Vision on CLOUDs and the impact on European R&D

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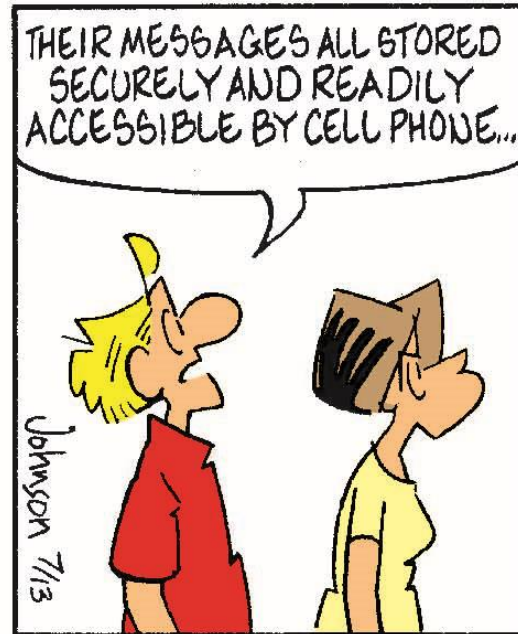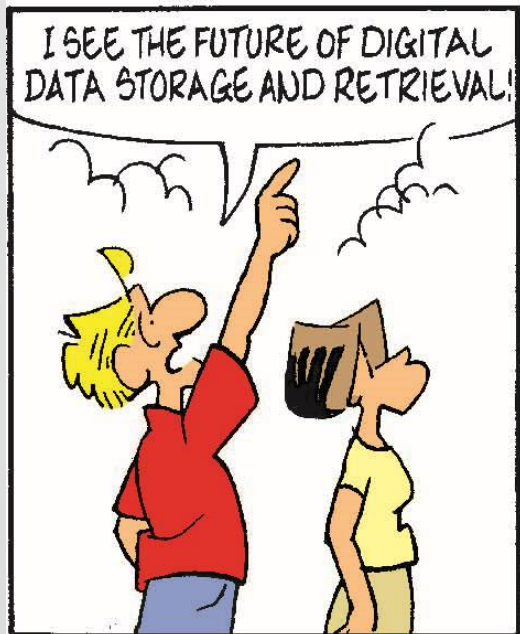## Structure

Introduction to CLOUDs
Challenges with CLOUDs
The Gaps
Current Activities in Europe
EC Opportunities
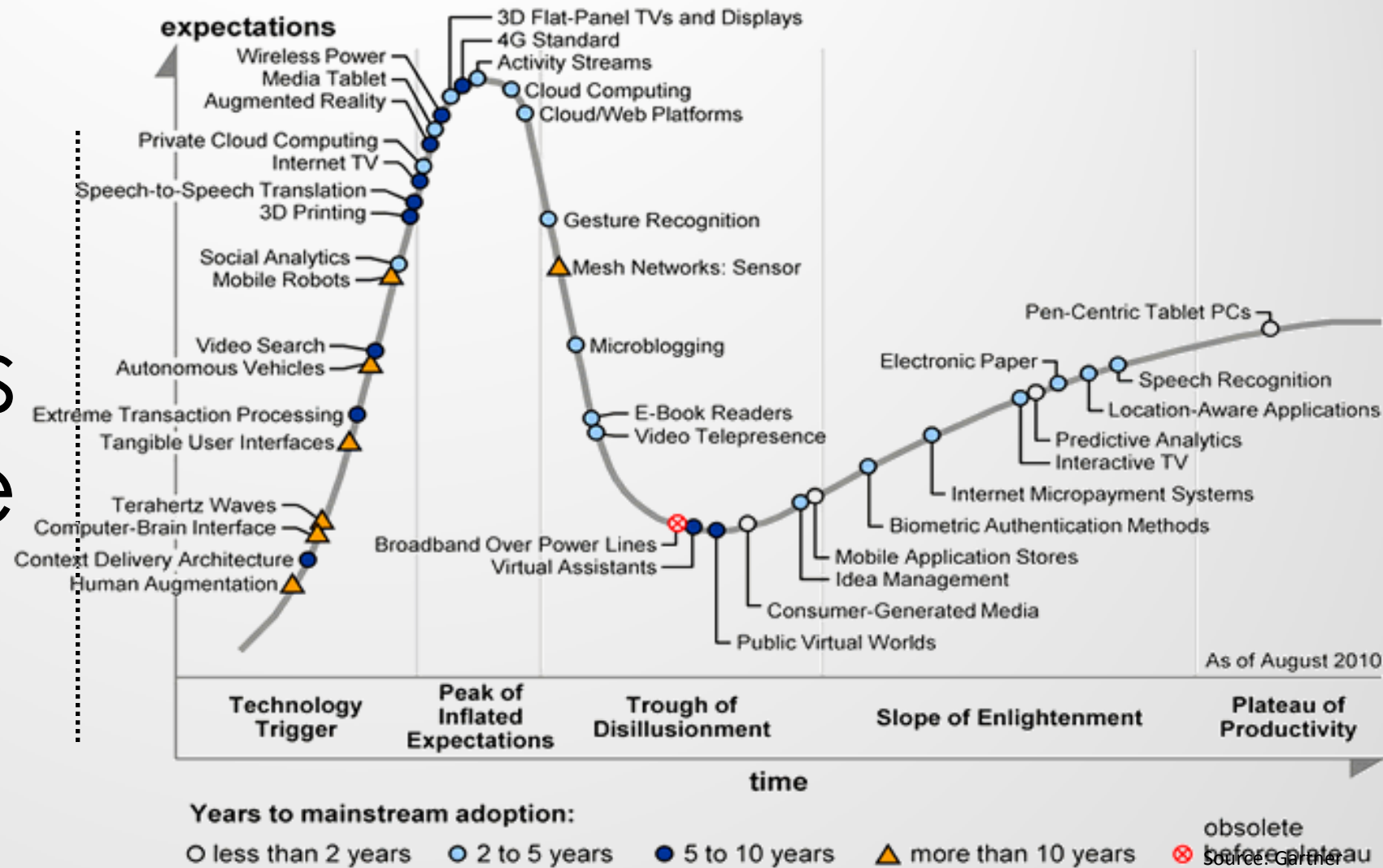
The Promises of Clouds

all fluffy and rainbows?

