Distributed Systems

Cloud Fundamentals

The Path to cloud computing

- Cloud computing is based on ideas and the experience accumulated in many years of research in parallel and distributed systems.
  - Cloud applications are based on the client-server paradigm with a relatively simple software, a thin-client, running on the user's machine, while the computations are carried out on the cloud.
  - Concurrency is important; many cloud applications are data-intensive and use a number of instances which run concurrently.
  - Communication is at the heart of cloud computing. Communication protocols, coordination of distributed processes etc

Cloud Computing

- Cloud Computing: emerging paradigm promising to turn the vision of computing utilities" into a reality
- A new approach to design systems and applications based on "dynamic provisioning"
- Service orientation and virtualisation
- Advantages?
- Lack of standardisation

Definition

- Cloud Computing refers to both the applicatios delivered as services over the Internet and the hardware and system software in the datacenters that provide those services
- Cloud 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.
- A cloud is a type of parallel and distributed system consisting of a collection of interconnected and virtualised computers that are dynamically provisioned and presented as one or more unified computing resources based on service-level agreements established through negotiation between the service provider and consumers

The Cloud

- Historical roots in today's Internet apps
  - Search, email, social networks
  - File storage (Live Mesh, Mobile Me, Flicker, …)
- A cloud infrastructure provides a framework to manage scalable, reliable, on-demand access to applications
- A cloud is the "invisible" backend to many of our mobile applications
- A model of computation and data storage based on "pay as you go" access to "unlimited" remote data center capabilities

The Next Revolution in IT
Cloud Computing

- **Classical Computing**
  - **Buy & Own**
    - **Hardware, System Software, Applications often to meet peak needs.**
  - **Install, Configure, Test, Verify, Evaluate**
  - **Manage**
  - **..**
  - **Finally, use it**
  - **$$$$....$(High CapEx)**

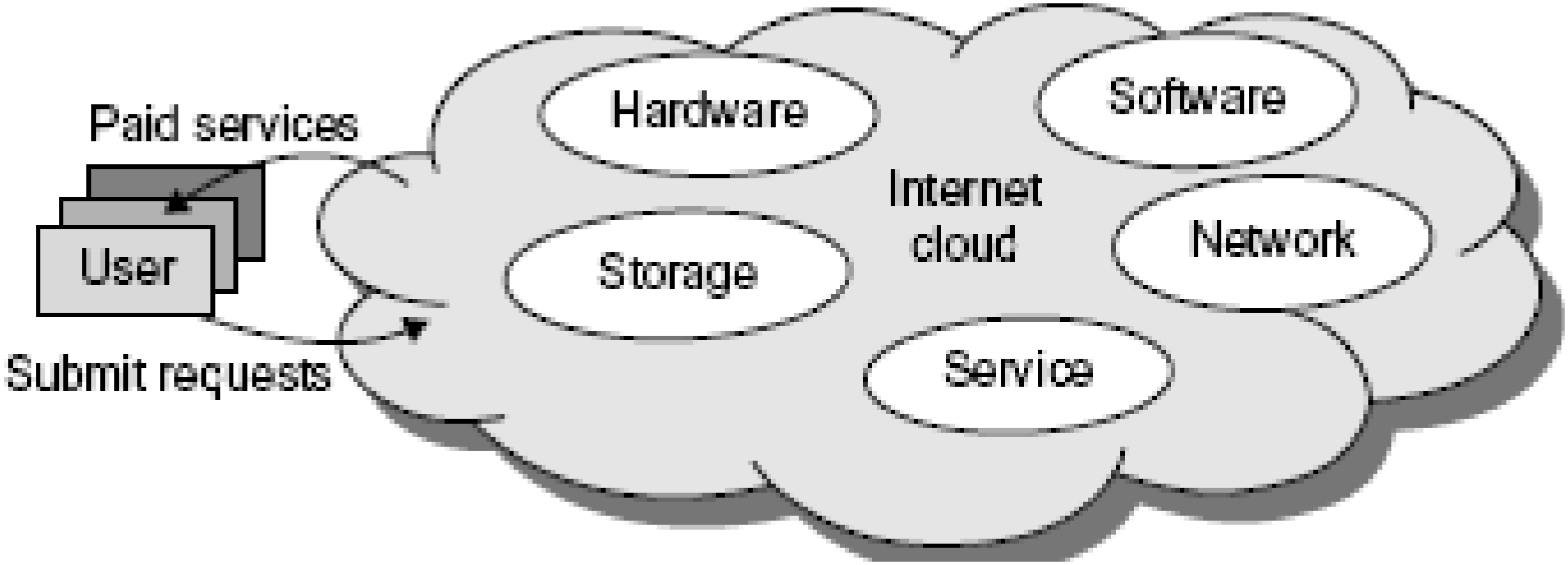
Every 18 months?

