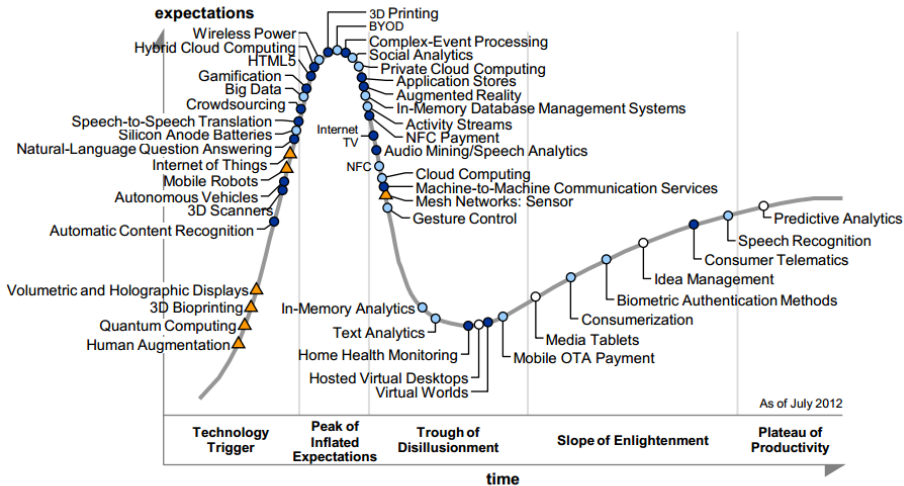
Gartner Hype Cycle 2011

Gartner Hype Cycle 2012

Gartner Hype Cycle 2013
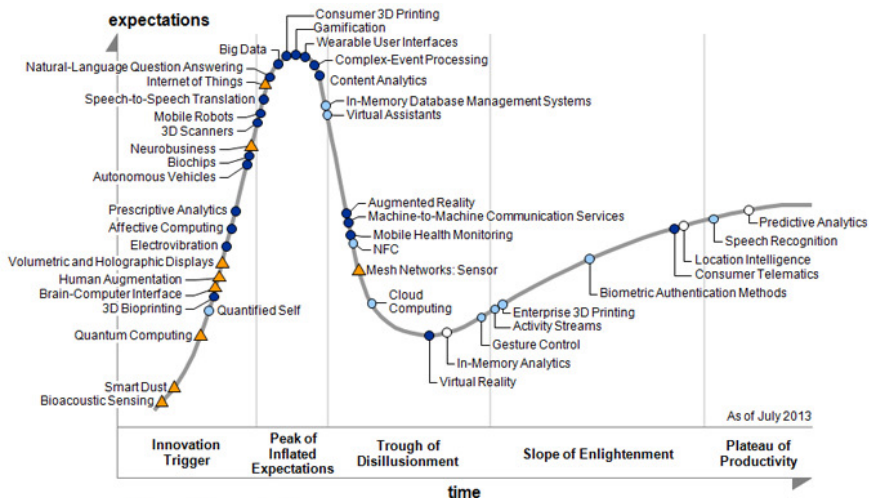
Gartner Hype Cycle 2014
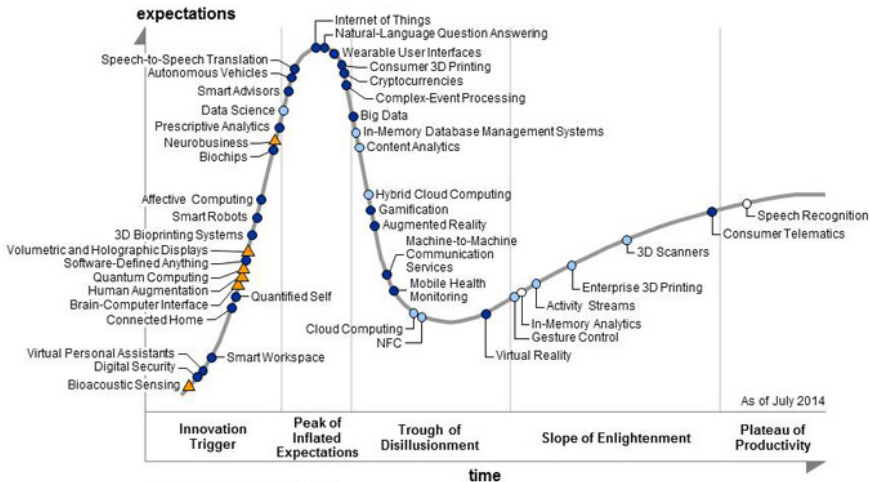
Gartner Hype Cycle 2015