Clouds

the best invention since sliced bread?

accessible from anywhere

virtually endless

always available

high speed

cheap

secure

elastic

reliable

Gartner's Hypecycle

expectations

Wireless Power
Media Tablet
Augmented Reality

3D Flat-Panel TVs and Displays
4G Standard
Activity Streams
Cloud Computing
Cloud/Web Platforms

Private Cloud Computing
Internet TV
Speech-to-Speech Translation
3D Printing

Gesture Recognition

Social Analytics
Mobile Robots

Mesh Networks: Sensor

Pen-Centric Tablet PCs

Electronic Paper
Speech Recognition

Video Search
Autonomous Vehicles

Microblogging

Location-Aware Applications
Predictive Analytics
Interactive TV

Extreme Transaction Processing
Tangible User Interfaces

E-Book Readers
Video Telepresence

Internet Micropayment Systems
Biometric Authentication Methods

Terahertz Waves
Computer-Brain Interface
Context Delivery Architecture
Human Augmentation

Broadband Over Power Lines
Virtual Assistants

Mobile Application Stores
Idea Management
Consumer-Generated Media
Public Virtual Worlds

As of August 2010

Technology Trigger	Peak of Inflated Expectations	Trough of Disillusionment	Slope of Enlightenment	Plateau of Productivity

time

Years to mainstream adoption:

○ less than 2 years   ○ 2 to 5 years   ● 5 to 10 years   △ more than 10 years   ⊗ obsolete before plateau

Clouds are on the rise

- **$150 Billion: The size of the Cloud Computing Market by 2013.**

- **$750 Million: The Amount Amazon.com's AWS expects to earn in 2011.**

- **7/10: Companies using cloud services that will move new applications to the cloud.**

- **54%: Amount of respondents citing Security as their top concern for transitioning to the cloud.**

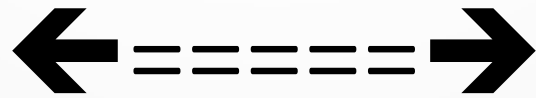- **60%: Server workloads that will be virtualized by 2014.**

Clouds are on the rise
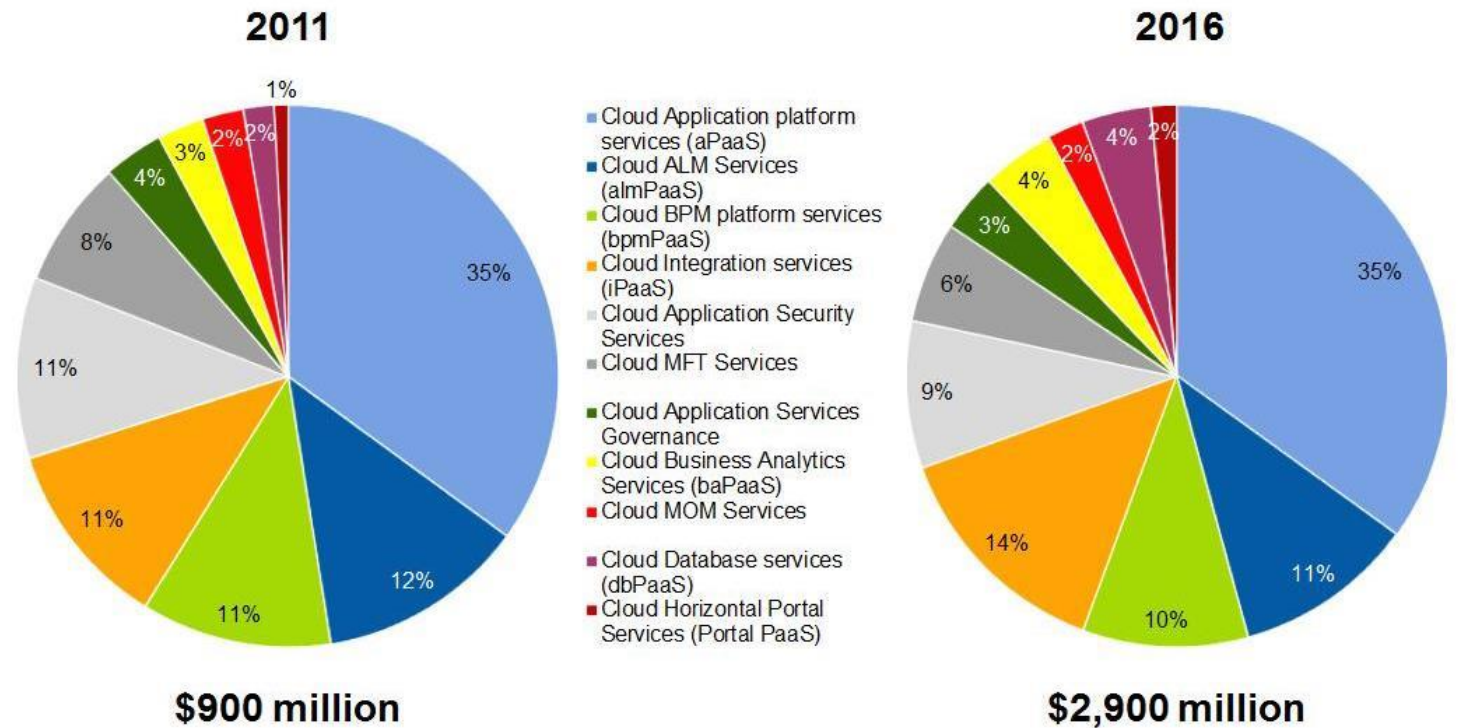
Clouds are not ⬅===➡ Clouds are

Clouds are not	Clouds are
• They do *not* make any application fast	• a mechanism for outsourcing any internet-based service
• or immediately available	• a mechanism for dynamically adapting the amount of resources according to need
• They are not generally cheap and	• a mechanism for improving availability
• The CLOUD is *not* the internet	