- **Cloud Computing**
  - **Subscribe**
  - **Use**

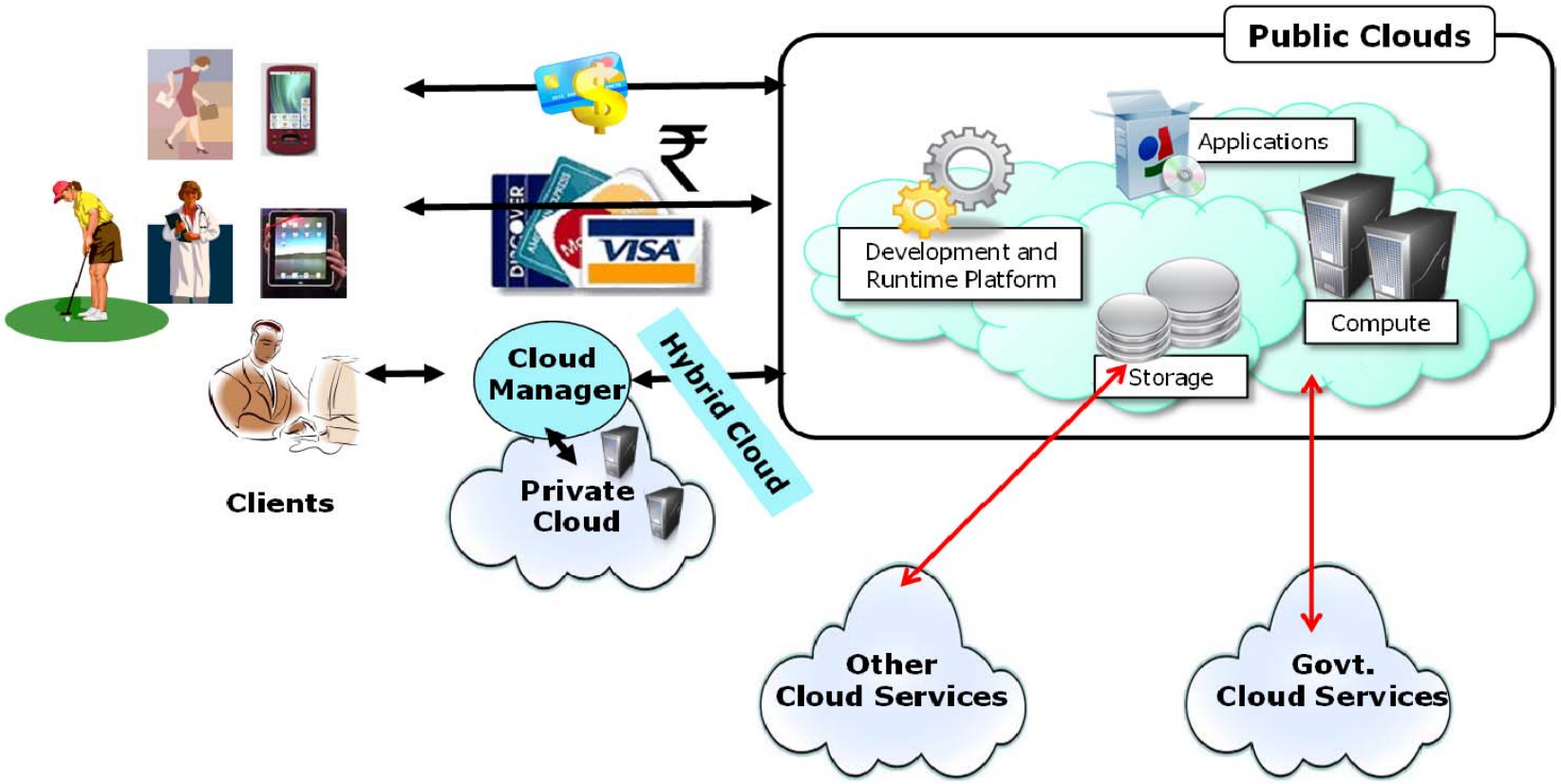
  - **$ - pay for what you use, based on QoS**

