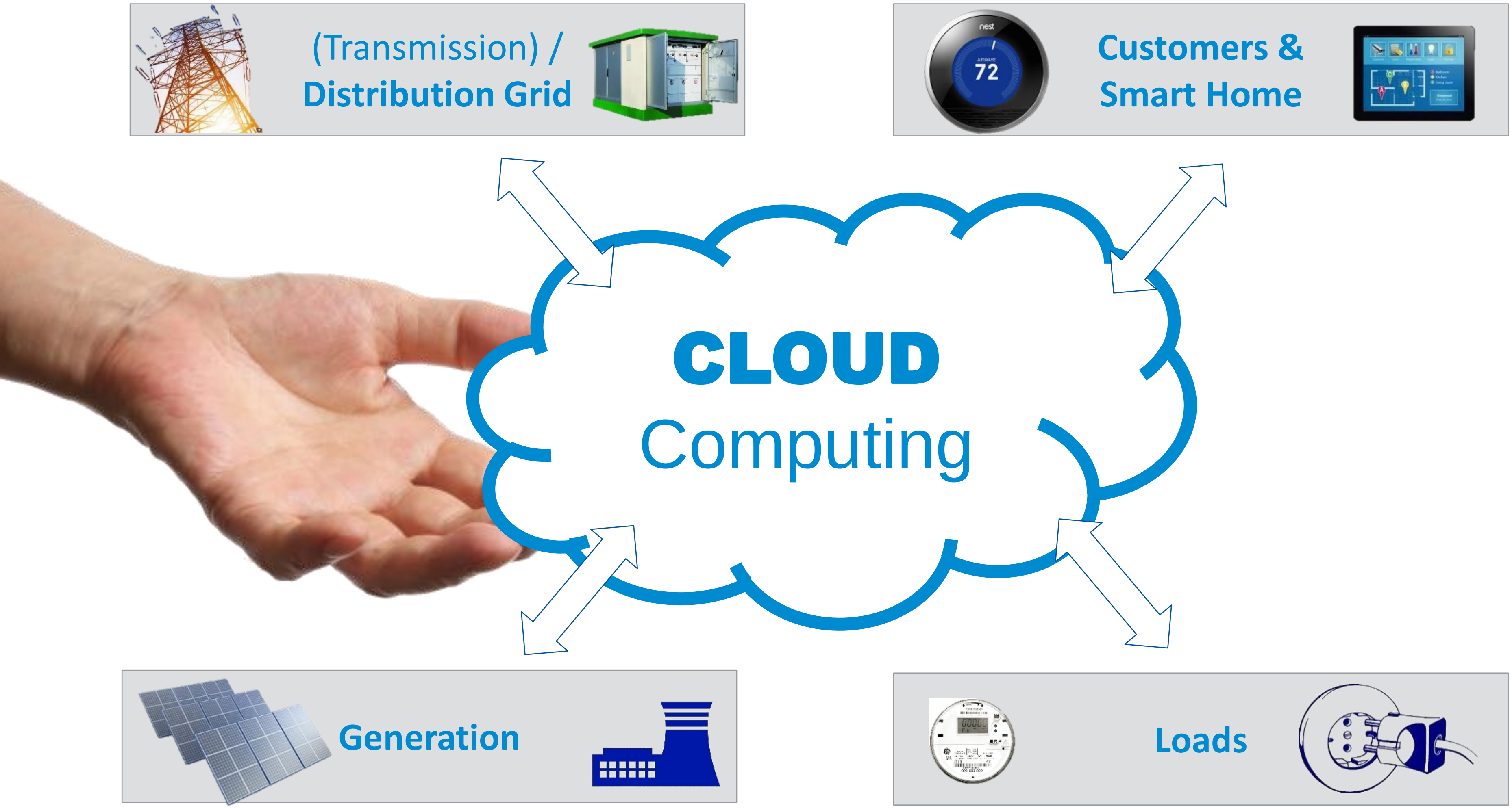
Cloud Computing for Energy Applications

Smart Energy Conference, 27th October 2016

Dr. Kai Daniel

Leading Question for Smart Grids

Has Cloud Computing an Impact on Energy Applications?



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- Introduction
  - Motivation to Discuss „Cloud Computing“
  - Definition: “What is Cloud Computing”
  - Evolution to Cloud Computing
  - Fundamental Cloud Service Building Blocks
- Significance for Cloud Computing
  - It as a Cost Drivers
  - Application Areas for Cloud Computing
  - Market Overview
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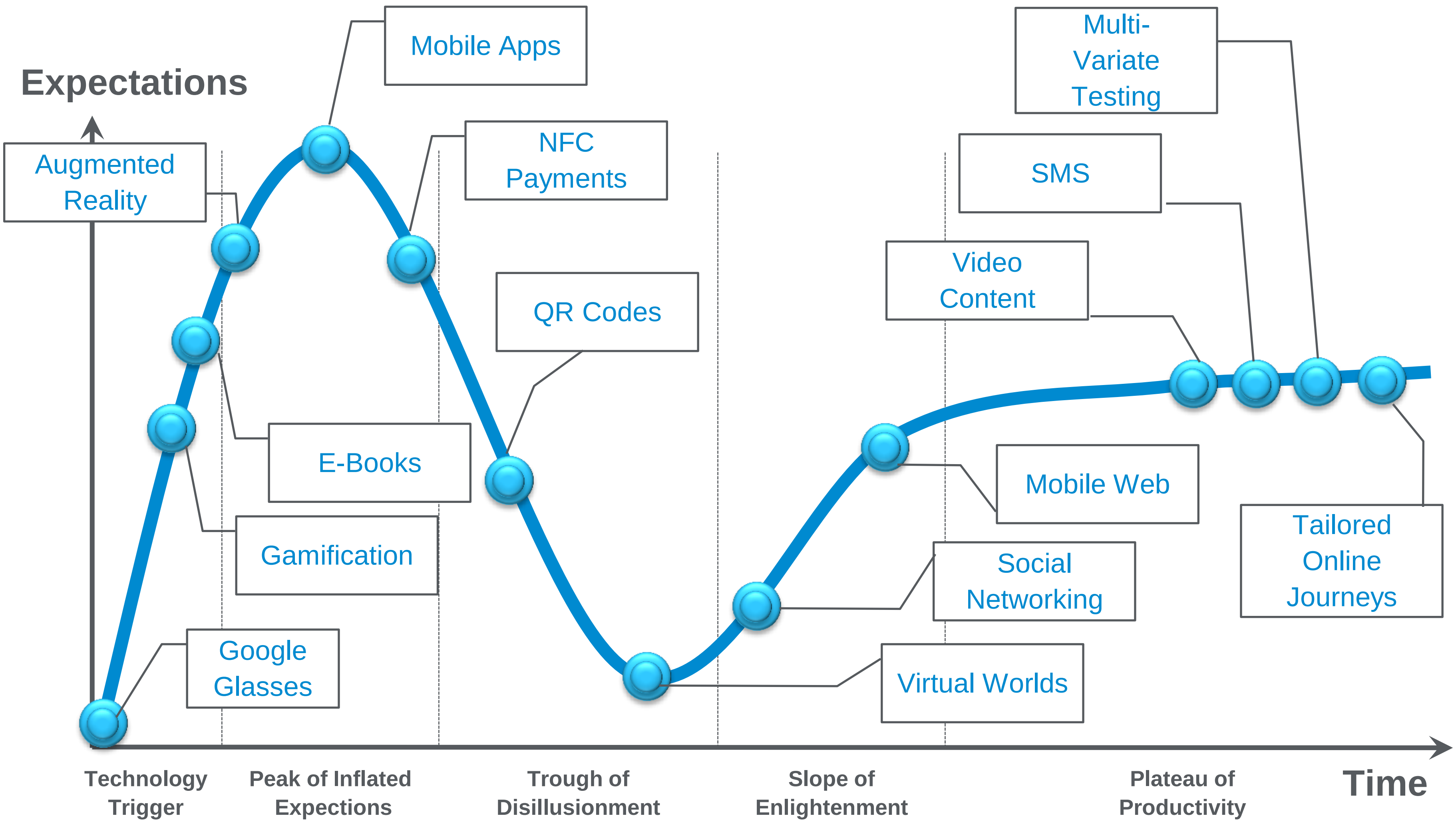
Introduction
Gartner Hype Cycle

