Cloud Computing
A 21st Century Technological Panaceum

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AGENDA

1.LET’S GET IT !!!

2.LET’S THINK IT…

3.REFLECTIONS ???

LET'S GET IT !!!

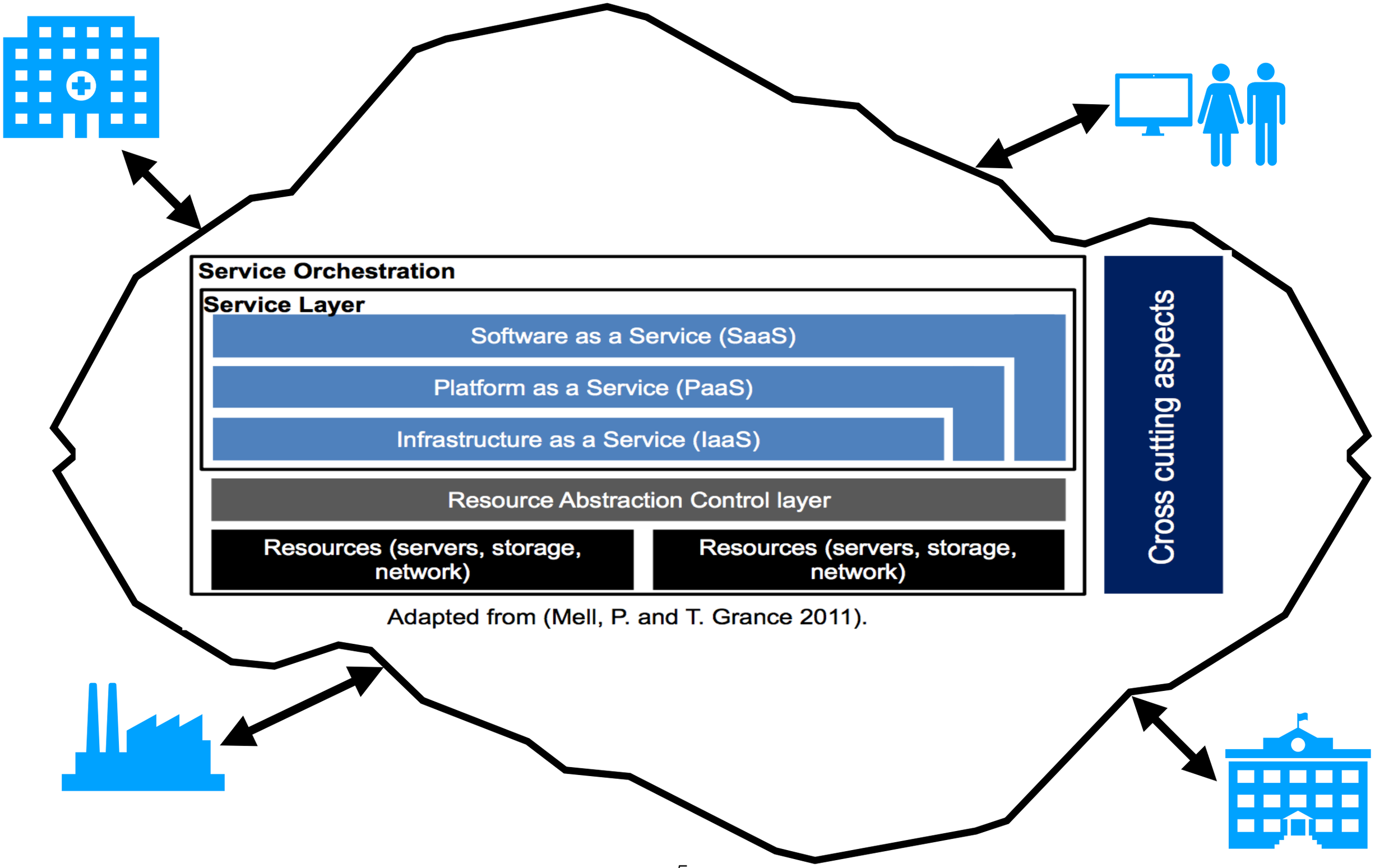
- What exactly ***IS*** Cloud Computing?
- Why has Cloud Computing become a "buzzword of ***SUCCESS***"?
- What qualities ***DOES*** Cloud Computing offer to customers?
- Cloud Computing ***ASSURANCES*** for the customer

What exactly *IS* Cloud Computing?

Cloud Computing Key Characteristics (ISO/IEC 17788:2014)

- Broad Network Access
- Measured service
- Multi-tenancy
- On-demand self-service
- Rapid elasticity and scalability

What exactly *IS* Cloud Computing?



Adapted from (Mell, P. and T. Grance 2011).

What exactly *IS* Cloud Computing? (2)

- Software as a Service (SaaS):
  - a ready-to-use service that serves the purposes of its intended user
  - built as:
    - a single application, or
    - the dynamic algorithmic combination of several services/applications
  - resides entirely in the Cloud
  - user's interaction with SaaS is through a dedicated User Interface
  - user has no access to the service's internal structure and/or content (Black Box approach)