(Courtesy of Raj Buyya, 2012)

Basic Concept of Internet Clouds



Subscription-Oriented Cloud Services:
X{compute, apps, data, ..} as a Service (..aaS)



Public/Internet Clouds

* 3rd party, multi-tenant Cloud infrastructure & services:

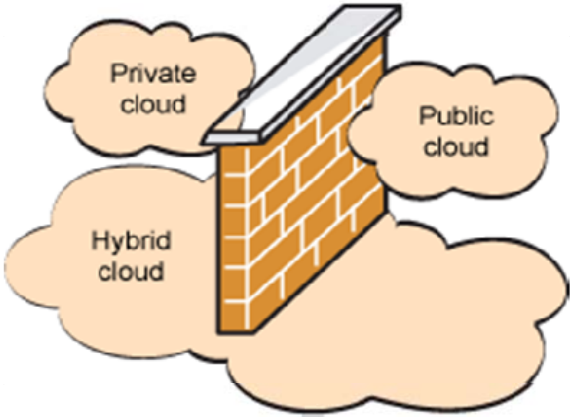
* available on subscription basis to all.

Private/Enterprise Clouds

* A public Cloud model within a company's own Data Center / infrastructure for internal and/or partners use.

Hybrid/Inter Clouds

* Mixed usage of private and public Clouds: Leasing public cloud services when private cloud capacity is insufficient



