UNIK4750 - Measurable Security for the Internet of Things

L2 - Internet of Things

György Kálman,
Mnemonic/CCIS/UNIK
gyorgy@unik.no

Josef Noll
UiO/UNIK
josef@unik.no

http://cwi.unik.no/wiki/UNIK4750, #IoTSec, #IoTSecNO

L2- Overview

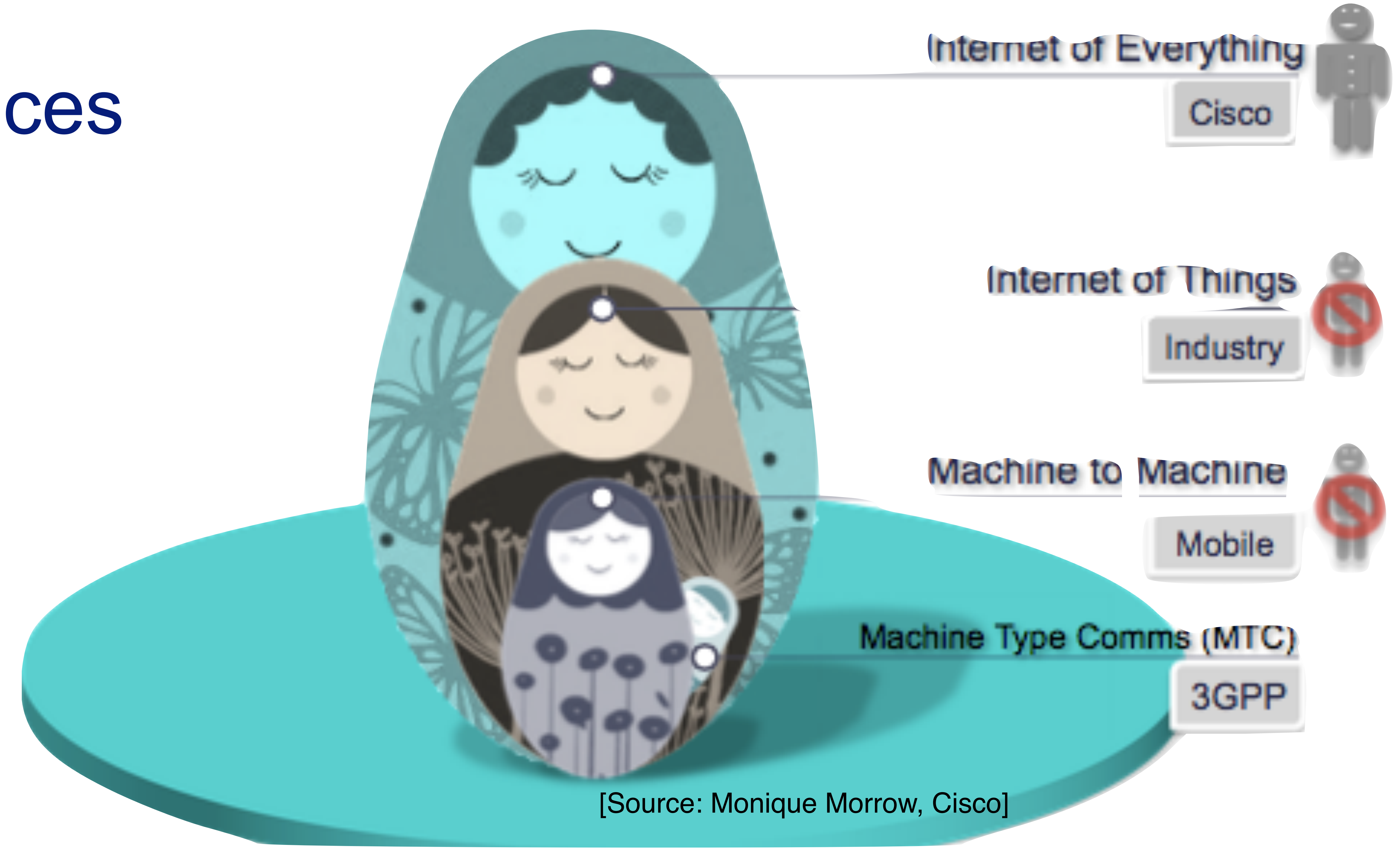
- History of Internet of things (IoT)
- Merging several domains
  - ➡ Things
  - ➡ Semantics
  - ➡ Internet
- What about?
  - ➡ Security
  - ➡ Privacy
  - ➡ Multi-owner requirements
- "How can we tell sensors to speak Norwegian?"

Expected outcome:

- Describe the domains being merged in IoT
- Provide examples of challenges in each of the domains
- Establish requirements for multi-owner service requests of "a thing"
- Analyse security and privacy requirements in an envisaged scenario

Internet of Things aspects

- The Internet of People Things and Services (IoPTS)
  - The Internet of Things (IoT)
  - The Internet of Everything (IoE)
- Identity in the IoT
  - Identity and trust between people
  - Identity in IoT
- Privacy and Security
  - Privacy, Context-awareness
  - Measurable Security
  - Innovation through Measurable Security
- Conclusions



[Source: Monique Morrow, Cisco]

DNV report 2013, DNV GL report 2014

Technology Outlook 2020 / Transformative Technologies

- Technology applications in Maritime, Renewables & Electricity, Health Care, Oil & Gas and Food & Water industries
  - ➡ sensors will drive automated data management
  - ➡ from passive data to automated decisions
  - ➡ automated decision tools by 2020

- Maritime: «policy driven»
- Health care: «trust» on sensor and mobile apps

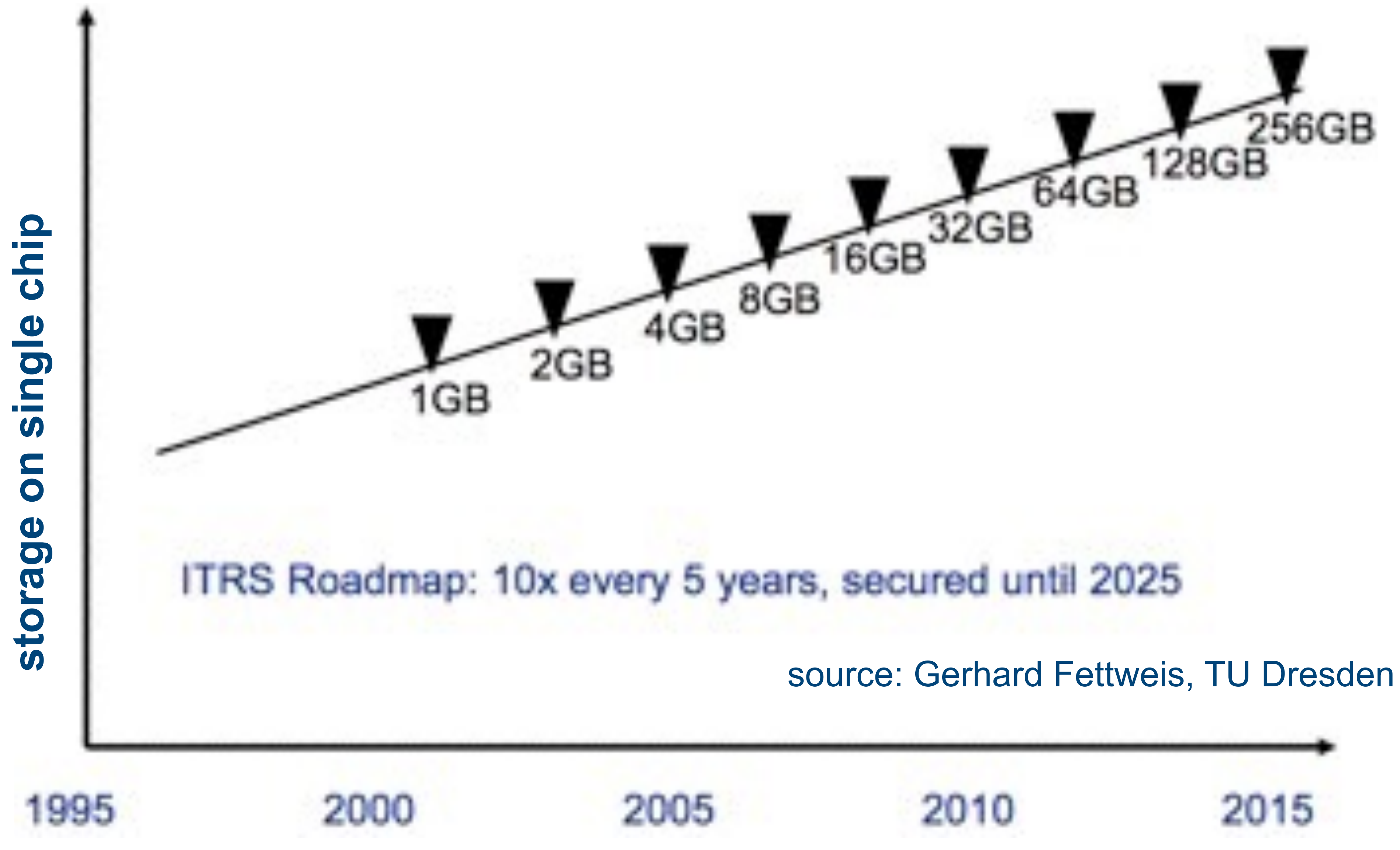
> **“Only 59% of the public trust the energy industry,” (Edelman Trust Barometer 2013)**

> **“In any change management process, the challenge is communicating risk,” (Peter Bjerager, DNV GL)**

IoT paradigm

- From "Internet of PCs" towards the "Internet of Things" with 50 to 100 billion devices connected to the Internet by 2020. [CERP-IoT, 03.2010]
- Things have their own identity, communicate with other things and humans (IoPTS)

