クラウドコンピューティング基礎論

第１回

創造情報•小林克志

ikob@acm.org

Copyright (c) 2018, Katsushi Kobayashi. All rights reserved.

Outline

1. Administrivia
2. Definition of cloud computing

I-REF trivia

- Hilobby will close at 6PM on weekday.
  - Men’s restroom without valid ID is ONLY at 1st floor.
  - 3rd to 5th floors under ID card security, even during office hours.
- Return power-plug cover to the original position.

Who am I ?

- Katsushi Kobayashi
  - Project Associate Professor in charge of enPiT project.
- http://www.ci.i.u-tokyo.ac.jp/~ikob
- Office hours: Not defined.
  But, any students are welcome at my office located at 4th floor of I-REF.

Who I am?

Affiliations

Collaborations

Contributions

http://www.ci.i.u-tokyo.ac.jp/~ikob

Who am I ? (contd.)

量子化学

電気通信大学

1993

1998

NTT マルチメディア共同利用プロジェクト

標準化(1)

実時間映像通信システム、IEEE1394(5)

情報通信研究機構（通信総合研究所）

2006

ネットワークの見える化（クロスレイヤ）[CMU との共同研究](4)

アジア太平洋先端研究ネットワーク

APAN 運用、米国学術ネットワーク計測(3)

産業技術総合研究所

2010

アクセス網のクラウド化

FAIN: スケーラブルな並列ネットワークアーキテクチャ(2)

理化学研究所計算科学研究機構

2013

「京」の対外ネットワーク HPCI の技術調整

東京大学情報理工学研究科

ネットワーク遅延制御に関する研究開発

enPiT

(1) K. Kobayashi *et al.*, “RTP Payload Format for DV (IEC 61834) Video,” RFC 6469, 2012
(2) K. Kobayashi, “Flexible arrays of inexpensive network (FAIN): toward global parallelism in the internet to satisfy future traffic growth,” ACM ReArch, 2008
(3) Z. Shu and Katsushi Kobayashi, “Rtanaly: a system to detect and measure IGP routing changes,” IEEE IPOM, 2005
(4) K. Nakauchi and K. Kobayashi, “An explicit router feedback framework for high bandwidth-delay product networks,” COMNET, 2007
(5) K. Kobayashi, “Design and Implementation of Firewire device driver on FreeBSD,” USENIX ATEC 99

What is enPiT ?

- MEXT funded a new IT education project called
  - 分野・地域を越えた実践的情報教育協働ネットワーク (enPiT1)

    クラウド実践道場 (FY12 - 16, 阪大)

    enPiT-セキュリティ (SecCap) (FY12 - 16)
  - 高度IT人材を育成する産学協働の実践教育ネットワーク (enPiT2)

    ビッグデータ・AI 分野 (FY16 - FY20)
- Unfortunately, the project target is not graduate course student, but undergraduates.
  However, UT continues both enPiT1 courses without external support.

Class Outline

1. Administrivia
2. Cloud computing
3. Service reliability
4. Distributed data stores
5. Global services
6. Datacenter networkings (1)
7. Datacenter networkings (2)
8. Network performance
9. User experiences
10. Network latencies
11. Advanced topics

Class Information

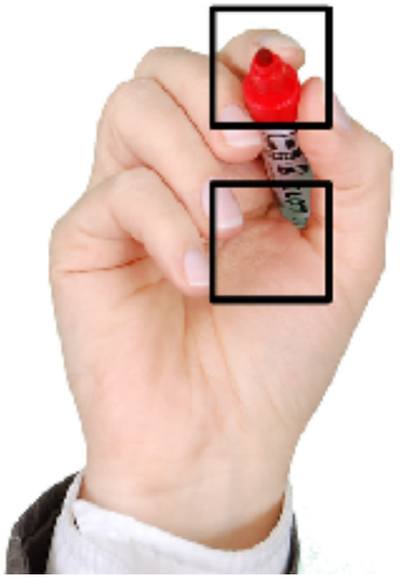
- Provided by Web page:
  http://www.ci.i.u-tokyo.ac.jp/~ikob/lecture/2018-fcloud
  - Includes report submissions/roll calls/materials.
  - An authorization is required for access:
    User: cloud
    Pass: cloud!2018

Requirements

- Bring your own laptop computer.
  - WiFi connectivities are provided : “ist-members” or “iref-guest”.
- Student have to setup a virtualization system on own laptop for assignments for later classes either :
  - VM hypervisor, e.g., Oracle VirtualBox
  - Docker system
    - VM image or Docker containers will be provided with instructions.

Grade Policy

- Course comprises lectures (2/3) and exercises (1/3).
- Grade by achievements of :
  - Quiz and/or homework at each class
    - Quiz due during the class period, instead of roll call.
    - Homework due at the two days before the next class (or next Tuesday).
- Exercises
- Final report instead of exam
  Will submit review report for a paper on the reading list.
  Reading list will be given during the course.



Class objectives

- Understand state of the art in “cloud computing” infrastructure.
  - Discuss technologies on datacenter and network from the viewpoint of qualities, such as, reliability, user experience.
  - Review relating topics both in terms of practical and research approaches.
  - Get skills to resolve relating issues through process cycles, i.e., identify, understand, verify and resolve.

One more thing…

- This course is practical.
  In other words, less- systematic and organized.

- Cloud computing :
  - Practical approach with existing technologies, even some of which are immature.
  - The technologies include not only of computing, but of broader areas, e.g., building facility, power grid, submarine-cable systems.

Issues in operations are not simple.

