ITU Kaleidoscope 2014

Living in a converged world - impossible without standards?

Data- vs. Device-centric Cloud Services for Resource Monitoring

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Outline

- Introductory concepts
- Cloud and Sensing/Actuation
- Cloud middleware architecture
- Examples
- Conclusions

Cloud Computing is …

"Biggest Paradigm Shift in 20 years"

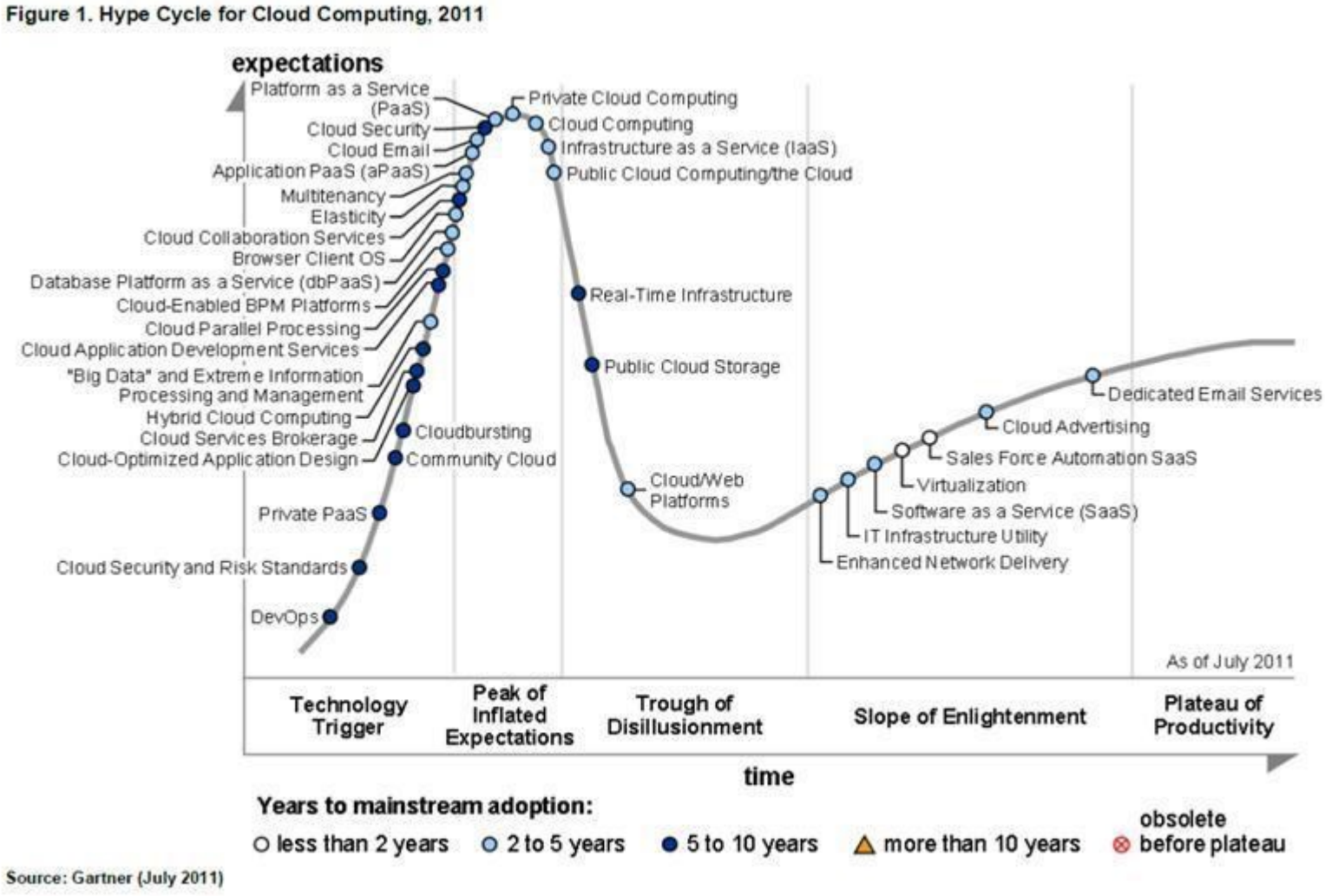
"Game Changers"

"Just On"

"Pay As You Go"

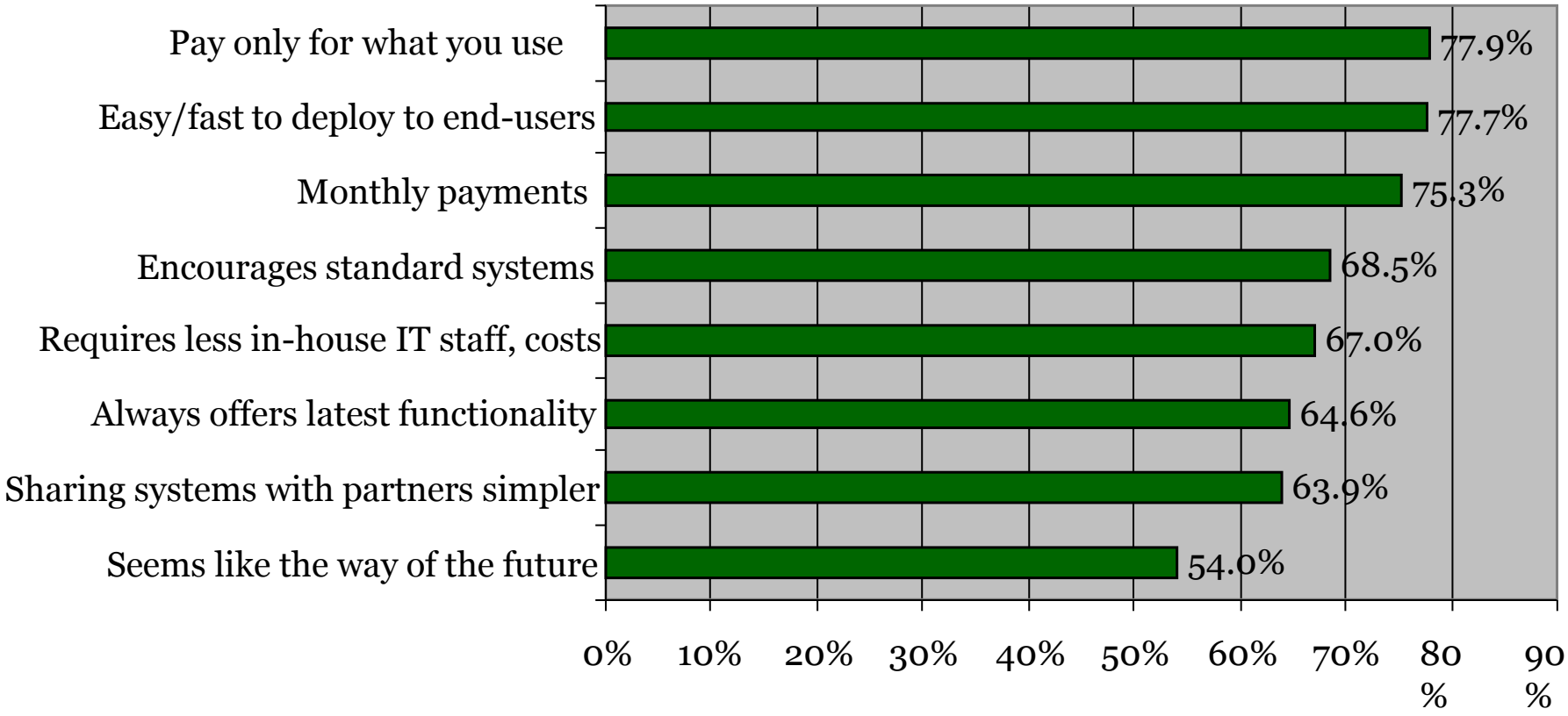
"Tremendous Cost Cutting"

Hype cycle for Cloud Computing



Source: Gartner, Hype Cycle for Cloud Computing, 2011 David Mitchell Smith Publication Date: 27 July 2011 ID Number: G00214915 © 2011

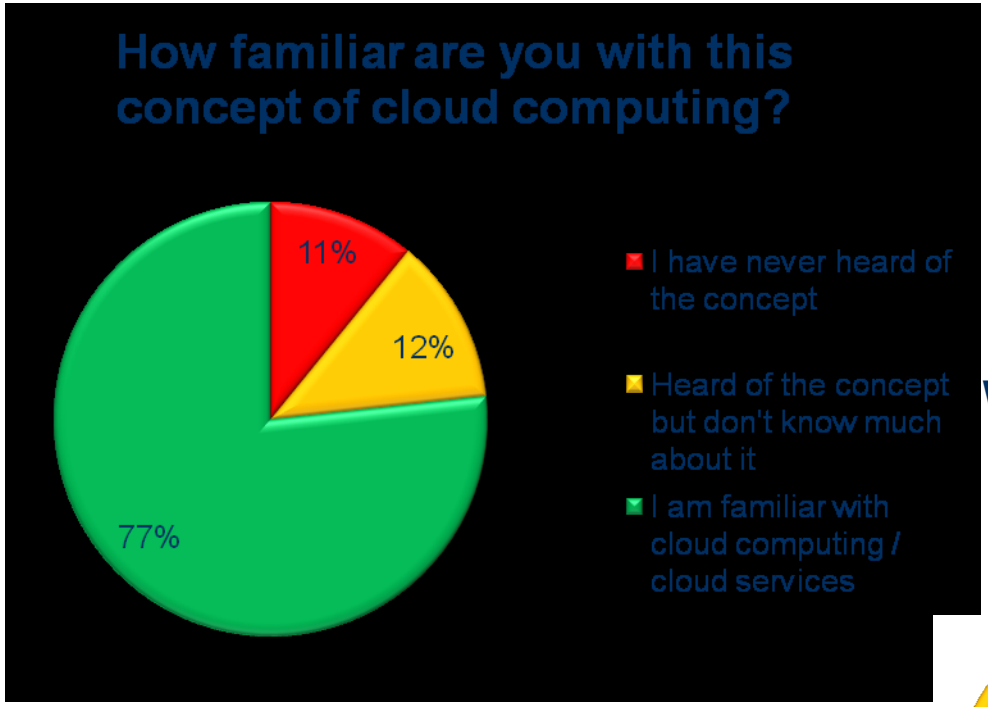
Cloud User Surveys - Benefits



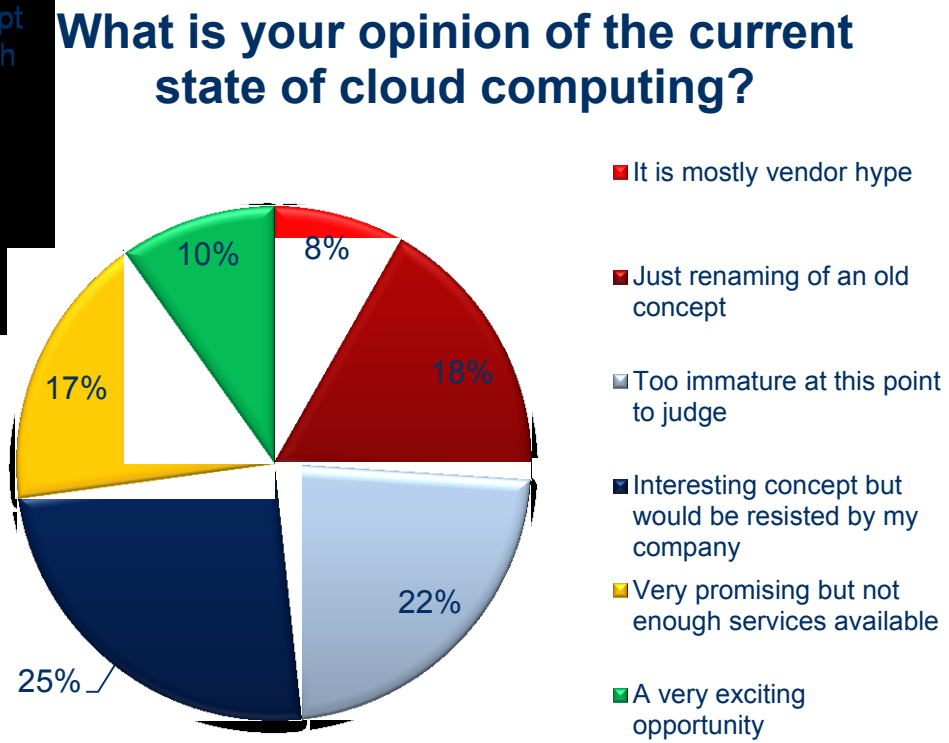
(Scale: 1 = Not at all important 5 = Very Important)