Transparent Cloud Computing Environment

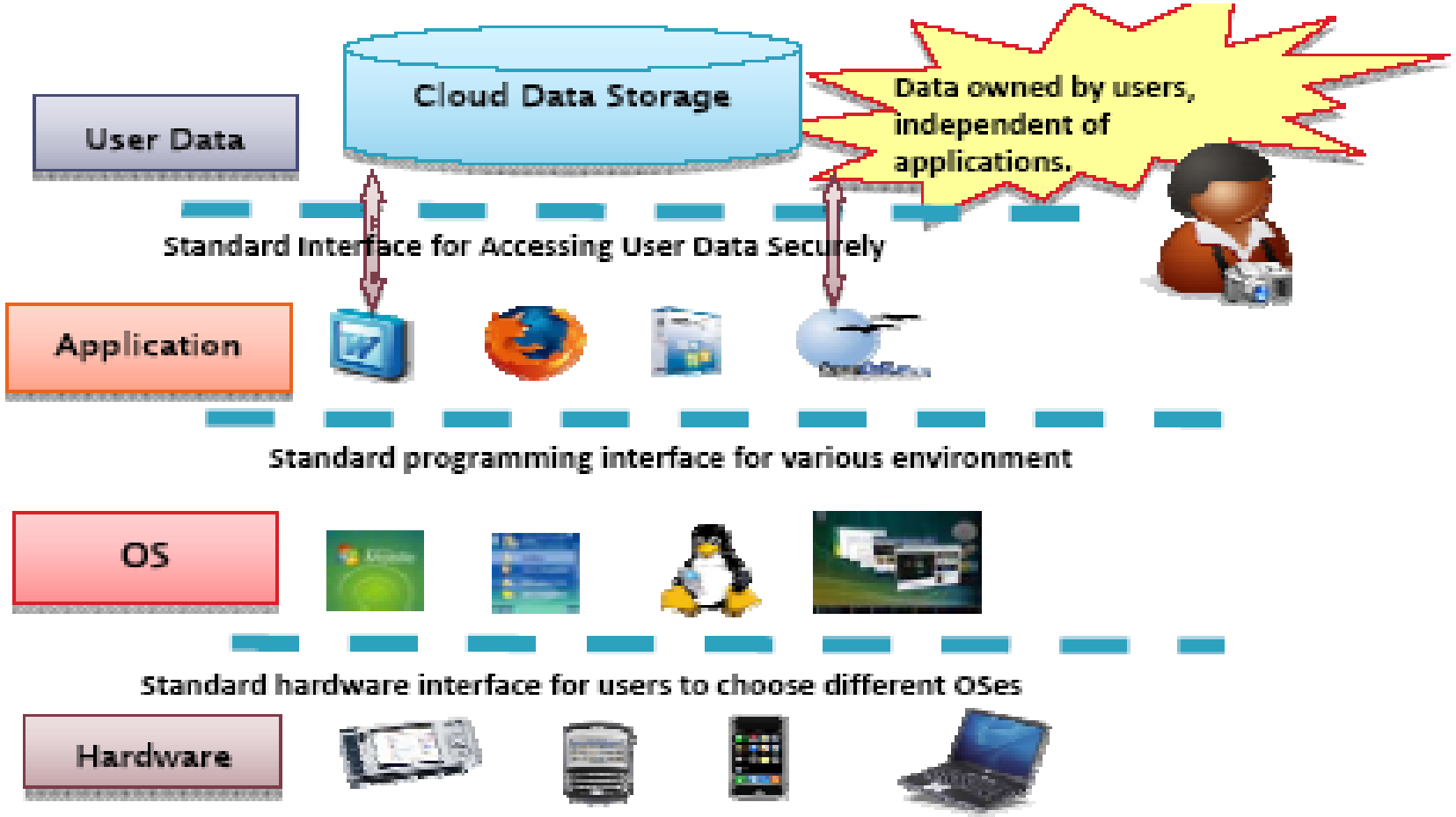
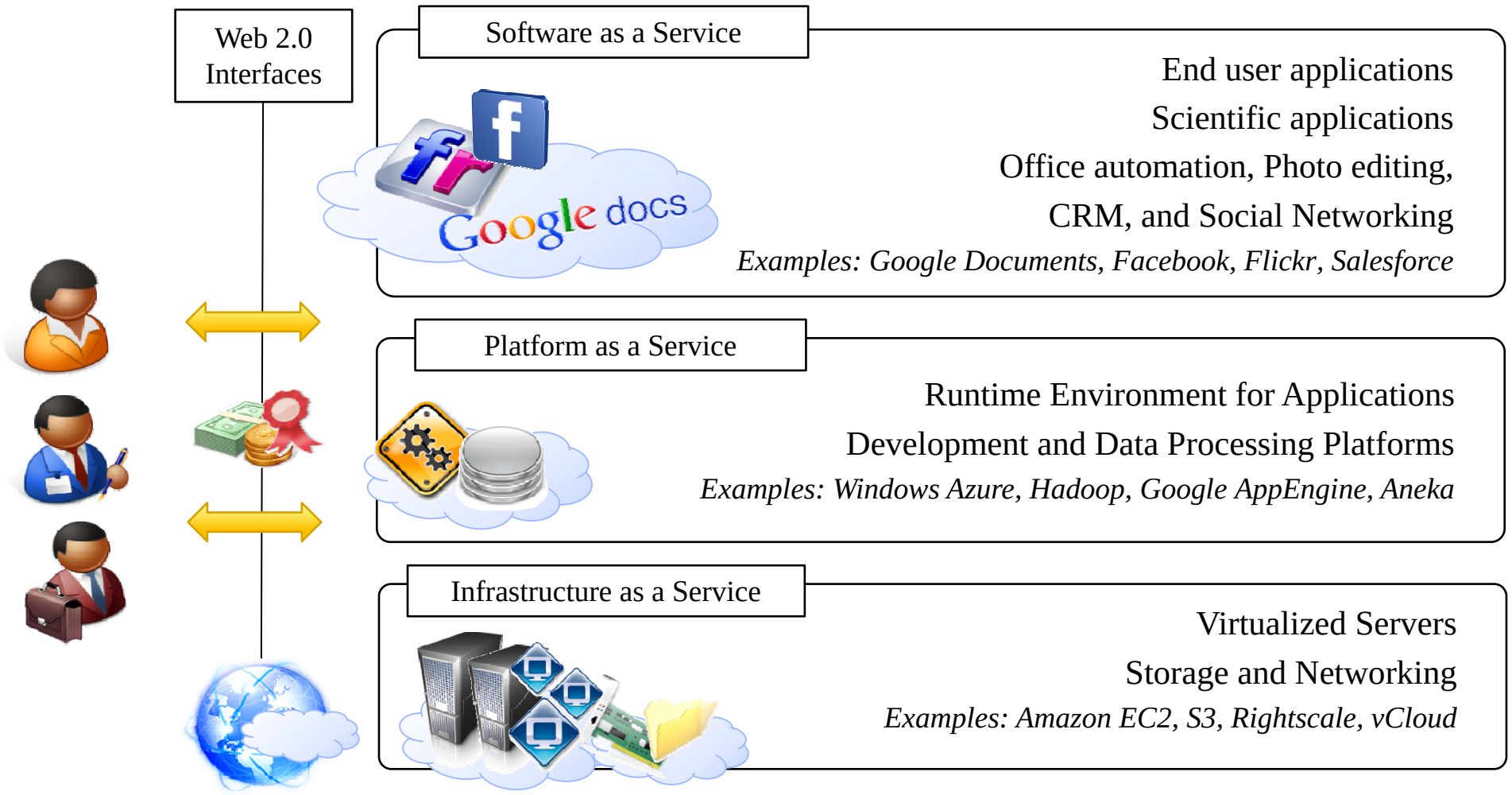