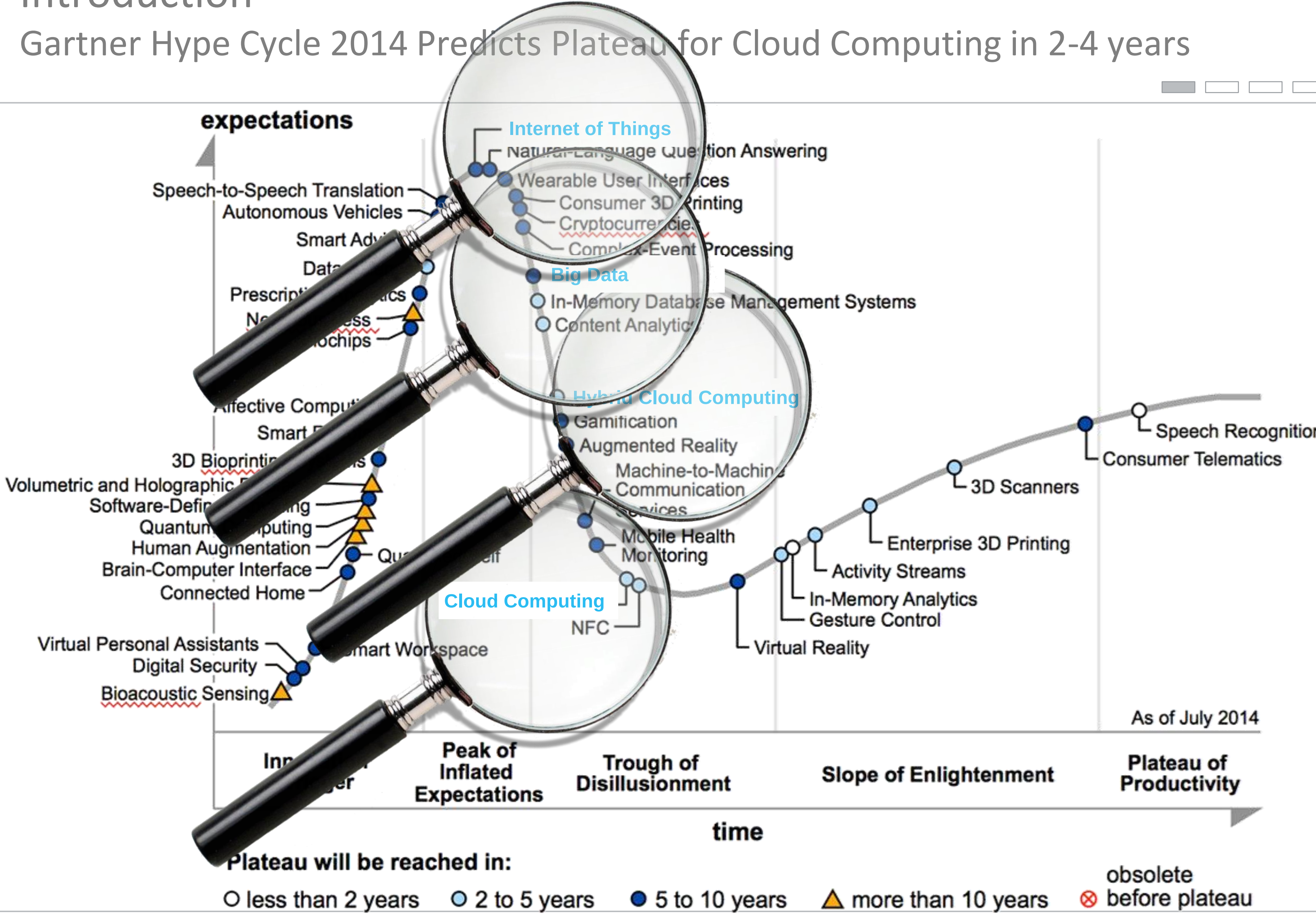
Introduction

Gartner Hype Cycle 2012



Introduction

Gartner Hype Cycle 2014 Predicts Plateau for Cloud Computing in 2-4 years



Definition

The NIST Definition of Cloud Computing

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“*

http://nvlpubs.nist.gov/nistpubs/Legacy/SP/nistspecialpublication800-145.pdf

BUILDING BLOCKS OF CLOUD COMPUTING

Virtual Computers/Servers	**Data Storage Capacity**
Networks	**Services**

NOTE

…it is still a buzz word…

Definition – Simple Explanation

"Cloud Computing is like Crude Oil"

