Industrial Internet: Internet of Things, Big data, & Security

A grand vision getting 'concensus'

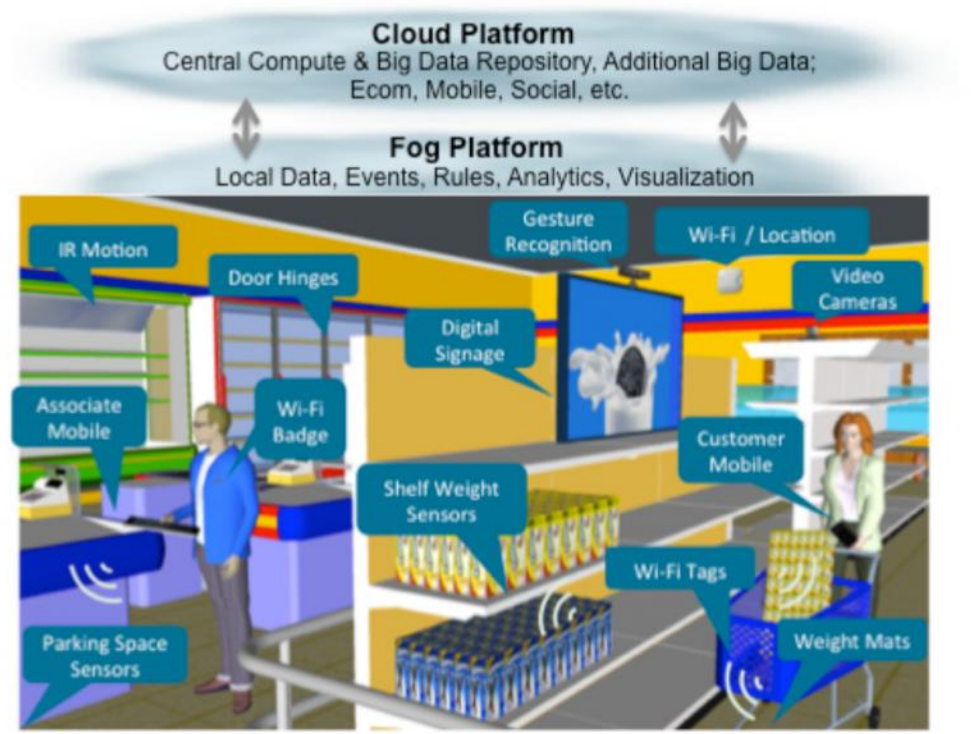
Gérard Memmi

Sensors in a retail shop

'Wired' Sensor

University project in the 90's
RFID based

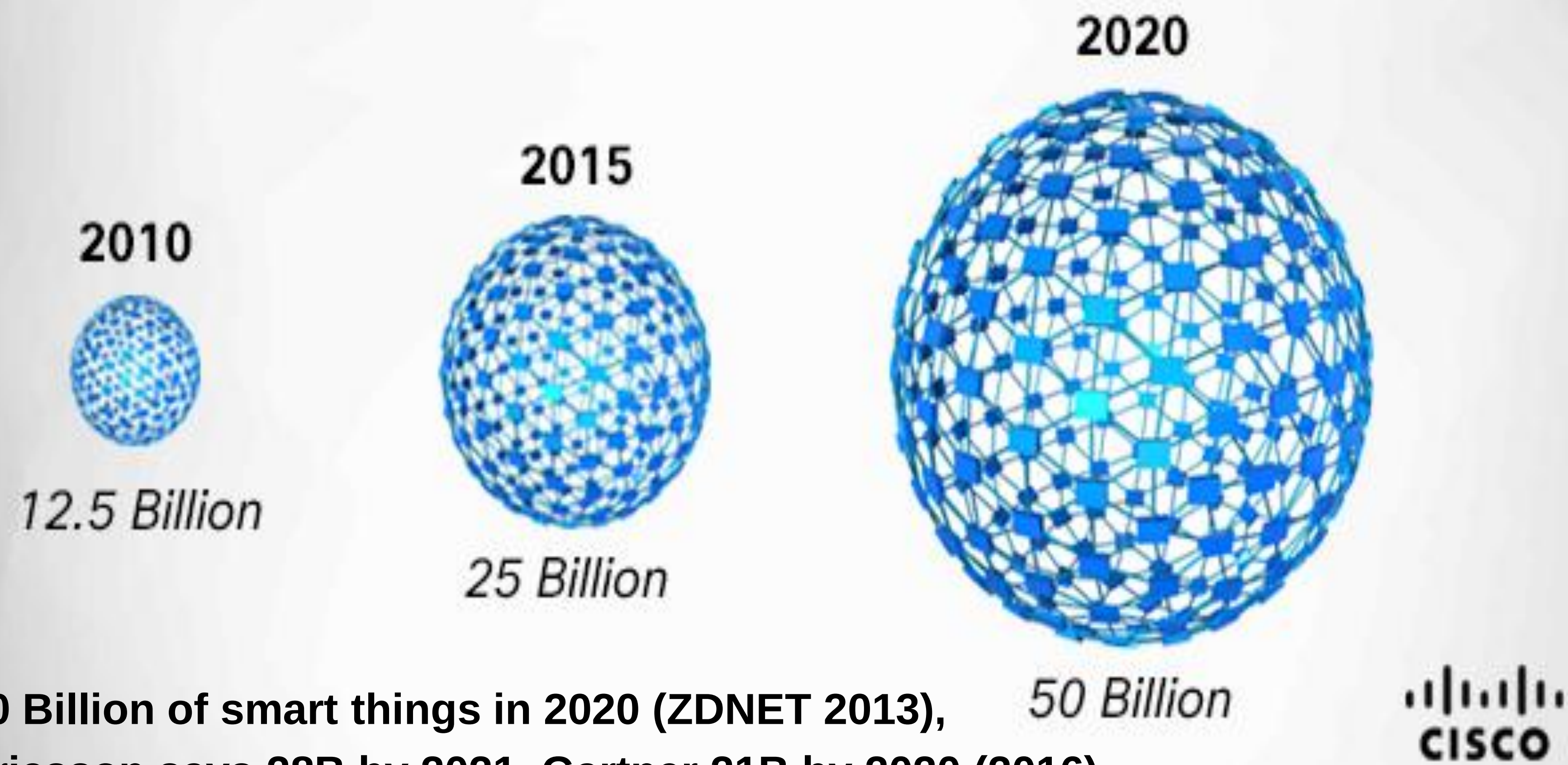
Cisco project in 2014
Wireless sensors +
Passive sensors



Flexible, hyper-local, real-time, sensor fusion, and big data analytics driving the next generation of Retail Value Chains

Market Opportunity

IT'S HUGE, BUT HOW IS IT CONNECTED?