Source: IDC Enterprise Panel, 3Q09, n = 263, September 2009

Cloud's Position in Asia/Pacific

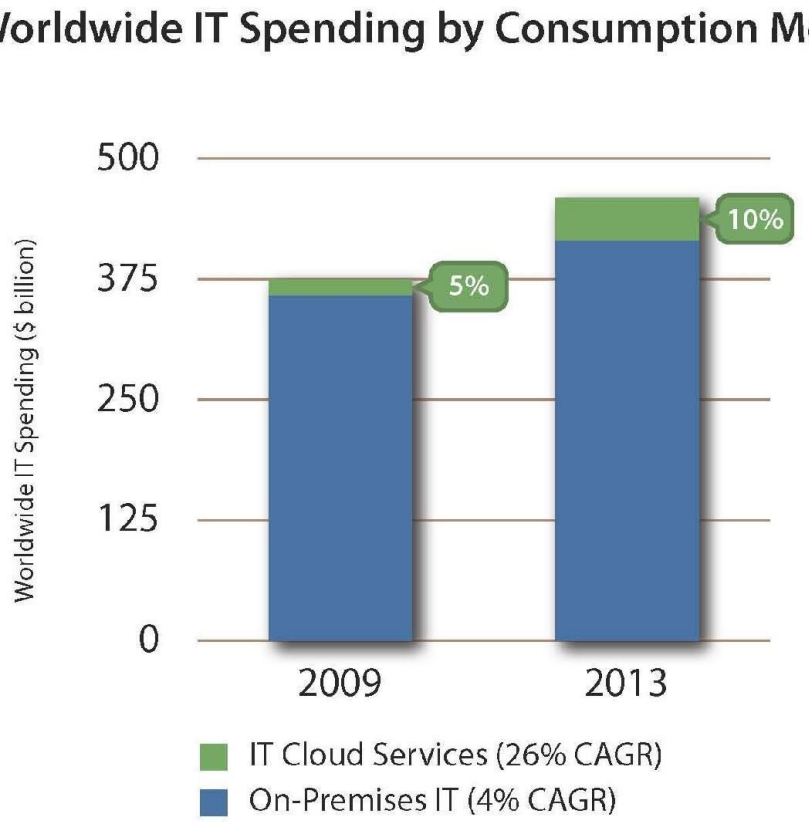


- Familiarity is high
- But opinion is low!



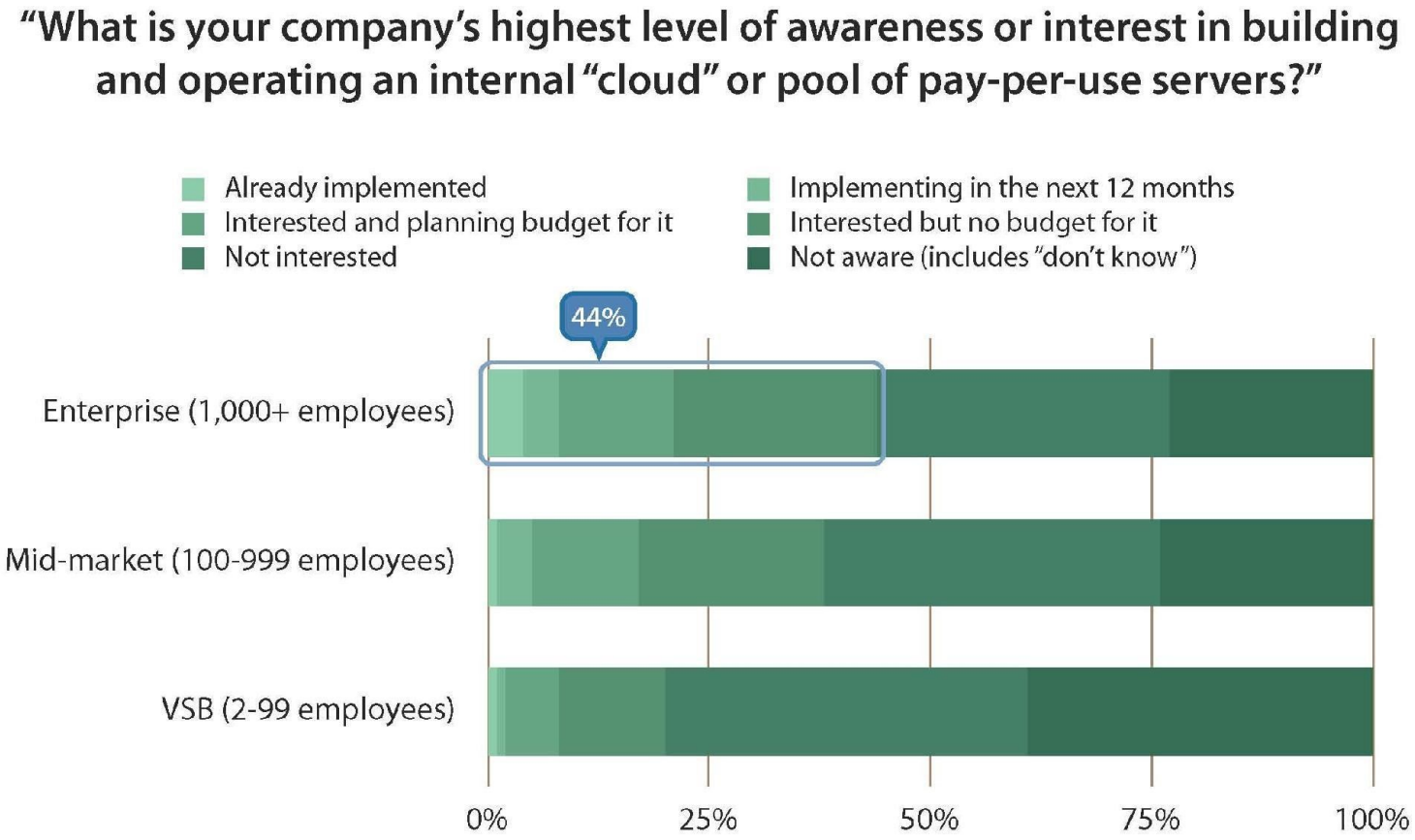
Source: IDC Asia/Pacific End-user Cloud Computing Survey, 2009, n=667

Public Cloud vs. On-Premises IT



Source: IDC, September 2009

44% of Large Enterprises want a Private Cloud



Source: Forrester, Q3 2008

Requires

a New Way

of Thinking

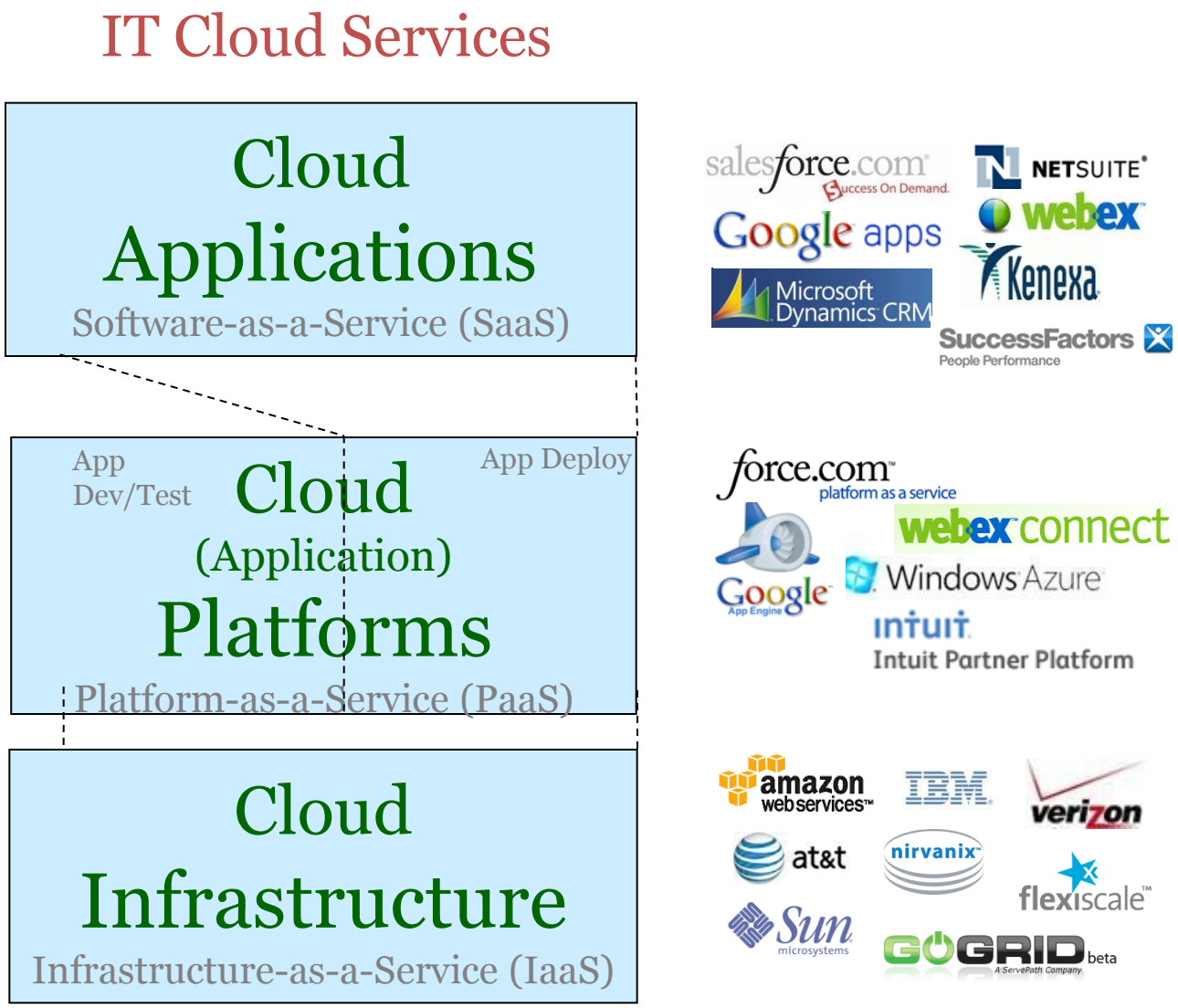
Why Cloud Computing?