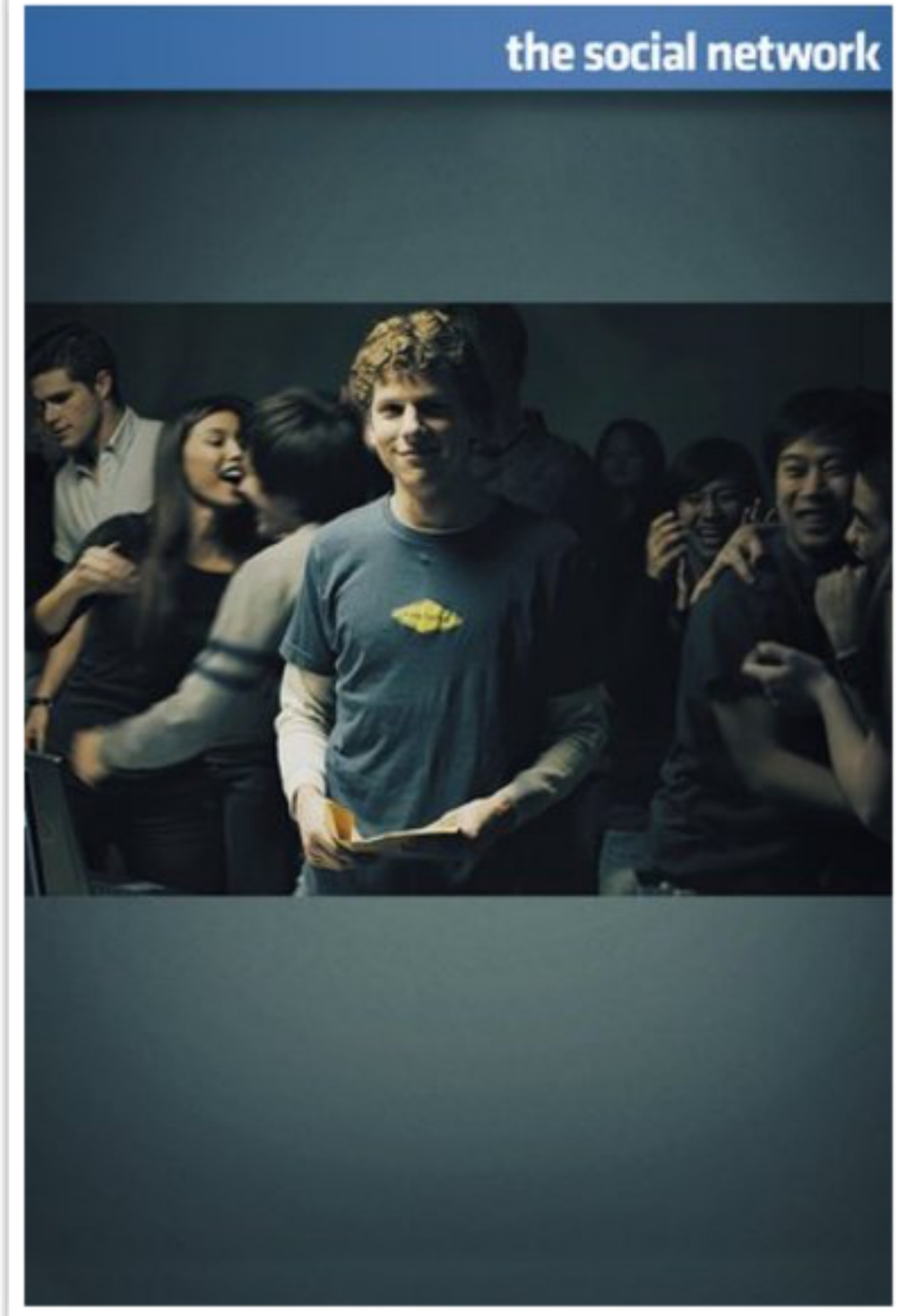
- Your customer will ask questions like :
  - The performance is degraded.
  - Stuck during actions.
  - Not working smoothly.
  - Something different from the yesterday.
- You must resolve it under such obscure situations.

Outline

1. Administrivia
2. Definition of cloud computing

Cloud computing : Background

- Adaptation to changing market.
  - To develop service with limited resources, e.g., engineer, time, $$$
    - Small start, Iterative improvement and feedback from customer.
    - Development style shifts from water-fall to agile.
- To scale service on demand.
  - Nobody can predict a service demand before its start.
  - But, missing opportunity should be avoided.

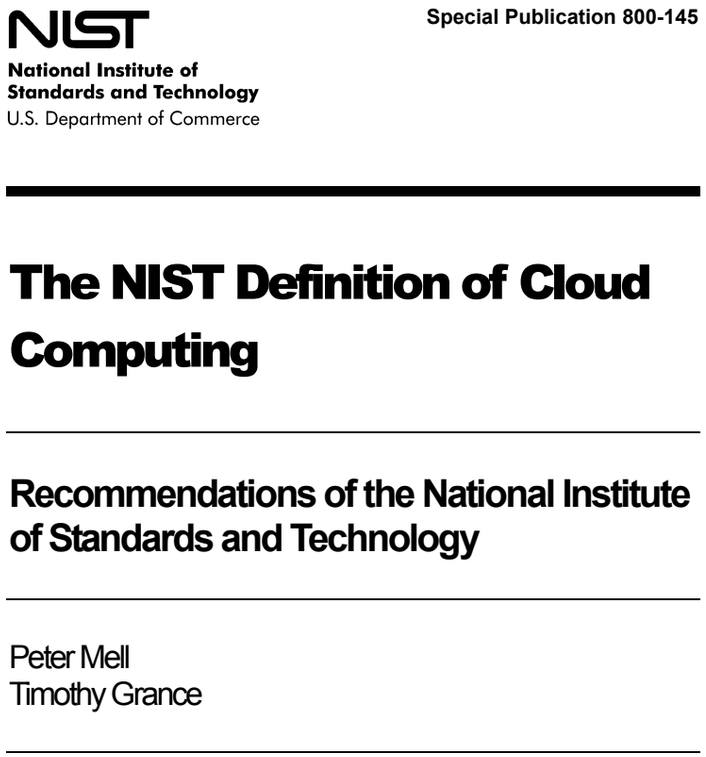

the social network

Cloud computing : Recognition in Japan

- “Household eco-point (エコポイント)” system provided by Salesforce.
  - Reward program by Japanese government from 2009 to stimulate economy:
    - Switch more ecological house appliances.
    - Terrestrial digital TV broadcast.
- Tight and hard conditions :
  - Only one-month development after the decision.
    - Impossible to build from scratch, e.g., to acquire datacenter space, server hardware.
  - Must release all resources after the program.
  - 20M applications expected, but 45M in actually.

Cloud Computing : NIST definition

“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. This cloud model is composed of five essential characteristics, three service models, and four deployment models.”



NIST
National Institute of Standards and Technology
U.S. Department of Commerce

Special Publication 800-145

The NIST Definition of Cloud Computing

Recommendations of the National Institute of Standards and Technology

Peter Mell
Timothy Grance

Mell, Peter, and Tim Grance. "The NIST definition of cloud computing." (2011).