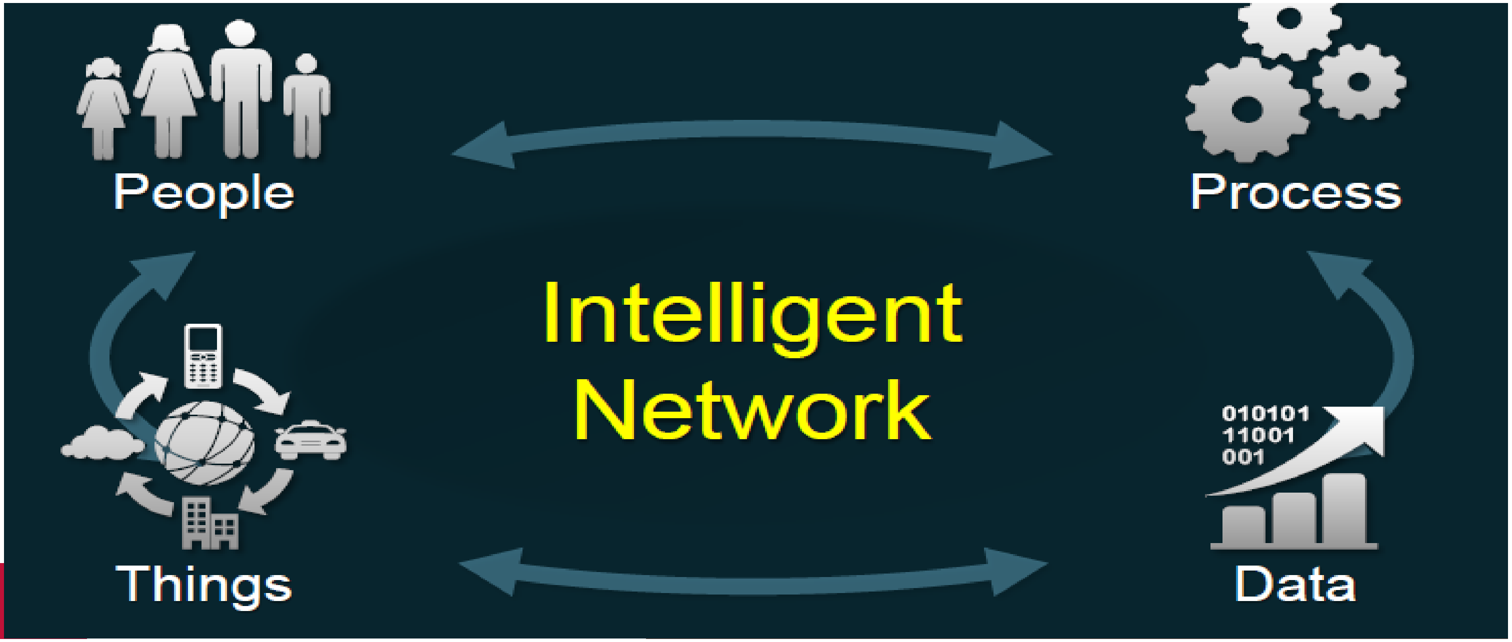


- **80 Billion of smart things in 2020 (ZDNET 2013),**
- **Ericsson says 28B by 2021, Gartner 21B by 2020 (2016)**

IPv4 has only 4.3 B addresses (over 32 bits; ex 192.168.0.1)!
IPv6 has 667M of B addresses (over 128 bits; ex fe95:b500:89c2:a100:0000:0800:200a:3ff7)

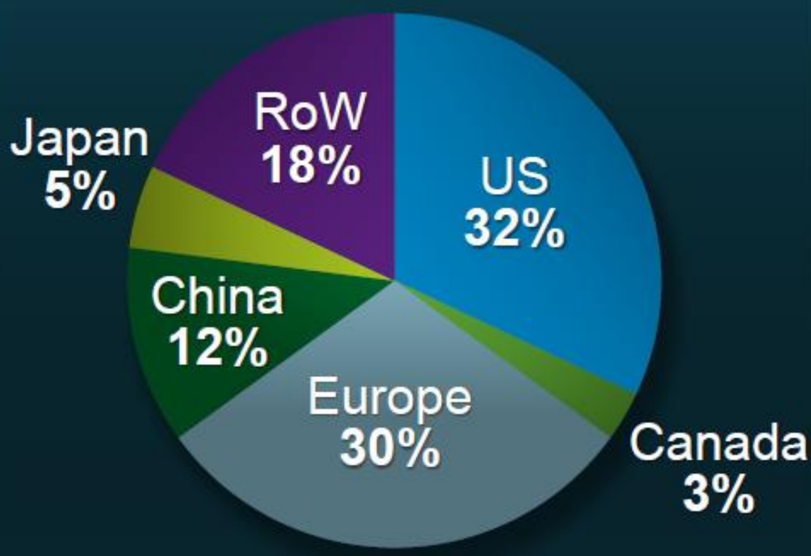
WHAT IS IOT?

- Kevin Ashton (MIT/AutoID Lab) first mentioned the Internet of Things in a presentation he made to Procter & Gamble in 1999.
- The Internet of Things (IoT) is a general purpose system of "smart things" (ubiquitous sensors and actuators) connected via the internet
- The internet of things brings together people, process, data, and « things » turning information into physical actions, and the other way around; creating new capabilities for individuals, businesses (commerce and industry), and eventually countries



Market Size (Cisco 2013)