Sources

Transport

Process

Storages

Services

Demand

Significance of Cloud-Technologies

Known Digitalization Trends built on Interacting Technologies

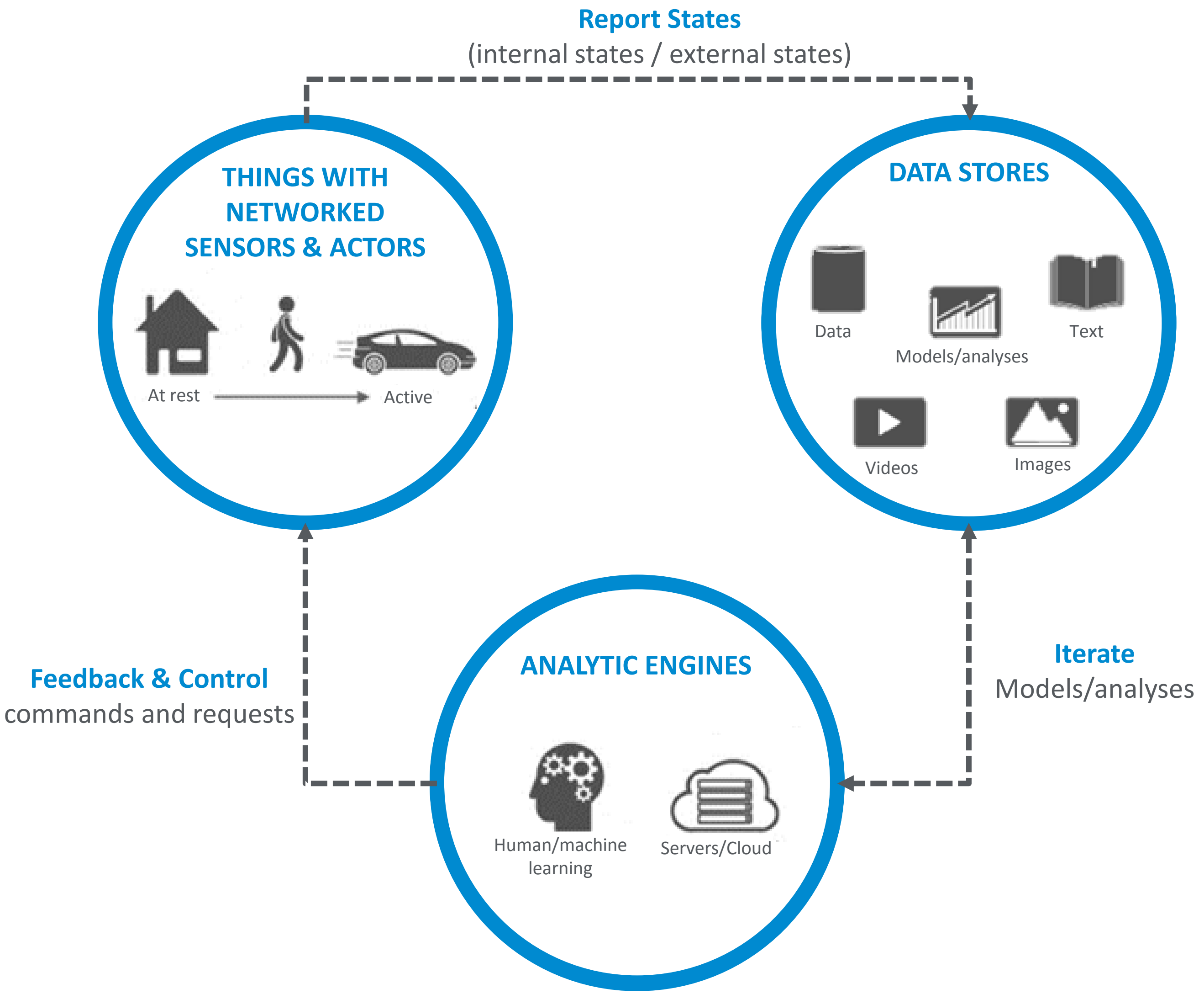
INTERNET OF THINGS

CLOUD COMPUTING

BIG DATA ANALYTICS

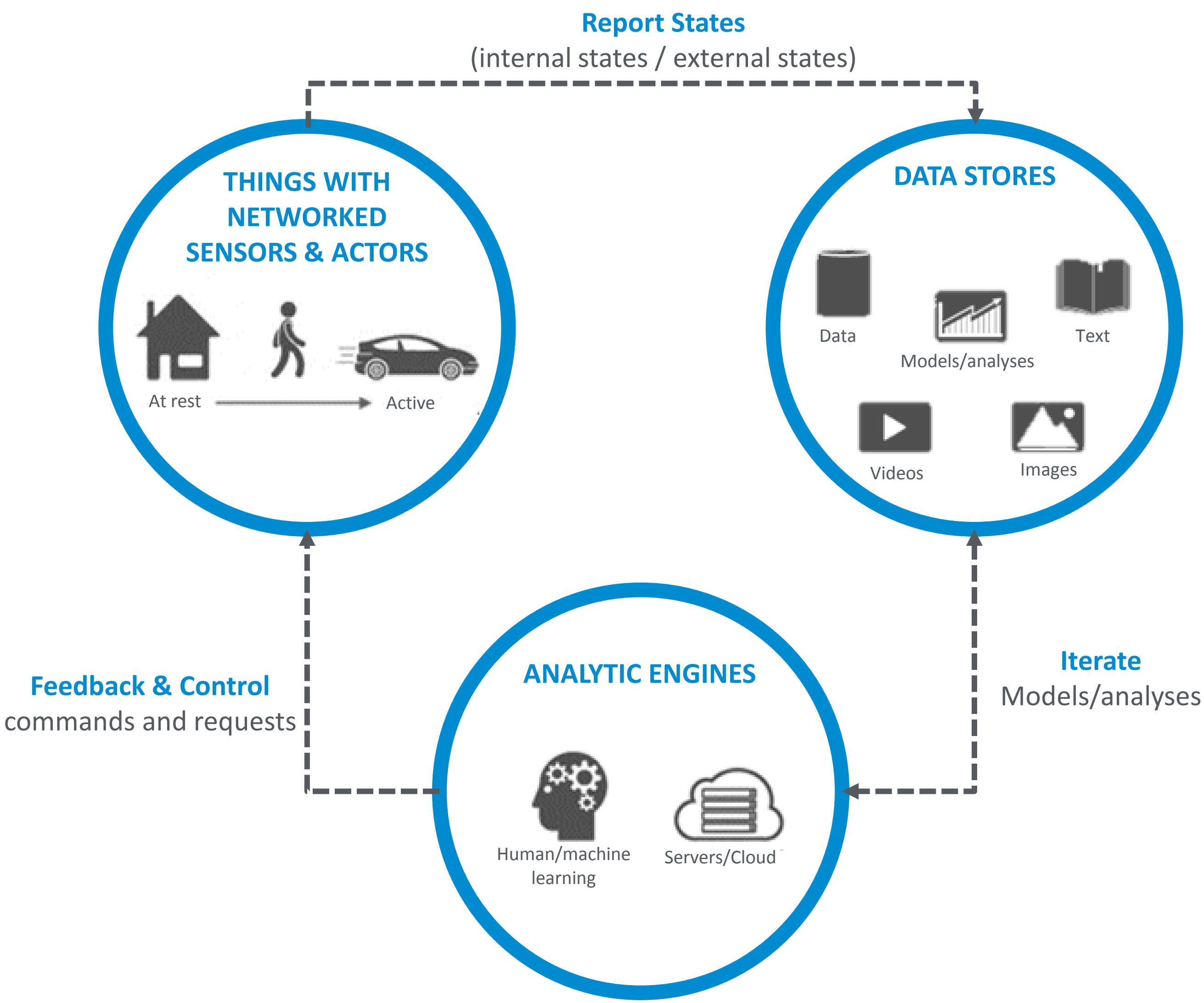
Significance of Cloud-Technologies

Known Digitalization Trends built on Interacting Technologies

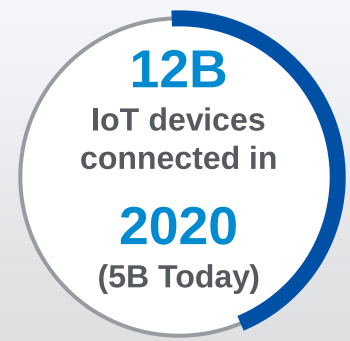


Significance of Cloud-Technologies

Known Digitalization Trends built on Interacting Technologies



CONNECTED DEVICES



Source: Cisco

DATA AS A COST DRIVER

„The total amount of data being captured and stored by industry doubles every 1.2 years“

Source: http://www.waterfordtechnologies.com

Cloud Computing is a Next Step in the Computing Evolution

Grid Computing

- Solving large problems with Parallel computing
- Made mainstream By Global Alliance

Decentrally controlled
Example: Seti@home

Utility Computing

- Offering computing resources as a metered service
- Introduced in late 1990s

Rented Computing resources on demand without virtualization
Example: Storage

SaaS Computing

- Network-based subscriptions to applications
- Gained momentum in 2001

Rented Computing resources on demand without virtualization
Example: Cisco WebEx, GoogleApps

Cloud Computing

- Next-Generation Internet computing
- Next-Generation Data Centers

Centrally controlled and based on virtual resources
Example: GoogleWebMail

source: http://www.dsp-ip.com

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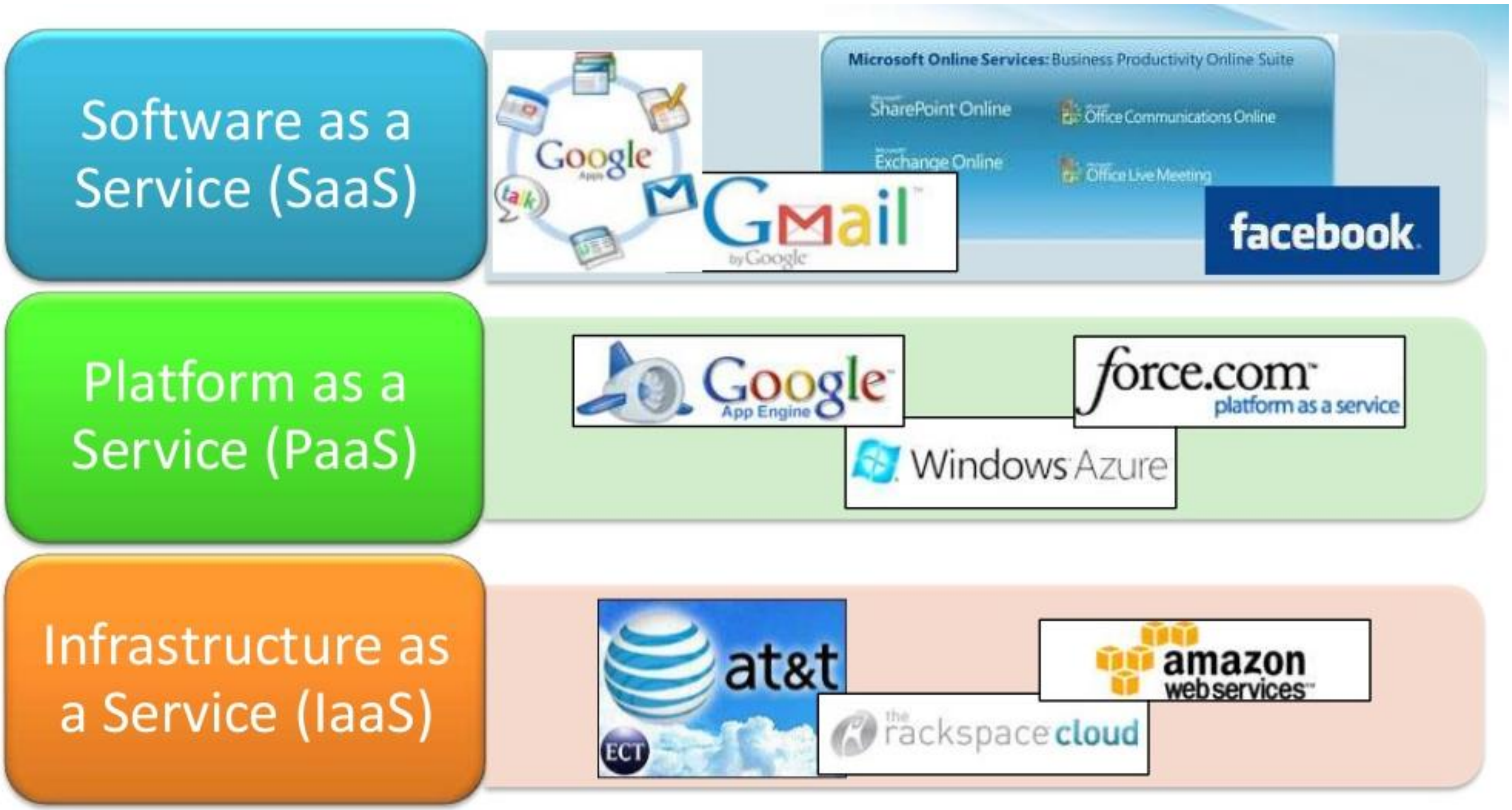
Cloud Computing Reached the Plateau of Productivity, where Several Services are Available Today