- Cloud computing brings a new level of efficiency and economy to delivering IT resources on demand just like public facilities and it opens up new business models and market opportunities.
- It offers more than a “pay-per-use” model. The major trends are:
  - **IT Efficiency.** Companies are minimizing costs, converting them from capital expenses to operating expenses through technologies such as virtualization (i.e. an enterprise do not have to buy expensive equipments to build its business but can build its infrastructure compousing services).
  - **Business Agility.** Companies are maximizing return using IT as a competitive weapon through the rapid time to market, by mean of integrated application stacks, instant machine image deployment, and parallel programming

Virtualization

- Virtualization is the main technology behind the clouds.
- It allows servers, storage devices, and other hardware to be treated as a pool of resources rather than discrete systems.
- These resources can be allocated on-demand.
- It allows also to exploit and migrate resources, regardless of the underlying real physical infrastructure.
- Virtualization solves several core challenges of datacenter managers and delivers specific advantages, including:
  - Higher utilization rates
  - Resource consolidation
  - Lower power usage/costs
  - Space savings
  - Disaster recovery/business continuity
  - Reduced operations costs

IT Cloud Services Taxonomy

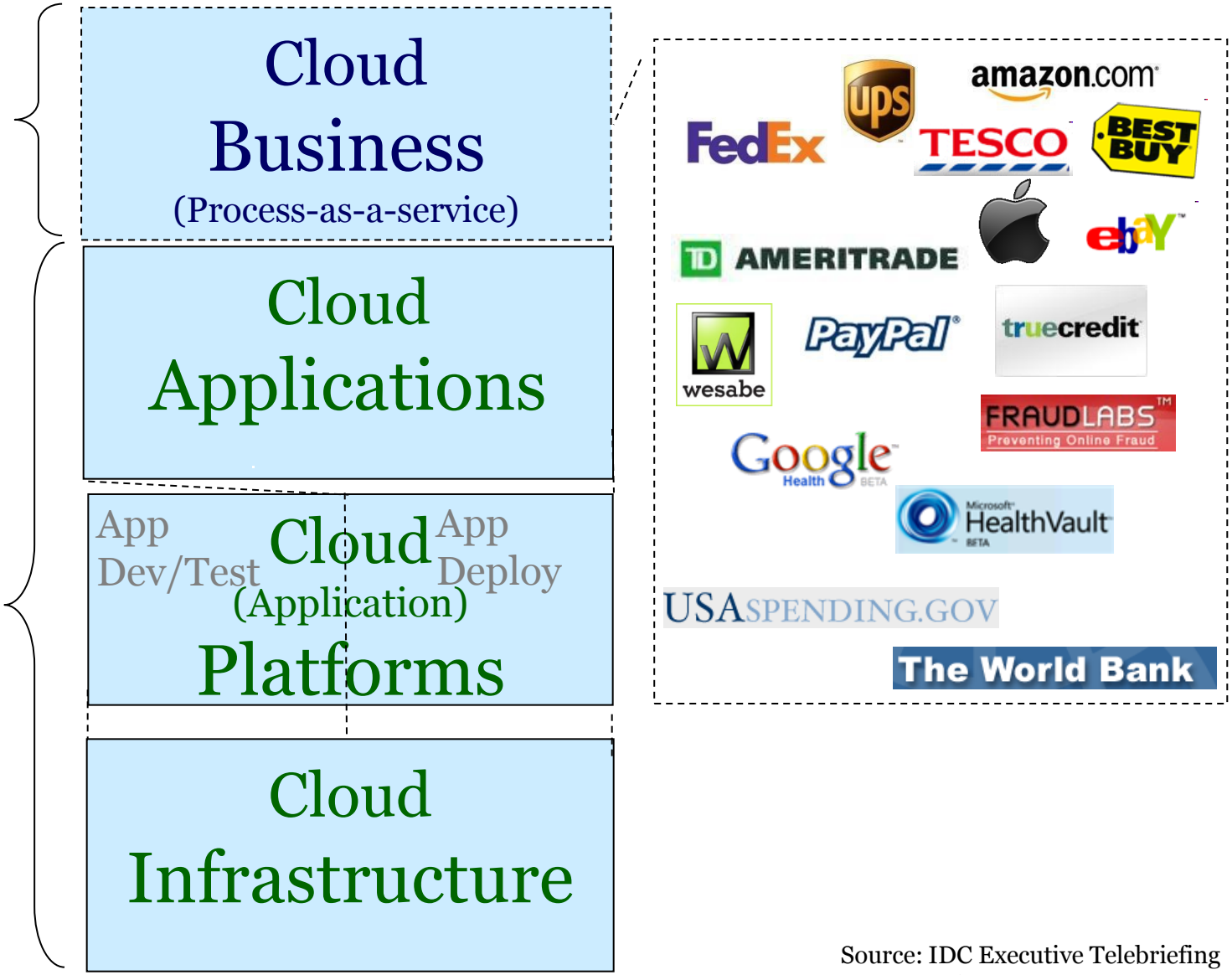


Source: IDC Executive Telebriefing
29 September 2009

Cloud Services *Beyond* the IT Industry

Every *Other* Industries' Cloud Services

The IT Industry's Cloud Services



Source: IDC Executive Telebriefing
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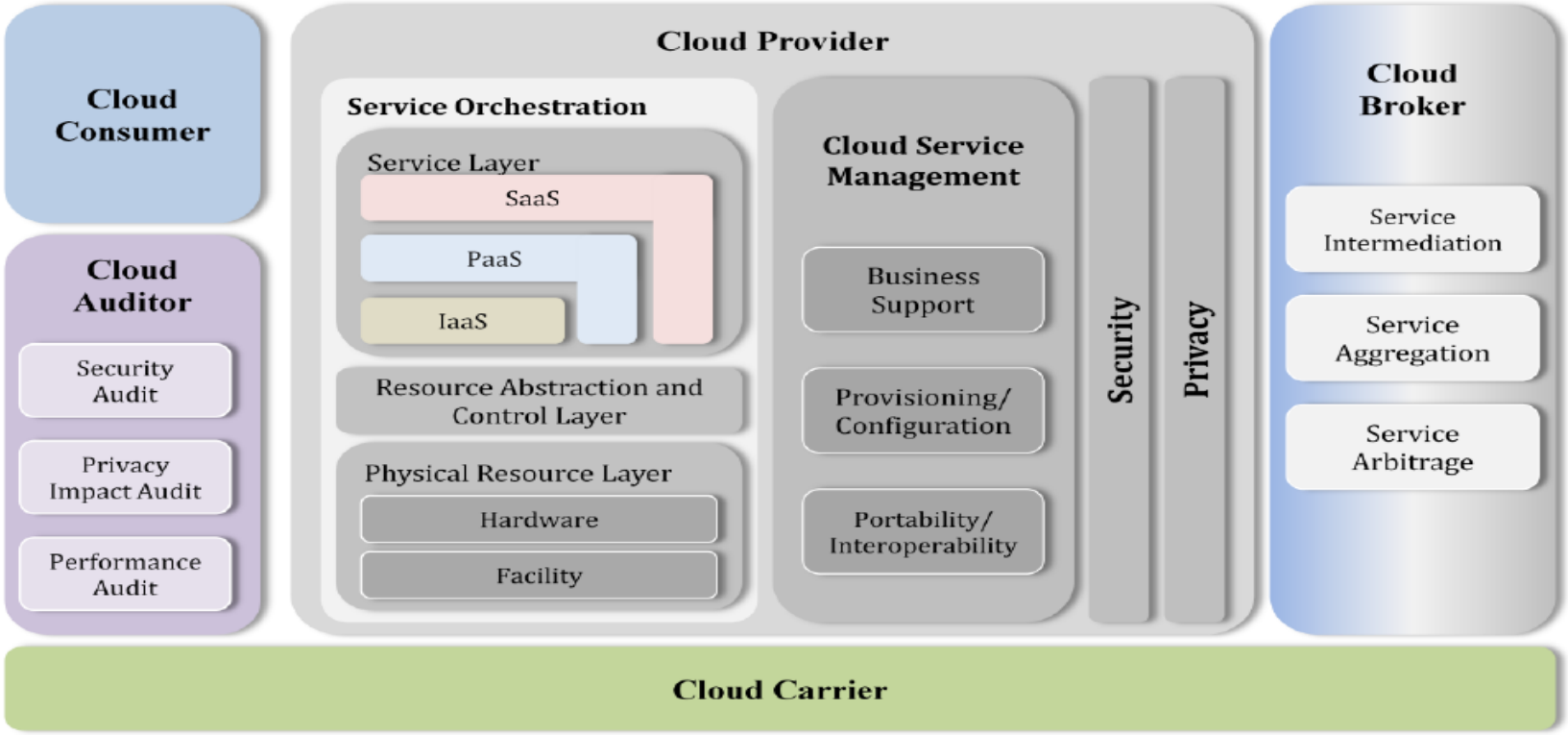
NIST Cloud Computing New Reference Architecture



"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 promotes availability [...]."

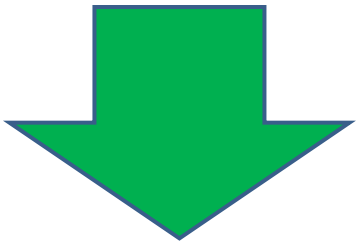
Cloud and Sensing/Actuation

WSNs/mobiles: towards the IoT

- ***smart*** things get linked through the Net
- IoT/Future Internet, the current trends underlying the ubiquitous ***convergence*** of devices and Web

Cloud towards sensing

- Widespread availability of cheap sensing devices
- On-board components built into a wide range of systems (e.g., smartphones, indash units, body sensor networks...)
- Advances in pervasive computing techniques



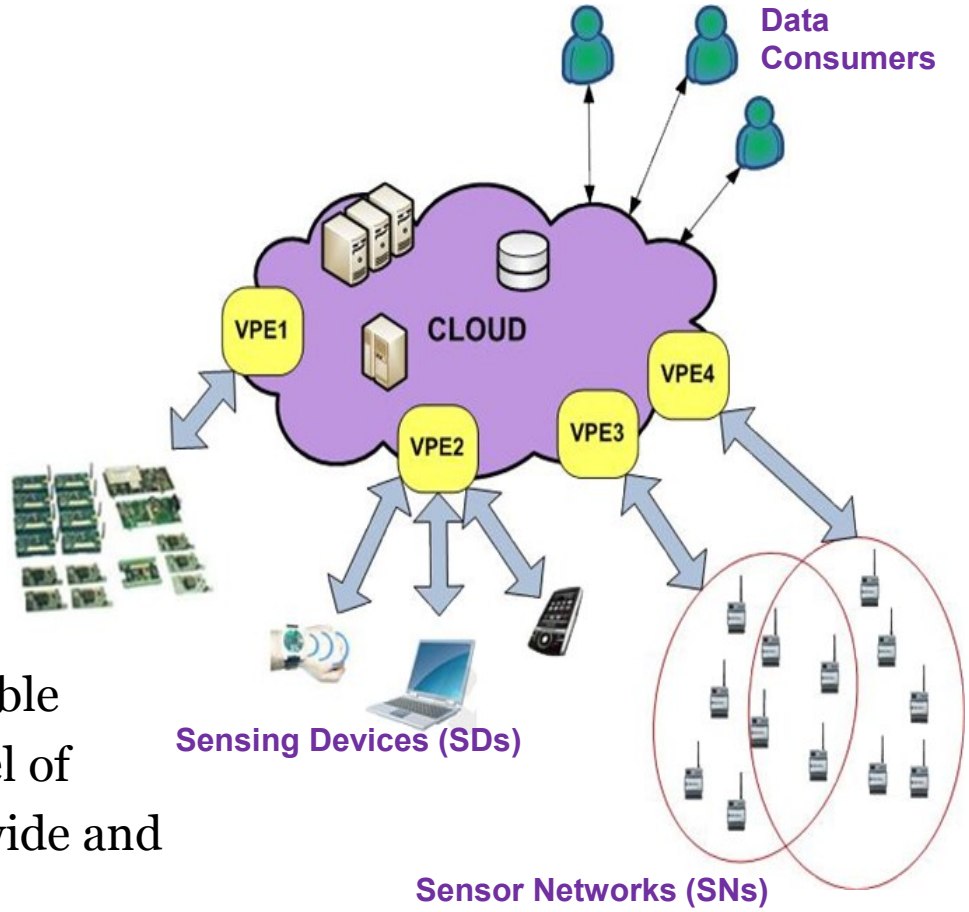
- Many application scenarios: healthcare, smart city, domotic, traffic assistant, ...
- Many concepts, standards and projects:
  - Internet of Things (IoT)
  - OGC Sensor Web Enablement (SWE),W3C Semantic Sensor Networks (SSN),...
  - SIMONE(Sistema Integrato per il MONitoraggio della produzione di Energia elettrica), DAMOCLES (Developing Arctic Modeling and Observing Capabilities for Long-term Environmental Studies), CASA (Center for Collaborative Adaptive Sensing of the Atmosphere), Portolan Network Sensing Architecture,...