Cloud : Five essential characteristics

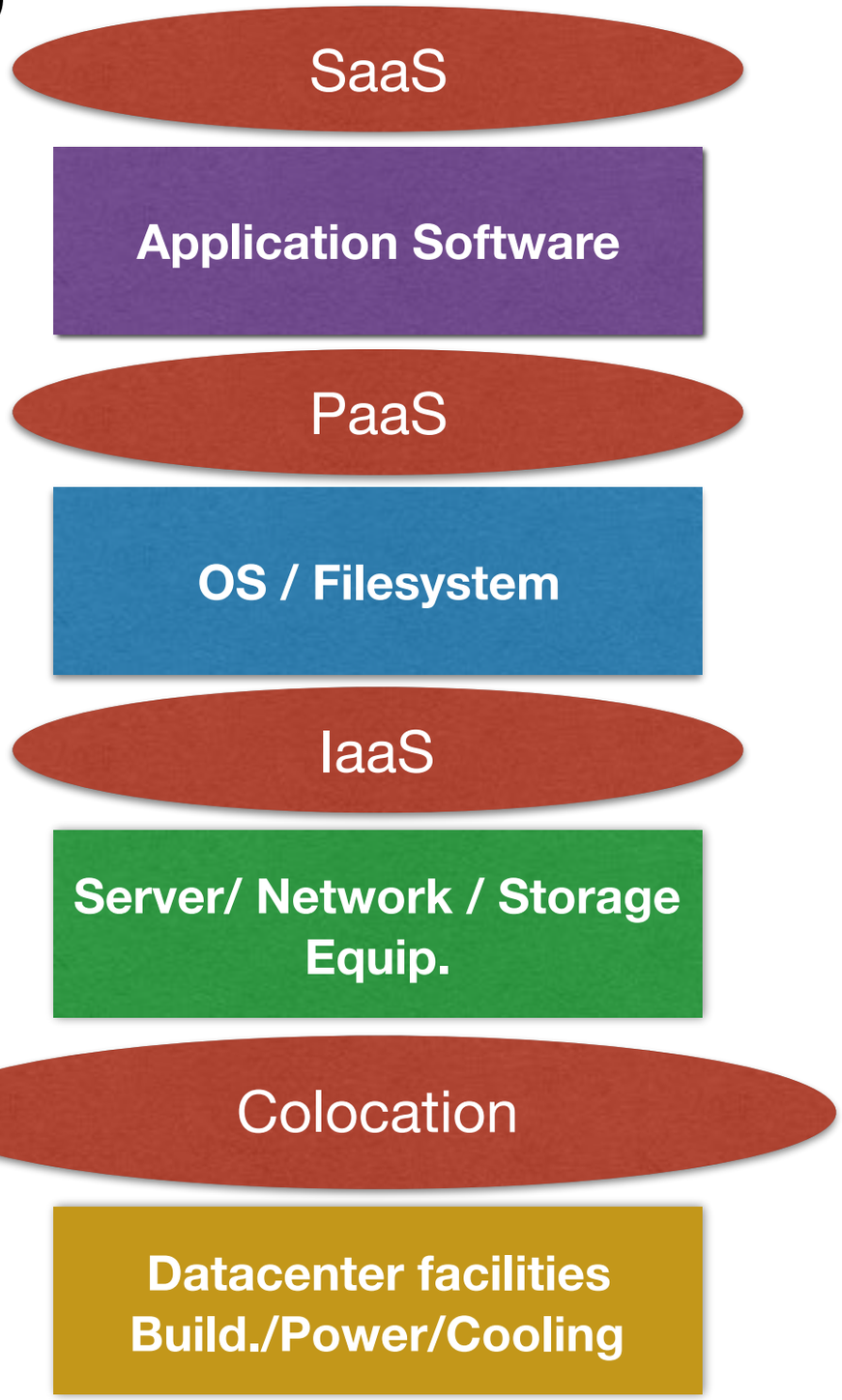
1. On-demand Self-service
    - provision computing capabilities without requiring human interaction
2. Broad network access
3. Resource pooling
    - location independence
4. Rapid elasticity
    - provisioned and released, to scale rapidly outward and inward
5. Measured service
    - metering capability, e.g., storage, processing, memory, network bandwidth, user-accounts

Mell, Peter, and Tim Grance. "The NIST definition of cloud computing." (2011).

Cloud : Three service models 1/3

1.Software as a Service (SaaS) :

- “The capability provided to the consumer is to use the provider’s applications running on a cloud infrastructure. The applications are accessible from various client devices through either a thin client interface, such as a web browser (e.g., web-based email), or a program interface. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, storage, or even individual application capabilities, with the possible exception of limited user- specific application configuration settings.”
- e.g., Google Docs, Office 365, Salesforce CRM, SAP ERP



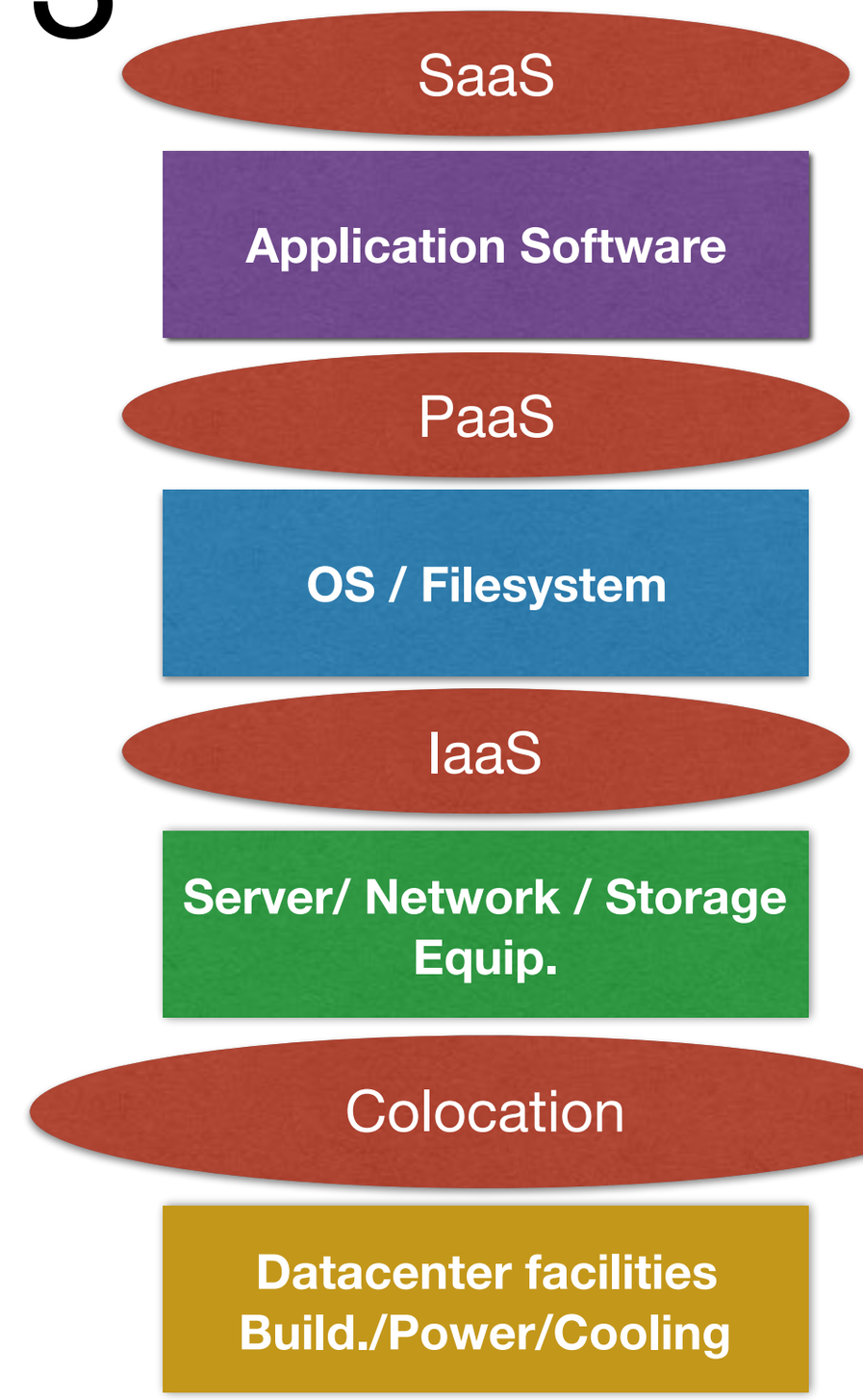
Mell, Peter, and Tim Grance. "The NIST definition of cloud computing." (2011).