Fundamental Building Blocks: Cloud Computing is the Headline for Different Services, which are Part of a Cloud

Infrastructure as a Service (IaaS)

Fundamental Building Blocks: Cloud Computing is the Headline for Different Services, which are Part of a Cloud



On Average, Business loose between 130K€ to 500k€ every hour of unplanned IT system downtime (1/2)

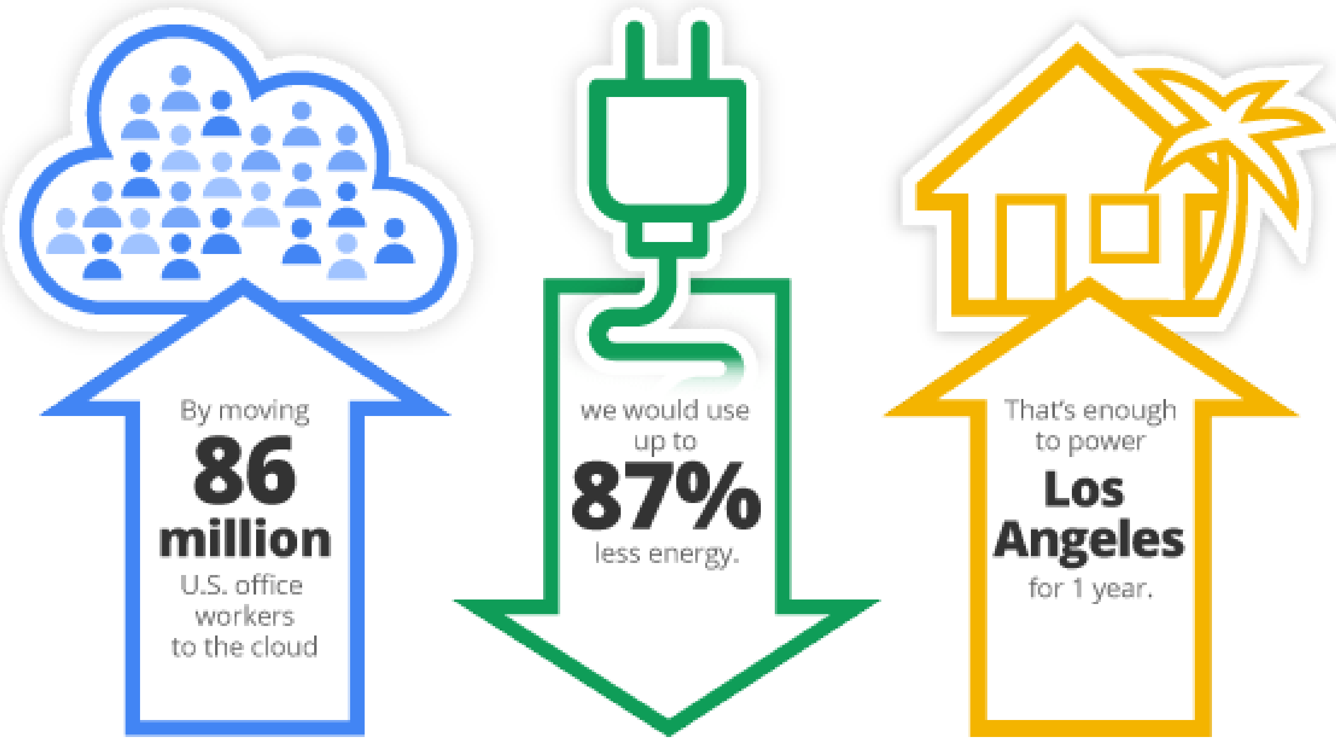
[Source: Gartner – Network Downtime, 2014]

On Average, Business loose between 130K€ to 500k€ every hour of unplanned IT system downtime (2/2)

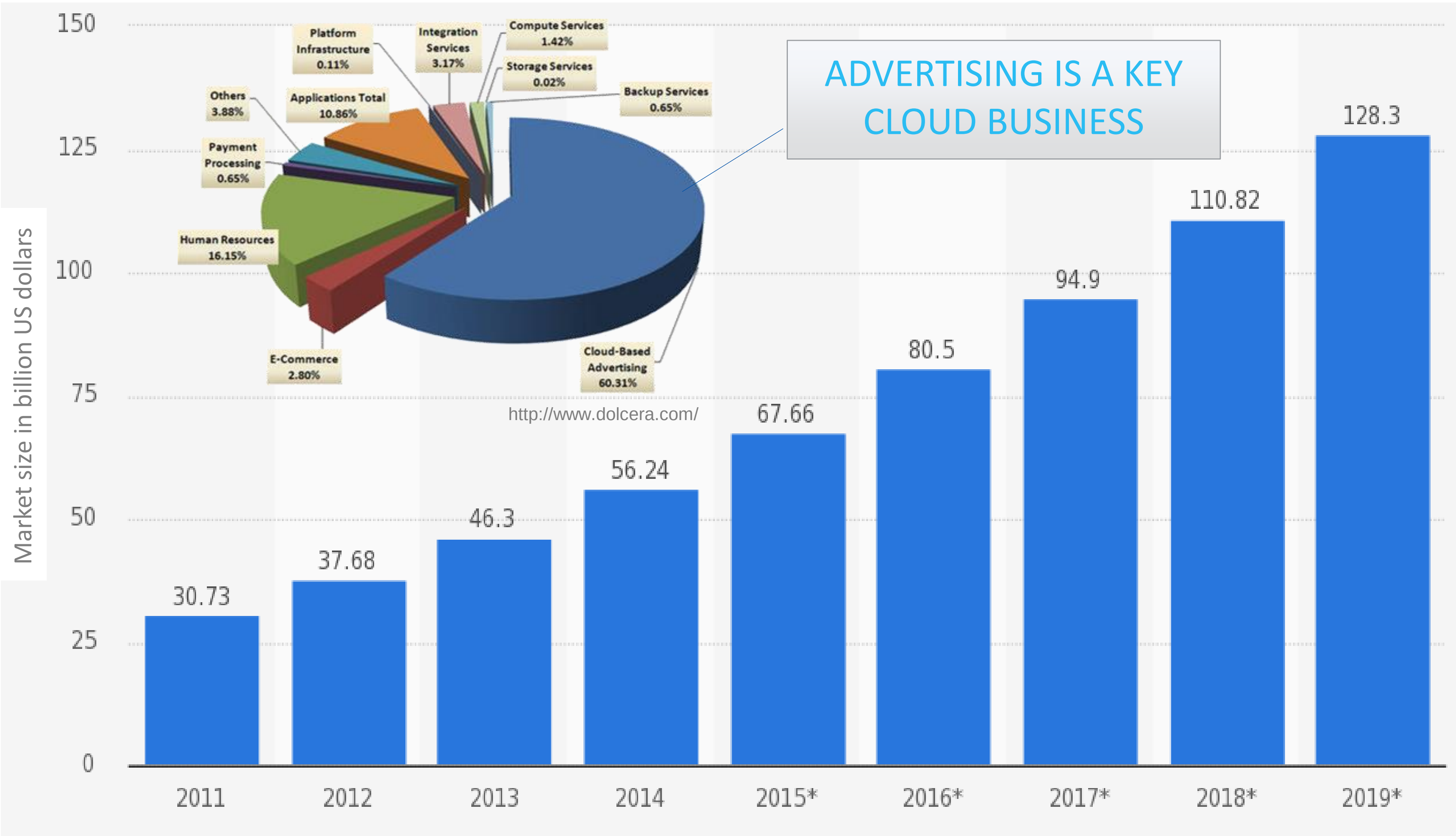
Cloud Computing is Furthermore Motivated by Green Internet: Impact of Cloud Computing on Energy Consumption