Cloud computing

Cloud computing might be the GLUE for aggregating heterogeneous systems able to gather information from the environment

A Cloud Data provisioning system:

- for capturing information from the physical world
- interacting with heterogeneous devices and observation environments
  - HW and SW sensing
- able to store and manage huge amount of data



- **virtualization**, it is the most suitable approach to guarantee the high level of interoperability. It allows a world-wide and cross-related range of **services**

Towards a sensing Cloud: a new take

- Geographic SN
- PaaS-like, seamless sensing data provisioning across heterogeneous monitoring environments
- IaaS-like, on-demand service provisioning of (virtual) sensing and actuation resources
- Basic functionalities:
  - Abstraction, virtualisation, customisation of sensing resources
  - Enrolment, management of contributing nodes (static and mobiles – SN and smart devices)
  - On-demand provisioning of virtual sensing resources: discovery, monitoring, management, etc.

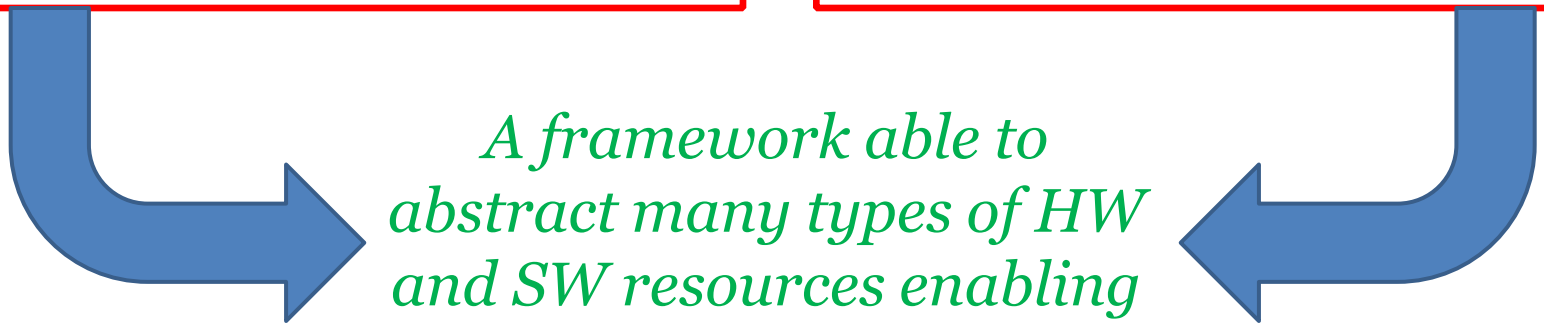
New challenges

Heterogeneous sensing environments

- smart sensors/actuators
- embedded systems
- sensor networks
- …

Uniform management of resources

- data monitoring
- application deployment
- remote system control
- …



A framework able to abstract many types of HW and SW resources enabling an integration between application requirements and sensors capabilities

Cloud4Sens:

a Cloud framework for sensing/actuaction resource provisioning

Service Properties

- *Decoupling*
  - sensing functionalities are uncoupled from the client ones since they do not need to know about their presence or requirements
  - clients can ignore the hardware and software infrastructure of the sensing system
- *Scalability*
  - parallel management of involved entities, caching messages, shared rooms for data access.
  - thanks to XMPP communications, distributed solutions and hierarchical logic infrastructures.

Service paradigms

- *data-centric*
  - offer data on physical measurements and environmental information in a uniform format to clients
  - clients do not needto have knowledge of the monitoring system's features or technologies, but they make intensive access to data gathered by the monitoring system
  - PaaS
- *device-centric*
  - virtual sensing/actuation nodes
  - features of physical sensing/actuaction nodes composed according to client requirements
  - IaaS

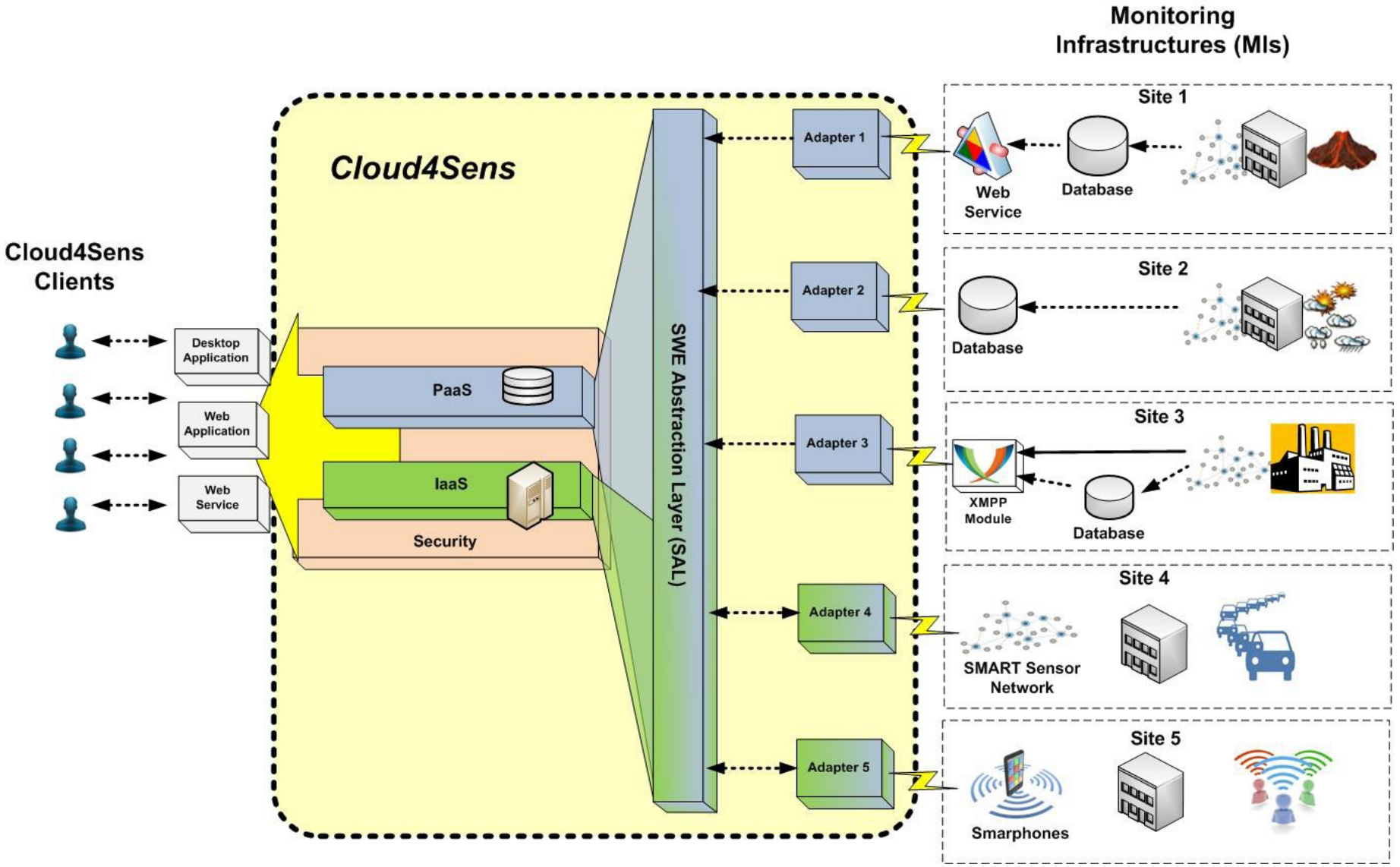
Data-centric vs Device-centric

	Feature	Data-Centric	Device-Centric
1	Type of resources	Data	Infrastructure
2	Type of offered Cloud service	PaaS	IaaS
3	Client needs	Getting environmental information, not only physical measurements, but composed observations	Interacting with the environment by exploiting specific capabilities in terms of sensing/actuation, processing power and memory.
4	Support for heterogeneous distributed infrastructures	YES	YES
5	Need of abstraction technologies	YES	YES
6	Need of virtualization technologies	NO	YES
7	Decoupling between Cloud and MI activities	High	Low

Cloud4Sens Design

- Data provisioning service compliant with the ***Sensor Web Enablement (SWE)*** standard defined by the Open Geospatial Consortium.
  - XML-based languages
  - W3C Semantic Sensor Networks: a new ontology to describe sensors and observations
    - is based on the semantic annotation of OGC-SWE
- Data accessed through a ***XMPP*** Multi-User Chat (MUC)
  - decentralized service, high degree of scalability, high number of hosts involved, flexibility in the system, interoperability and native security features based on TLS/SSL
- Message oriented middleware for Cloud
  - XML-based document
- Big Data storage (***MongoDB***)