Cloud : Three service models 2/3

2.Platform as a Service (PaaS)

- “ The capability provided to the consumer is to deploy onto the cloud infrastructure consumer-created or acquired applications created using programming languages, libraries, services, and tools supported by the provider. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, or storage, but has control over the deployed applications and possibly configuration settings for the application-hosting environment.”
- e.g., Google App Engine, Amazon Elastic Beans Talk, Heroku

Mell, Peter, and Tim Grance. "The NIST definition of cloud computing." (2011).

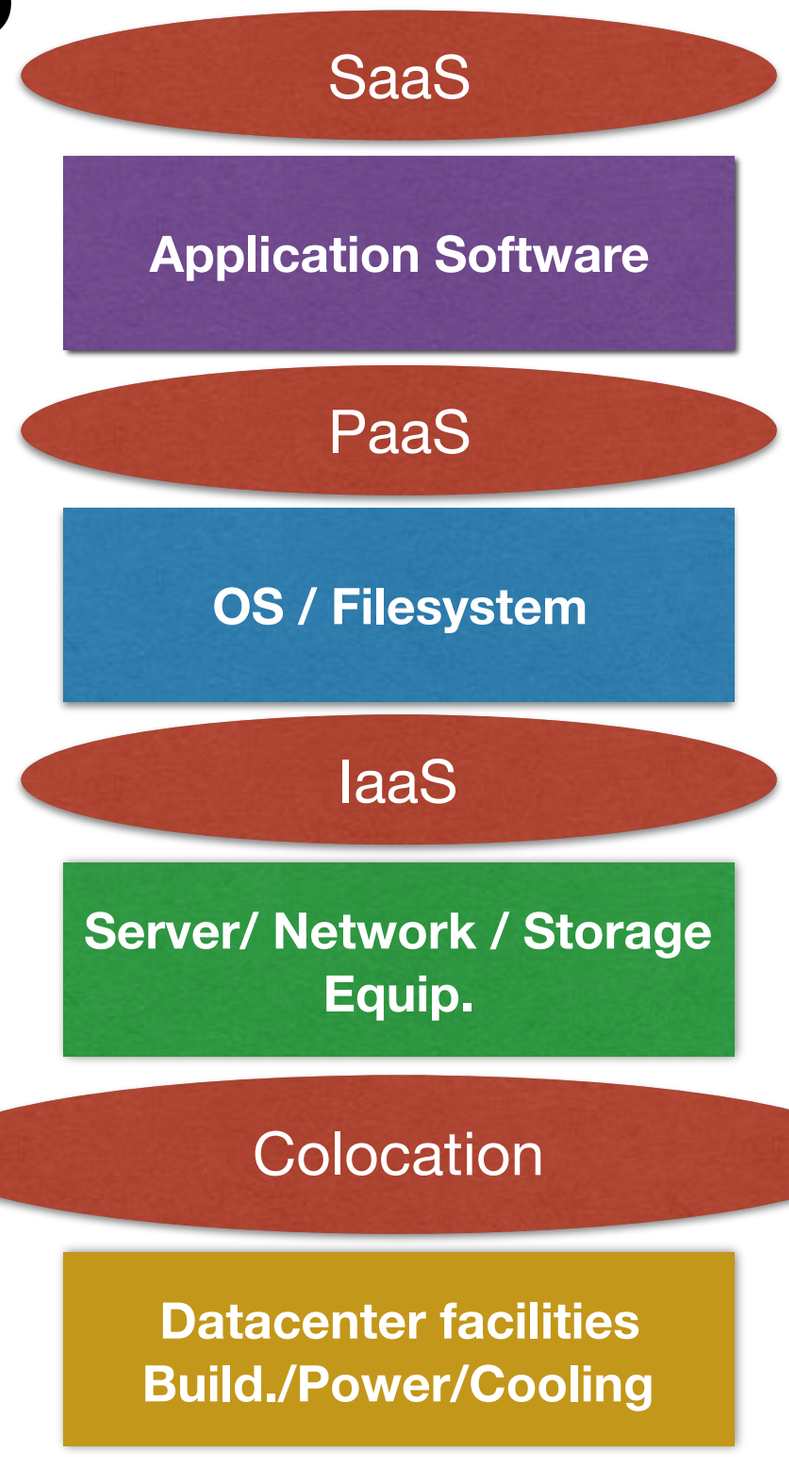


Cloud : Three service models 3/3

3.Infrastructure as a Service (IaaS)

- “The capability provided to the consumer is to provision processing, storage, networks, and other fundamental computing resources where the consumer is able to deploy and run arbitrary software, which can include operating systems and applications. The consumer does not manage or control the underlying cloud infrastructure but has control over operating systems, storage, and deployed applications; and possibly limited control of select networking components (e.g., host firewalls).”
- e.g., Amazon EC2, Microsoft Azure

Mell, Peter, and Tim Grance. "The NIST definition of cloud computing." (2011).