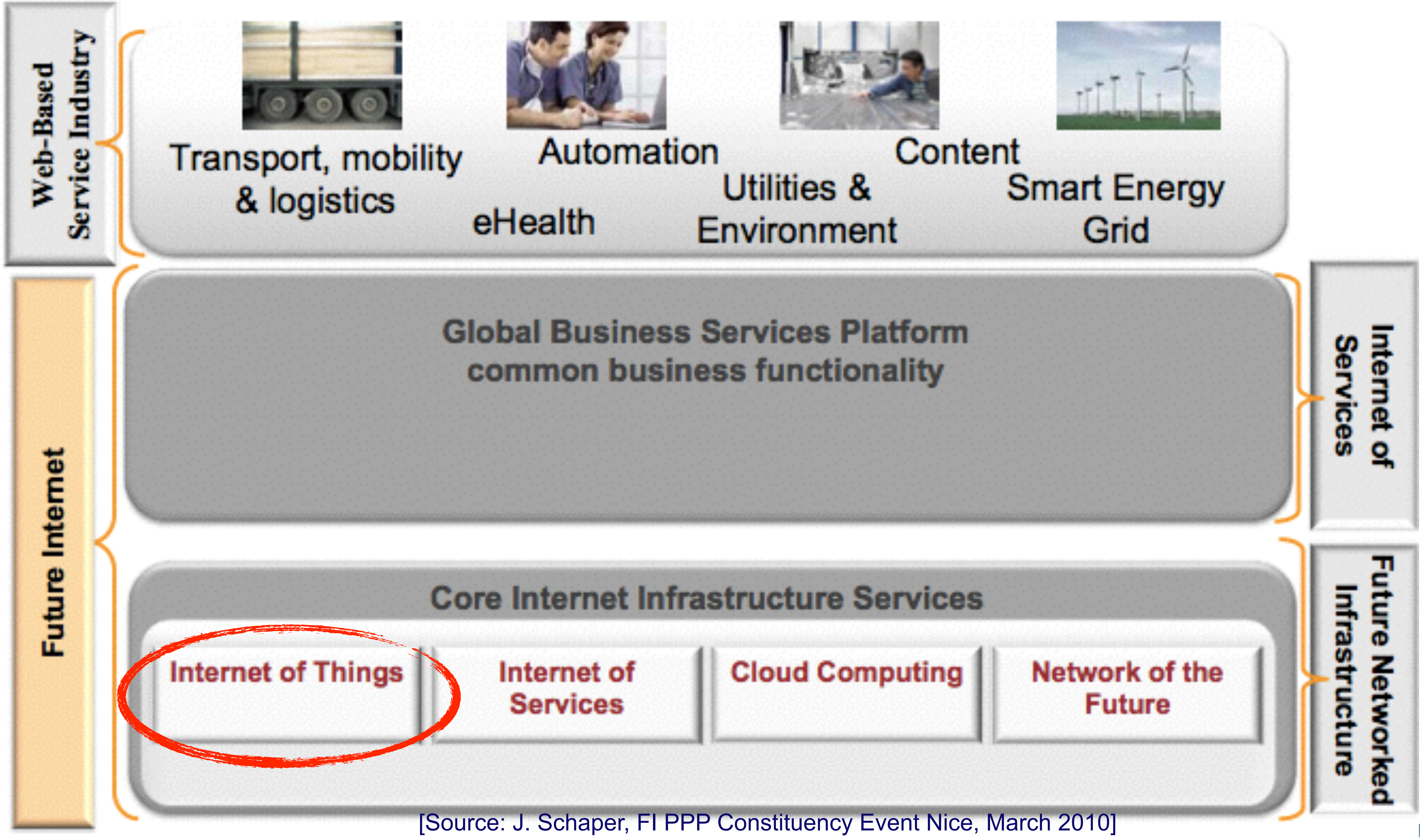
- The speed of development



source: Gerhard Fettweis, TU Dresden

> **"Now (2010) we have roughly 5.2 Mio mobile subscribers. In some year we will have 30...50 Mio devices on the mobile network"**
>
> – Hans Christian Haugli, CEO, Telenor Objects

Principal Objective of the FI PPP - A Holistic Global Service Delivery Platform



Web-Based Service Industry

Transport, mobility & logistics

eHealth

Automation

Utilities & Environment

Content

Smart Energy Grid

Future Internet

Global Business Services Platform
common business functionality

Internet of Services

Core Internet Infrastructure Services

Internet of Things

Internet of Services

Cloud Computing

Network of the Future

Future Networked Infrastructure

[Source: J. Schaper, FI PPP Constituency Event Nice, March 2010]

Paper analysis:
The Internet of Things

- Paper: L. Atzori et al., The Internet of Things: A survey, Comput. Netw. (2010), doi:10.1016/ j.comnet. 2010.05.010
- Create groups of 2-3 people
- Analyse the paper
  - ➡ Read 15 min
  - ➡ Discuss 20 min
- Establish aspects of IoT, e.g.
  - ➡ technologies
  - ➡ interfaces
  - ➡ standards
  - ➡ …
- Present your "top 5"

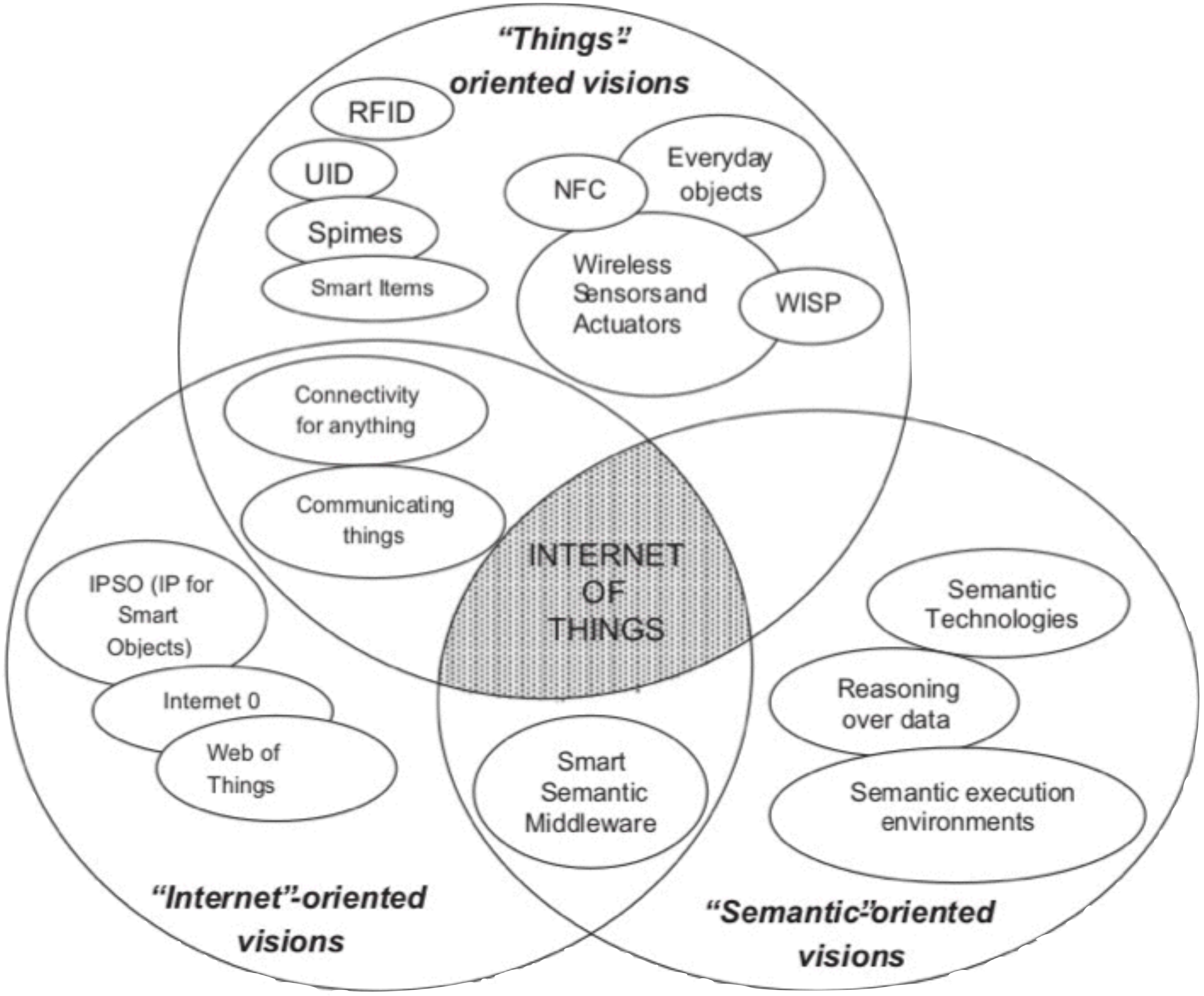

"Things"
oriented visions
RFID
UID
Spimes
Smart Items
NFC
Everyday objects
Wireless Sensors and Actuators
WISP
Connectivity for anything
Communicating things
INTERNET OF THINGS
IPSO (IP for Smart Objects)
Internet 0
Web of Things
Smart Semantic Middleware
Semantic Technologies
Reasoning over data
Semantic execution environments
"Internet"-oriented visions
"Semantic"-oriented visions

Fig. 1. "Internet of Things" paradigm as a result of the convergence of different visions.

“Your take on IoT”

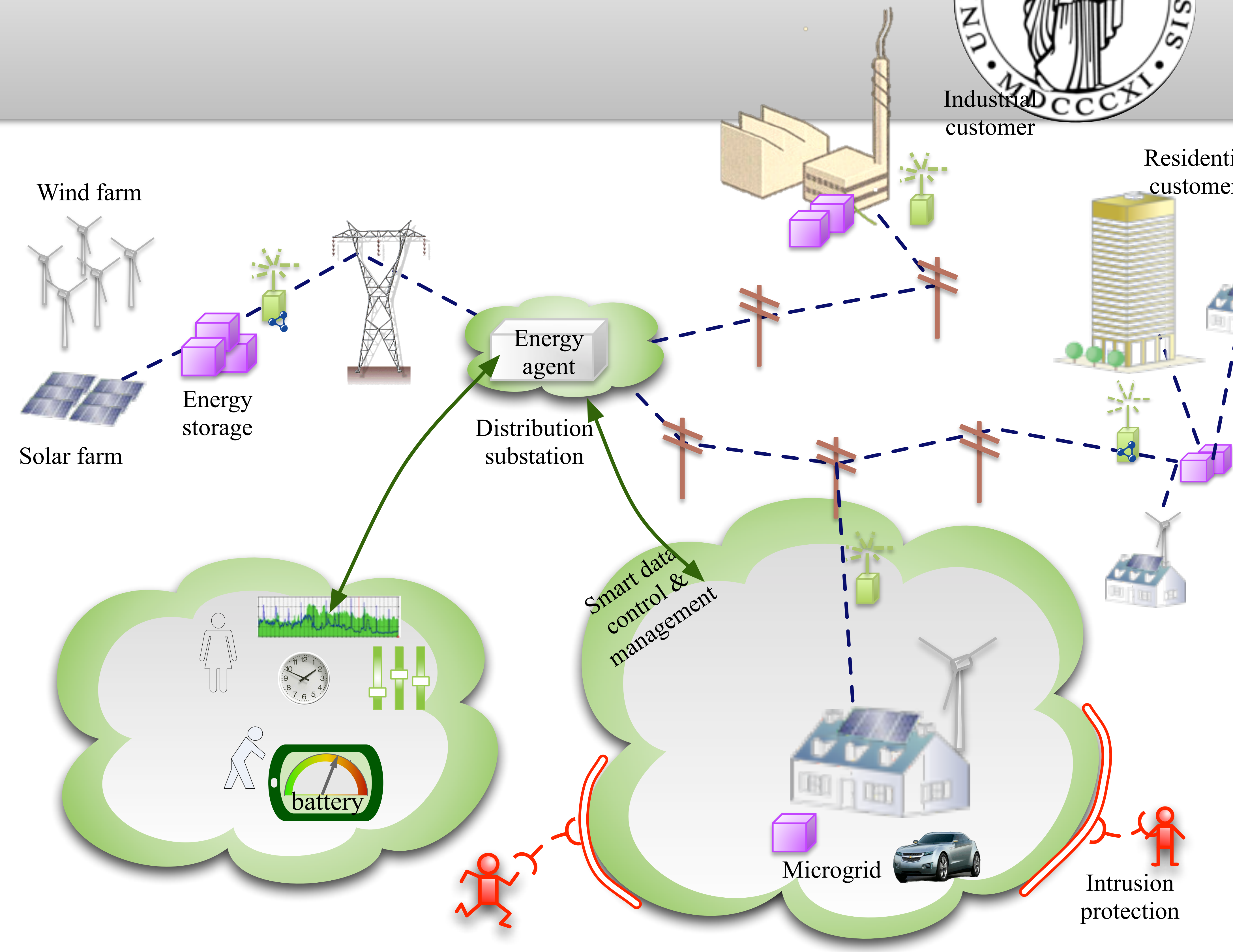
- ….