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Target
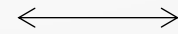
Private CLOUD
(inhouse, cluster)

interface

Common Service Environment with metadata
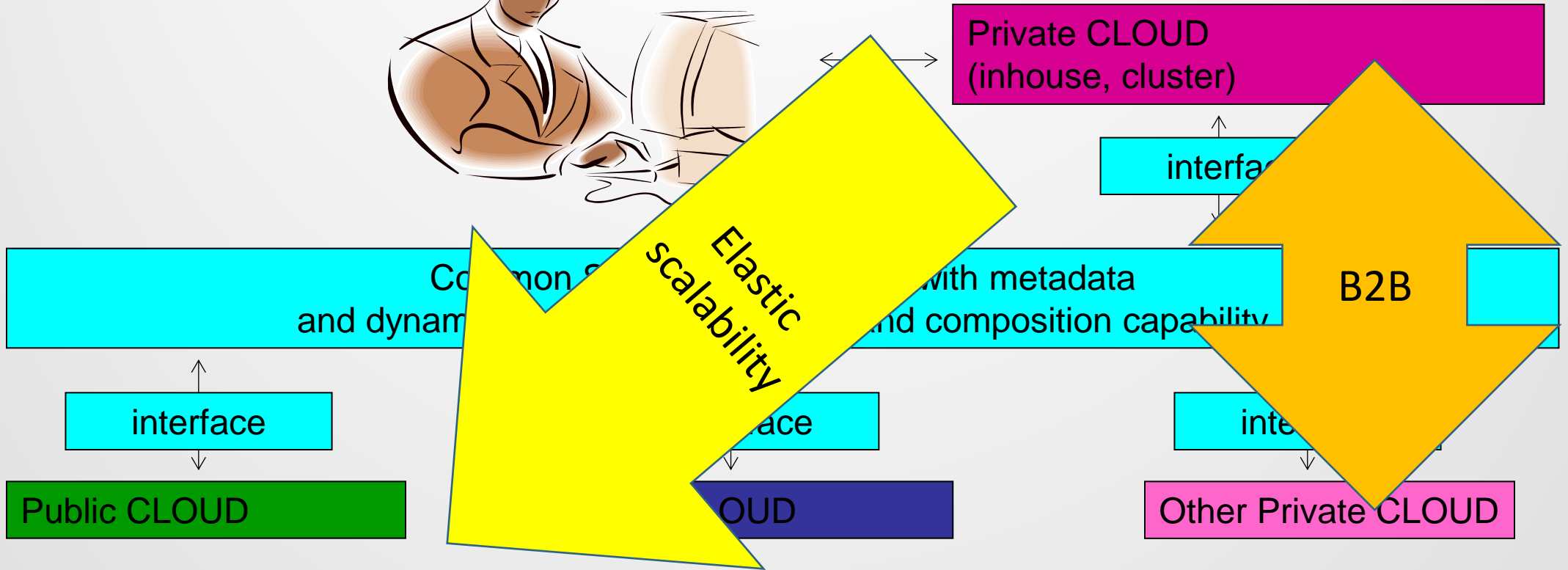and dynamic systems development and composition capability

interface

interface

interface

Public CLOUD

Public CLOUD

Other Private CLOUD

Target

Private CLOUD
(inhouse, cluster)

interface

Common S... with metadata
and dynam... and composition capability

Elastic
scalability

B2B

interface

interface

...ace

interface

Public CLOUD

OUD

Other Private CLOUD

Main Research Topics

1. Data Management
2. Communication & Network
3. Resource description & usage
4. Resource management (Provider Support)
5. Multiple Tenants
6. Federation (& interoperability, portability)
7. Programmability & Usability
8. Political & Legislatory
9. Security
10. Business & Cost Models

Immediately Relevant Topics
(short-term innovation)

- Managing data deluge
- Improved networking
- Improve the capabilities to exploit CLOUD features
- Improve the performance and portability of applications
- (Security) vulnerabilities
- Reducing vendor lock-in
- Comparability between offerings
- Viable business models / clear European benefit
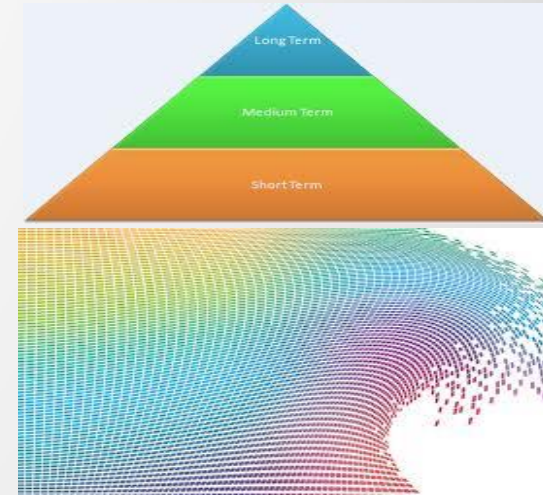
Sustainability R&D Topics
(medium-term innovation)

- better understanding of the relationship between application and user / usage behaviour
- Means to use that relationship – this includes
  - manage service discovery, (re-)composition and execution autonomically
  - allow developers to produce quickly and cheaply well-designed software
  - identification and provisioning of typical CLOUD usage patterns (cf. HADOOP)
- Deal better with the growing heterogeneity
- Paving the way for personalised service provisioning and usage
- Extended outsourcing and composition of capabilities
- Scalable orchestration of services and virtualised resources
- Maintain / improve trust through
  - Enhanced protection
  - Address privacy concerns
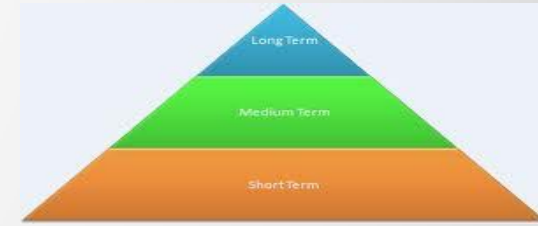
Paradigm Shifters

New paradigms to address the underlying challenges and 'leapfrog' the competition – longer-term innovation

- Dynamic (re-)composition of services; intelligent networking; cross-platform service deployment
- Big data managing integrity (state) and heterogeneity of data models.
- Declarative programming with execute-time data binding –for flexibility, heterogeneity, consistency etc.
- Interoperation and federation (heterogeneity and mobility) - appear to the application environment as one uniform platform.
- Exploitation of new device types and environments
  - advances in hardware for processors, storage, detectors and instruments and networks – along with associated low-level (embedded) software
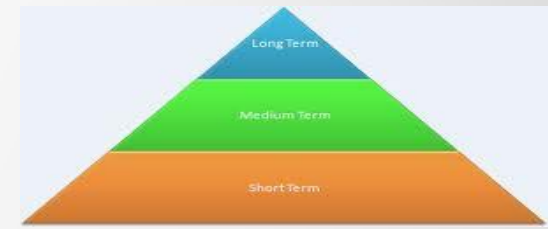
What Stops us..