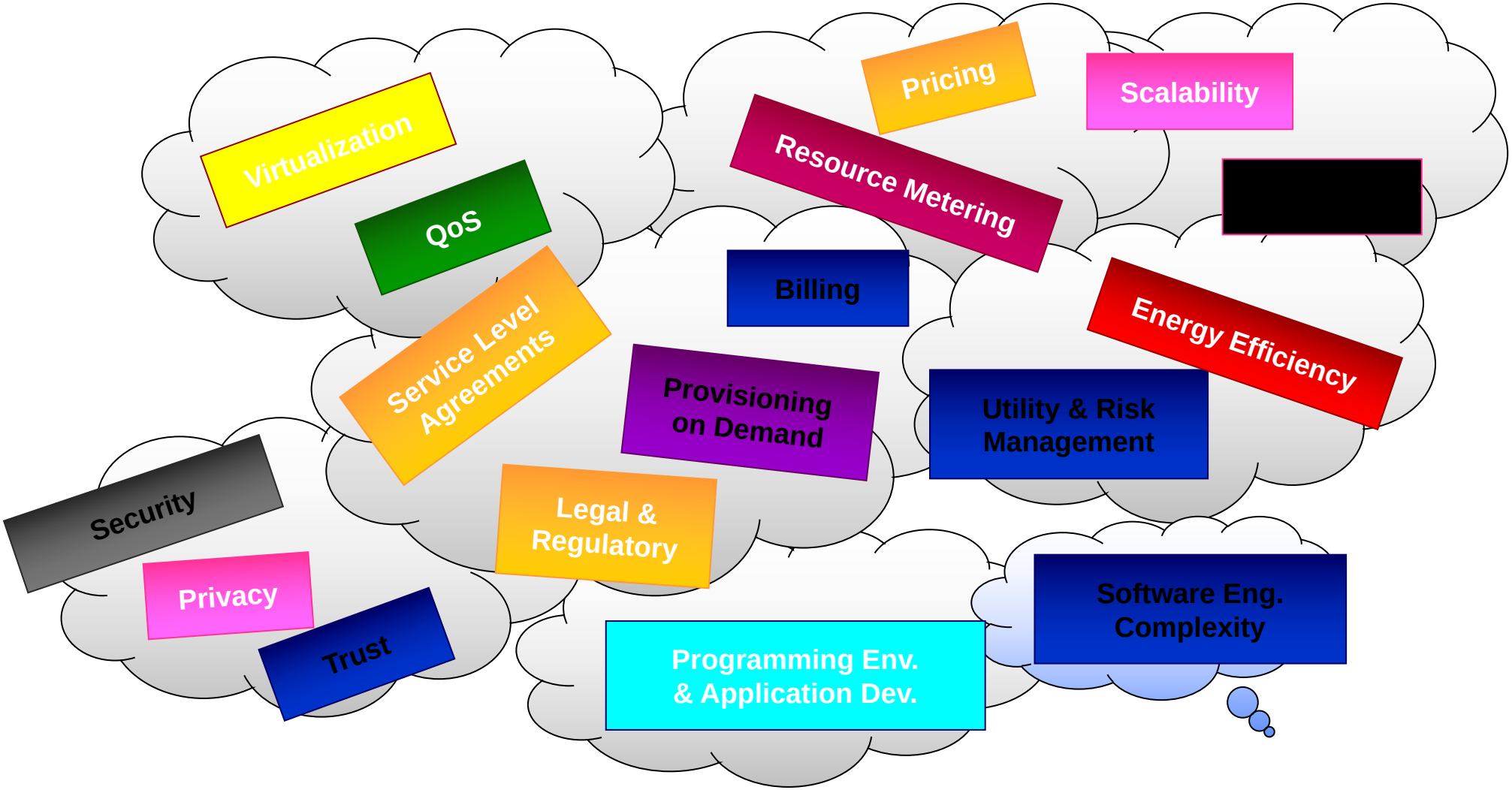
Figure 3 Transparent computing that separates the user data, application, OS, and hardware in time and space – an ideal model for future Cloud platform construction