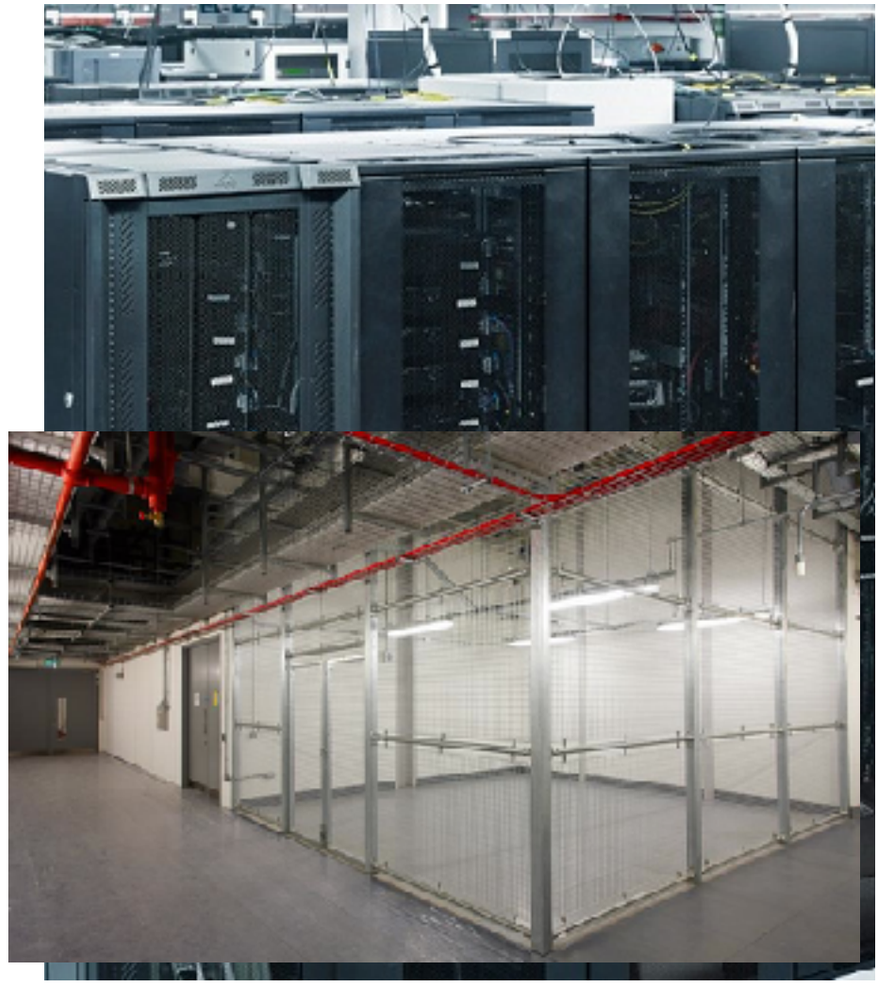


Cloud service models

	customer effort	# users / HW	revenue model	Implementations
SaaS	Application setting/ Using API	?	Charge to user, Advertisement,…	Rekognition, Route53
PaaS	Control deployed application	< 100	Charge per container, storage	EC2 Container Service (ECS)
IaaS	OS / Application / Limited network	# of CPU cores	Charge per VM	AWS EC2
Server Hosting	OS / Application / Server / Network	1	Charge per Server	AWS EC2 (dedicated server)

Four deployment models

1. Private cloud
   - Exclusive use by a single organization or business unit.
   - Either On-/Off- premiss
2. Community cloud
   - Exclusive use by a specific community, e.g., government.
   - Either On-/Off- premiss
3. Public cloud
   - Open use, Off- premiss.
4. Hybrid cloud



Shared / Dedicated server space in a DC floor

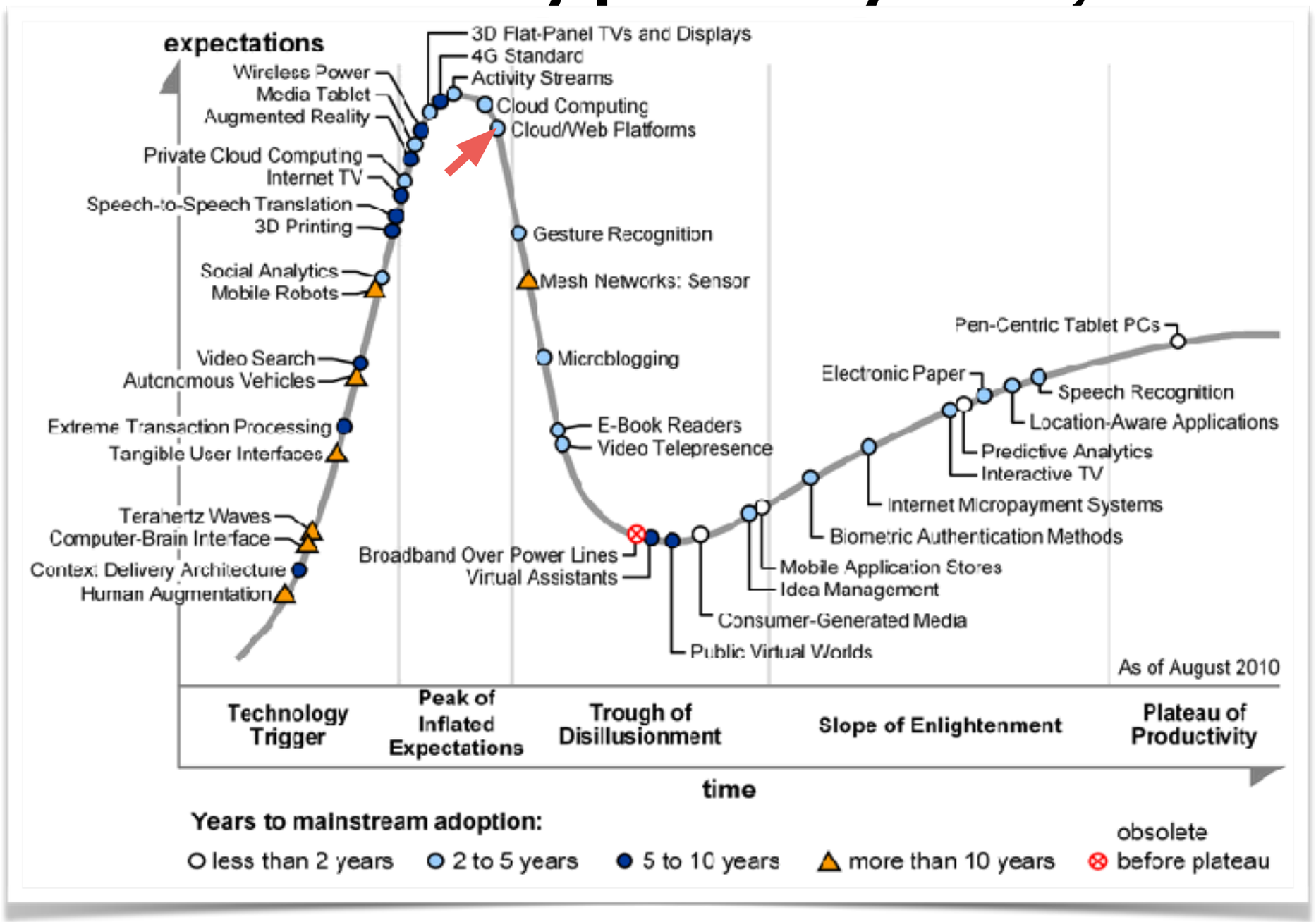
http://www.telehouse.net/

In fact, “Cloud computing”