Main drivers for IoT

- …
- Cheap sensors
- Wireless connectivity
- Apps
- on-time monitoring

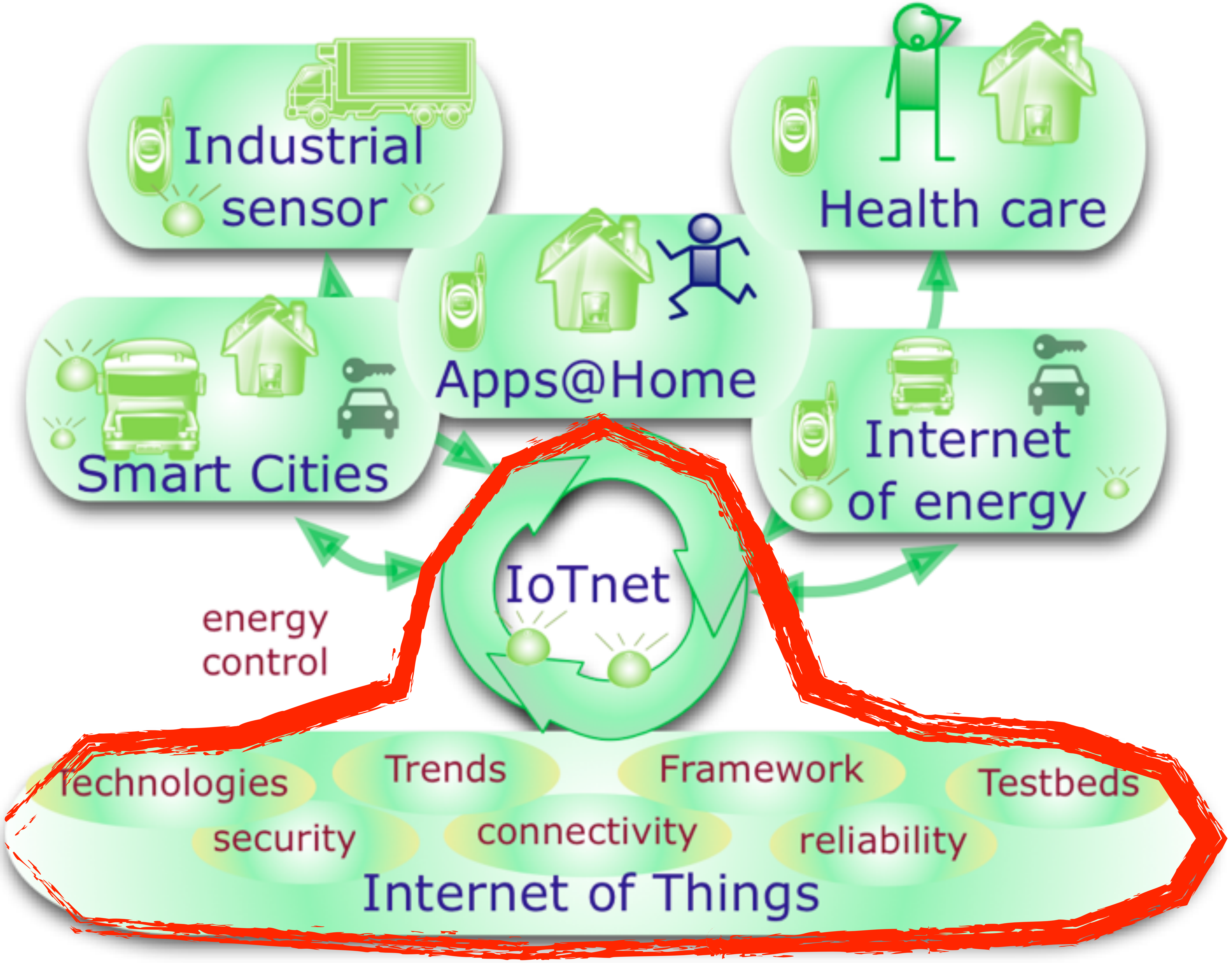
Business drivers

- novel services
- costs
- efficiency

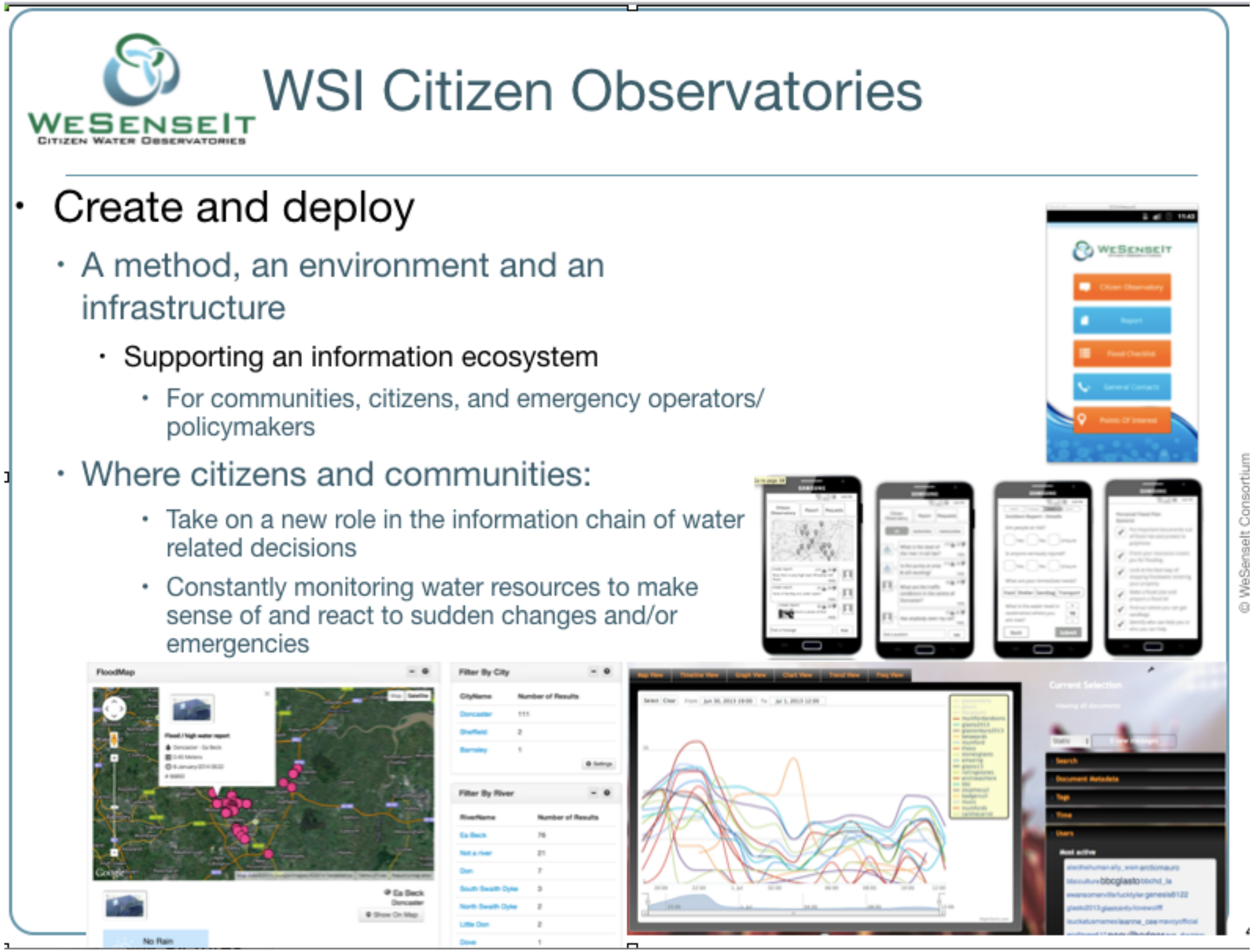


- Smart grid with prosumers
- various control mechanisms
- attack scenarios
- critical infrastructure

The IoT technology and application domain



Examples of future IoT applications



WESENSEIT
CITIZEN WATER OBSERVATORIES

WSI Citizen Observatories

- Create and deploy
  - A method, an environment and an infrastructure
    - Supporting an information ecosystem
      - For communities, citizens, and emergency operators/ policymakers
  - Where citizens and communities:
    - Take on a new role in the information chain of water related decisions
    - Constantly monitoring water resources to make sense of and react to sudden changes and/or emergencies