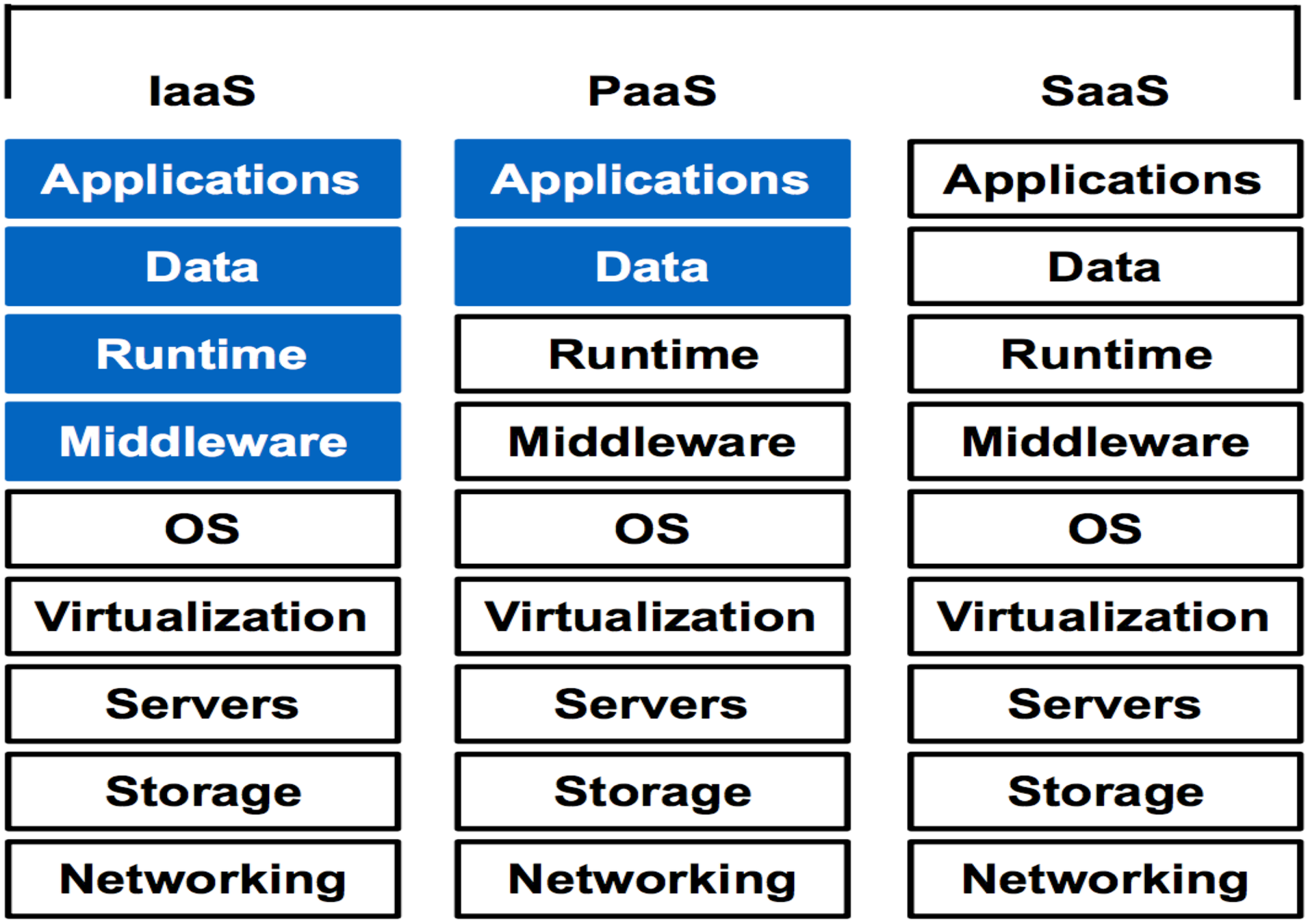
What exactly *IS* Cloud Computing? (3)

- Platform as a Service (PaaS):
  - a ready-to-use platform that allows for independent development of services
  - offers:
    - an infrastructure:
      - hardware and OS (ex. a fully equipped UNIX server)
      - middleware and runtime on the top of it (ex. Java Runtime, development tools)
  - resides entirely in the Cloud
  - user's interaction with PaaS is through a dedicated Developer Interface (APIs and development tools)
  - user has no access to the service's internal structure and/or content (i.e. cannot interfere with the OS or installed tools)

What exactly *IS* Cloud Computing? (4)

- Infrastructure as a Service (IaaS):
  - a ready-to-use infrastructure that allows for creating the individual development environment and further services
  - offers:
    - hardware and OS (ex. a fully equipped UNIX server)
    - OS-native middleware and runtime
  - resides entirely in the Cloud
  - user's interaction with IaaS is through OS-native developer interface and APIs
  - user has no access to the service's internal structure and/or content (i.e. cannot interfere with the OS or its APIs)

What exactly *IS* Cloud Computing? (5)

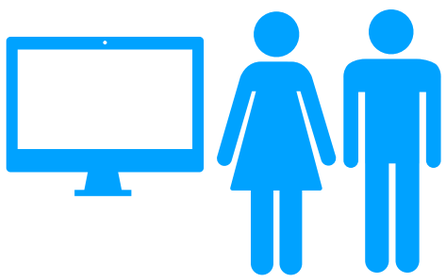


Adapted from Pramod, N., et al. (2013).