Reference Scenario

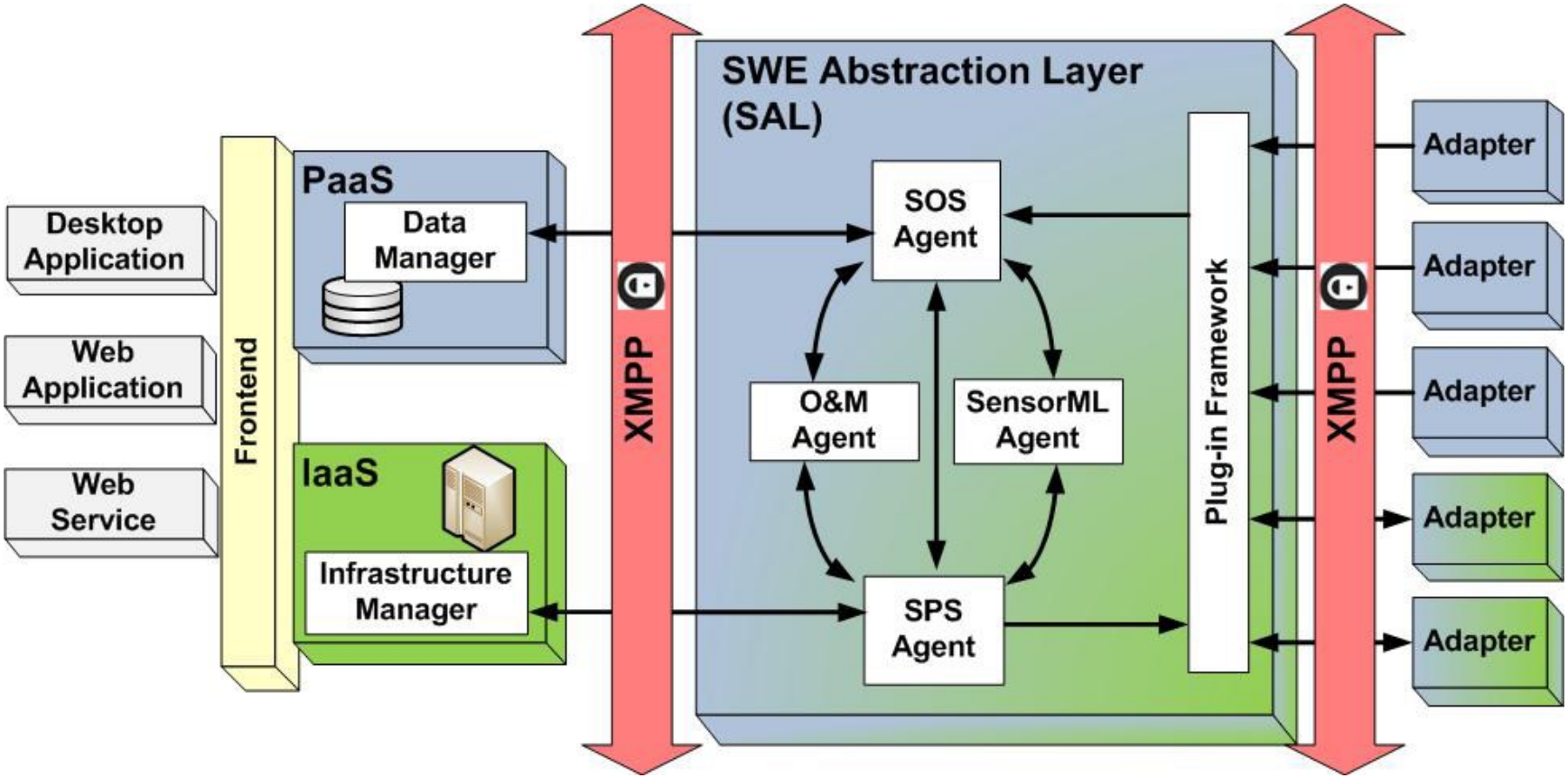


Sensor Web Enablement (SWE)

Standard defined by the Open Geospatial Consortium

- ***SOS*** (Sensor Observation Service)
  - interface for requesting, filtering, and retrieving observations and sensor system information;
- ***SPS*** (Sensor Planning Service)
  - interface for requesting user-driven observations;
- ***SAS*** (Sensor Alert Service)
  - interface for publishing and subscribing alerts from sensors.
- ***SensorML***
  - models and XML schemas for describing sensors systems and processes;
- ***O&M*** (Observation and Measurements)
  - models and XML Schema for encoding observations from a sensor network;

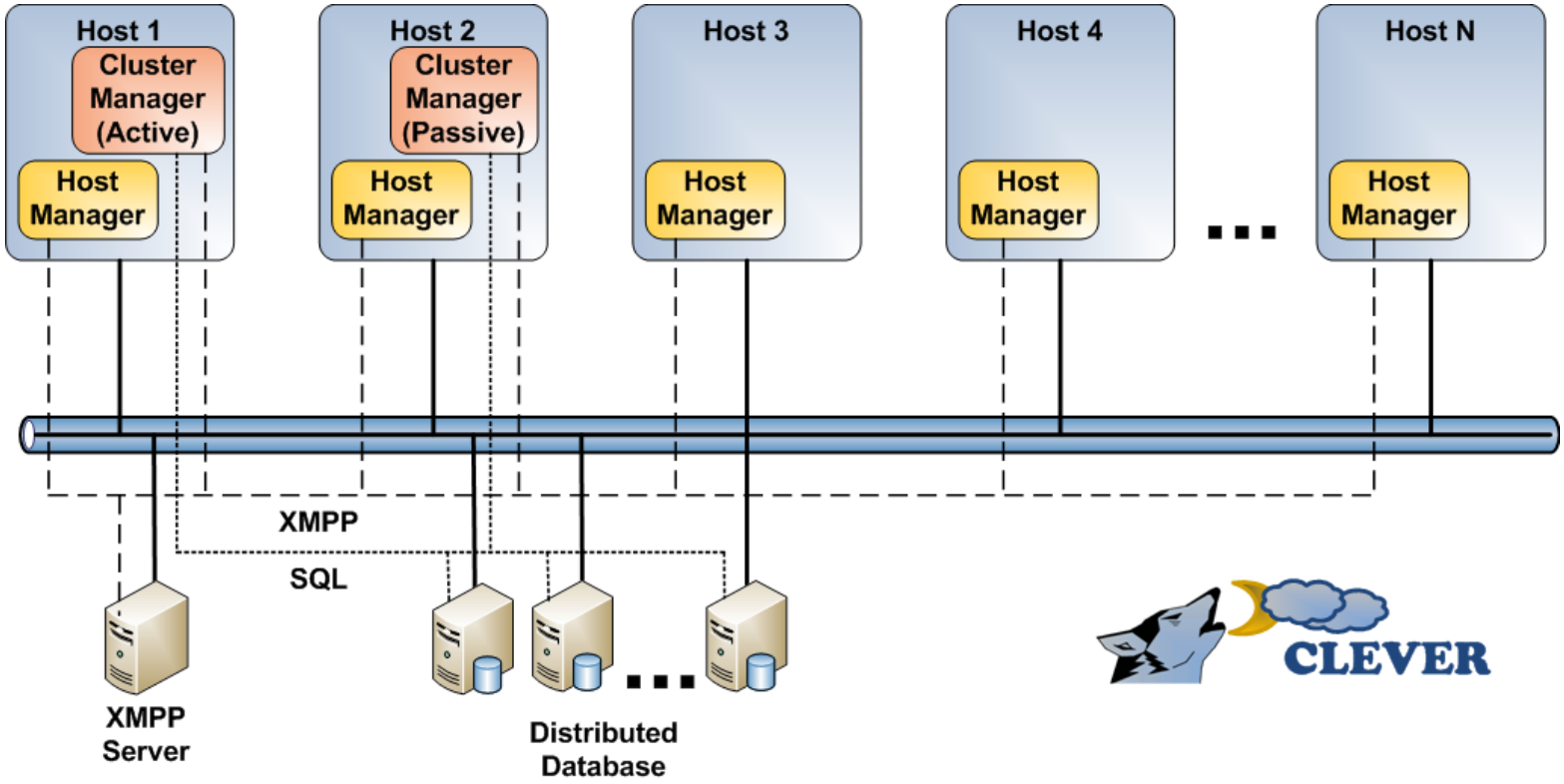
Cloud4Sens Architecture



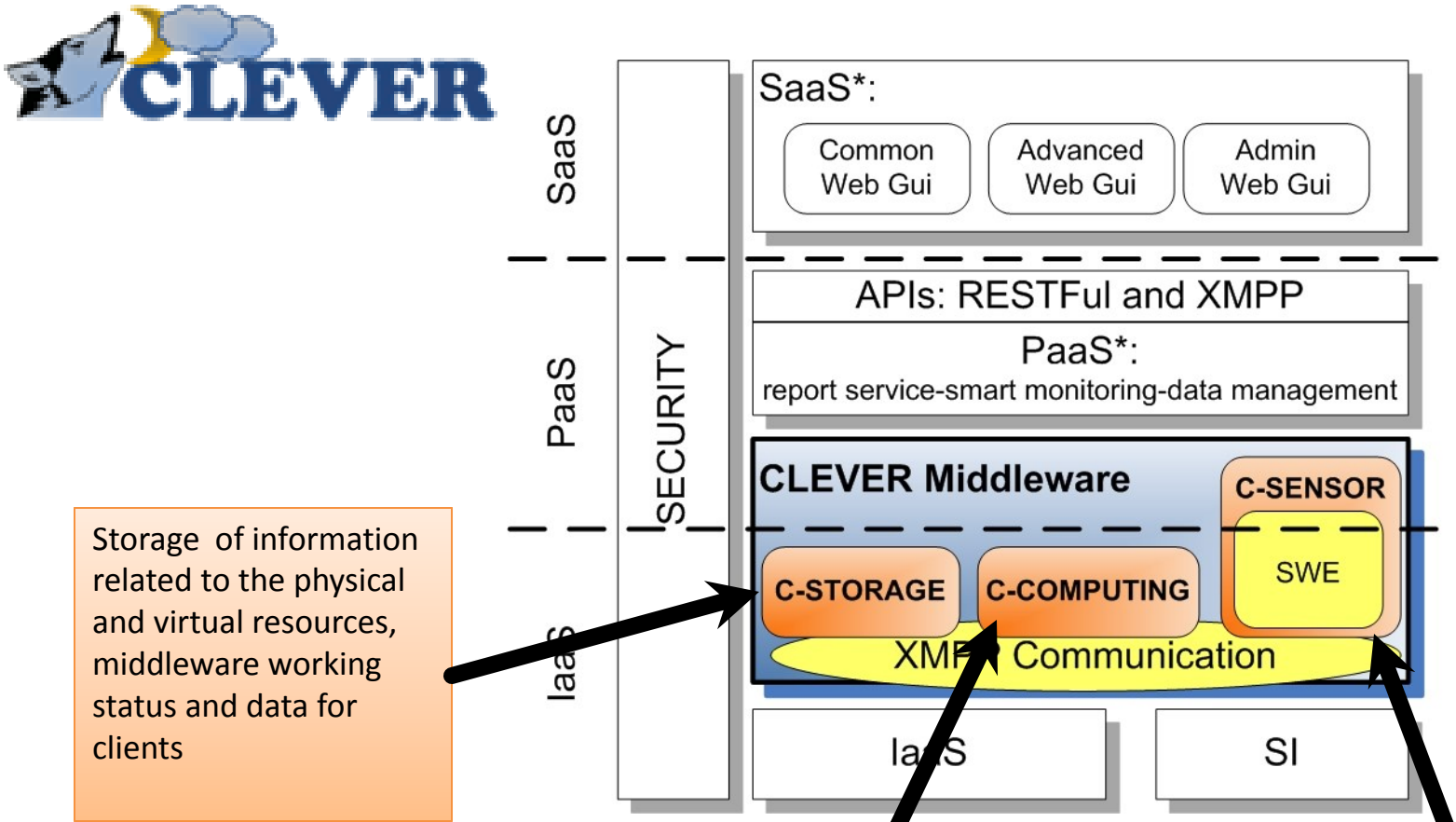
System implementation

- ***CLEVER*** (CLoud-Enabled Virtual EnviRonment) is a Virtual Infrastructure Manager (VIM) able to manage Virtual Machines (VMs) in IaaS environments.

- ***C-SENSING*** offers the sensing data provisioning service through the implementation of an extention of CLEVER agent.