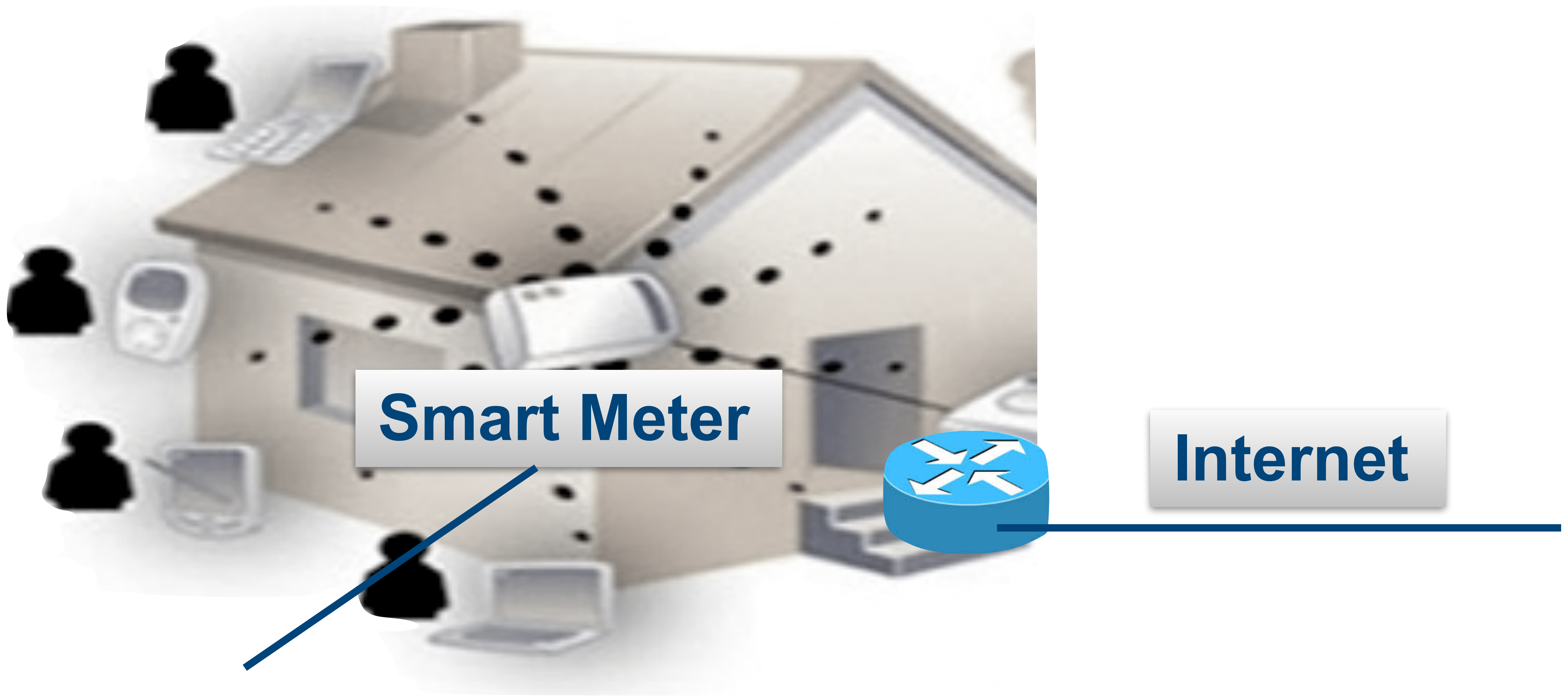
© WeSenseIt Consortium

- Cost reduction by an order of magnitude
  - from €10k to €1k, from €1k to €100, from €100 to €20
- Sensors:
  - Weather stations, Soil moisture probes, Gauge boards, Radar sensor flow gauges, Disdrometers …

© WeSenseIt Consortium

Smart Grid Services in the home

- Example: automatic meter reading (AMR) and -system (AMS)
- Billing
- Alarm (temperature, burglary, fire, water)
- Health (surveillance of people and infrastructure)
  - ➡ Fridge with open door
  - ➡ Person who has fallen
- Electricity (monitoring, reducing, securing supply)

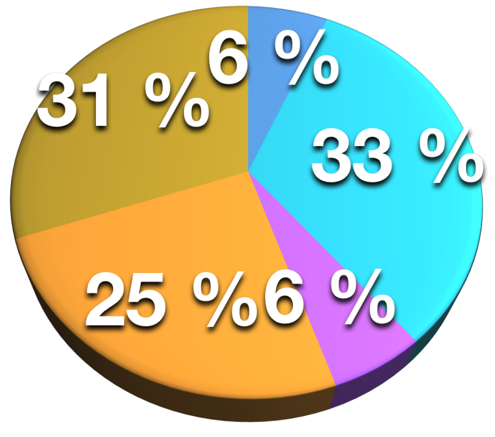


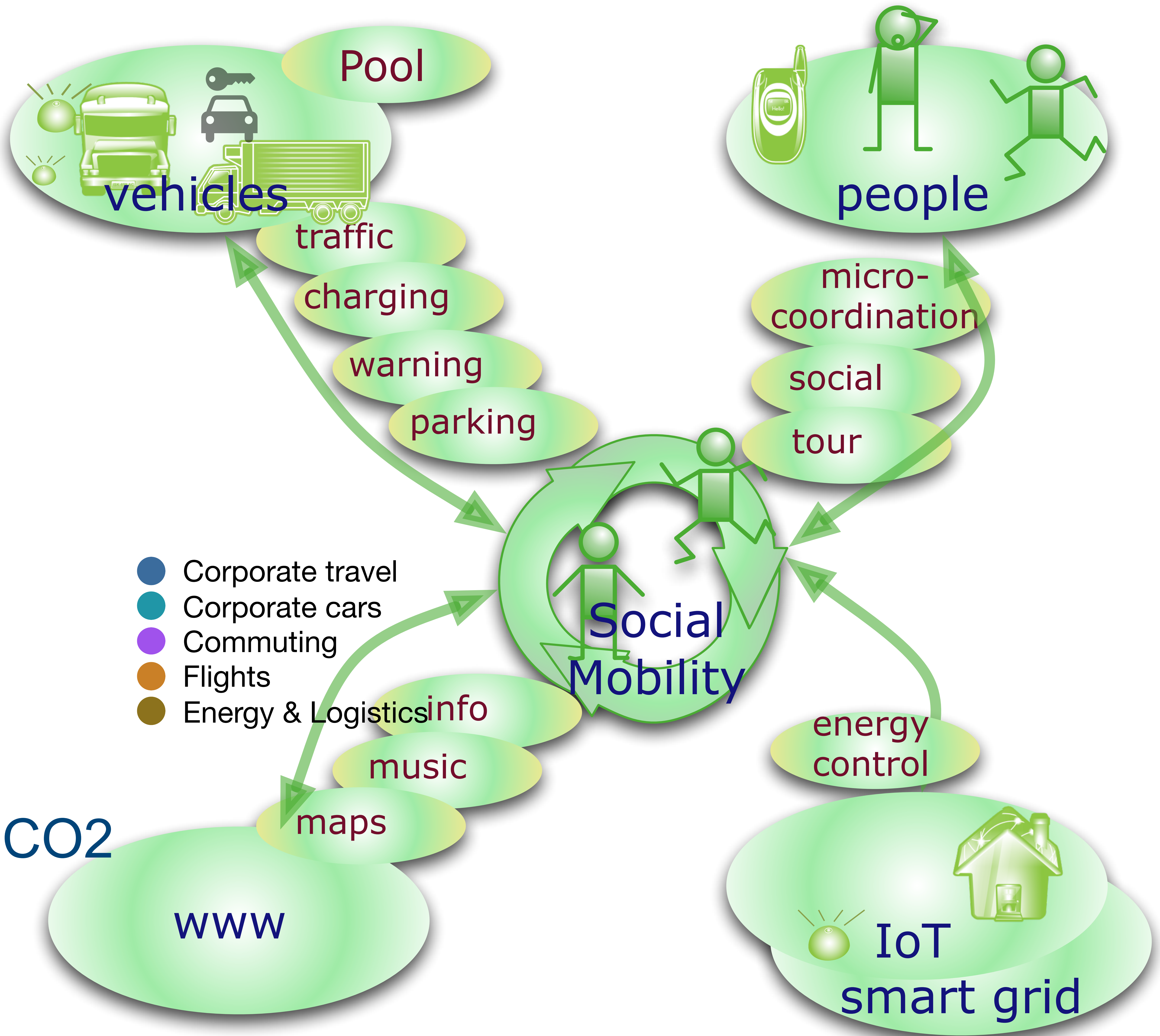
[source: seminarsonly.com]

Application Example: Socialtainment (eMobility)

- From Entertainment to Socialtainment
- Social mobility through inclusion of social networks

CO2 consumption





- answering the need for CO2 reduction in transport
  - SAP 45% (2009)

Connected Rail Operations

PASSENGER SECURITY

- In-station and onboard safety
- Visibility into key events

ROUTE OPTIMIZATION

- Enhanced Customer Service
- Increased efficiency
- Collision avoidance
- Fuel savings

CRITICAL SENSING

- Transform "data" to "actionable intelligence"
- Proactive maintenance
- Accident avoidance

[Source: Cisco, Mikhail Kader, DSE, Cisco, ITU Workshop on "ICT Security Standardization for Developing Countries"]

Smart City

CONNECTED TRAFFIC SIGNALS

- Reduced congestion
- Improved emergency services response times
- Lower fuel usage

PARKING AND LIGHTING

- Increased efficiency
- Power and cost savings
- New revenue opportunities

CITY SERVICES

- Efficient service delivery
- Increased revenues
- Enhanced environmental monitoring capabilities

[Source: Cisco, Mikhail Kader, DSE, Cisco, ITU Workshop on “ICT Security Standardization for Developing Countries”]

The Connected Car

WIRELESS ROUTER

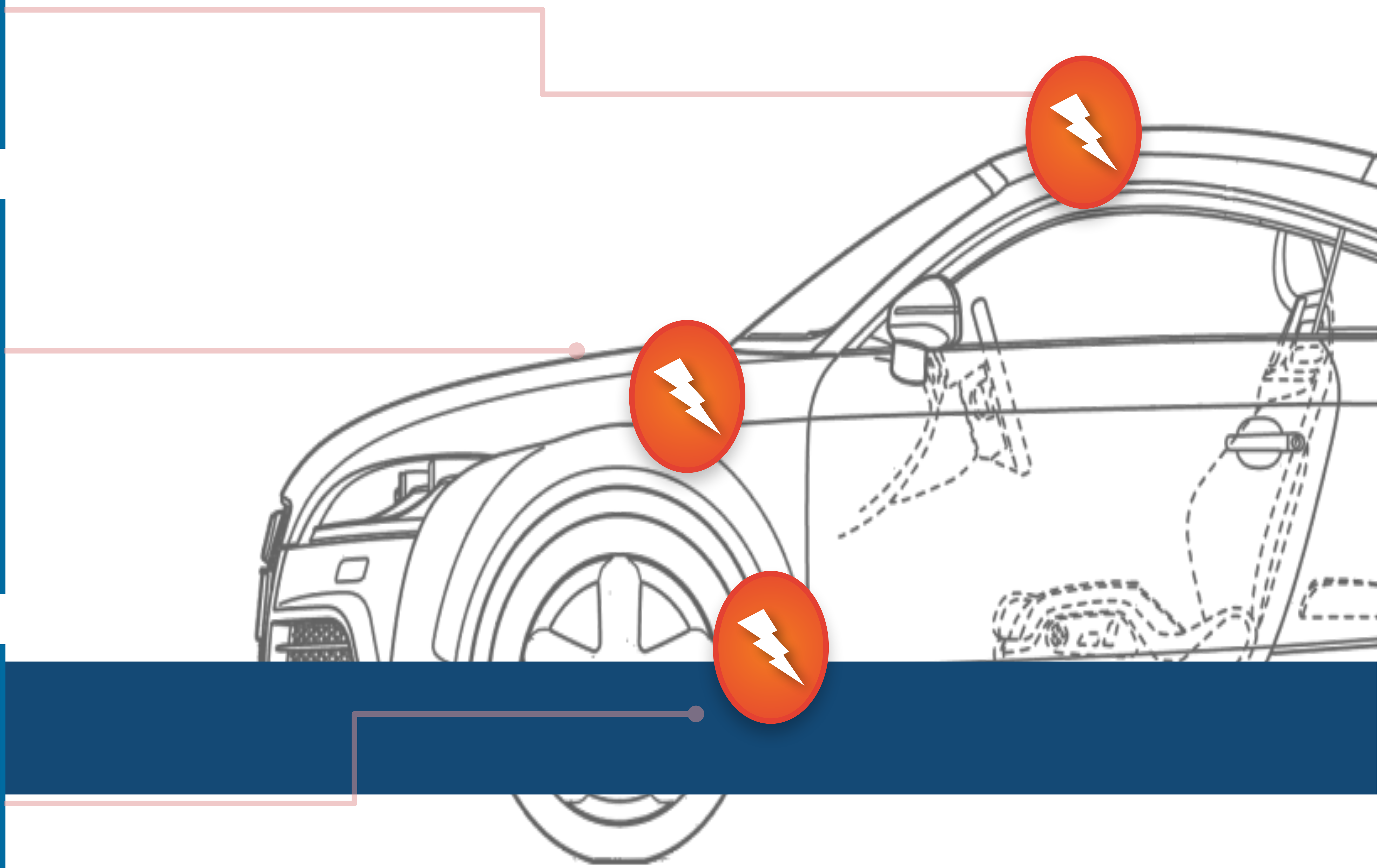
- Online entertainment
- Mapping, dynamic re-routing, safety and security