- I have listed a whole lot of CLOUD specific problems already such as:
  - Interoperability / vendor lock-in
  - Security, privacy
  - Quality of service / service level agreements
  - Legislation

- **But CLOUDs throws into sharp relief many underlying computer science / informatics problems**

Perennial challenges

- Metadata   to permit automated virtualisation
- State   to ensure information currency
- Data Representativity   to ensure accuracy
- Data quality, veracity, permanency   to assure
- Trust, security, privacy   to protect
- Management of service and quality   to comply
- Systems development methods   to productise
  - New programming paradigms
    - Co-design software with management
    - Built in trust / security / privacy
    - Dynamically (re-)composable services
  - Supporting toolsets

WARNING
CHALLENGES AHEAD

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Growing Demands

User expectations:

Requirements

Technological Capabilities

**Increasing gap cannot be met by traditional iterative approaches**

2010

2015

2020
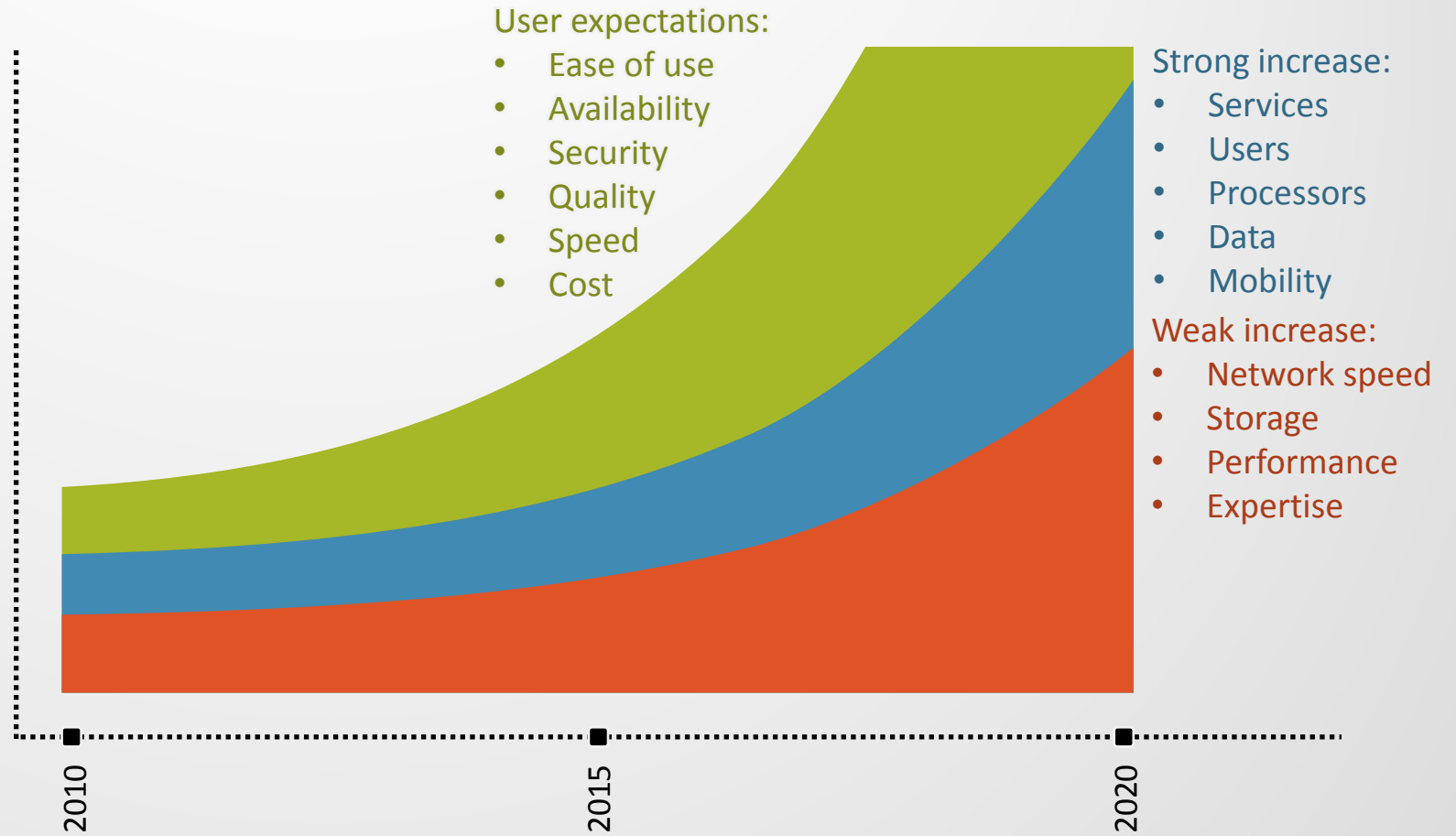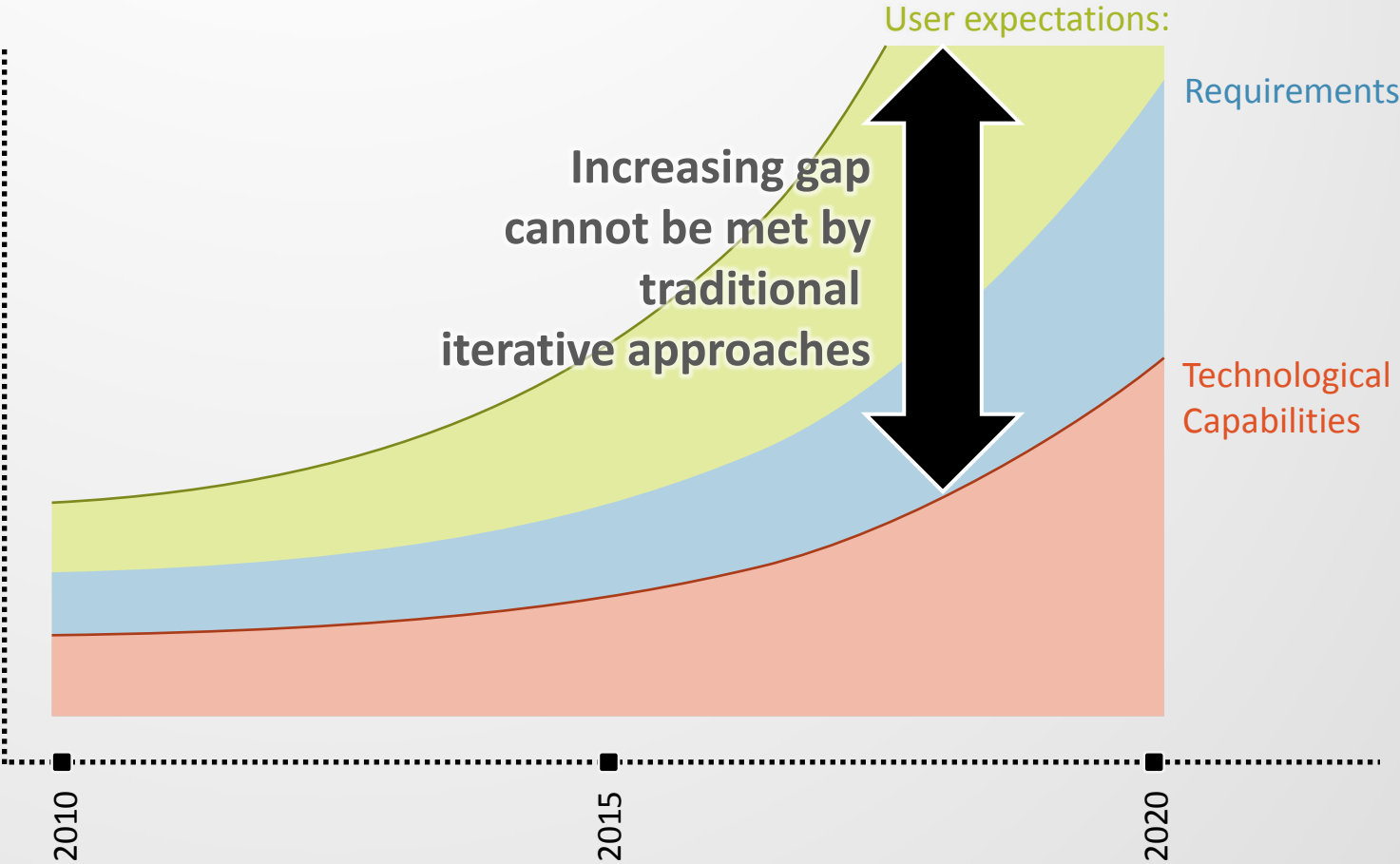
- Manageability and Self-* (autonomicity)
- Data Management
- Privacy & Manageable Security
- Federation & Interoperability
- Elasticity (Vertical and Down)
- Programming Models & Resource Control