Value at Stake ~ $14.4T

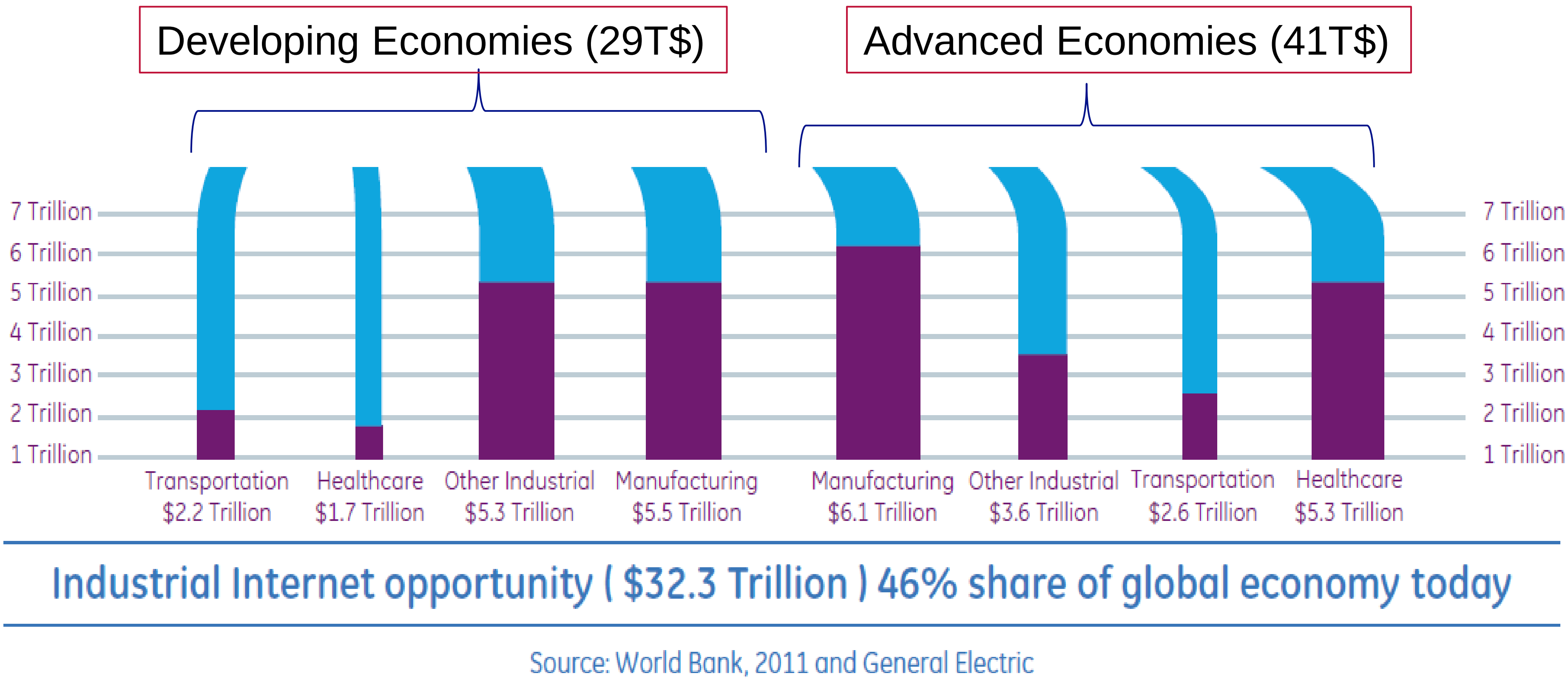


Source: Cisco IBSG, 2013

Initial Top 6 Contributing Verticals

Manufacturing	27%
Retail Trade	11%
Information	9%
Finance / Insurance	9%
Healthcare (private sector only)	7%
Education Service (private sector only)	6%

Market Size (GE)



Saving 1%

What if... Potential Performance Gains in Key Sectors

Industry	Segment	Type of Savings	Estimated Value Over 15 Years (Billion nominal US dollars)
Aviation	Commercial	1% Fuel Savings	$30B
Power	Gas-fired Generation	1% Fuel Savings	$66B
Healthcare	System-wide	1% Reduction in System Inefficiency	$63B
Rail	Freight	1% Reduction in System Inefficiency	$27B
Oil & Gas	Exploration & Development	1% Reduction in Capital Expenditures	$90B

Saving 30%

- A smartphone CPU consumes between 60 to 400mW
- There are about $7x10^9$ smartphones sold in the last 5 years, there will be $50x10^9$ ‘smart objects’ in 2020
- saving of 30% would provide grossly about 280 MW for the smartphones, about 3 GW for the smart objects
- A This would save between a tidal and a nuclear power station