CONNECTED SENSORS

- Transform "data" to "actionable intelligence"
- Enable proactive maintenance
- Collision avoidance
- Fuel efficiency

URBAN CONNECTIVITY

- Reduced congestion
- Increased efficiency
- Safety (hazard avoidance)



[Source: Cisco, Mikhail Kader, DSE, Cisco, ITU Workshop on "ICT Security Standardization for Developing Countries"]

IoT services

- Enabled by wide scale data gathering
- Monitoring of massive systems
- Real-time insight to processes
- Observation of systems
- Performance measurement and optimisation
- Proactive and predictive methods
- To serve the automation goals, the services provided must be: scalable, distributed, have a real reference to the physical world (e.g. time), must ensure security and privacy of the users
- Just using existing security solutions is not leading to secure IoT deployments
- Composed by IT, operations and the IoT enabled objects

IoT is transforming Industry
Automation as we know it

- Centralised intelligence
- Traditionally operated as islands by operations
- Direct connection with the physical world
- Is made for information gathering and processing by machines
- Has a lag of approx. 15-20 years (one generation of devices)
- Still a current question: collisions on Ethernet, what happens if one has to share infrastructure with others, how to operate a link with long step-out distance
- Economic press leads to adoption of internet-based services which *require* a paradigm change

Mine (Boliden)

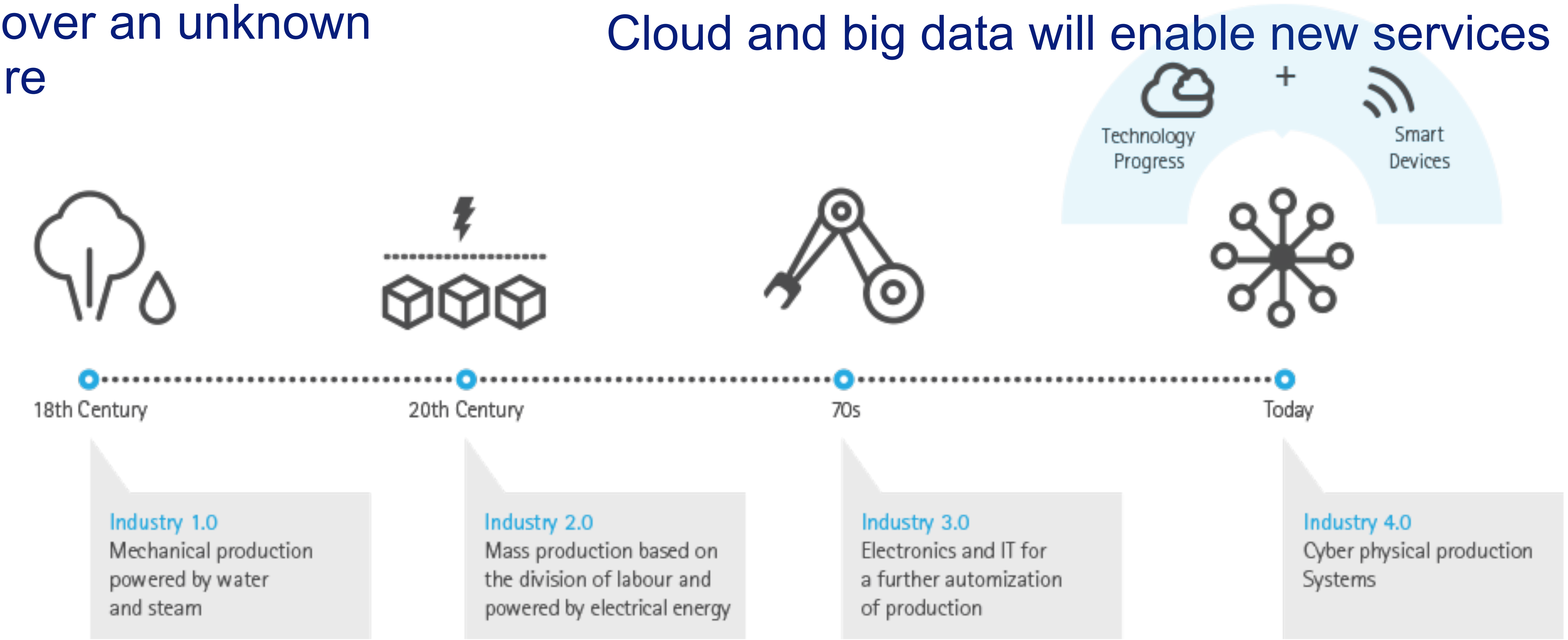
ABB robots

http://www07.abb.com/images/librariesprovider104/Extended-Automation/control-room-consolidation-by-abb.png?sfvrsn=1

Merging sensors with industrial production
Generating Data and Services

- Internet is the infrastructure – sensor, actuator, controller not on the same physical network any more
- ”dissolves” the automation system in the internet
- Automation processes run over an unknown communication infrastructure

- Network communication gets physical impact
- Automation meets real internet-type deployment
- Already happening
- The real value of IoT: data.
  Cloud and big data will enable new services



Industry 1.0
Mechanical production powered by water and steam

Industry 2.0
Mass production based on the division of labour and powered by electrical energy

Industry 3.0
Electronics and IT for a further automization of production

Industry 4.0
Cyber physical production Systems

http://prd.accenture.com/microsites/digital-industry/images/digital/industrial-infographic-large.png

The Security and Trust Dimension

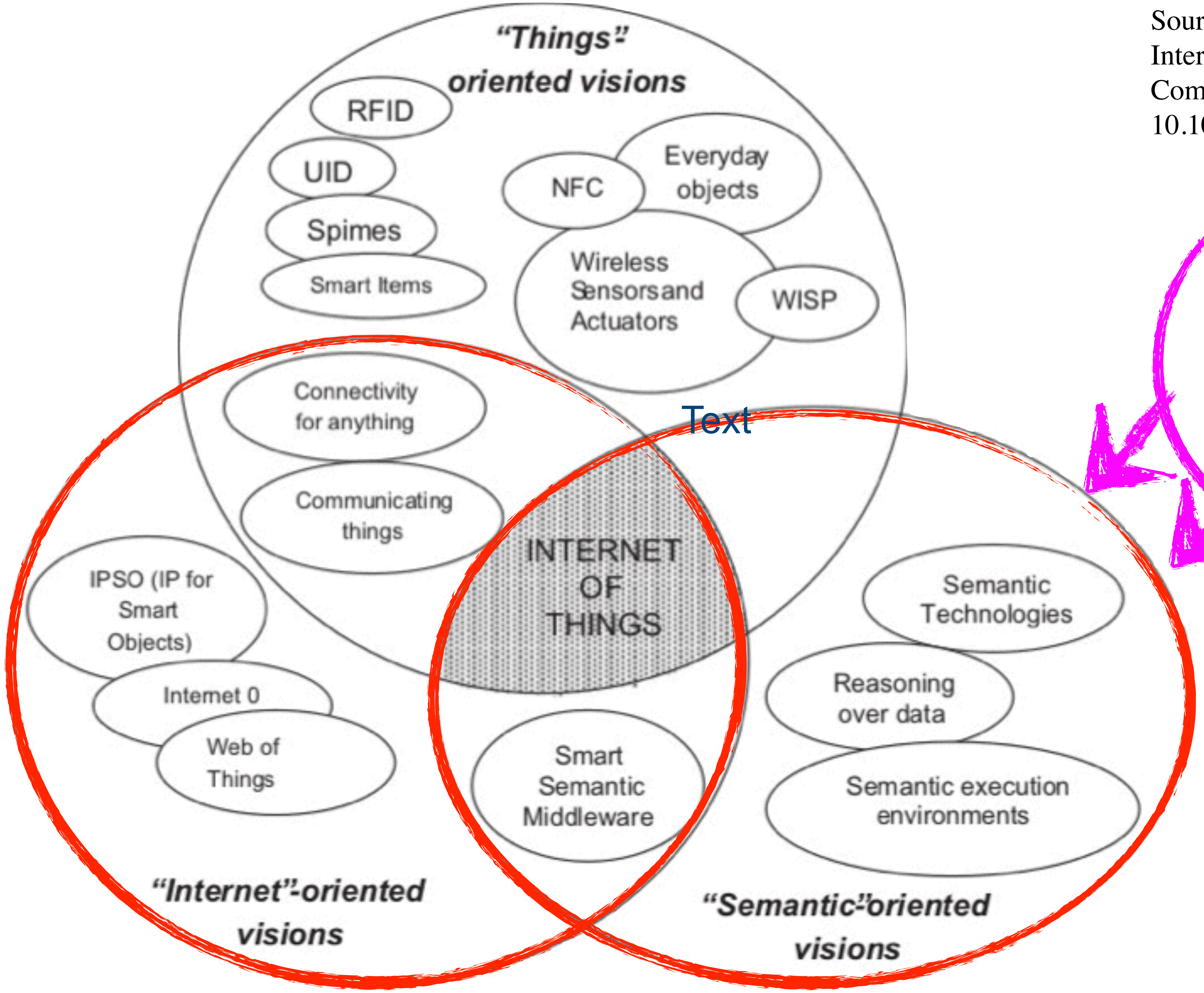
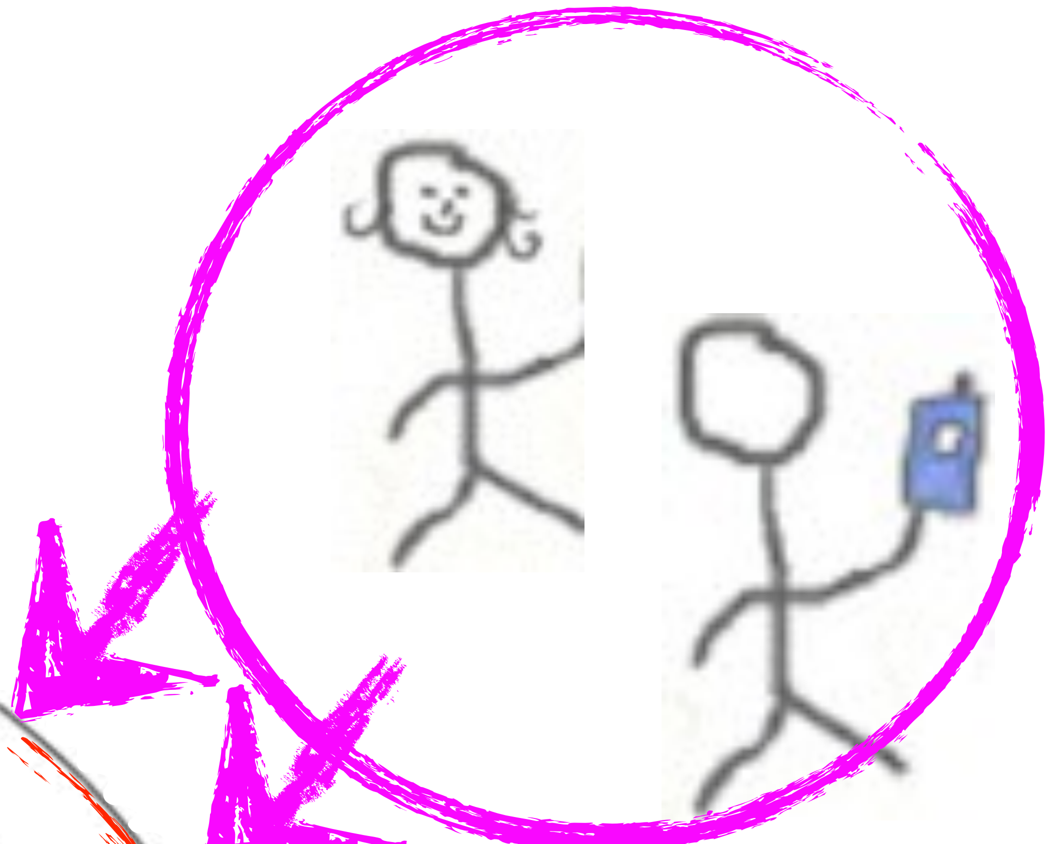