Manageability and Self-*

- Efficiency & Overhead of management
- Interoperability of management frameworks
- Compensation for insufficient resources
- Boundary criteria (QoS, legal, environmental)
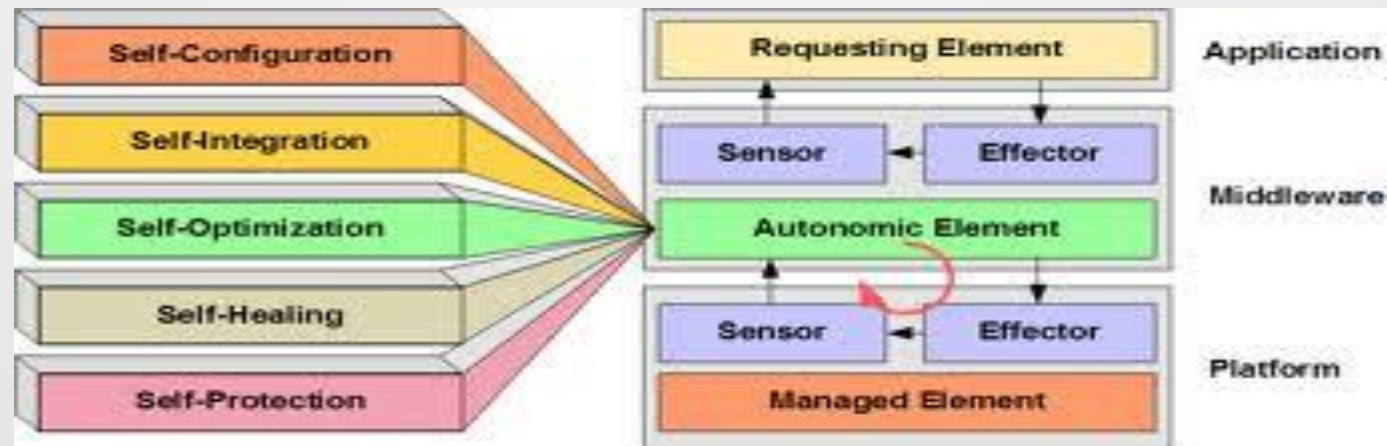
Data Management

- Data size (with new access patterns)

- Lifecycle control (compliance & economic)

- Multi-tenancy

- Flexibility, expressiveness

- Consistency and concurrency models*

- Partitioning and replication
  - Performance
  - Security

*see also programming models
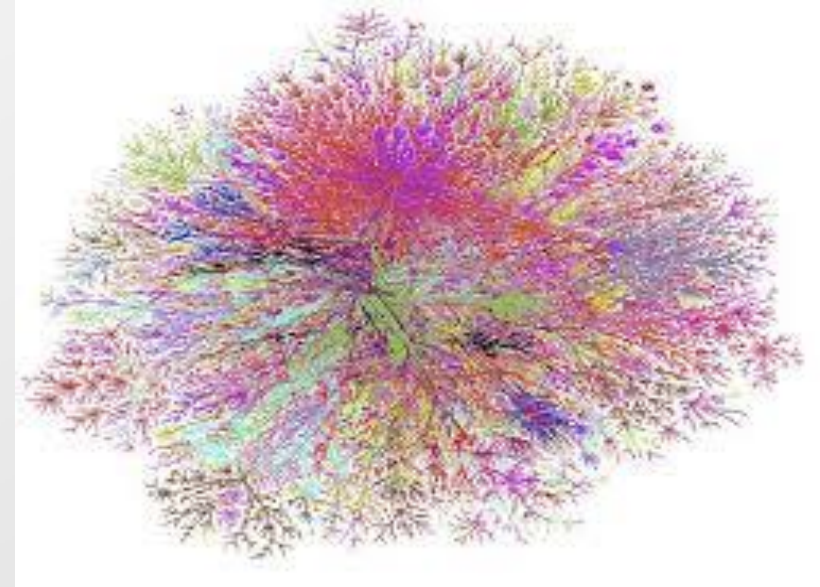
Privacy & Manageable Security