What exactly *IS* Cloud Computing? (6)

- Types of Cloud Computing:
  - Public Cloud
    - services (platforms, infrastructures) accessible through the public network (Internet)
    - resources located and distributed within the network belong to many owners/suppliers
  - Private Cloud
    - services (platforms, infrastructures) accessible through the private network:
      - fully owned and controlled physical network, or
      - virtual private network
    - resources located and distributed within the network belong to a single organization (ex: Ericsson)
  - Mixed (Hybrid) Cloud
    - Private and Public Cloud mixed in proportions resulting from functional, quality, performance and cost requirements (among the others)

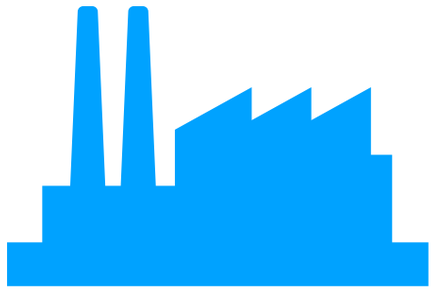
Why has Cloud Computing become a "buzzword of *SUCCESS*"? (1)



<u>Very Small Enterprise (VSE) or an Individual User</u>:

- A service ready to use, just sign the licence (and give your credit card number) 😡
- No need for extra investments or expenditures, an existing PC should suffice
- Usage costs considerably lower than of its individual-dedicated equivalent
- More and more often the dynamic payment model, i.e. pay-as-you-use

Why has Cloud Computing become a "buzzword of *SUCCESS*"? (2)



Industrial User:

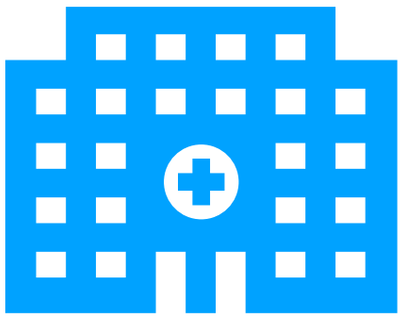
- A ready to use Cloud solution (IaaS, PaaS or SaaS, as needed)
- Severely reduced investments, as compared to buying, installing and maintaining a private equivalent of the chosen solution
- Usage (operation) costs considerably lower than of its individual-dedicated equivalent
- More and more often the dynamic payment model, i.e. pay-as-you-use

Why has Cloud Computing become a "buzzword of *SUCCESS*"? (3)

Educational User:

- A ready to use Cloud solution. For example:
  - IaaS and PaaS for laboratories
  - SaaS for teaching and administration
- Severely reduced investments, as compared to buying, installing and maintaining a private equivalent of the chosen solution
- Usage (operation) costs considerably lower than of its individual-dedicated equivalent
- More and more often the dynamic payment model, i.e. pay-as-you-use

Why has Cloud Computing become a "buzzword of *SUCCESS*"? (4)

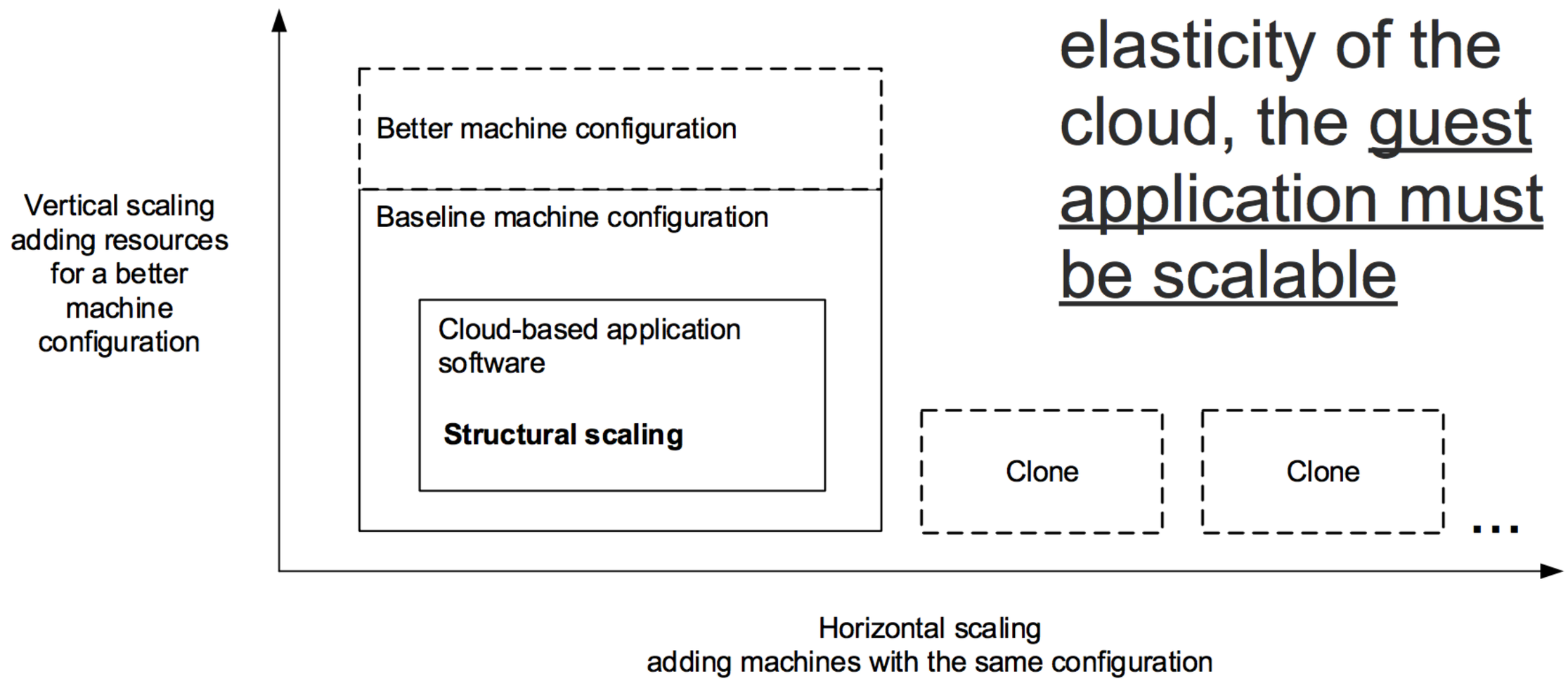


Public Services:

- A ready to use Cloud solution. For example:
  - IaaS and PaaS for data/security sensitive applications (finances, health care, national defence)
  - SaaS for administration, contacts with citizens, services feedback or advertising.
- Severely reduced investments, as compared to buying, installing and maintaining a private equivalent of the chosen solution
- Usage (operation) costs considerably lower than of its individual-dedicated equivalent
- More and more often the dynamic payment model, i.e. pay-as-you-use

Why has Cloud Computing become a "buzzword of *SUCCESS*"? (5)

Rapid elasticity and scalability



- To benefit from the elasticity of the cloud, the <u>guest application must be scalable</u>

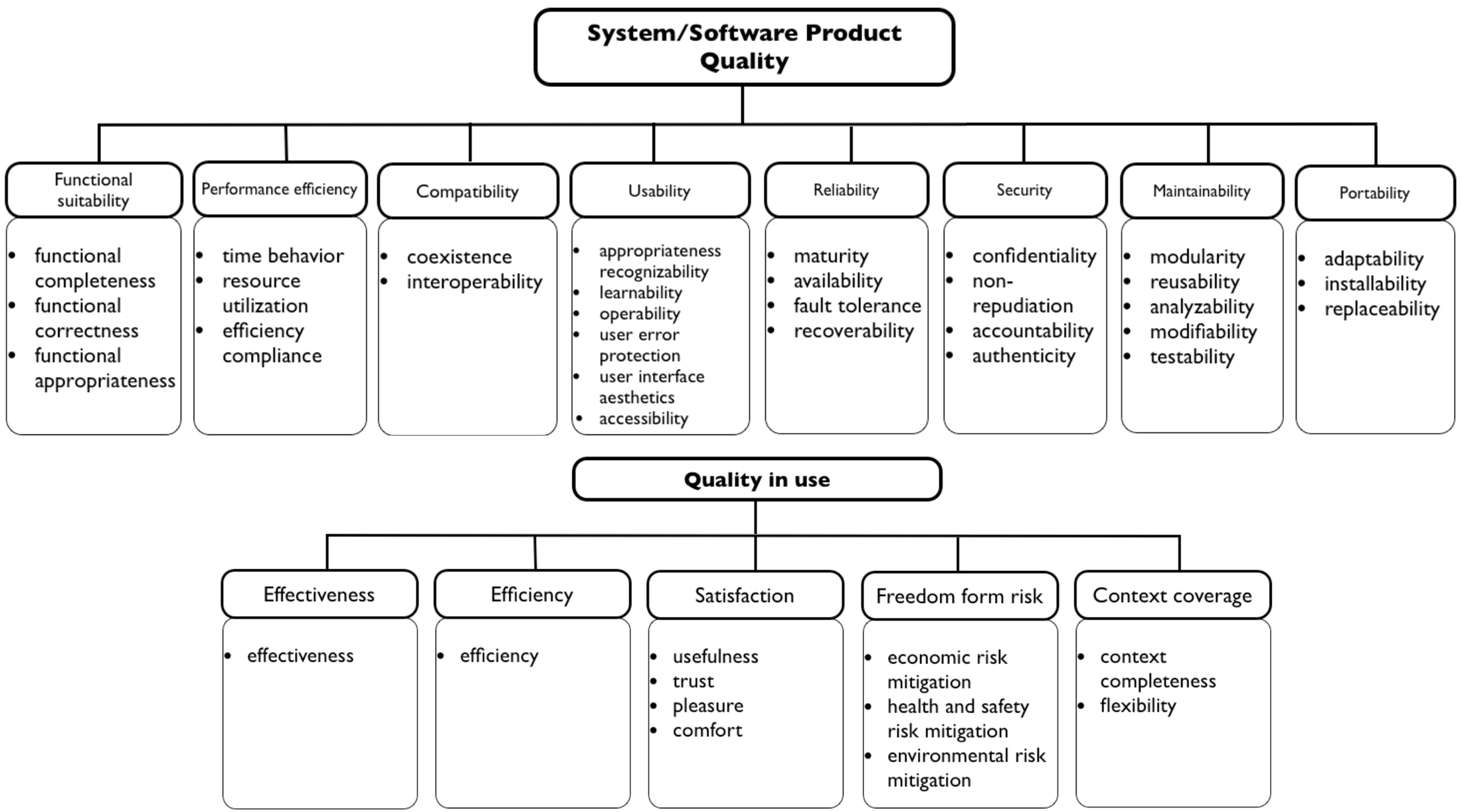
Adapted from (Majakorpi, M. 2013)

What qualities *DOES* Cloud Computing offer to customers?

- How do we define the quality of an IT service?
  - individual, personal evaluation (publicly irrelevant)
  - group of interest evaluation (broader recognition but biased)
  - evaluator-independent evaluation (national or international standards, national or international consensus)

What qualities *DOES* Cloud Computing offer to customers? (2)

- Existing standards for IT quality measurement and evaluation: ISO/IEC 25000 SQuaRE



What qualities *DOES* Cloud Computing offer to customers? (3)

- Cloud Computing quality attributes identified to date*:
  - Functionality
  - Suitability
  - Accuracy
  - Interoperability
  - Usability
  - Learnability
  - Operability
  - Accessibility
  - Security
  - Reliability
  - Confidentiality
  - Integrity
  - Availability
  - Security Management
  - Authenticity
  - Scalability
  - Extensibility
  - Response time
  - Resiliency
  - Adaptability
  - Customizability
  - Testability
  - Stability
  - Composability
  - Recoverability
  - Auditability
  - Multi-tenancy
  - Robustness