"Things"-oriented visions
RFID
UID
Spimes
Smart Items
NFC
Everyday objects
Wireless Sensors and Actuators
WISP
Connectivity for anything
Communicating things
IPSO (IP for Smart Objects)
Internet 0
Web of Things
INTERNET OF THINGS
Smart Semantic Middleware
Semantic Technologies
Reasoning over data
Semantic execution environments
"Internet"-oriented visions
"Semantic"-oriented visions
Text

Fig. 1. "Internet of Things" paradigm as a result of the convergence of different visions.

Source: L. Atzori et al., The Internet of Things: A survey, Comput. Netw. (2010), doi: 10.1016/ j.comnet.2010.05.010



* security
* privacy
* dependability
* context-aware
* personalised

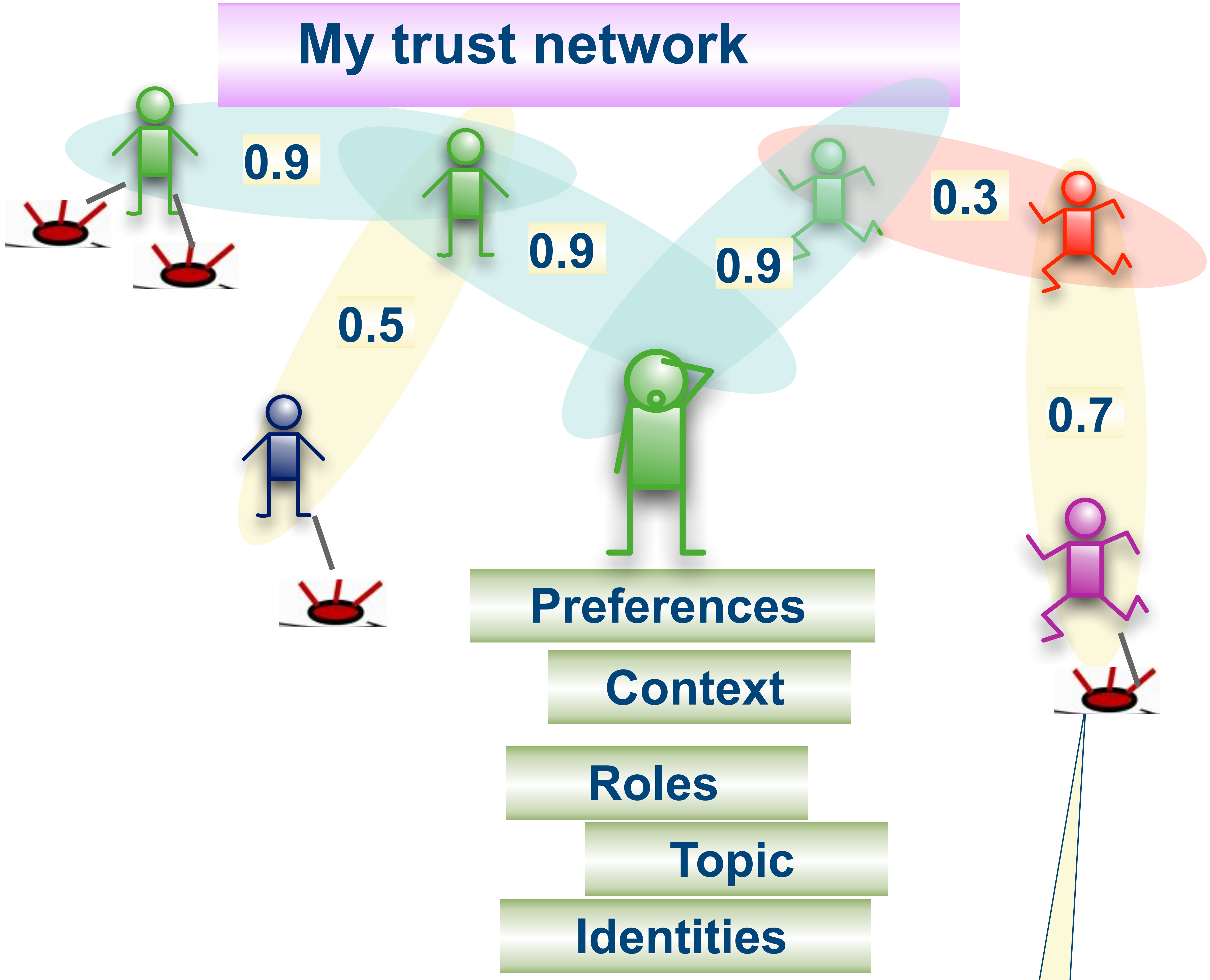
"Only 59% of the public trust the energy industry," (Edelman Trust Barometer 2013)

Paradigm change for
The Internet of the Real World and IoT

- Trust related privacy
  -> **Representing the user adequately**

- Connecting to **sensors, devices** and **services**
  -> **Provide privacy and ensure trust relations**

- An ever increasing complexity in the digital environment
  -> **Hiding the complexity from the use**



My trust network

Preferences

Context

Roles

Topic

Identities

Thanks to Vladimir Oleshchuk for ideas and discussions

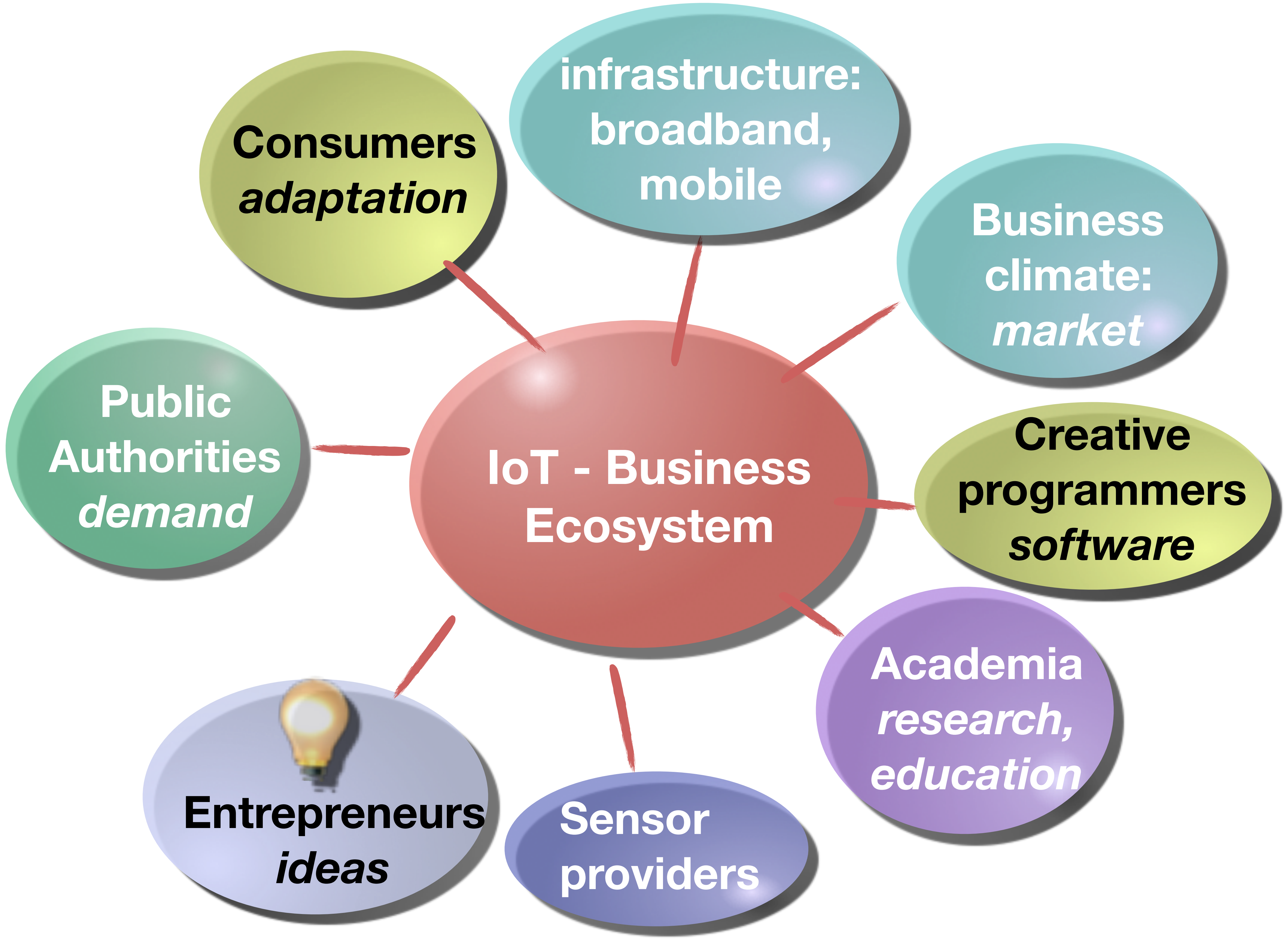
Sociable Internet of Things

- Things" become socially intelligent
  - yes, without doubts
  - requires new trust model
  - measurable security
- Growing Internet of Things (IoT) market
  - broad connectivity
  - essential openness of smart "*everything*"
  - security, privacy, dependability
- «What about me?»
  - The Internet of People, Things and Services (IoPTS)