- Multi-tenancy

- Provenance & compliance

- Composable security
  - Consistent across services
  - User role (temporal validity)
    - Authorities / responsibilities
    - Permissions (licensing…)

Federation & Interoperability

- Propietary de-facto standards
- Vendor lock-in
- Lack of agreed upon abstractions and interfaces for federation
  - SLA/QoS
  - Trust, Security, Privacy
  - Dynamic, partial (component)) Migration

Elasticity

- Rapid release of unused resources

- Scheduling with variable resources
  - Resource characteristics / appropriateness

- Vertical elasticity*
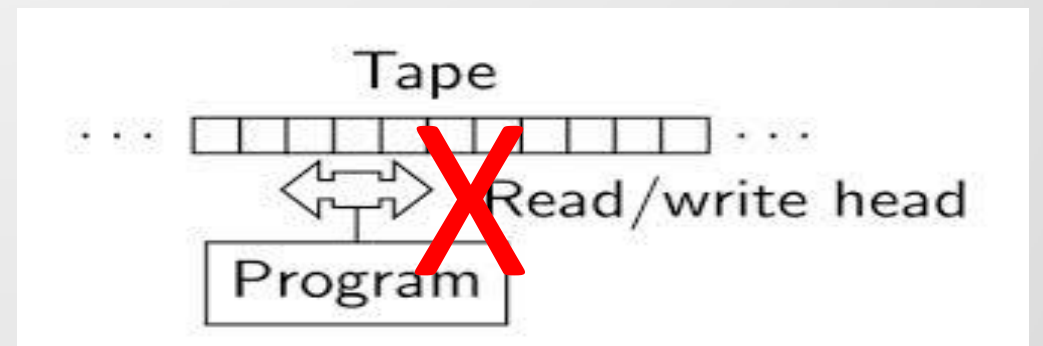
- Rapidly changing workloads

*see also programming models
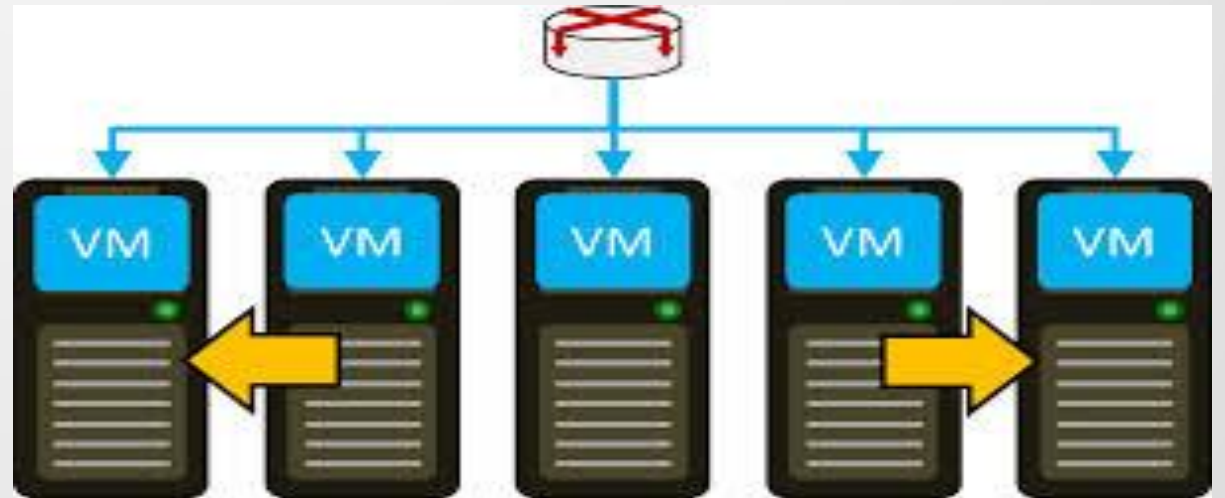
Programming Models & Resource Control

- Vertical scalability

- Intelligent distribution of code & data

- Reliability

- Ease of Use

- Development and operations support

A move away from Turing and von Neumann?

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Ongoing European Research Projects

a few examples of European investment into improving Clouds

Federation

- XIFI
- FELIX
- ModaClouds
- PaaSage
- *and more*

Bring together multiple resource providers to jointly provide services. Typically require a common framework such as OpenStack.

Resource Matching

- CACTOS
- Panacea
- CloudScale
- *and others*

Applications and services have specific requirements in terms of SLAs and behaviour. Configuring the available resources to meet these requirements.

Software Engineering

- PaaSage
- POLCA
- Artist
- CoherentPaaS
- Harness
- *etc.*

Towards new software engineering methods that allow development of distributed and shared applications. First approaches generally model-driven.