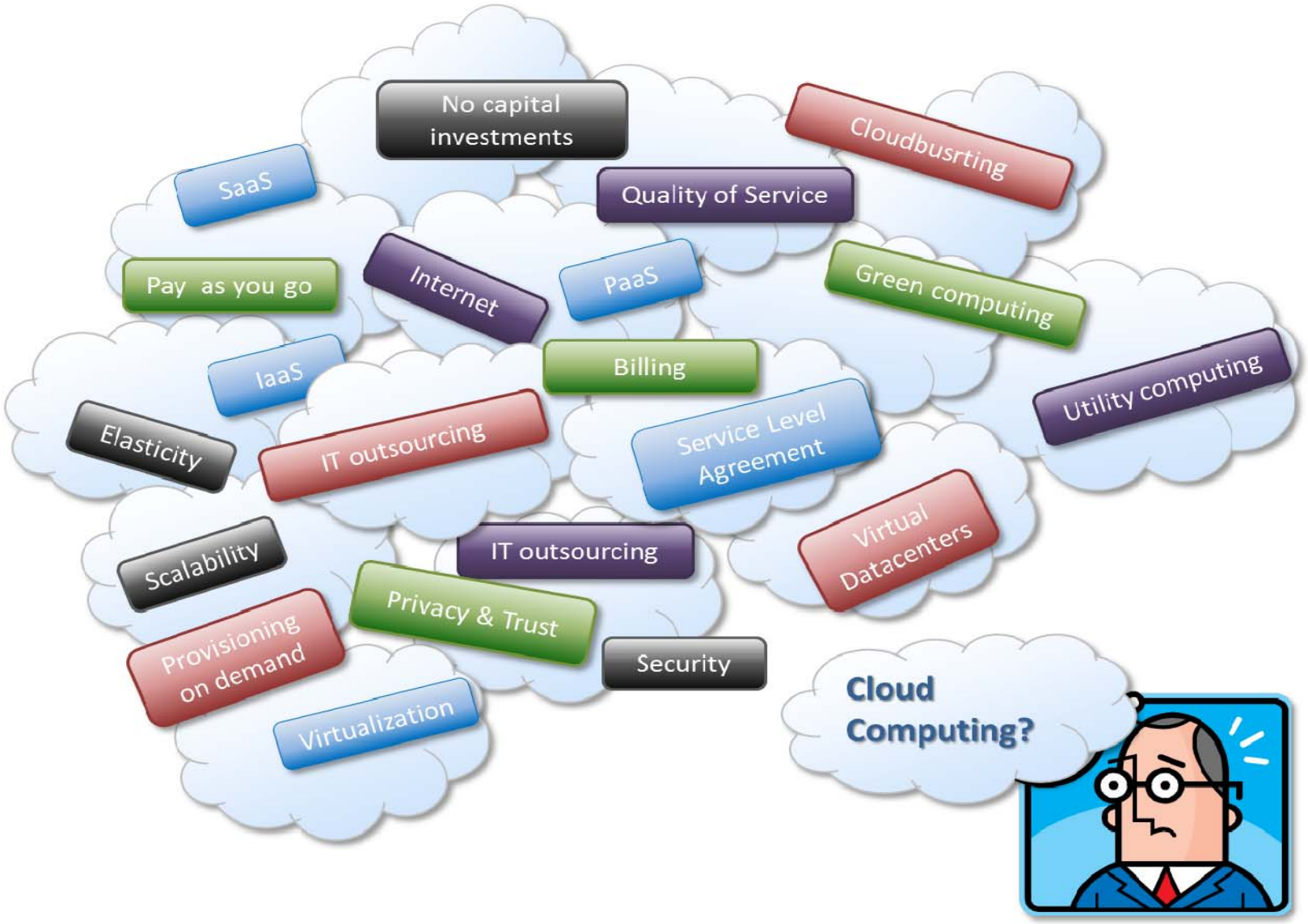
Reference Model



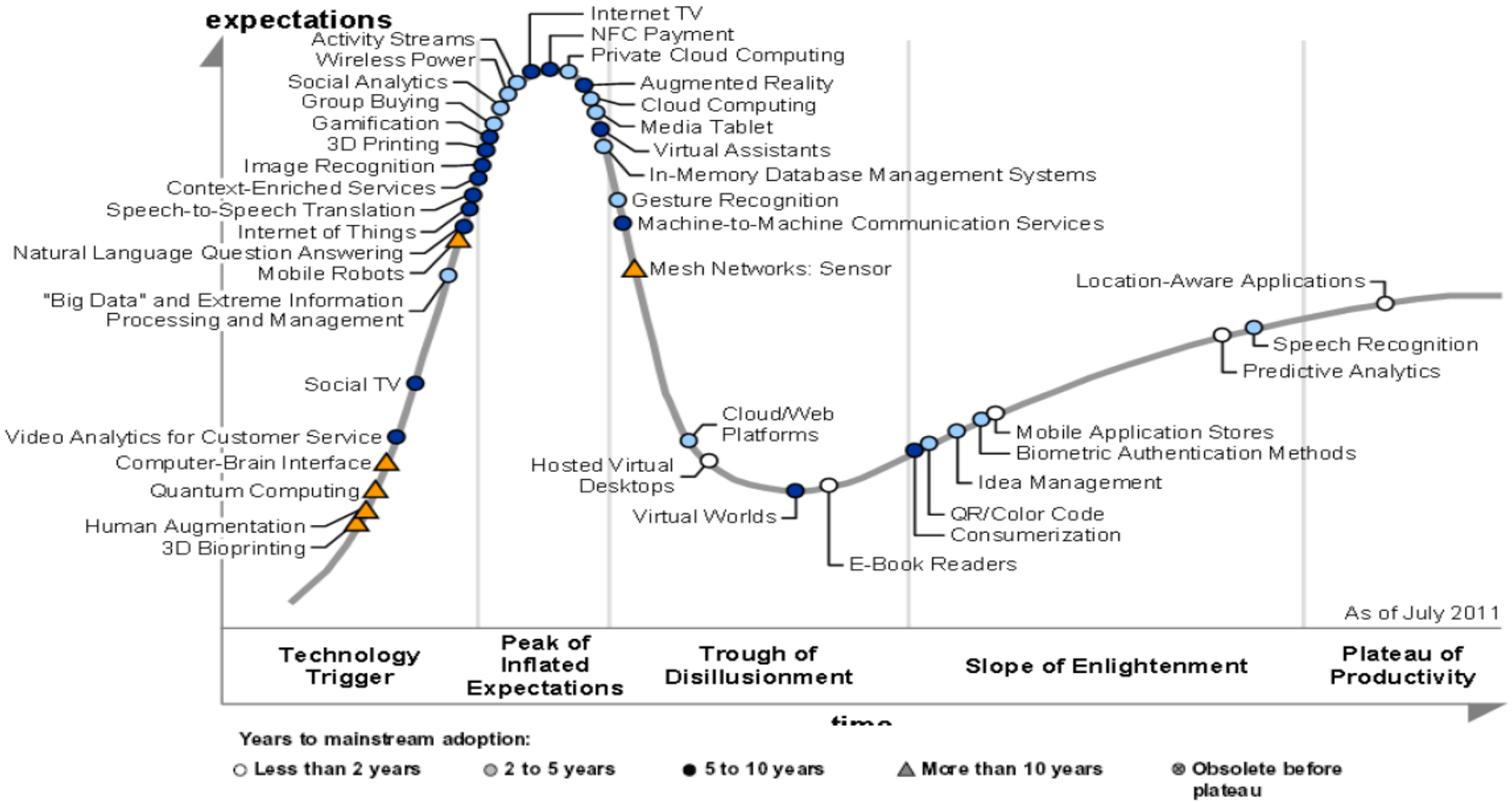
The vision


I need to grow my infrastructure, but I do not know for how long...
I cannot invest in infrastructure, I just started my business....
I want to focus on application logic and not maintenance and scalability issues
I want to access and edit my documents and photos from everywhere..
I have a lot of infrastructure that I want to rent ...
I have a surplus of infrastructure that I want to make use of
I have infrastructure and middleware and I can host applications
I have infrastructure and provide application services
Global Cloud Marketplace