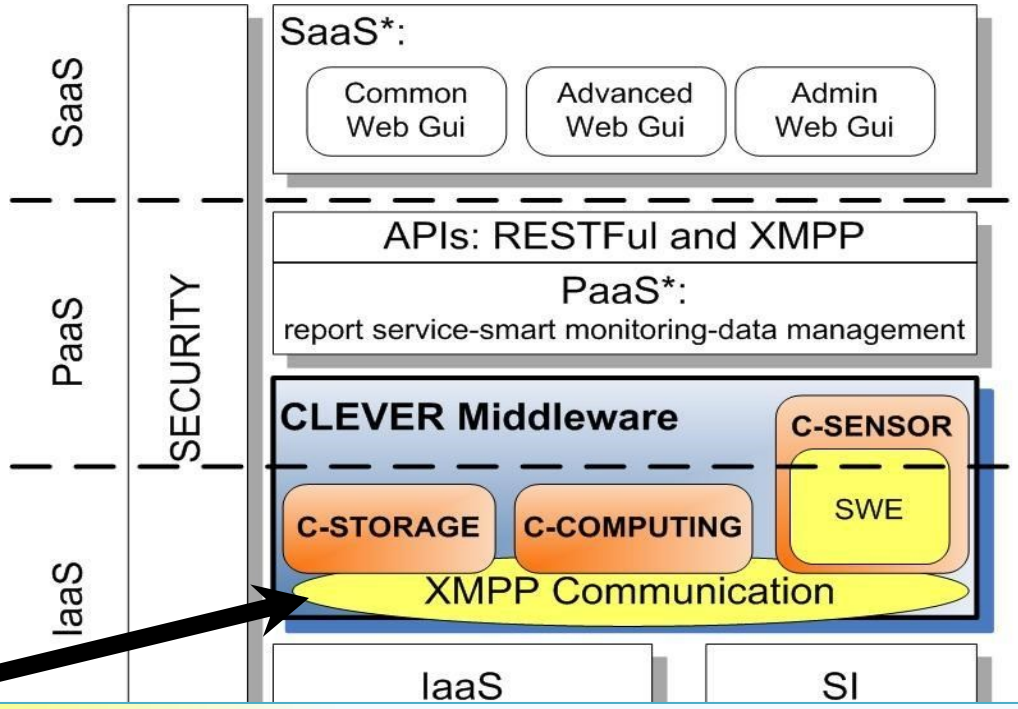
- Inter host (inter cluster) Communication: p2p
- Zero configuration: ZeroConf
- Monitoring
- Advanced Security features
- XMPP based: host presence, open standard
- Fault Tolerance: no central point of failure



Storage of information related to the physical and virtual resources, middleware working status and data for clients

Management of physical resource in a datacenter, providing user accounting, Service Level Agreements (SLAs), Billings,...

Management of physical sensing resources hiding underneath technologies.

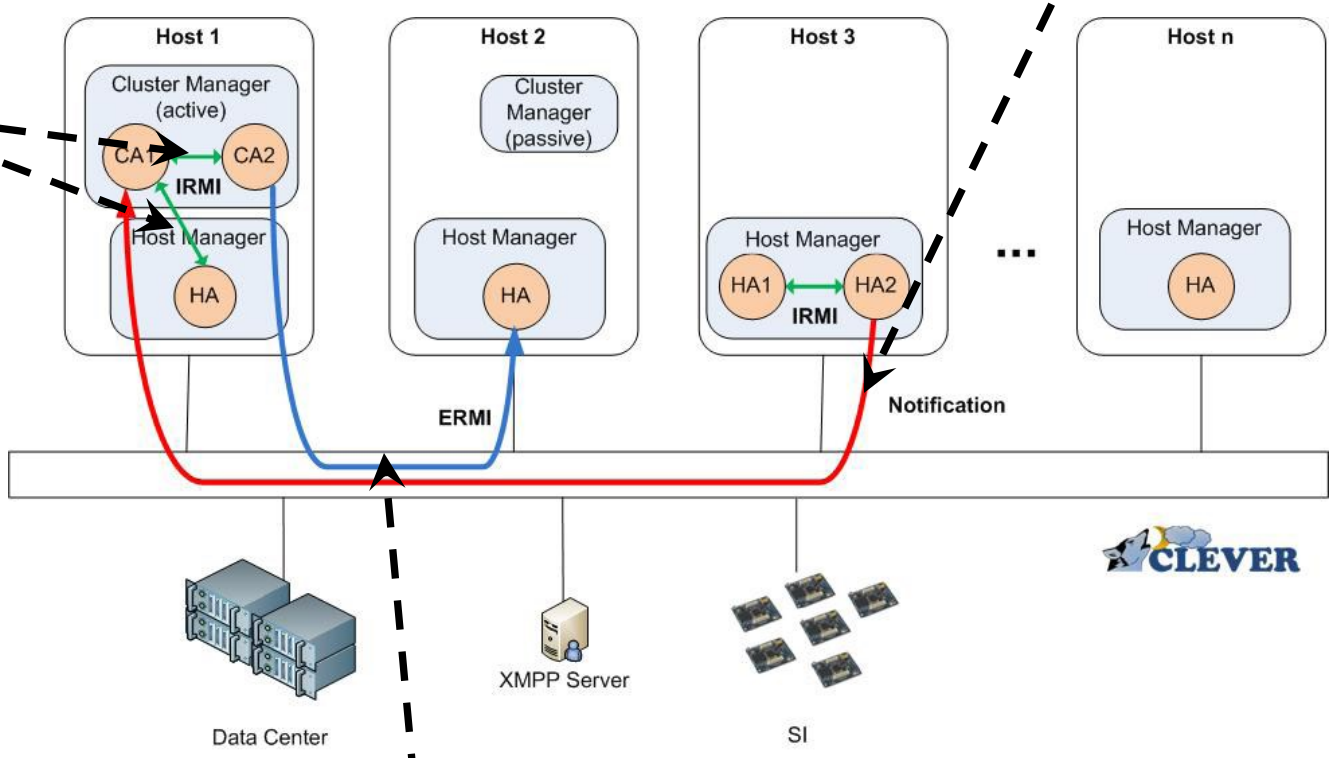


- **decentralization of communications**
- **flexibility in maintaining system interoperability**
- **native security features based on the use of channel encryption and/or XML encryption**
- **high fault tolerance level in communications**
- **system status recovery**

Data-centric approach

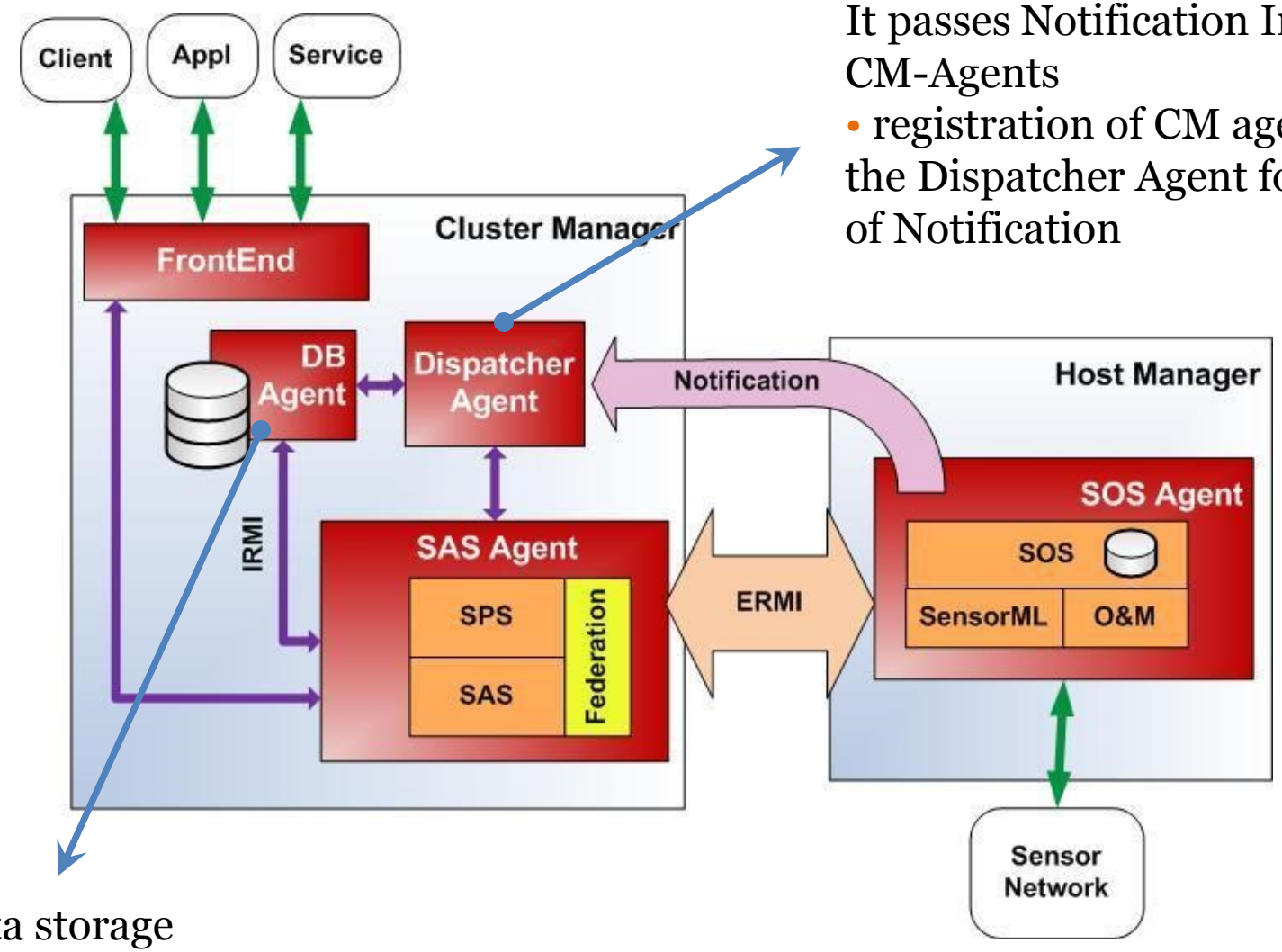
communications based on the XMPP protocol from HAs towards CAs.

Internal Remote Method Invoker: Inter Process Communication among Agents in the same host



External Remote Method Invoker: based on the XMPP protocol for communications from CAs towards HAs

Data-centric approach



It passes Notification Info to CM-Agents

- registration of CM agents to the Dispatcher Agent for type of Notification

Big Data storage service

SIGMA: SISTEMA INTEGRATO DI SENSORI IN AMBIENTE CLOUD PER LA GESTIONE MULTIRISCHIO AVANZATA

Goal

- acquire, integrate and compute heterogeneous data, from various sensor networks (weather, seismic, volcanic, water, rain, car and marine traffic, environmental, etc.), in order to strengthen control and monitoring systems to provide useful data for the prevention and management of risk situations through services provided to citizens and businesses, both public and private.

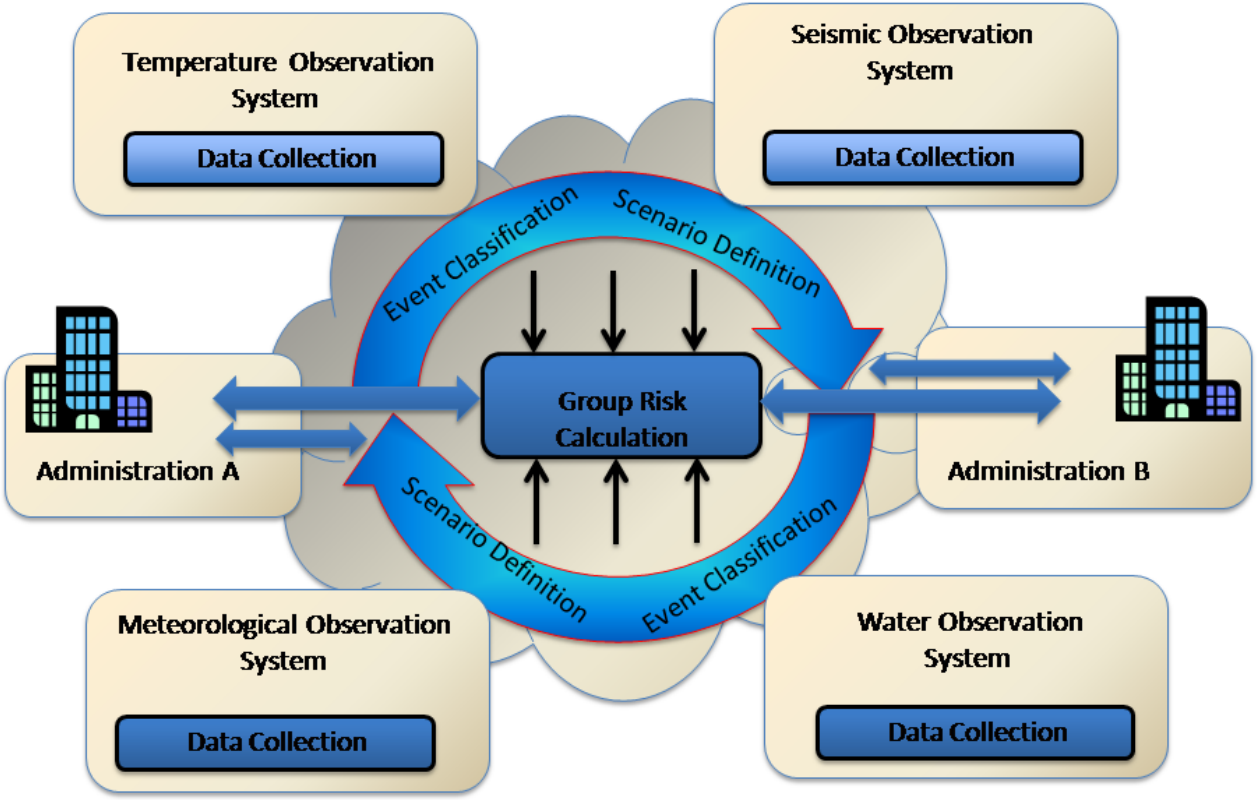
Innovations

- Cloud platform: develop a federated cloud management systems
- Security: technology for specifying/enabling security features
- Sensors and Cloud integration: define methods to grab data and interact with sensors
- Advanced Capabilities for Cloud-based Storage: support delivery of data-intensive services securely, at the desired QoS, at competitive costs
- Data Mobility and Federation: enable comprehensive data migration and interoperability across remote locations