- A buzzword for business
- Some of “cloud computing” service is just replaced its names / brandings:
    - Datacenter collocation / Renting servers
    - To focus hardware / System Integrator
    - Formerly called Application Service Provider (ASP), or Grid Computing.
- However, one of the hottest area in computer industry.
    - One of the most growth sector*

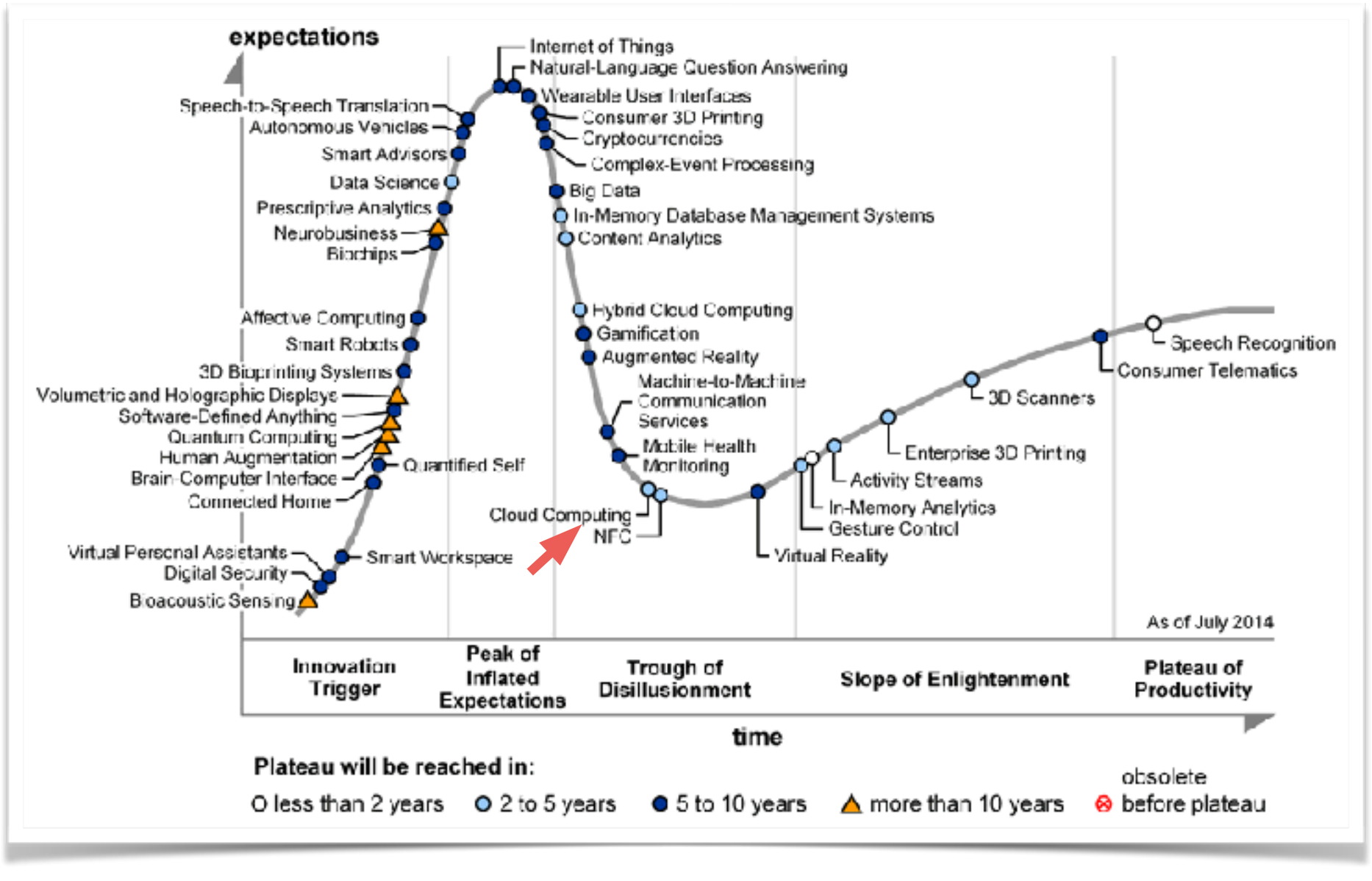
        * http://www.businessinsider.com/this-chart-from-ibm-explains-why-cloud-computing-is-such-a-game-changer-2014-4

Cloud computing in Gartner's Hype Cycle, 2010



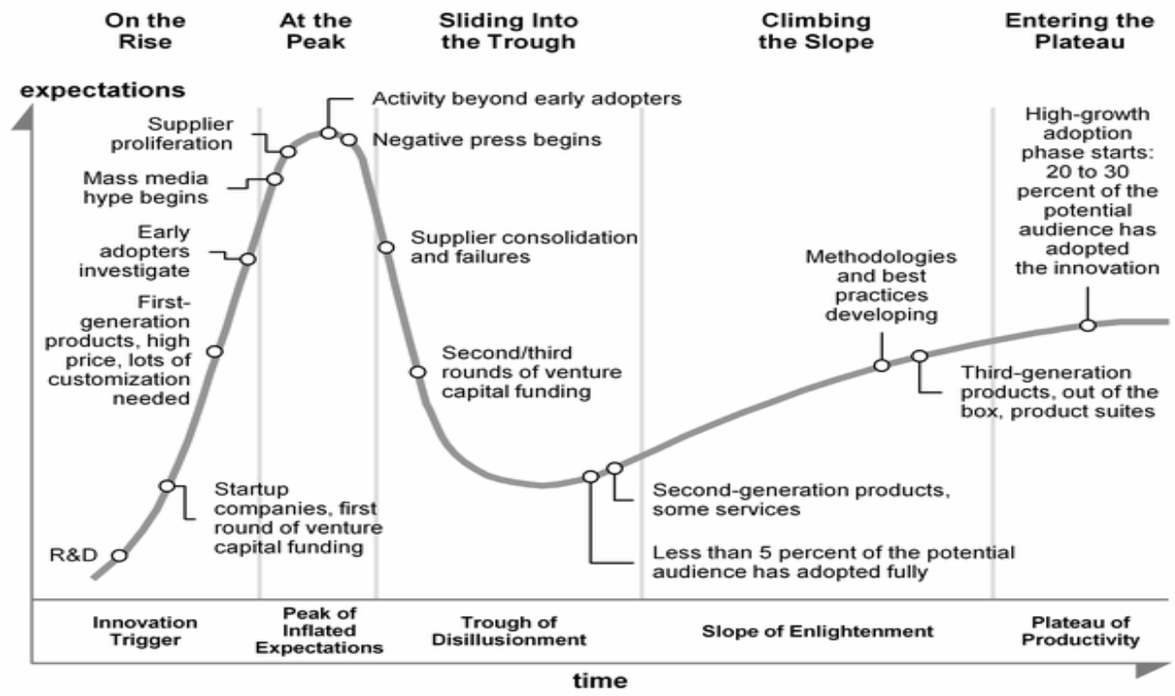
Gartner, "Applying Lessons From 20 Years of Hype Cycles to Your Own Innovation and Forecasting Strategies", 2014