*Based on the results of the research “Applicability of ISO/IEC 25010:1020 Standard in Context of SaaS” by M.Corriveau-Trudel, A.Lavallée, M.Diakhate, École de technologie superieure, Montreal, Canada, 2017

What qualities *DOES* Cloud Computing offer to customers? (4)

- Cloud Computing quality attributes vs ISO/IEC 25000*. Do they meet?
  - Surprisingly, in case of SaaS the majority of ISO/IEC 25000 attributes and measures can be applied
  - Certain SaaS specific attributes like multi-tenancy, scalability or robustness are not standardized yet.
  - IaaS and PaaS quality attributes are poorly represented in ISO/IEC 25000**

*Based on the results of the research "Applicability of ISO/IEC 25010:2010 Standard in Context of SaaS" by M.Corriveau-Trudel, A.Lavallée, M.Diakhate, École de technologie superieure, Montreal, Canada, 2017

** Extensive research in this subject is being conducted by Jonathan Roy, the PhD student at École de technologie superieure, Montreal, Canada, 2017

Cloud Computing *ASSURANCES* for the customer (1)

- SLA {SLO} - what does that mean?!!! It reads: “Service Level Agreement is based on the list of Service Level Objectives”
  - Definition of an SLA (ISO/IEC 17788:2014):
    - **service level agreement (SLA)**: Documented agreement between the service provider and customer that identifies services and service targets.

NOTE 1 A service level agreement can also be established between the service provider and a supplier, an internal group or a customer acting as a supplier.

NOTE 2 A service level agreement can be included in a contract or another type of documented agreement

- SLA characterizes quality of the cloud services delivered in terms of:
  - a set of **measurable properties** specific to cloud computing (business and technical), and
  - a given set of cloud computing roles (cloud service customer and cloud service provider and related sub-roles)

Cloud Computing *ASSURANCES* for the customer (2)

- Example: SLA on Cloud service performance • SLOs — ***measurable properties***
  - Cloud service response time
    - Cloud service response time mean
    - Cloud service response time variance
  - Cloud service capacity
    - Number of simultaneous cloud service connections
    - Limitation of available cloud service resources
    - Cloud service throughput
    - Cloud service bandwidth
  - Elasticity
    - Speed
    - Precision

Cloud Computing *Sub-Conclusion*

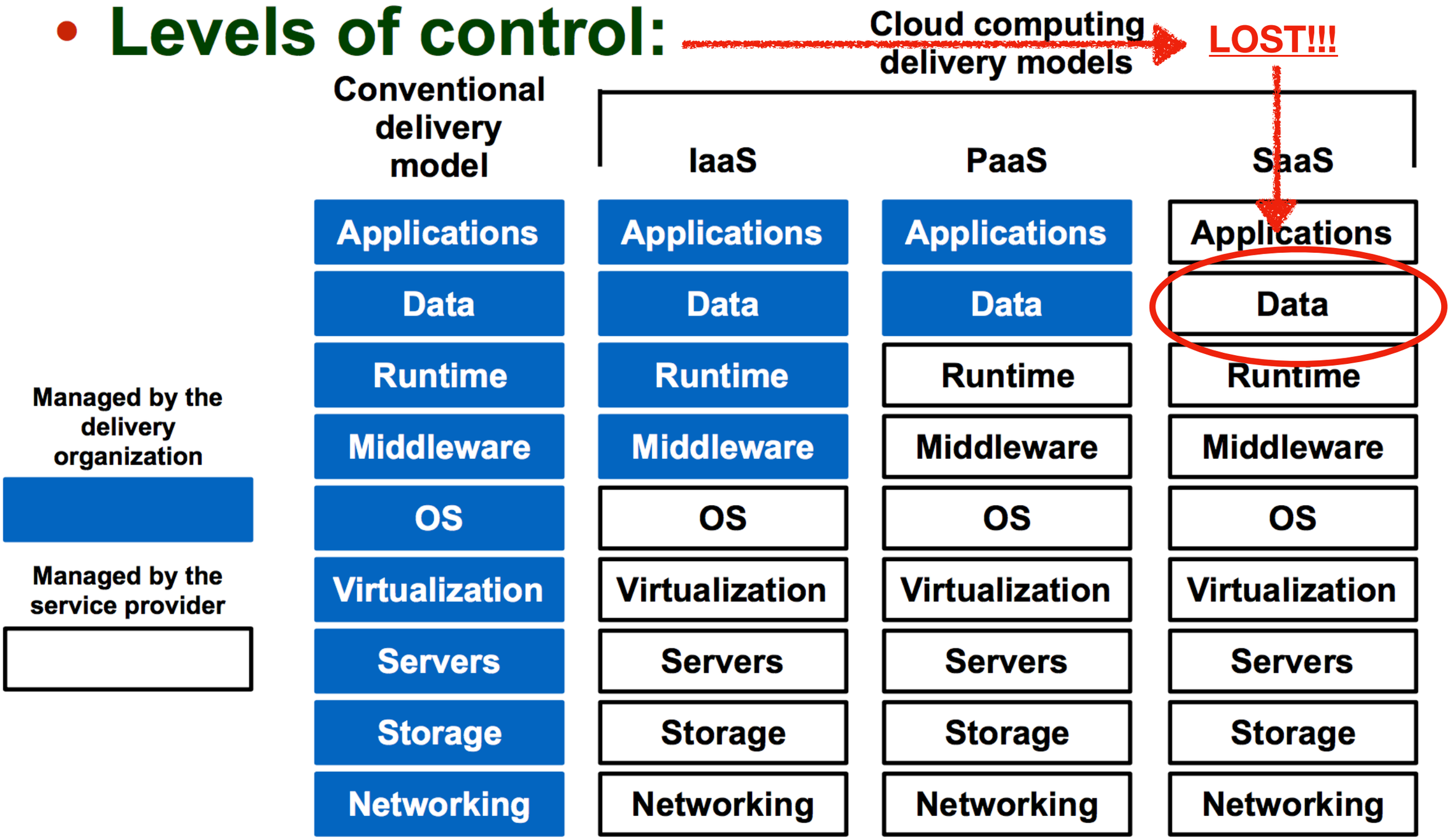
THAT IS FANTASTIC, LET'S GET IT!!!