Facts

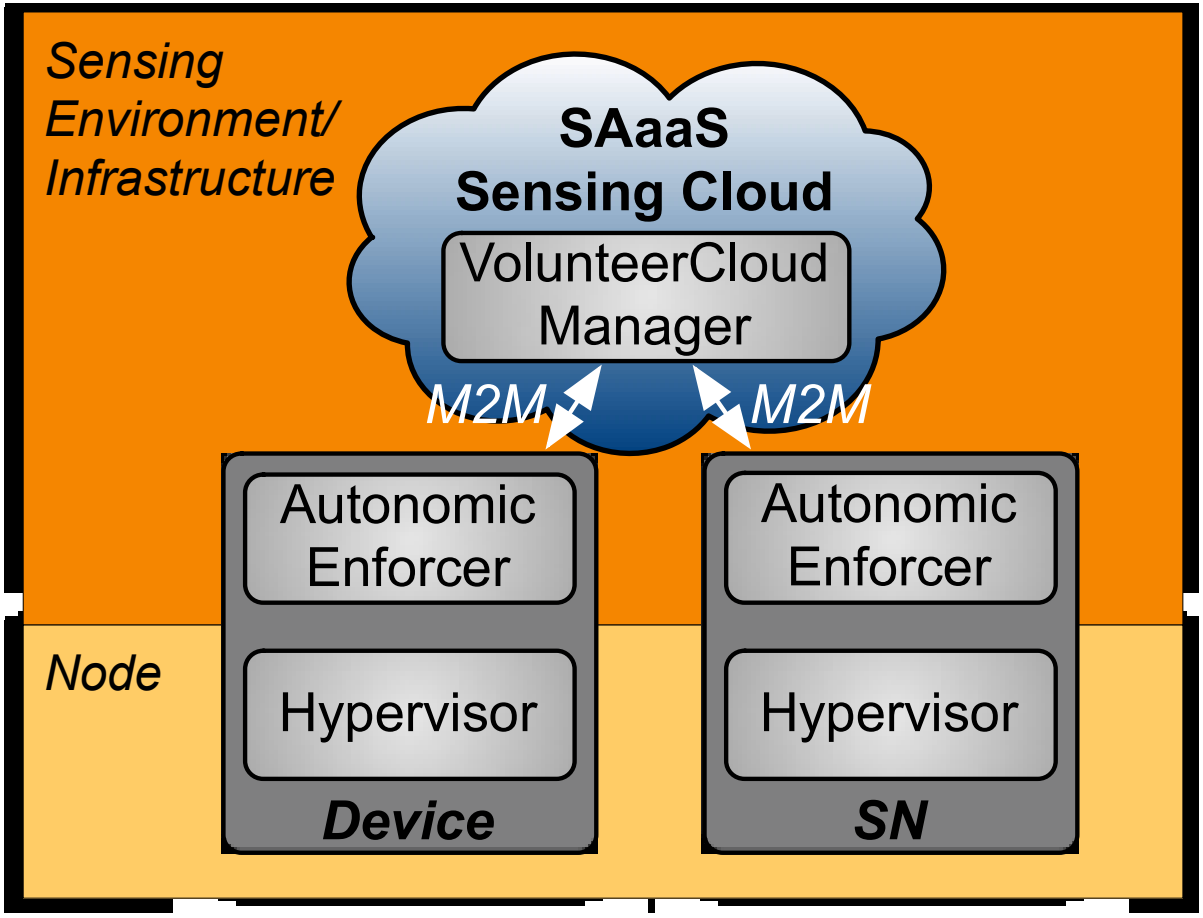
- A 2-year project, started May 2013
- €20.660 M (total budget all partners)

Risk management in CLoud4Sens

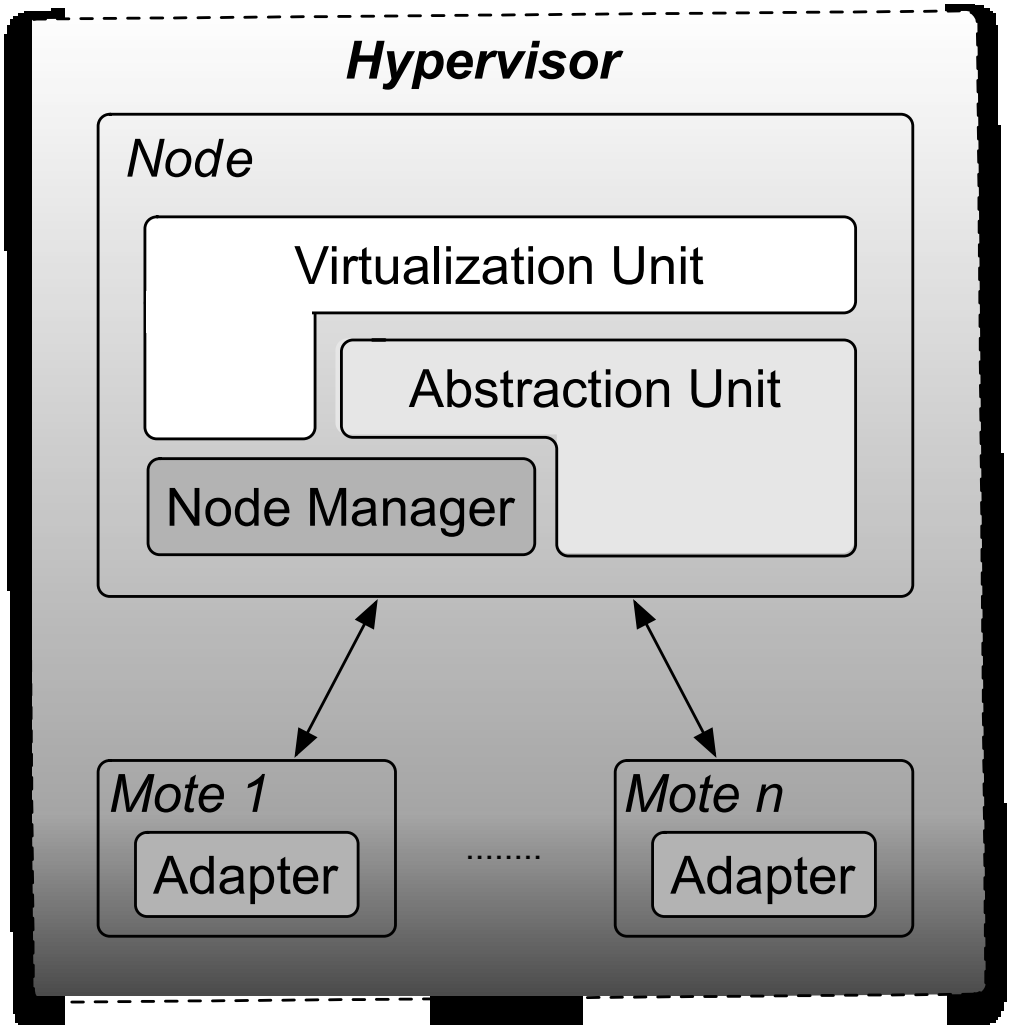


Risk management front-end

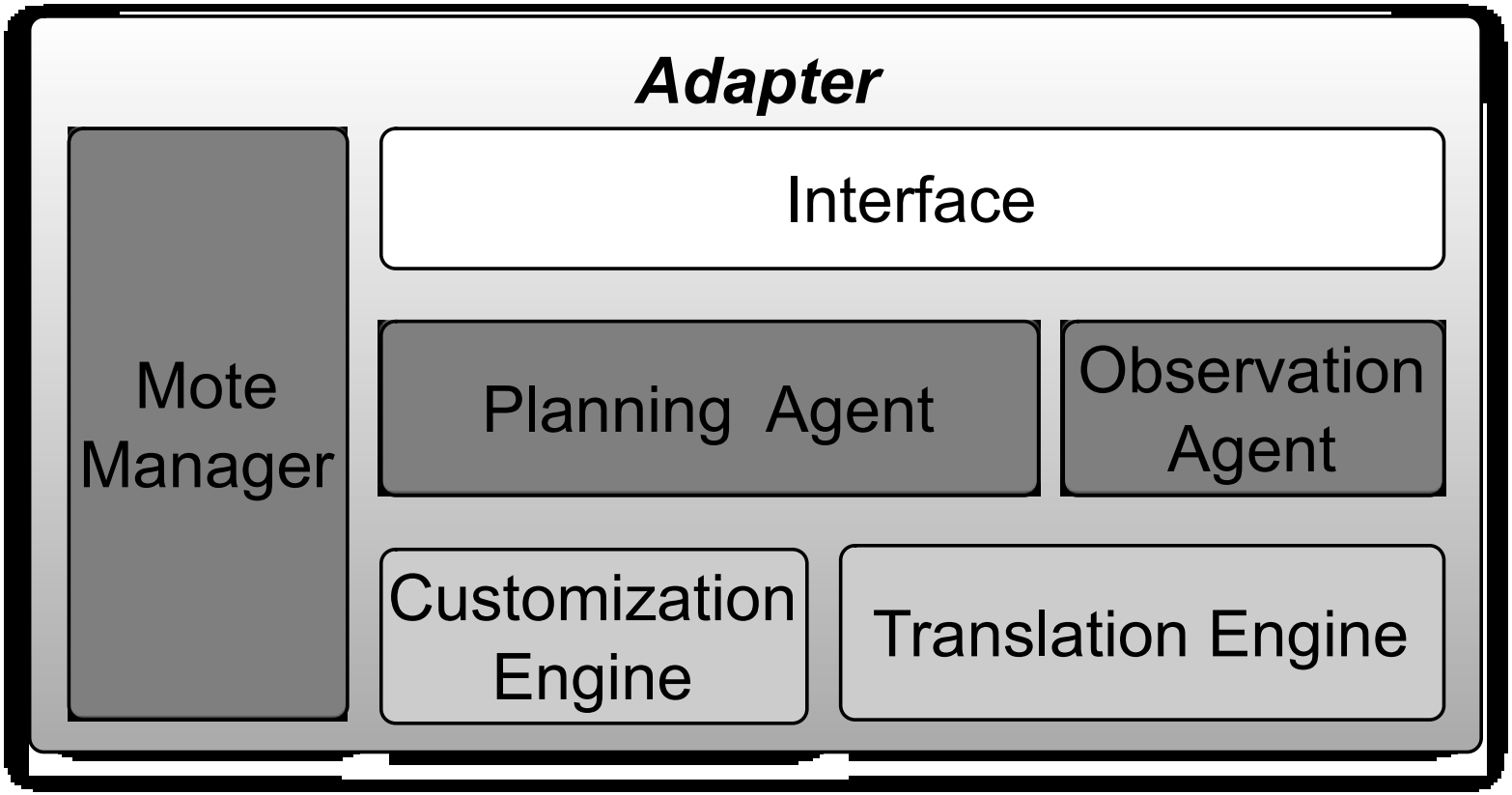
Device-driven approach



SAaaS: Hypervisor



SAaaS: Adapter



Mobile Crowdsensing application: PotHole Detector

- an Android app running on volunteer-owned mobiles
- a Back-End system to collect data, and also filter, analyze and mine it