Google

„Using a cloud saves up to 87% of the energy demand for IT infrastructures“



Size of the Cloud Computing and Hosting Market Wordwide from 2011 to 2019 (in billion USD)



http://www.statista.com, 2016

* Predictions

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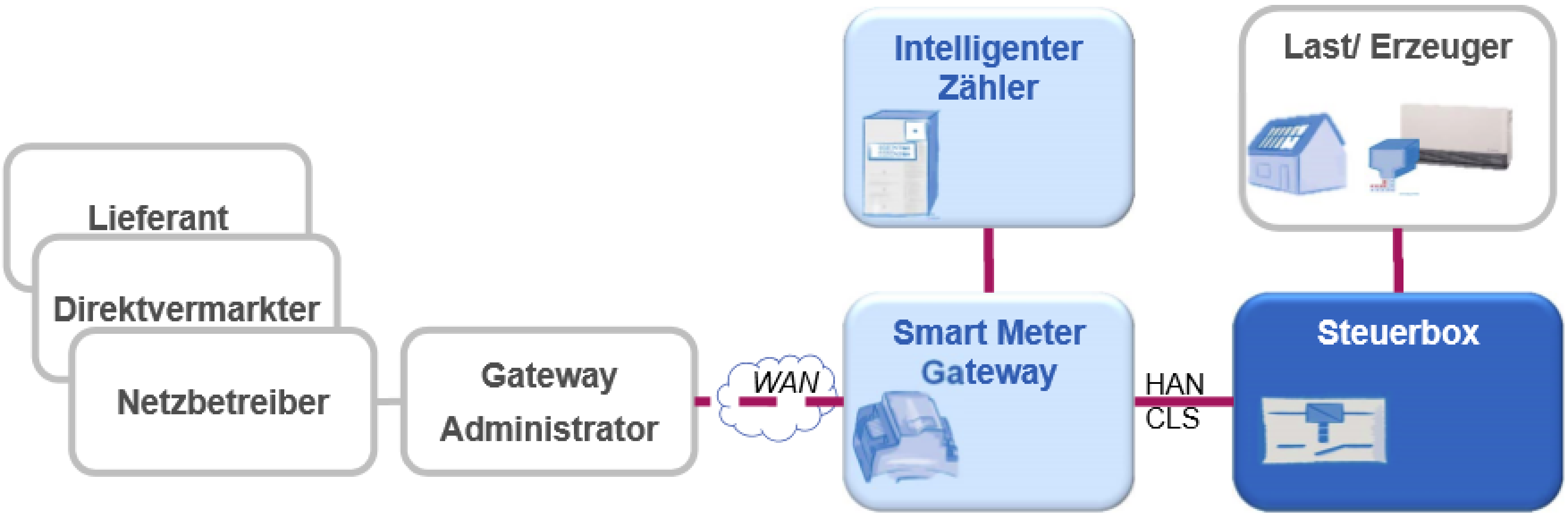
Use Case 1: Smart Metering

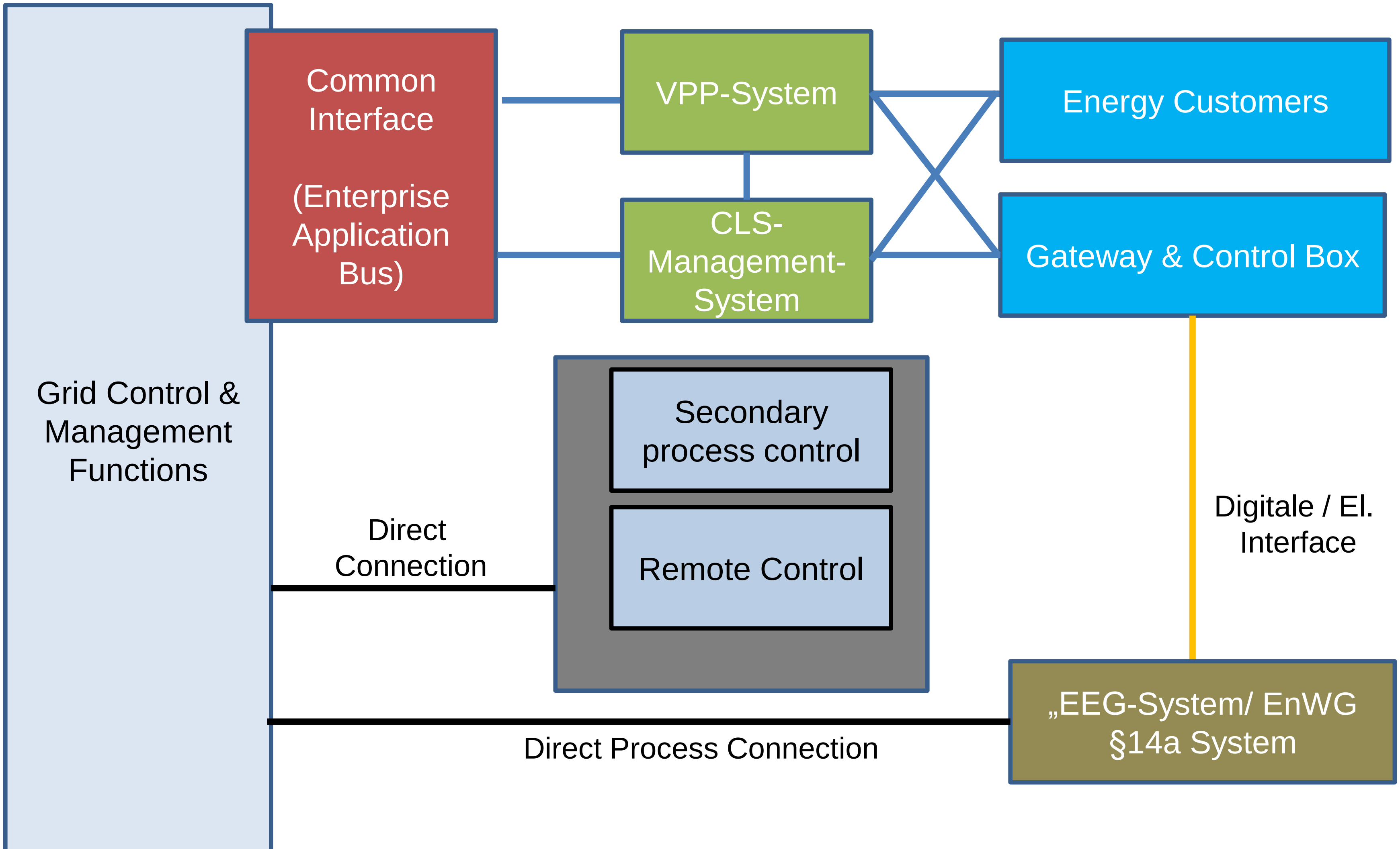
System-of-Systems Architecture Focussing Metering Functions



https://www.rewi.uni-jena.de/rewi2media/Bilder/Fakult%C3%A4t/Institute/Energierechtsinstitut/Veranstaltung+Smart+Metering/20160121_MME_IMSYS_ZAYER_F.pdf