> Imagine a world where things are connected, but unsociable. Every interaction would have to be explicitly scripted or it wouldn't happen. Oh wait, you don't have to imagine it. That's the current model for the IoT, and it won't scale.
>
> http://www.linuxjournal.com/content/true-internet-things

Internet of People, Things and Services
The IoPTS ecosystem

- Creating business
  - openness, competitive
  - climate for innovation
- Public authorities
  - trust, confidence
  - demand
- Consumers
  - (early) adapters
  - education
- Infrastructure
  - broadband, mobile
  - competition


IoT - Business Ecosystem
Consumers *adaptation*
infrastructure: broadband, mobile
Business climate: *market*
Public Authorities *demand*
Creative programmers *software*
Academia *research, education*
Entrepreneurs *ideas*
Sensor providers

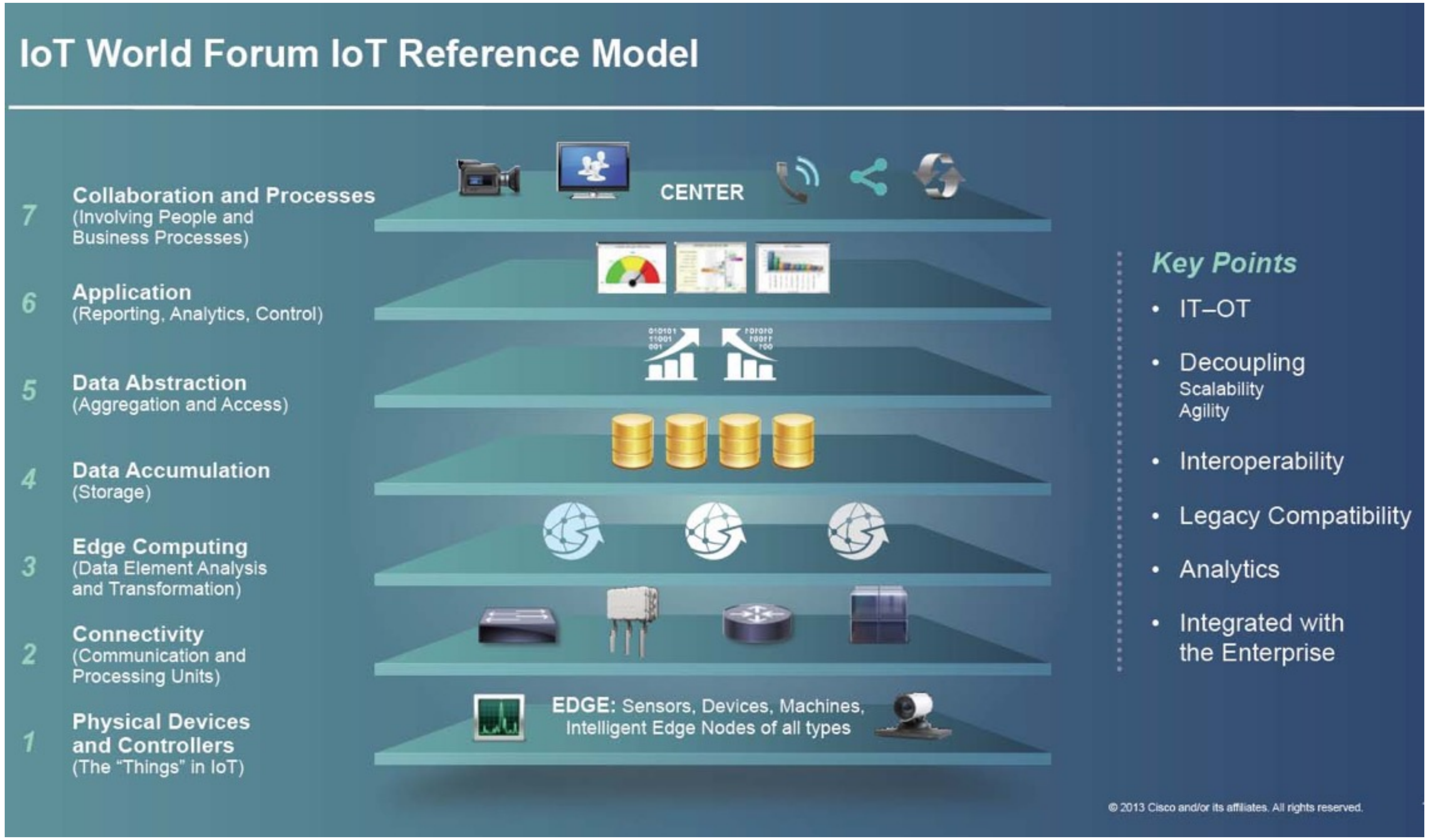
IoT services

- Enabled by wide scale data gathering
- Monitoring of massive systems
- Real-time insight to processes
- Observation of systems
- Performance measurement and optimization
- Proactive and predictive methods

- To serve the automation goals, the services provided must be: scalable, distributed, have a real reference to the phyisical world (e.g. time), must ensure security and privacy of the users
- Just using existing security solutions is not leading to secure IoT deployments
- Composed by IT, operations and the IoT enabled objects

Internet of Things

- Heading toward a fully connected world
- In a more focused way, in this course we speak about industrial internet of things
- The substantial difference is, that these systems have a physical dimension
- Considered as the next industrial revolution
- Automation to a new connectivity level –
  the internet is coming to automation
- Main challenges: how to join the physical
  and the logical world, how to achieve interoperability in a heterogeneous and conservative industry?