LET'S THINK IT…

- What exactly Cloud Computing ***IS NOT***?
- Why has Cloud Computing become a "***BUZZWORD*** of success"?
- What qualities Cloud Computing ***DOES NOT*** offer to customers?
- Cloud Computing assurances for the customer - their ***PRACTICAL VALUE***

What exactly Cloud Computing *IS NOT*?

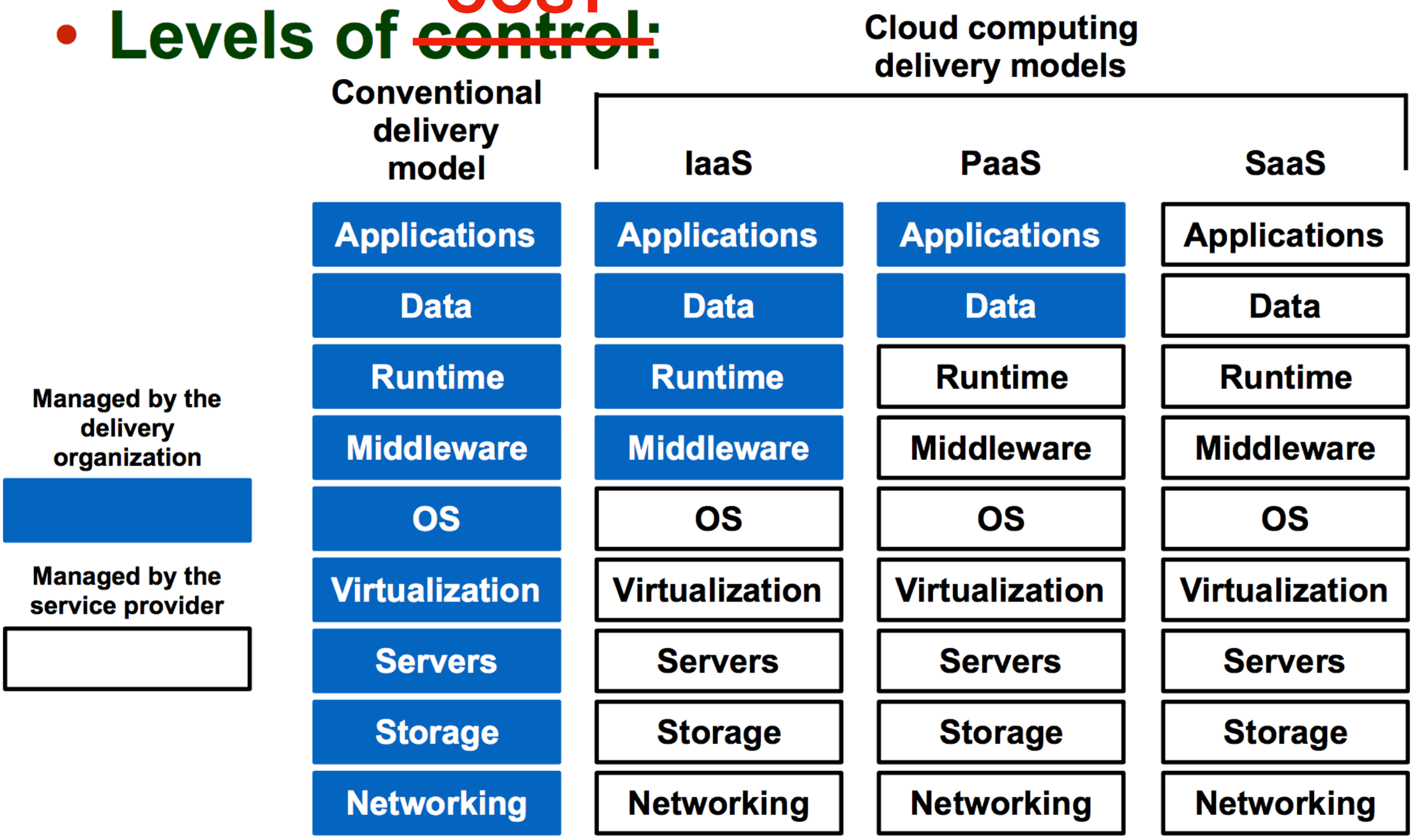
- **Levels of control:**



Adapted from Pramod, N., et al. (2013).

What exactly Cloud Computing *IS NOT*?

- Levels of ~~control~~ COST:



Adapted from Pramod, N., et al. (2013).

Why has Cloud Computing become a "*BUZZWORD* of success"?

- Let's think. What about that?:
  - data security
  - data integrity
  - security breaches
  - hacking
  - viruses, malware, ransomware (actual hacking attack in Europe)
  - multi-tenant separation, data isolation/osmosis, viral contagion, firewall breaches
  - the list goes on and on….