Use Case 2: Smart Grid

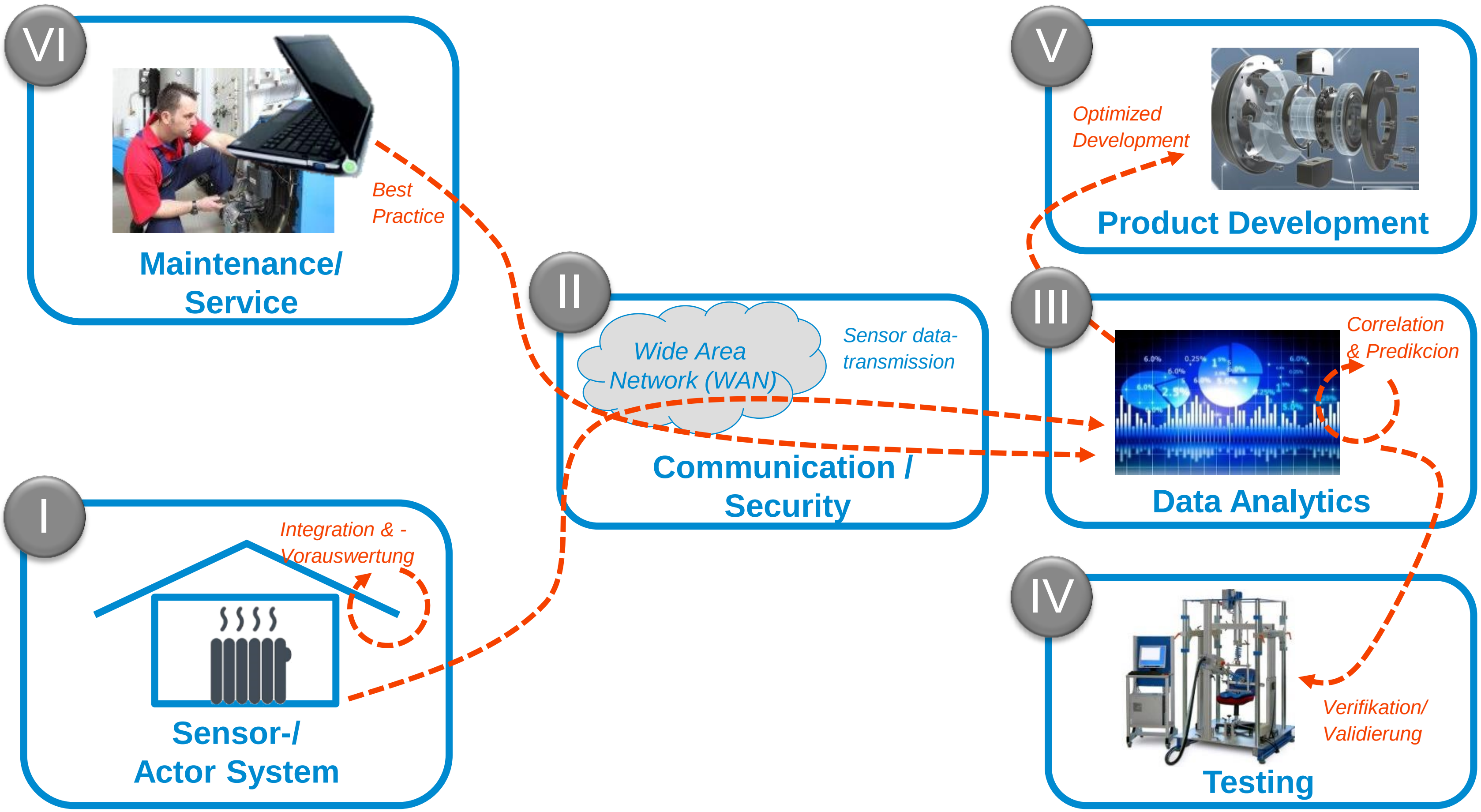
System-of-Systems Architecture Focussing Control Functions



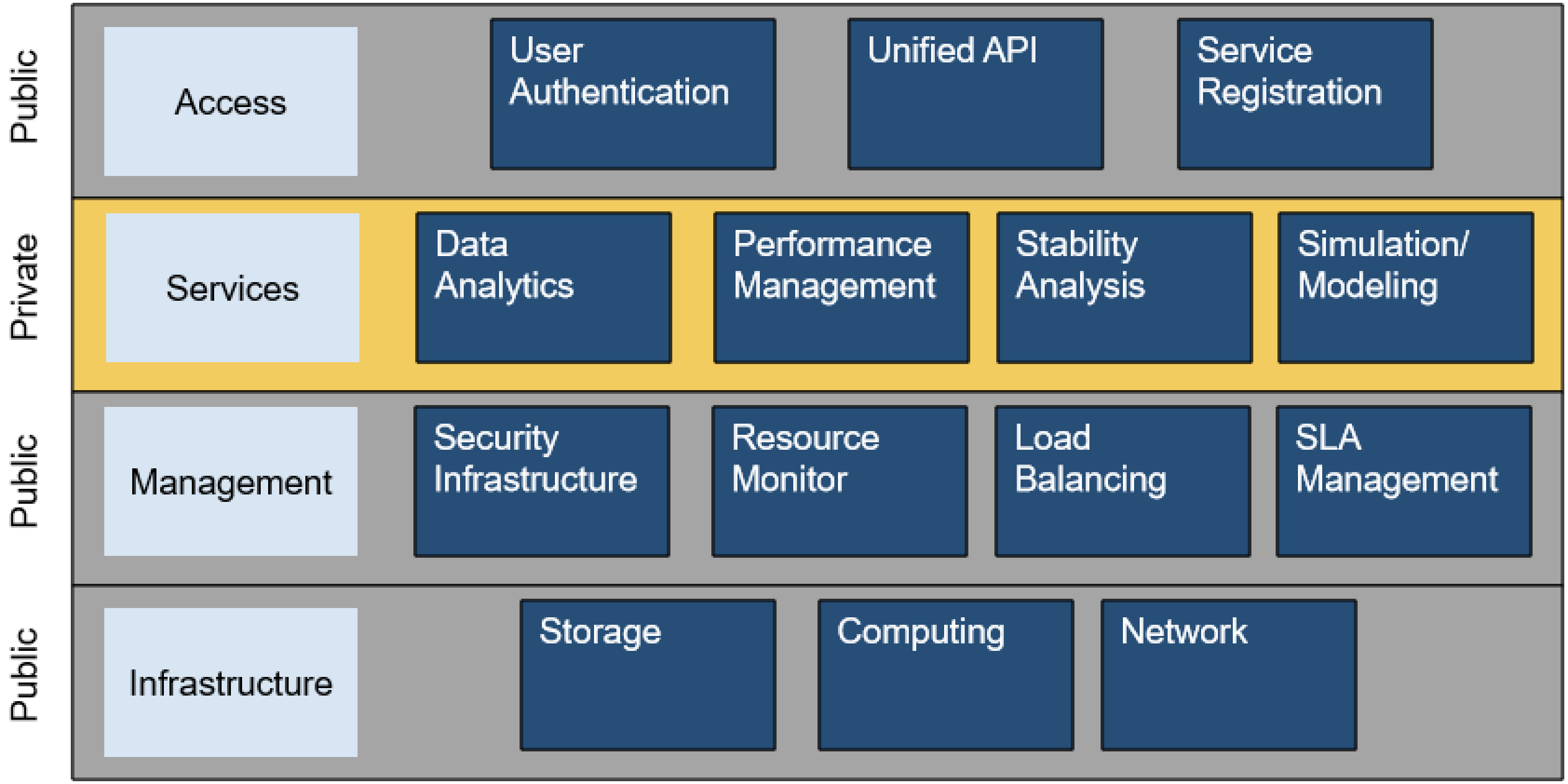
http://www.rwe.com/web/cms/mediablob/de/2936136/data/2926348/1/innogy-metering-gmbh/geschaeftsfuehrer-austausch/Netzdienliche-Schaltungen.pdf