IoT World Forum IoT Reference Model

7 Collaboration and Processes (Involving People and Business Processes)

6 Application (Reporting, Analytics, Control)

5 Data Abstraction (Aggregation and Access)

4 Data Accumulation (Storage)

3 Edge Computing (Data Element Analysis and Transformation)

2 Connectivity (Communication and Processing Units)

1 Physical Devices and Controllers (The "Things" in IoT)

CENTER

EDGE: Sensors, Devices, Machines, Intelligent Edge Nodes of all types

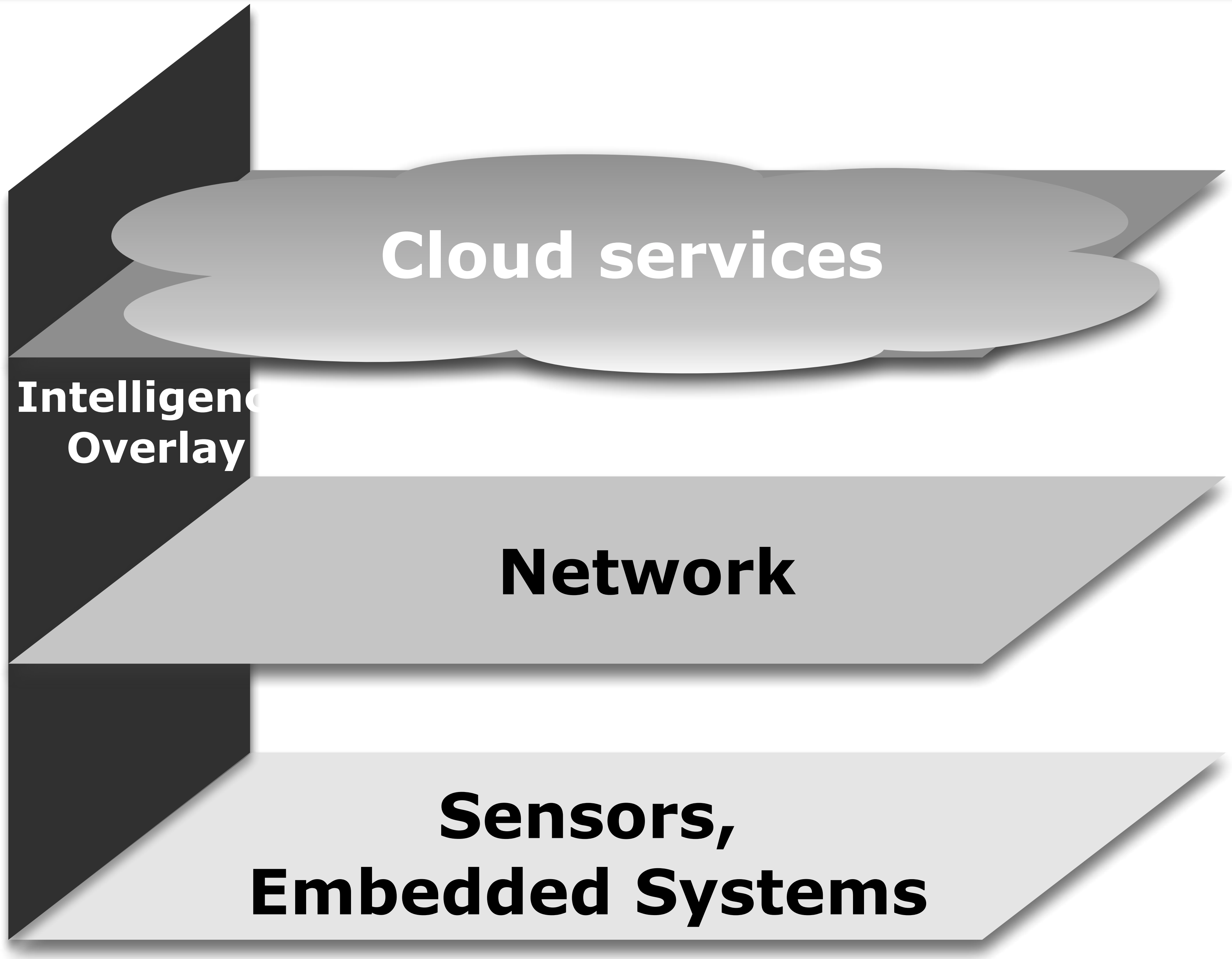
Key Points

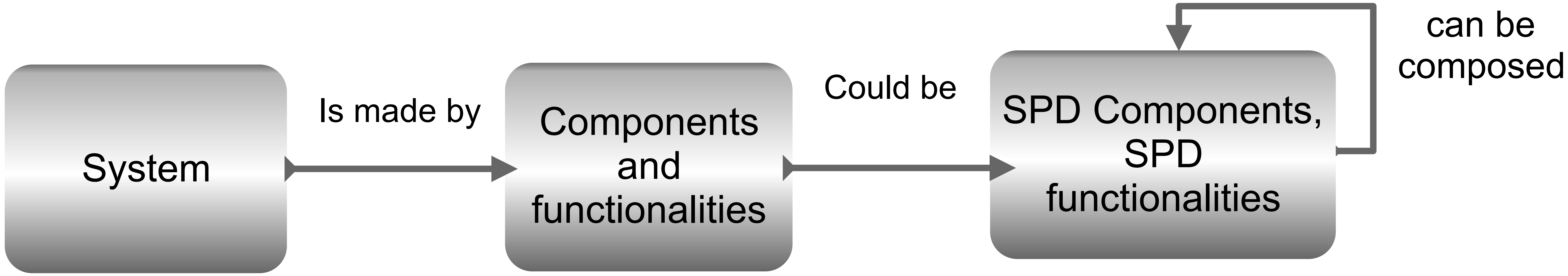
- IT–OT
- Decoupling
  Scalability
  Agility
- Interoperability
- Legacy Compatibility
- Analytics
- Integrated with the Enterprise

© 2013 Cisco and/or its affiliates. All rights reserved.

Common architecture of IoT systems

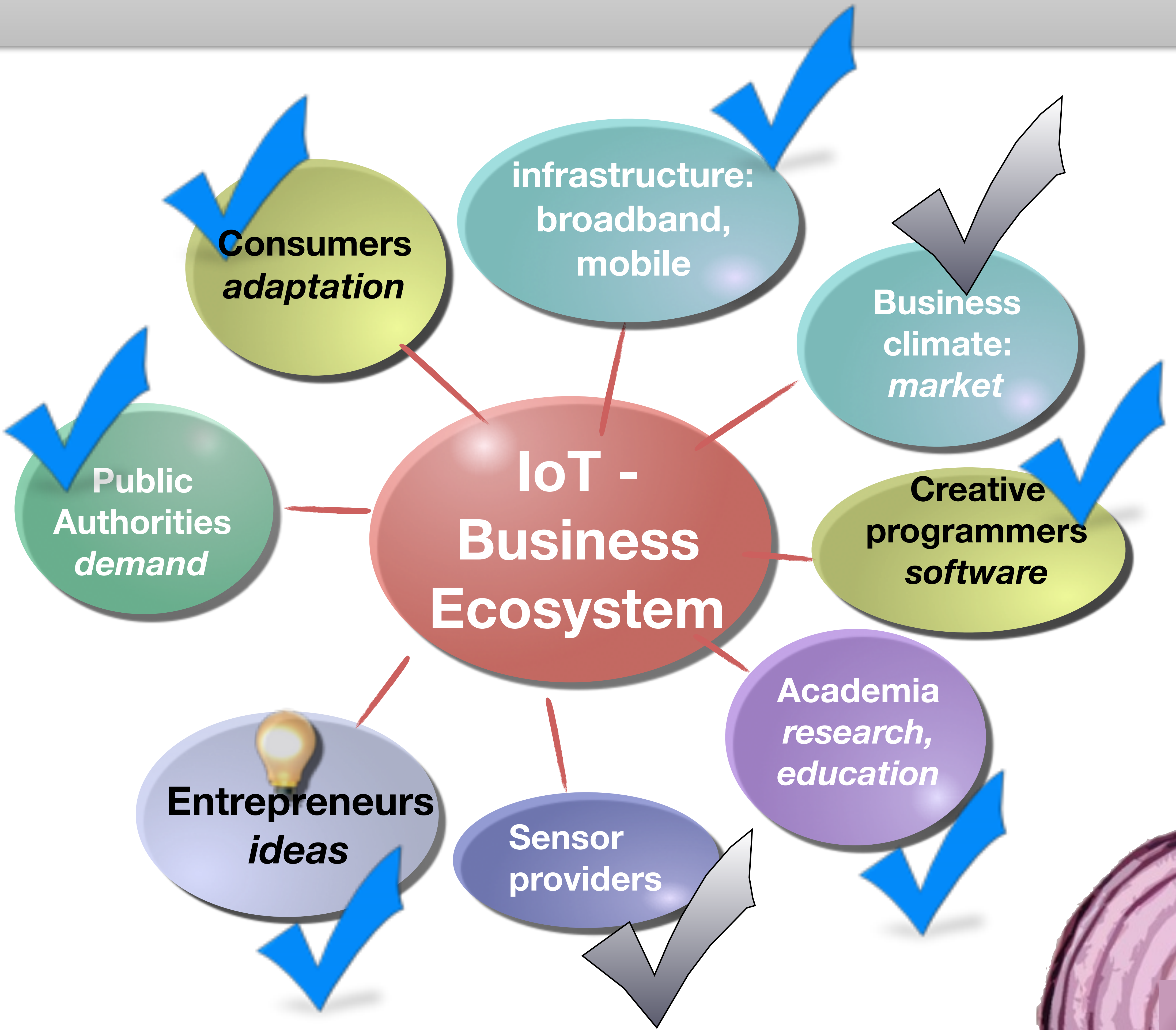
- Core system consists of
  - sensors and devices
  - network and communications
  - services
  - intelligent overlay
- Ability to adjust
  - from sensors to services
- Composing security



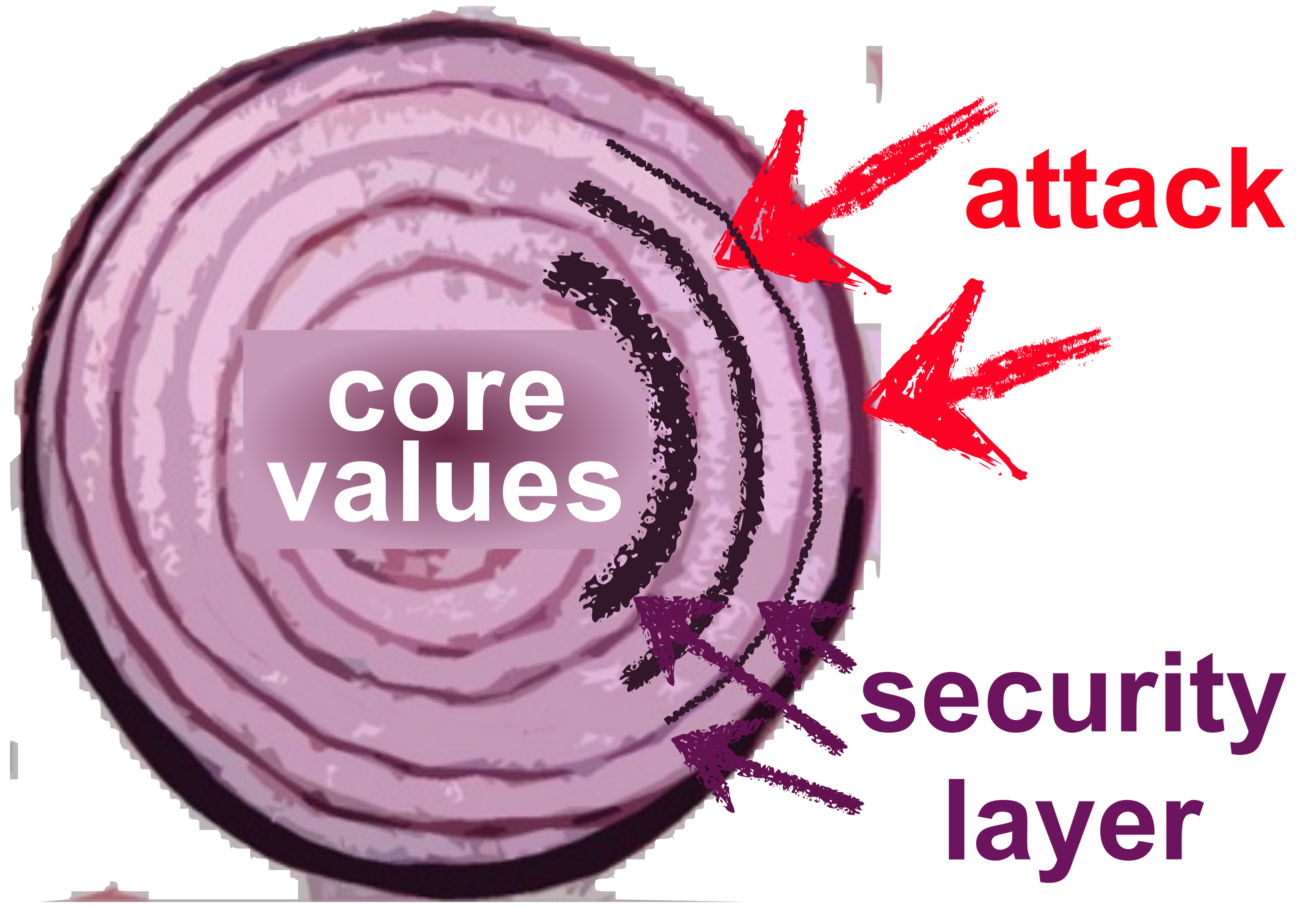

System
Is made by
Components and functionalities
Could be
SPD Components, SPD functionalities
can be composed

Create a successful ecosystem

- Demand
  - mobile/wireless
  - autonomy
  - "me", context-/content-aware
- Adaptation
  - infrastructure
  - business environment
  - trust
- Security, privacy



IoT - Business Ecosystem
Consumers *adaptation*
infrastructure: broadband, mobile
Business climate: *market*
Creative programmers *software*
Academia *research, education*
Sensor providers
Entrepreneurs *ideas*
Public Authorities *demand*



L2- Conclusion

- Difference between IoT, IoPTS, IoE
- Domains being addressed
  - ➡ Things
  - ➡ Semantics
  - ➡ Internet
- Security and privacy challenges
  - ➡ Security
  - ➡ Privacy
  - ➡ Multi-owner requirements
- Architecture components
- Services and Ecosystem

To remember: Ability to

- Describe the domains being merged in IoT
- Provide examples of challenges in each of the domains
- Establish requirements for multi-owner service requests of “a thing”
- Analyse security and privacy requirements in an envisaged scenario