Cloud computing in Gartner's Hype Cycle, 2014



Gartner, "Applying Lessons From 20 Years of Hype Cycles to Your Own Innovation and Forecasting Strategies", 2014

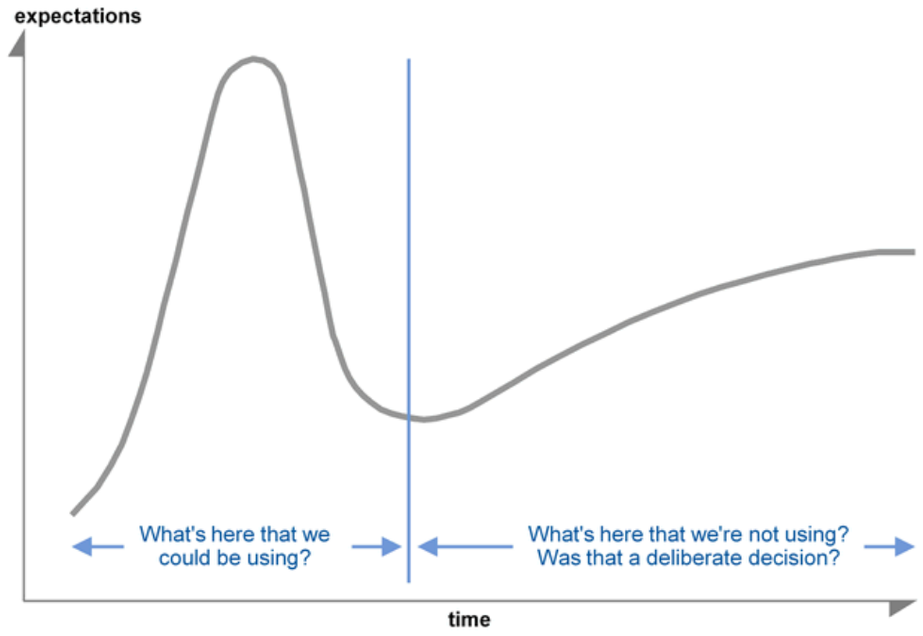
Understanding Gartner's Hype Cycle



 CONFIDENTIAL AND PROPRIETARY | © 2015 Gartner, Inc. and/or its affiliates. All rights reserved. Gartner and ITxpo are registered trademarks of Gartner, Inc. or it's affiliates.

Gartner

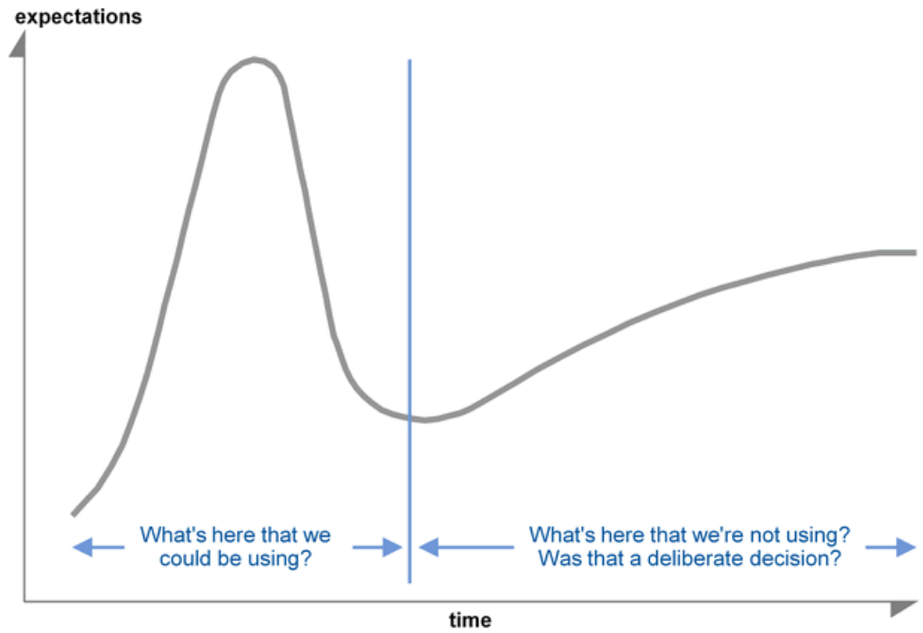
Key Hype Cycle Questions



 CONFIDENTIAL AND PROPRIETARY | © 2015 Gartner, Inc. and/or its affiliates. All rights reserved. Gartner and ITxpo are registered trademarks of Gartner, Inc. or it's affiliates.

Gartner

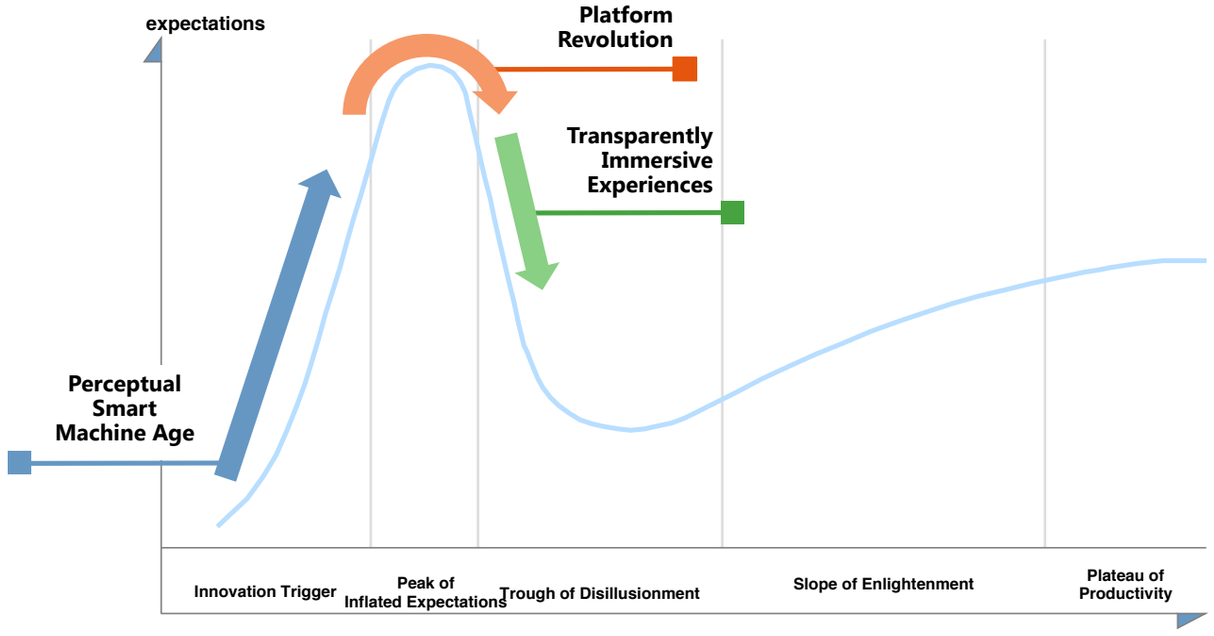
Key Hype Cycle Questions



CONFIDENTIAL AND PROPRIETARY | © 2015 Gartner, Inc. and/or its affiliates. All rights reserved. Gartner and ITxpo are registered trademarks of Gartner, Inc. or it's affiliates.