Use Case 3: Preventive Performance

Product Development as a Service

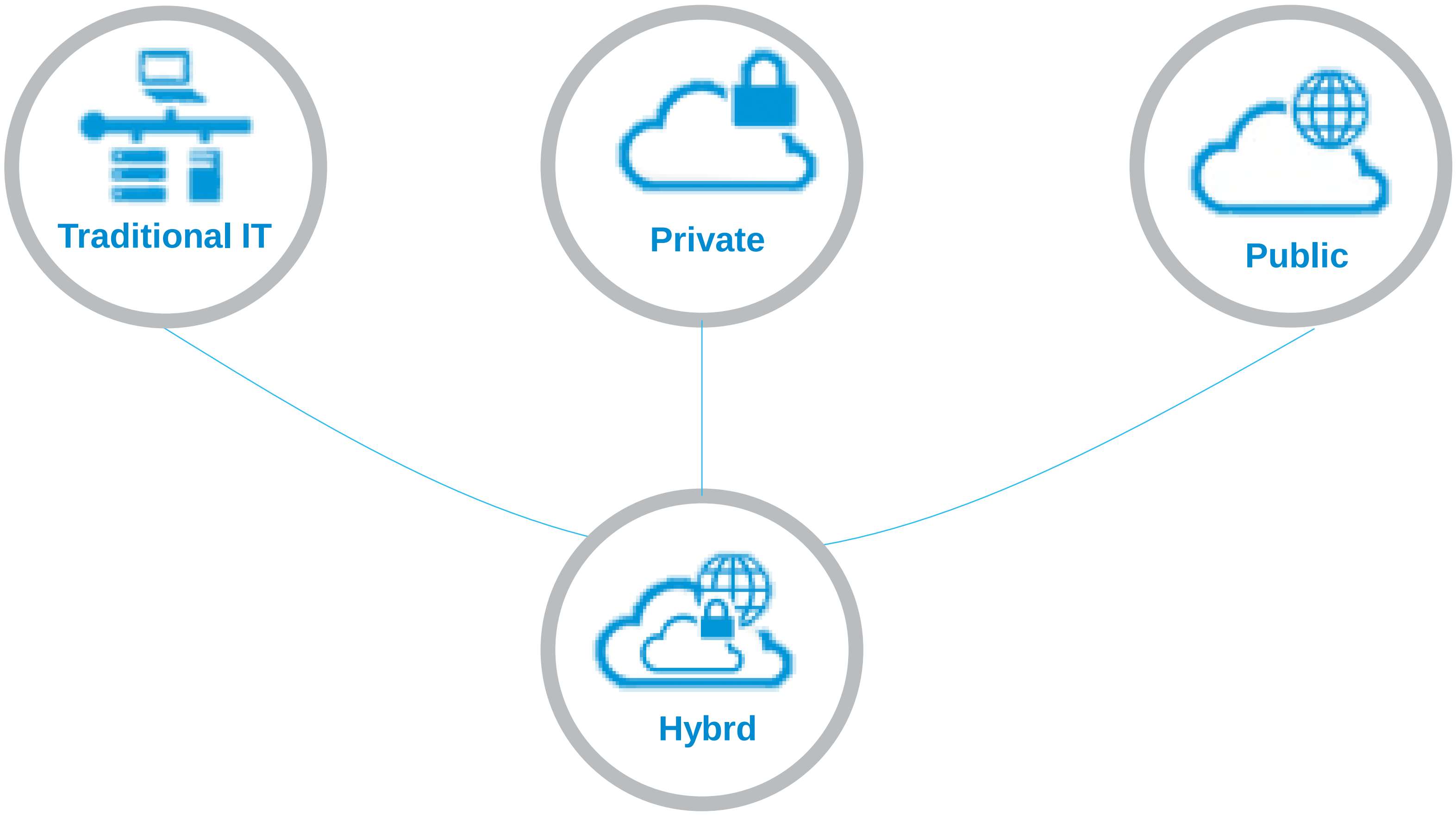


Requirements Towards Cloud Computing from Utility Perspective (1/2)



http://energy.gov/sites/prod/files/Friday_Trinity_Ballroom_3_0855_Primetica_final.pdf

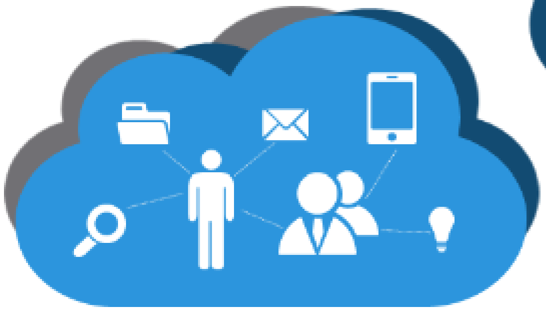
Hybrid Cloud Computing Allows to Exploit the Advantages of Cloud Technologies (1/2)



Hybrid Cloud Computing Allows to to Exploit the Advantages of Cloud Technologies (2/2)

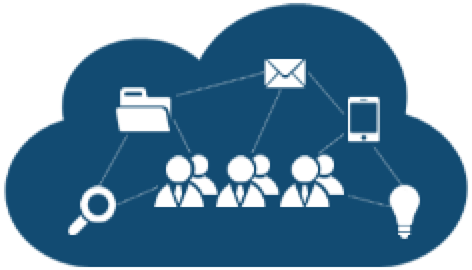
Private

- Single tenant implementation
- Owned and operated by IT organization
- Define your own data management policies
- Self-service and automation capabilities provide new agility



Hybrid

- Combination for Private & one or more public clouds
- Allows IT organizations to become brokers of services



Public

- Multi-tenant implementation
- Owned and operated by Service Provider
- Bound by multi-tenant data management policies
- Similar self-service and automation capabilities as Private Cloud

GRID CONTROL & MANAGEMENT

SMART METERING & PRODUCT DEVELOPMENT

SMART HOME & OFFICE IT

https://media.licdn.com

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Selected Benefits and Risks of Cloud Computing

BENEFITS

No Invest in Hardware and Cost Reduction by Outsourcing

Scalability and Flexibility of Services ("on demand")

High Availability and Reduction of Downtime Risks

Utilization of Infrastructures & "Green IT"

RISKS

Vulnerability
Violations of Data Security, e.g. Confidentiality and Integrity

Limited Control
Delete Data permanently
"Right to be forgotten"

Compliance Risks
(Multi-Country ⇔ Multi-Law)

Hardware
Insolvency and Confiscation of sub-contractors in foreign countries

Conclusion

Cloud Computing is an Established Technology for Energy Applications

CLOUD COMPUTING IS A MEGATREND…

…which

a) provides already mature technologies
b) facilitates the development of new and promising technologies

CLOUDs WILL COME TO ENERGY SECTOR

Clouds are already used in the energy domain. In particular for smart home or smart metering applications cloud technologies are already in use. However, interface to smart grid applications are still in development.

STANDARDIZATION IS A CHALLENGE

Deployment of hybrid cloud environments and using a variety of platform, development and connectivity technologies complicates **interoperability** for different application needs.