Automation & Adaptation

- PaaSage
- Midas
- Celar
- SeaClouds
- CACTOS
- *many others*

Most projects aim to automate the deployment and configuration etc. – typically within their respective context
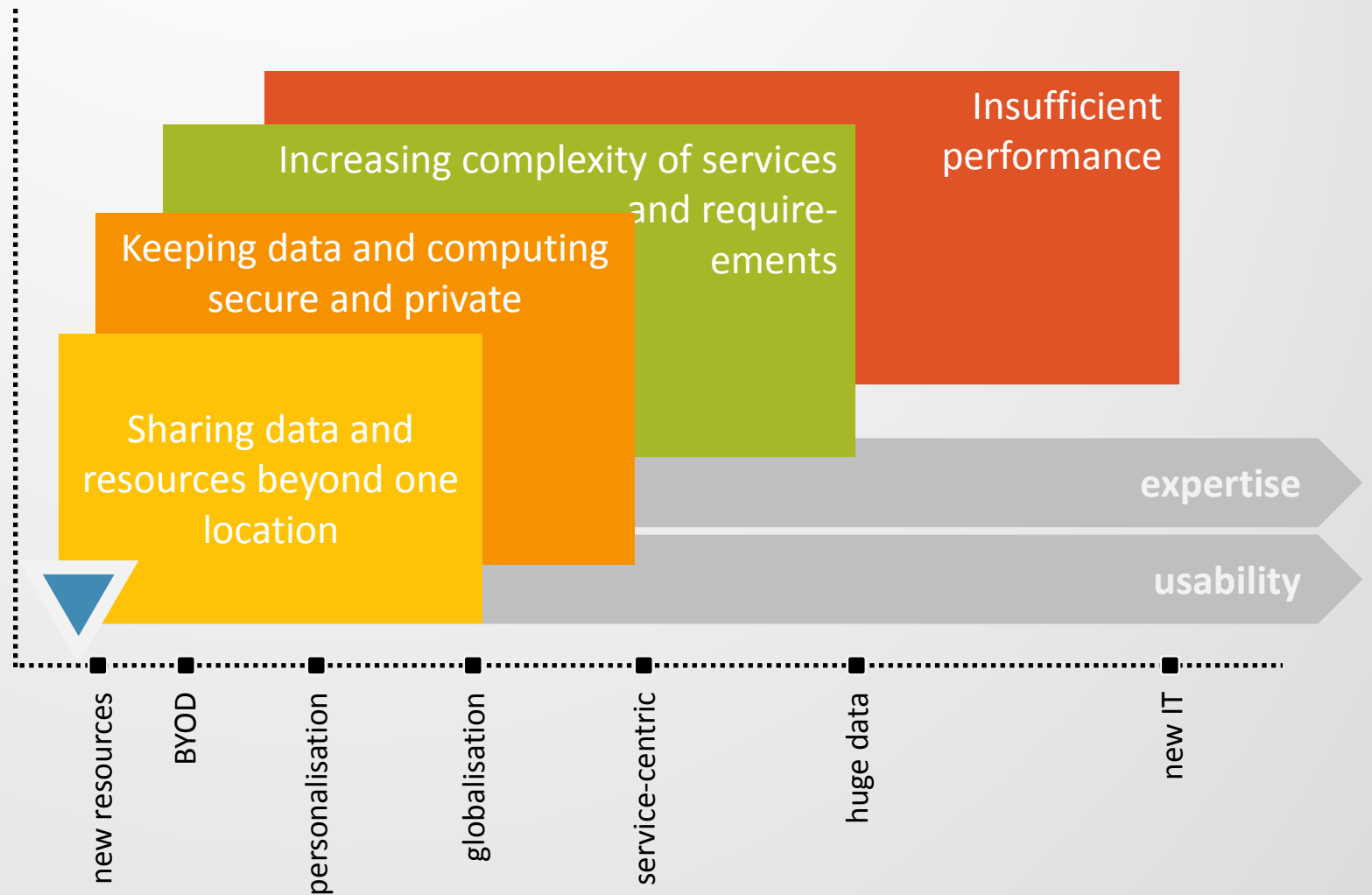
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The Commission Mission

- To foster Research and Development in Europe to improve competitiveness of European industry

- A specific focus on supporting small to medium enterprises to stay competitive and viable

- General idea:
improve the capabilities and offerings of European offerings by exploiting expertise across Europe

Participate

- EC research projects are open to anyone with a "good idea"
- You can participate in multiple ways:
  - Providing use cases that need to be improved
  - Participate directly in research & development work
  - Take up the results to improve your capabilities (at no to low cost*)
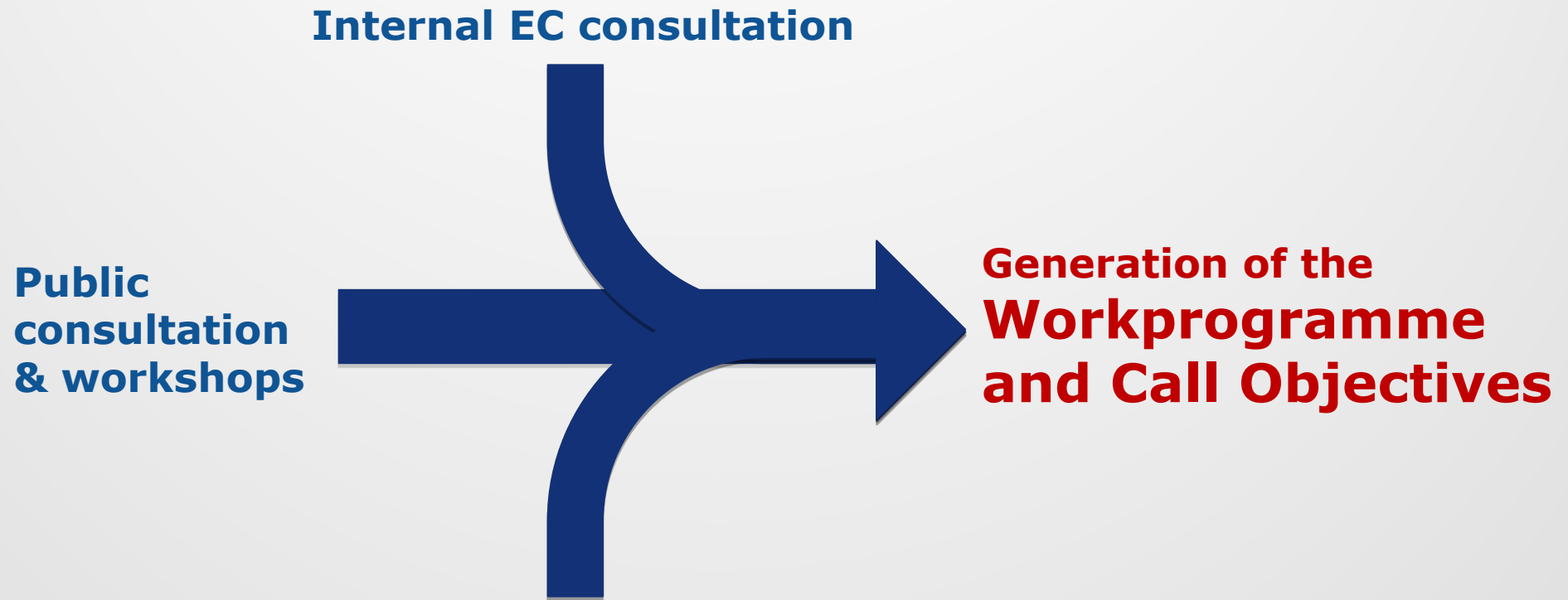 - Commercialise the results yourself*

depending on IPR and licensing by the project – most results are Open Source

Make YOUR Voice Heard

that's all not what I need, what now?