What qualities Cloud Computing *DOES NOT* offer to customers? (1)

- Subject 1 - quality measurement
  - Quality attributes associated with Cloud Computing are:
    - non-systematic
    - non-standardized
    - incoherent
    - with no measures
    - incomplete
    - with no consensus
  - Majority applicability of ISO/IEC 25000 quality attributes and measures identified in (*) was never verified in practice
  - Real possibilities of accessing Cloud systems in order to make measurements:
    - where exactly are we to go to measure f.e. resources utilization, and
    - will a Cloud service supplier let an evaluator in to his premises?

What qualities Cloud Computing *DOES NOT* offer to customers? (2)

- Subject 2 - quality evaluation
  - Quality evaluation for conventional systems is supported by:
    - measurement theory
    - measurements standards (ISO/IEC 15939)
    - quality models (ISO/IEC 25010)
    - quality measures (ISO/IEC 25022, -23, 24)
    - quality evaluation methods and management (ISO/IEC 25040)
  - Evaluating quality of Cloud systems begs the following questions:
    - what real measures will represent the best the quality attributes of SaaS, PaaS or IaaS?
    - how do we get those measures?
    - what estimation methods and models shall we use to get the reliable information about the real quality of an evaluated system?
    - who will perform the estimation? Will it be a trustworthy “entity”?

Cloud Computing assurances for the customer - their *PRACTICAL VALUE*

- Cloud Computing assurances TODAY:
  - SLA with its SLOs
    - just the document that states so called "measurable" service level objectives, but
    - ARE THE SLOs REALLY MEASURABLE?
    - CAN THEY BE PROVEN EXISTING or OTHERWISE?
    - HOW?

Cloud Computing assurances for the customer - their *PRACTICAL VALUE (2)*

- Cloud Computing assurances TODAY:
  - with all the questions related to service quality and particularly to data security, what are the real auditability possibilities (both technical and methodological) and resulting legal ramifications that would support the user in cases of:
    - data loss,
    - data corruption,
    - financial loss,
    - image loss,
    - health and safety damages

REFLECTIONS ???

- Proprietary or Cloud Computing? Or **both**…
- Can we **ignore** Cloud Computing?
- What are IT **observable tends**?

Proprietary or Cloud Computing?

Or both… (1)

- The answer to such a question must be given in function of the risk exposition (so, the probability and impact) associated with the below basic damages:
    - data loss,
    - data corruption,
    - financial loss,
    - image loss,
    - health and safety damages
    - environmental damages
- A simplified analysis method could be presented as follows:

$$CSA = F\left(\sum r_i\right)$$

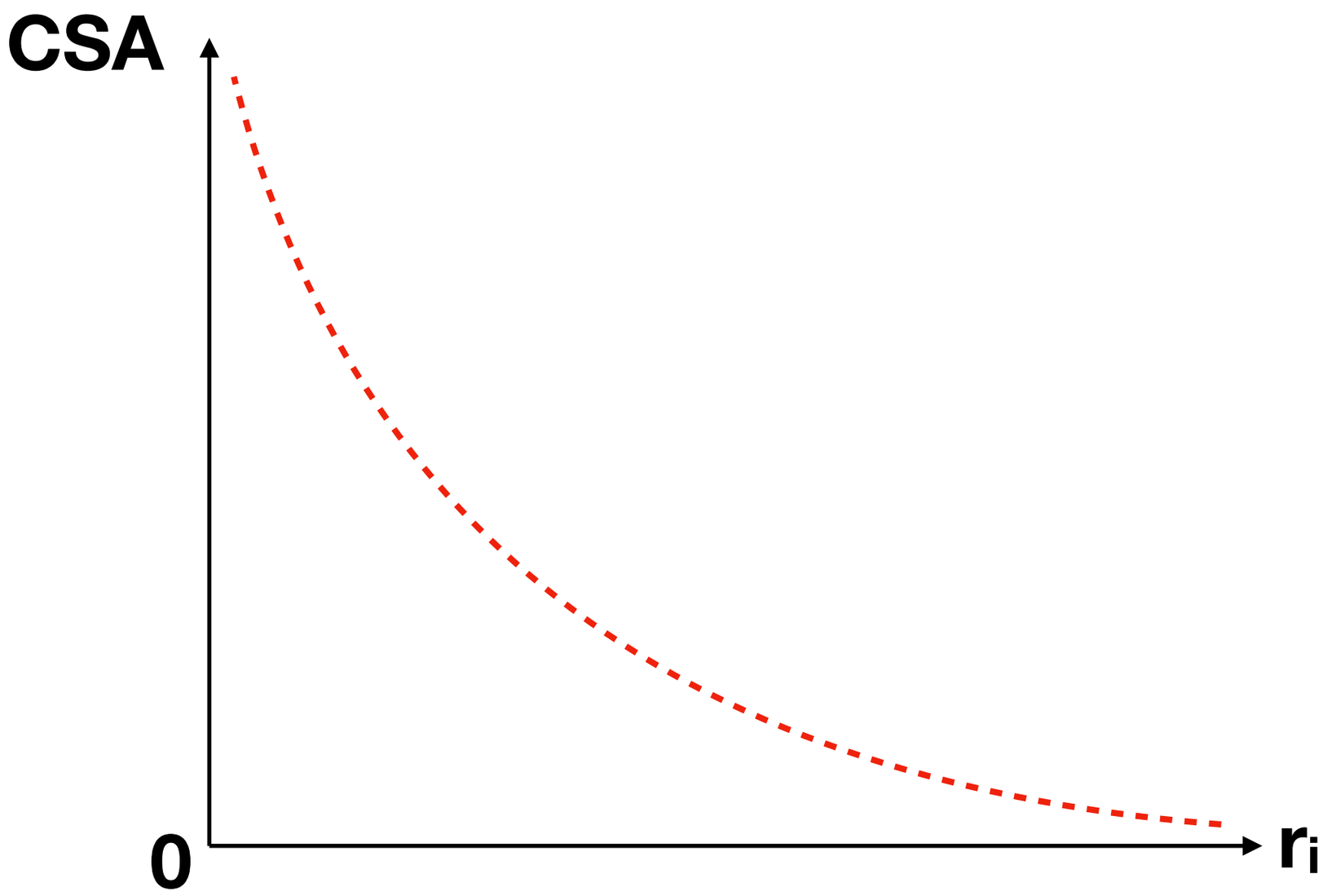
where: CSA is Cloud system applicability in an overall IT solution