Cloud Computing
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SaaS, PaaS and IaaS
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Opportunities and Risks
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Gartner Hype Cycle 2016

Gartner Hype Cycle 2017

Cloud Computing
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SaaS, PaaS and IaaS
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Opportunities and Risks
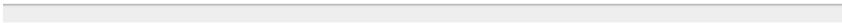○○○○○○○○○○○○○○○○○○○○○○○○

Current Situation
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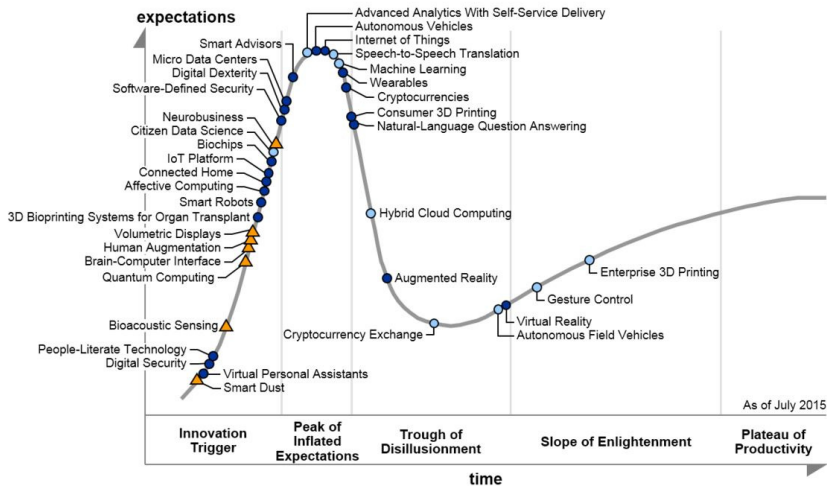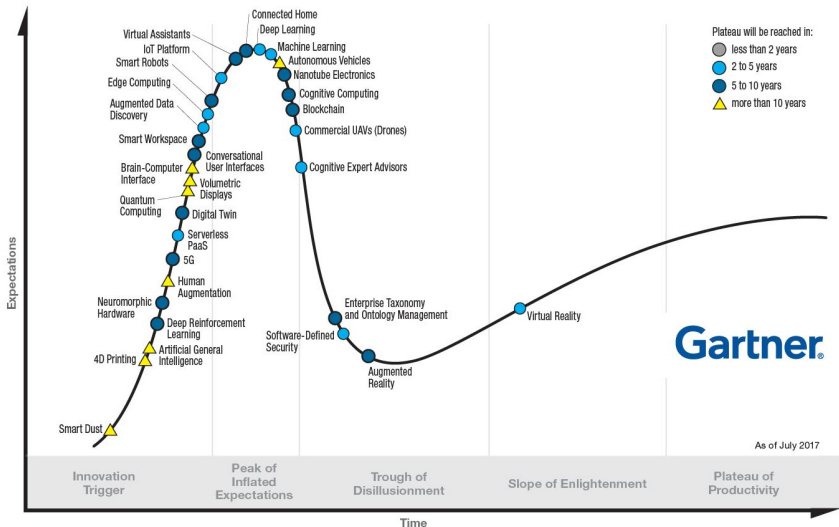
Opportunities and Risks

- Cloud Computig not an IT hype any more
  - but some cloud-related technologies are still IT hypes
- Cloud Computing can help to industrialize the IT
- Opportunities and risks exist – as with all IT solutions