Work Programme Preparation

Internal EC consultation

Public consultation & workshops

Generation of the Workprogramme and Call Objectives

Other sources: reports from different expert groups & workshops

EC Cloud Expert Group

- Initiated in 2009 by Maria Tsakali
- Moderated by Lutz Schubert, Keith Jeffery, Burkhard Neidecker-Lutz

- Consists of in total more than 100 experts, with
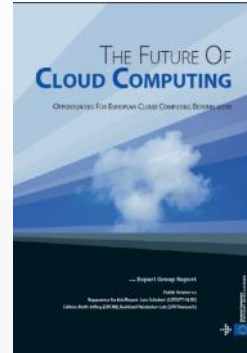 - ~60% industry
  - ~40% academia

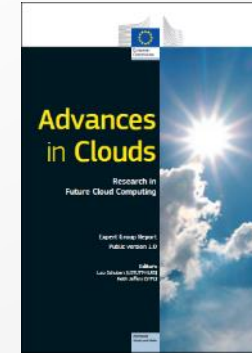EC Cloud Expert Group

Mission

- Bring experts together to identify the main challenges in Cloud Computing

- Focus in particular on the long-term relevant aspects

- Break down the concrete steps needed to address the challenges

- Develop a roadmap with short-, mid- and long-term objectives
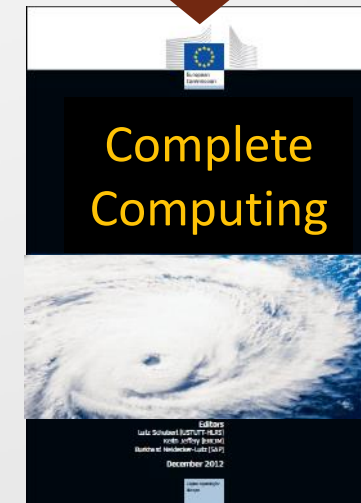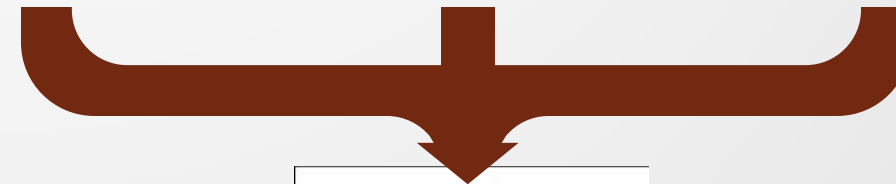
EC Cloud Expert Group

Reports

http://cordis.europa.eu/fp7/ict/ssai/docs/
cloud-report-final.pdf

http://cordis.europa.eu/fp7/ict/ssai/docs/
future-cc-2may-finalreport-experts.pdf

http://cordis.europa.eu/fp7/ict/ssai/docs/
cloud-expert-group/roadmap-dec2012-vfinal.pdf

Complete
Computing

http://ec.europa.eu/information_society/newsroom/cf/dae/
document.cfm?action=display&doc_id=6775

EC Cloud Expert Group

- Open for everybody
- Concrete future plans are in discussion

➢ Contact

- Maria Tsakali
  European Commission
  maria.tsakali@ec.europa.eu
- Keith Jeffery
  Keith G. Jeffery Consultants
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- Lutz Schubert
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SUCRE & OCEAN

- The EC Cloud Computing Expert Group focuses on *Europe*

- But Clouds / the internet is *global*

➢SUCRE & OCEAN investigate the requirements beyond Europe (specific focus: Japan)

NESSI is a European Technology Platform active in Information and Communication Technologies for contributing to the research and innovation space of Software and Service.

 NESSI stands for the Networked European Software and Service Initiative. It provides a platform for the community from industry and academia.

Shaping Europe's future for software,
Services & cloud

CloudWATCH is giving pain relief

Consumer concerns* that are slowing down adoption of the cloud:

Lack of control	Lack of standards
Lack of integration	Lack of RoI

What users want

A. Monitoring, management and transparency

B. Integration, open APIs, open source

C. Interoperability and portability

D. Business cases and proof

CloudWATCH delivers

➢ Recommendations for a more transparent cloud

➢ Working towards an ecosystem of open source services

➢ Unambiguous standards profiles for interoperability and portability

➢ Use cases, best practice and advice for trusted in the cloud

*GigaOM Consumer Survey 2013

CloudWATCH Achievements

Endoresment from VP Neelie Kroes – *"The EU-funded CloudWATCH project is actively promoting initiatives aligned with our cloud strategy: including Cloud Scout"*

The standards landscape

- Identification of best practices and landscape of standards through a coherent Reference Model Framework

Use cases

- Over 15 use cases analysed to identify user requirements and best practices for interoperability

Standard profiles

- Organisation of future cloud plugfests
- Cloud standards, and profiles, are nothing without demonstrating interoperability

Trust & Security

- Cloud certification guidelines contributing to C-SIG group
- Online legal guidance
- Webinars on legal & security issues

Supporting SMEs

- The launch of the EU Cloud Scout
- Online tool to support SMEs to the cloud

European CloudScout
How to move your SME to the Cloud

A growing community

- 400 content pieces on CloudWatchHUB.eu
- 55 projects, 17 events, 600 followers
- Over 200 at Concertation meetings for EC

CloudWATCHhub.eu & European CloudScout

European CloudScout is a simple online tool provides European SMEs with tailored information and recommendations on their use of Cloud

CloudScout is now hosted on the CloudWatchHUB

❑Originally developed by DsiN (<u>Deutschland sicher im Netz</u>) for Germany

❑Thanks to CloudWATCH, CloudScout is currently **available for Austria, Belgium (French & Flemish), Finland, Germany, Spain, United Kingdom**

❑Since its launch Cloud Scout has been **completed over 200 times by SMEs in Europe**

"Cloud Scout is a simple tool to give small businesses the information to decide on how to use the cloud: taking account of their legal, organizational and technical needs. Cloud Scout is very welcome. I encourage any other initiatives aligned with our cloud strategy to come forward too. Indeed the EU-funded CloudWATCH project is actively promoting many of them: including Cloud Scout."

The European Commissioner for the Digital Agenda, **Neelie Kroes** launched Cloud-Scout @ **European Cloud Scout: SMEs to navigate to the cloud** Event, **10 July 2014**, Brussels

On www.cloudwatchhub.eu

45 Position papers from Sofware Services and cloud projects
http://www.cloudwatchhub.eu/concertation-position-papers#

Presentations
http://bit.ly/1wNaTV9

Recommendations Report
http://bit.ly/YhTlnW

www.cloudwatchhub.eu|info@cloudwatchhub.eu|@cloudwatchhub

Questions?