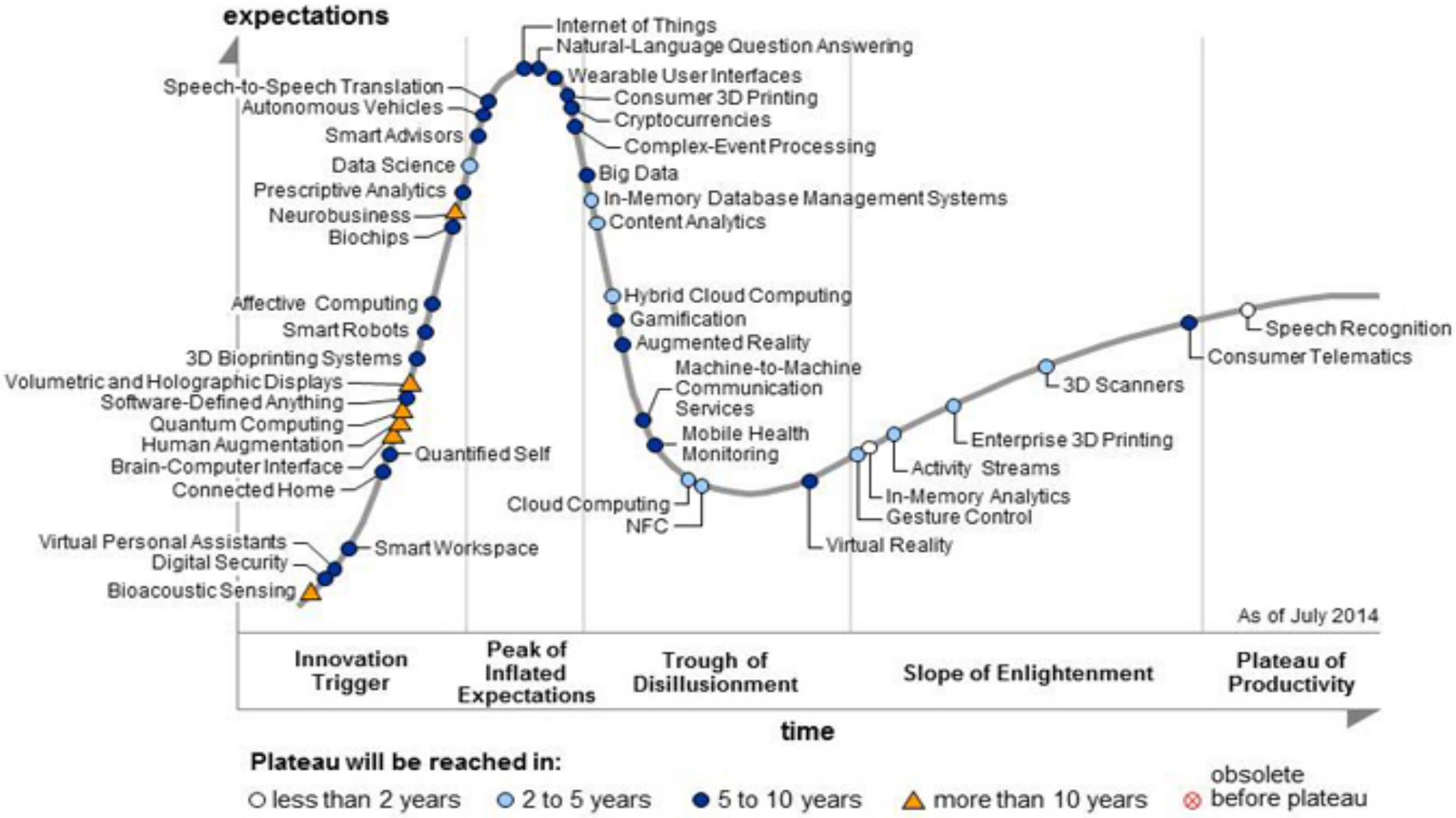

Virtualization
Pricing
Scalability
Resource Metering
QoS
Billing
Service Level Agreements
Energy Efficiency
Provisioning on Demand
Utility & Risk Management
Security
Legal & Regulatory
Privacy
Trust
Software Eng. Complexity
Programming Env. & Application Dev.


No capital investments
Cloudbusrting
SaaS
Quality of Service
Pay as you go
Internet
PaaS
Green computing
IaaS
Billing
Utility computing
Elasticity
IT outsourcing
Service Level Agreement
Scalability
IT outsourcing
Virtual Datacenters
Privacy & Trust
Provisioning on demand
Security
Virtualization
Cloud Computing?

2011 Gartner "IT Hype Cycle" for Emerging Technologies



2014 Gartner "IT Hype Cycle" for Emerging Technologies



Gartner Hype Cycle for Cloud Computing, 2015