Gartner

Emerging Technology Trends

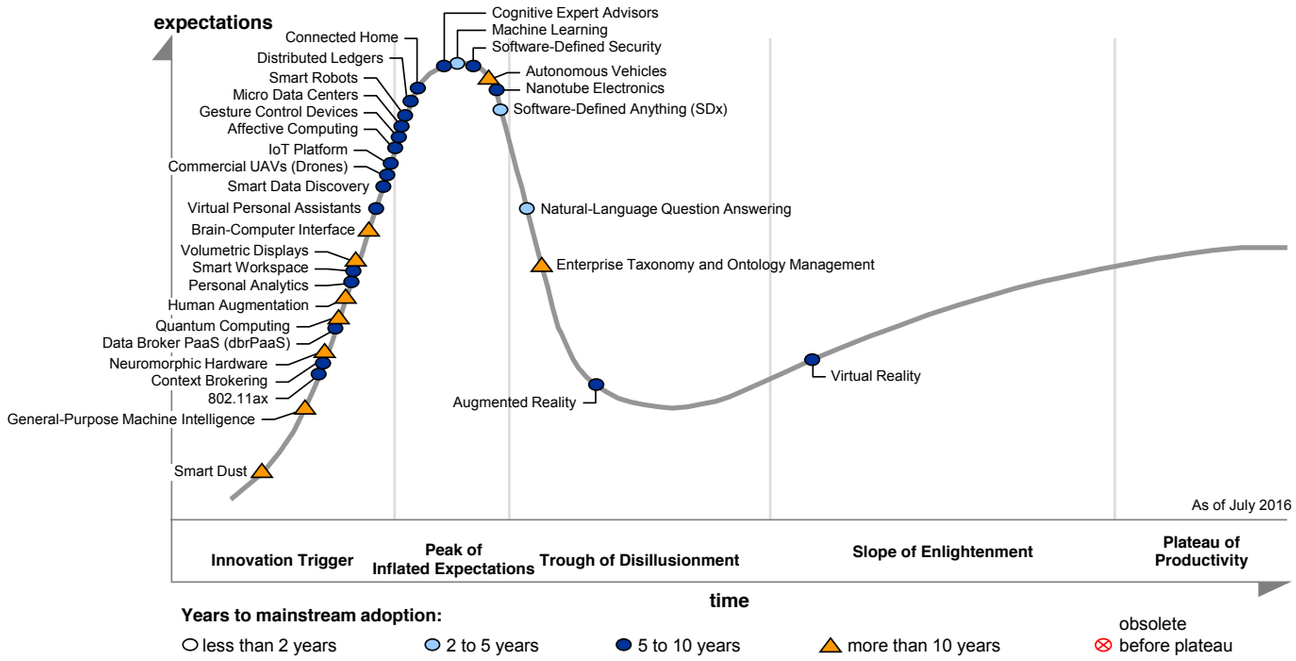


#GartnerSYM

CONFIDENTIAL AND PROPRIETARY | © 2015 Gartner, Inc. and/or its affiliates. All rights reserved. Gartner and ITxpo are registered trademarks of Gartner, Inc. or it's affiliates.

Gartner

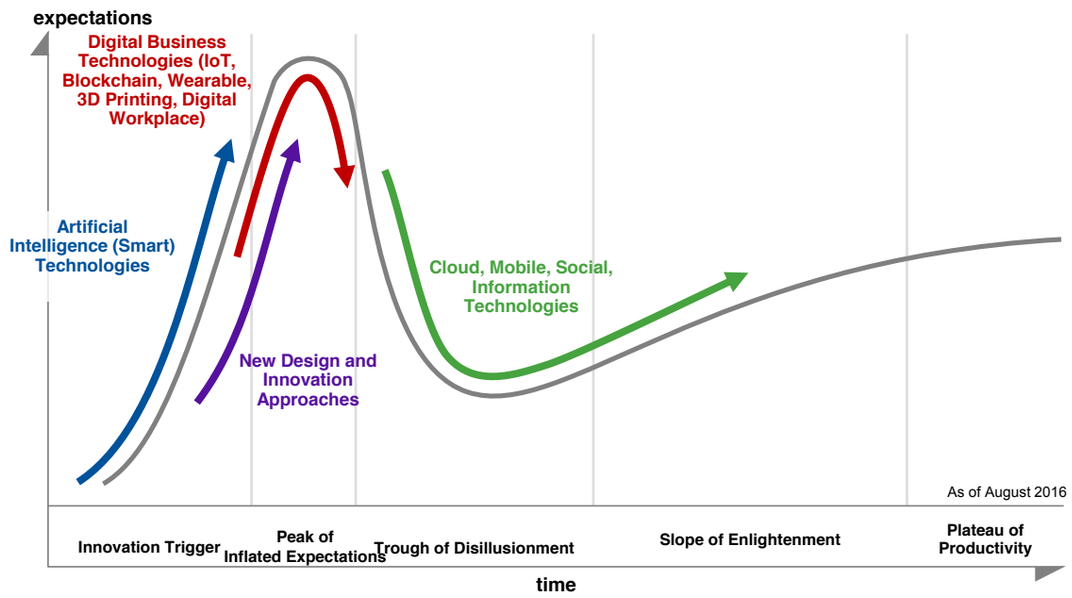
Hype Cycle for Emerging Technologies, 2016



From "Hype Cycle for Emerging Technologies, 2016," 19 July 2016 (G00299893)

Gartner

2016 Megatrends Driving Significant Profile Shifts



CONFIDENTIAL AND PROPRIETARY | © 2015 Gartner, Inc. and/or its affiliates. All rights reserved. Gartner and ITxpo are registered trademarks of Gartner, Inc. or it's affiliates.

Gartner

Student Polling

- Fill the polling form from:
  https://form.jotform.me/81073730442450
- Note that the polling records are regarded as today’s roll call. So, every student must fill it.