Contact

Thank you very much for your attention

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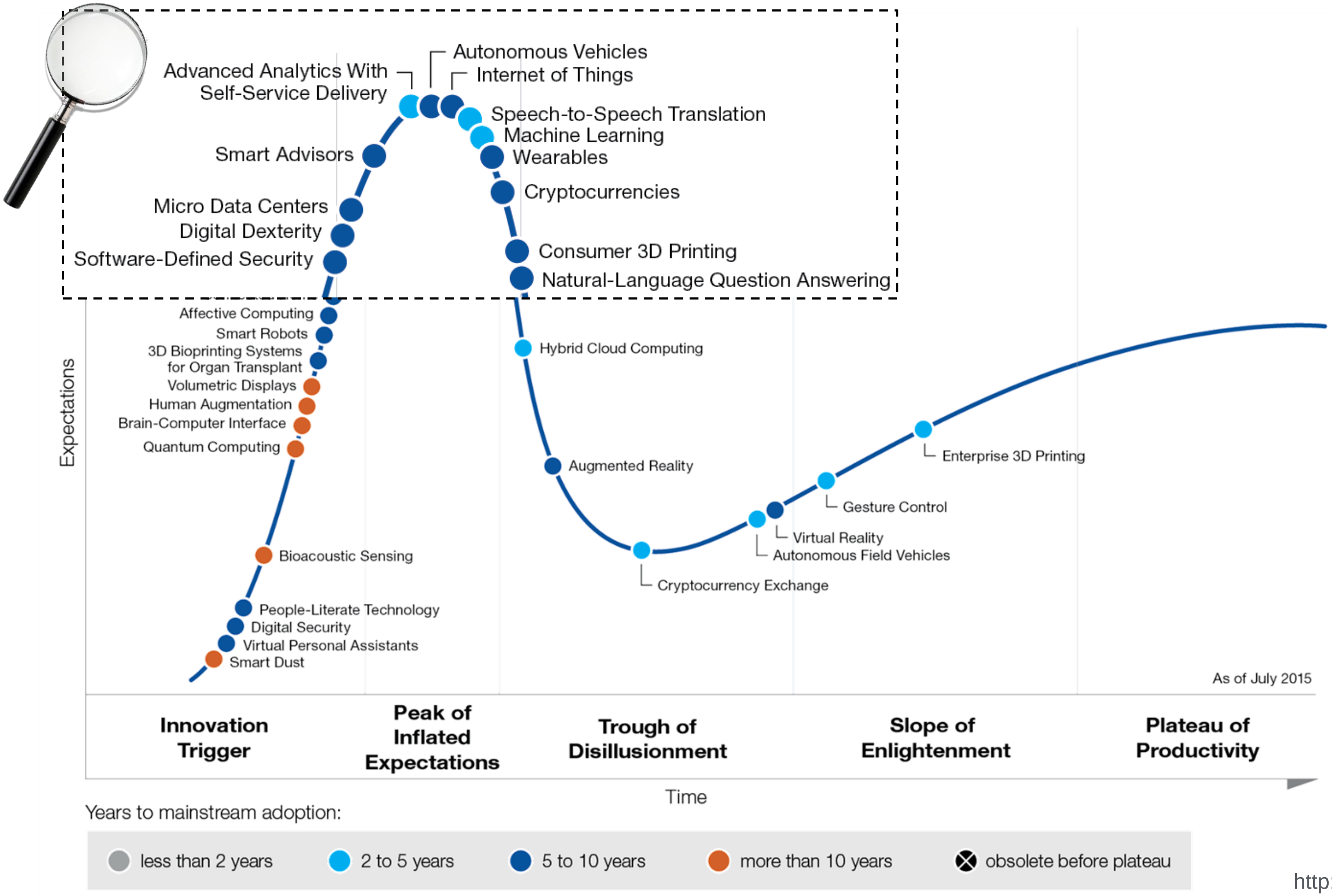
Introduction

Gartner Hype Cycle 2015 Motivates to Investigate Emerging Technologies



http://blogs.gartner.com

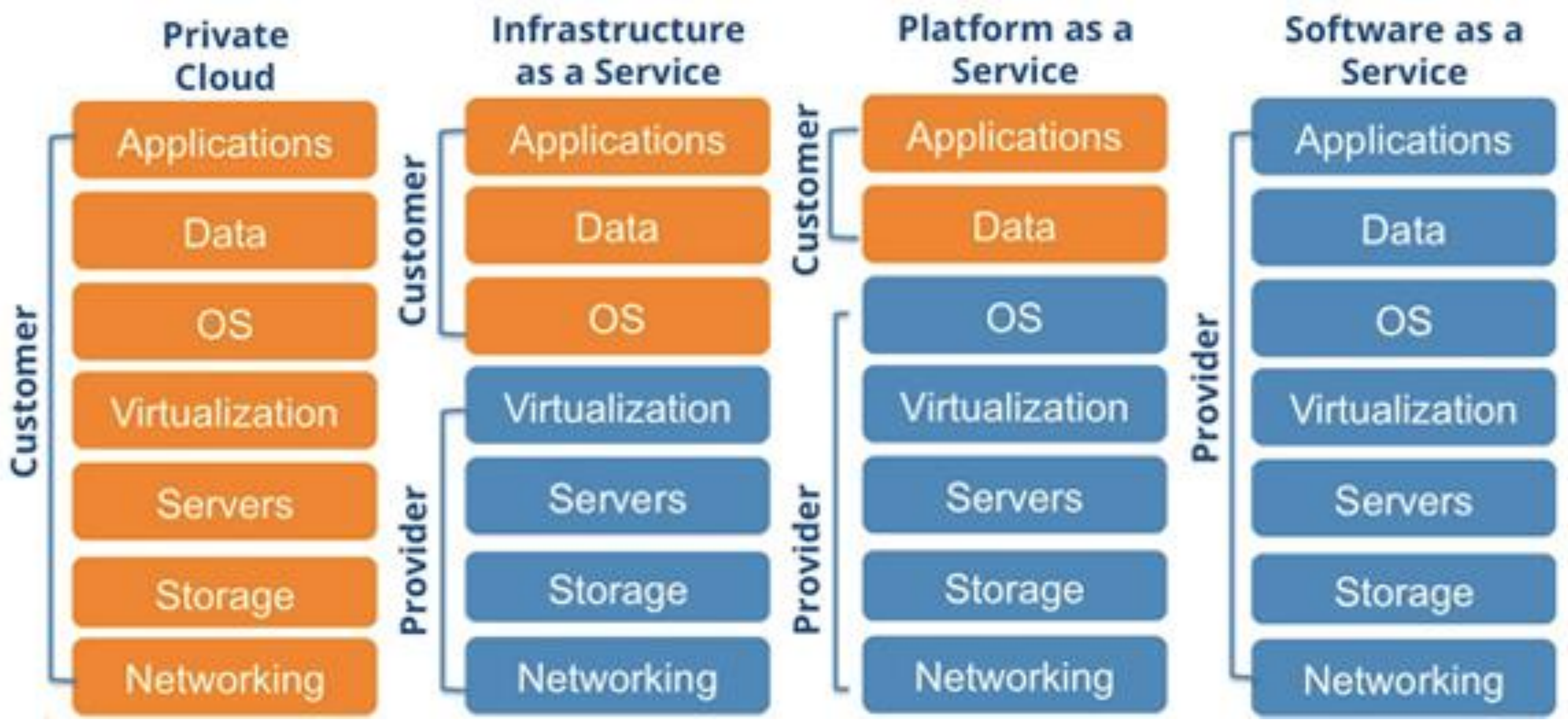
Speaker Profile

- Dr. Kai Daniel is the Director of Systems & Engineering in the Corporate Research and Technology Division of Carl ZEISS.

  Prior to this position he gained experience in the development of information and communication systems at Nokia Mobile Phones, RWE Deutschland AG (which is Innogy SE today) and WILO SE.

  Kai studied Electrical Engineering and Information Technologies at the Ruhr-Universität Bochum and received his doctoral degree in the area of communication networks from TU Dortmund university.

Requirements Towards Cloud Computing from Utility Perspective (2/2)



https://www.sevone.com/

Key Elements of a Smart Grid

The following elements are critical to achieving this vision:

1. **Sensing and measurement technologies**: To support faster and more accurate response such as remote monitoring, time-of-use pricing and demand-side management.
2. **Advanced components**: To apply the latest research in superconductivity, storage, power electronics and diagnostics.
3. **Advanced control methods**: To monitor essential components, enabling rapid diagnosis and precise solutions appropriate to any event.
4. **Improved interfaces and decision support**: To amplify human decision-making, transforming grid operators and managers quite literally into visionaries when it come to seeing into their systems.