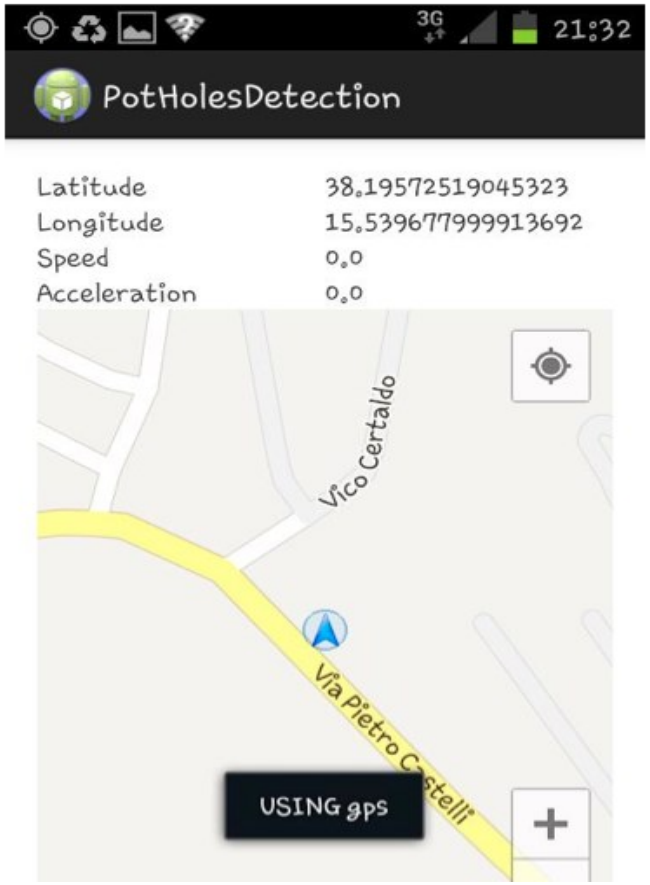
- exploiting mobile-carrying volunteering commuters to detect and classify automatically road surface conditions

- combined sampling of:
  - acceleration data from on-board motion detection sensors
  - geospatial coordinates as provided by the GPS

Mobile Crowdsensing application: PotHole Detector

- enables generating a quality map of traversed roads, pinpointing any distress condition and potential presence of potholes
- performs uninterrupted sampling of parameters coming from accelerometers
- computes changes in the sampled values for acceleration (intuitively, when bumping into a pothole on the way, or more generally going down a distressed road surface, these changes may turn out to be hefty) and marks the presence of a potentially critical condition at the corresponding geospatial coordinates
- info thus acquired to be stored in a centralized DB, as data source for a Web application in order to enable monitoring of roads condition
- the same information base could be useful for local government and competent authorities to plan carefully targeted maintenance actions and aptly arranging those according to levels of priority
- most business logic, data filtering and analysis routines reside inside the Web application, in order to keep computational duties for involved mobiles at a minimum, e.g. just essential mechanisms and filtering rules to drop false positives

Mobile Crowdsensing application: PotHole Detector



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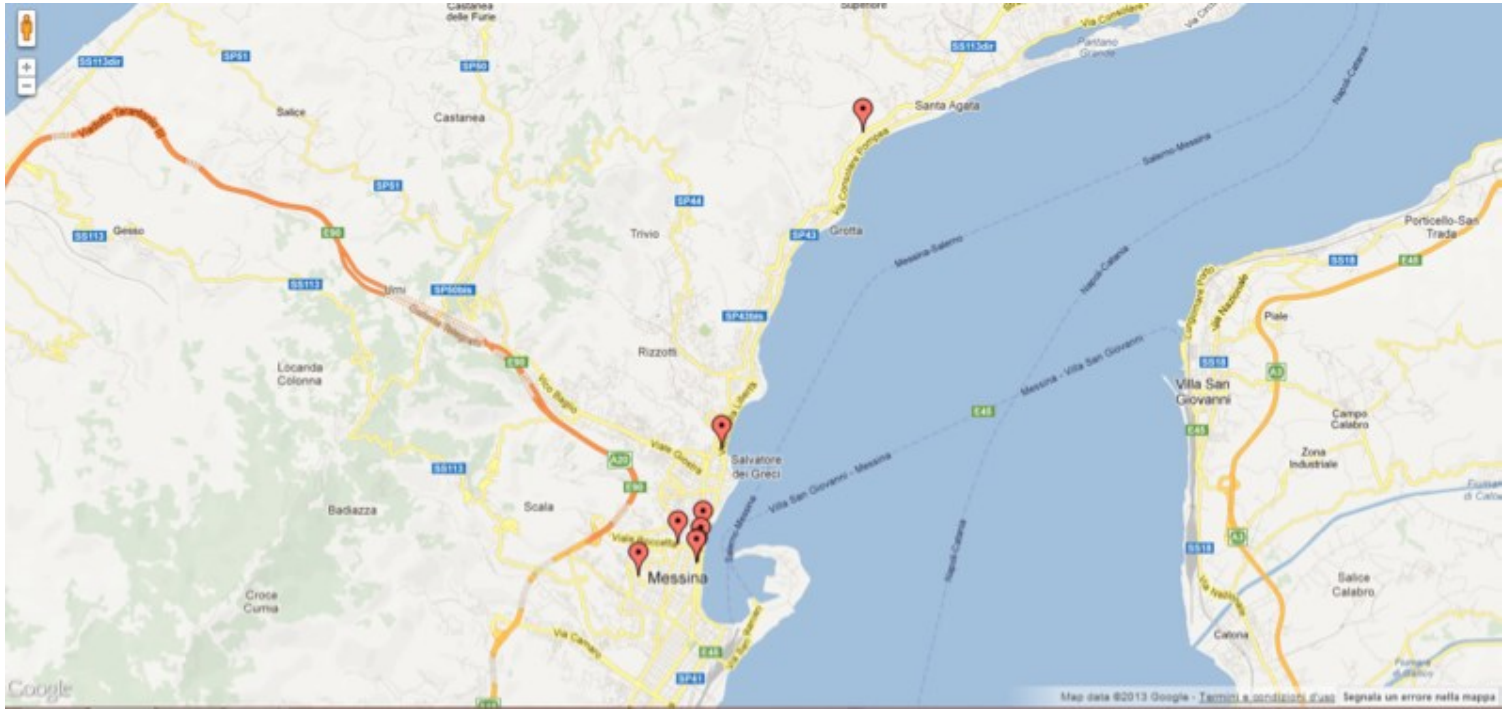
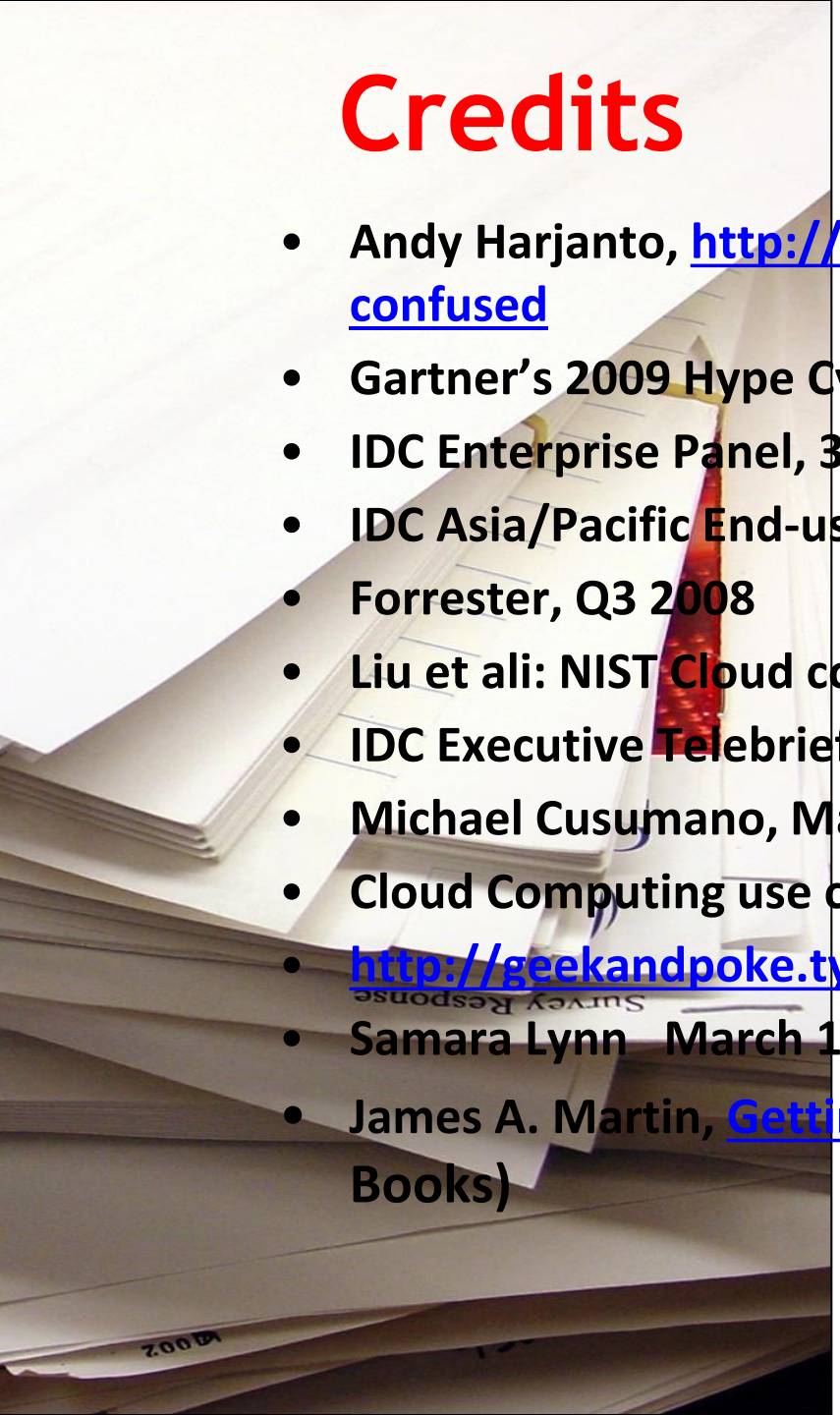


Future work

- IaaS Cloud4Sens customisation and self-management features
- Mobile-Cloud4Sens, porting PaaS Cloud4Sens functionalities into embedded platforms
- Cloud of Things, Things as a Service (TaaS)
  - semantically tagging devices



Credits

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A journey of a thousand miles
begins with a single step
Lao - tzu

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