r - risk exposition of the given category of damage

i - represents a category of potential damage, like data loss, financial loss etc.

Proprietary or Cloud Computing?

Or both… (2)



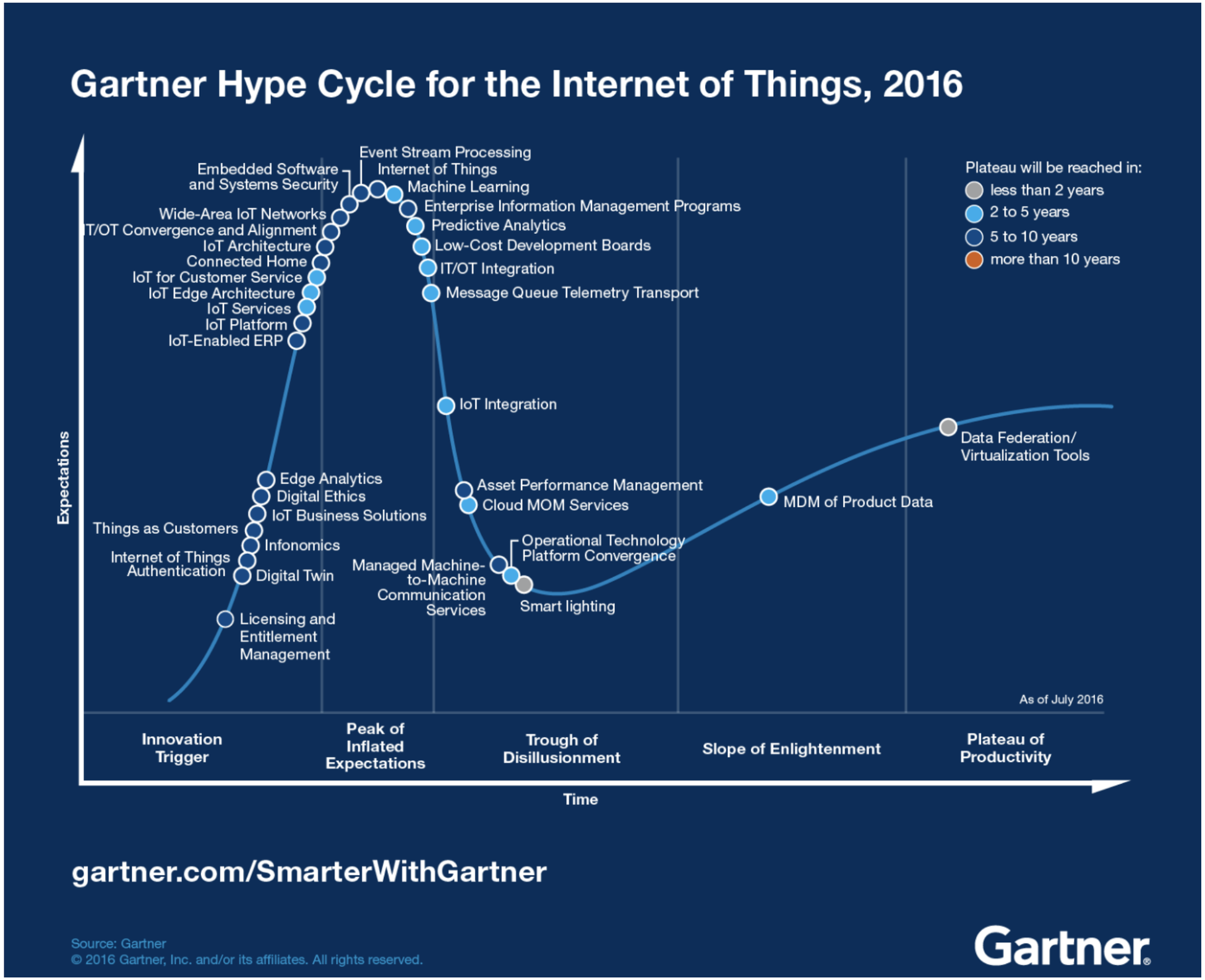
Illustrative representation of the relationship between the risk exposition of a given damage category r_i associated with cloud computing and its application in the overall IT solution

Can we ignore Cloud Computing?

- The answer is NO. Because:
  - it is already there
  - it offers considerable benefits
  - it is a global technological trend
  - the quantity of data circulating around the planet augments exponentially every year, and
  - Internet of Things is already at our doorstep
- What about all the risks, damages and potential losses attributed to Cloud computing?
  - the very serious research effort supported by international intellectual, technical and financial resources should be allocated to solve the problem of

Cloud Computing Controllability

What are IT observable tends?



HOT QUESTIONS

"If You were a Rich Man…" -
what would You choose?

And **Why?**

Thank you

Q&A

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