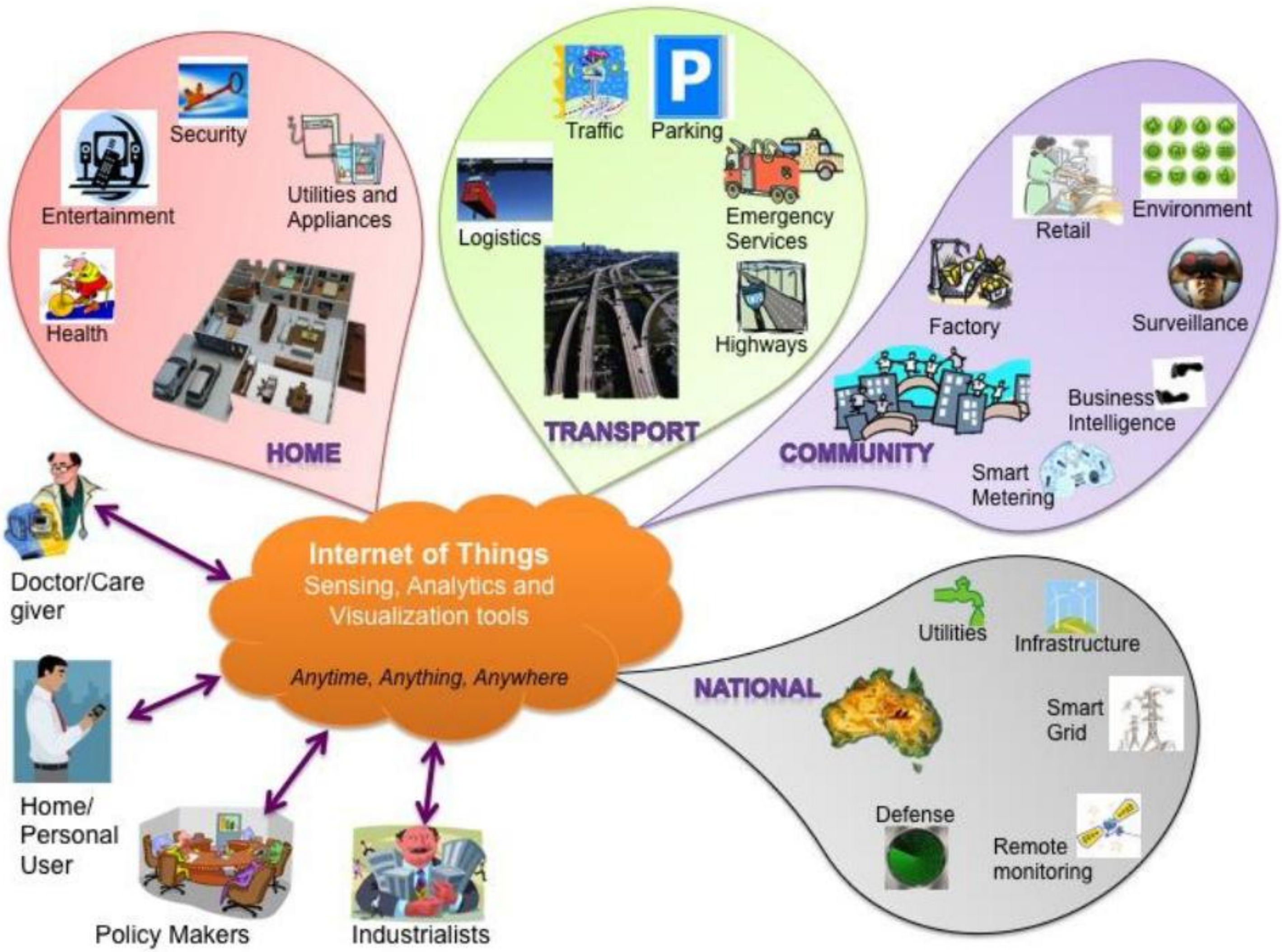
Marketing Research firms

- **IDC : a transformation is underway that will see the worldwide market for IoT solutions grow from $1.9 trillion in 2013 to $7.1 trillion in 2020.**
- **Gartner : "The Internet of Things will include 26 billion units installed by 2020. IoT product and service suppliers will generate incremental revenue exceeding $300 billion, mostly in services, in 2020. It will result in $1.9 trillion in global economic value-add through sales into diverse end markets.“**

- **Estimated growth rate between 15-20%**

First Reference Models
Value proposition

Vast multiple domains of applications

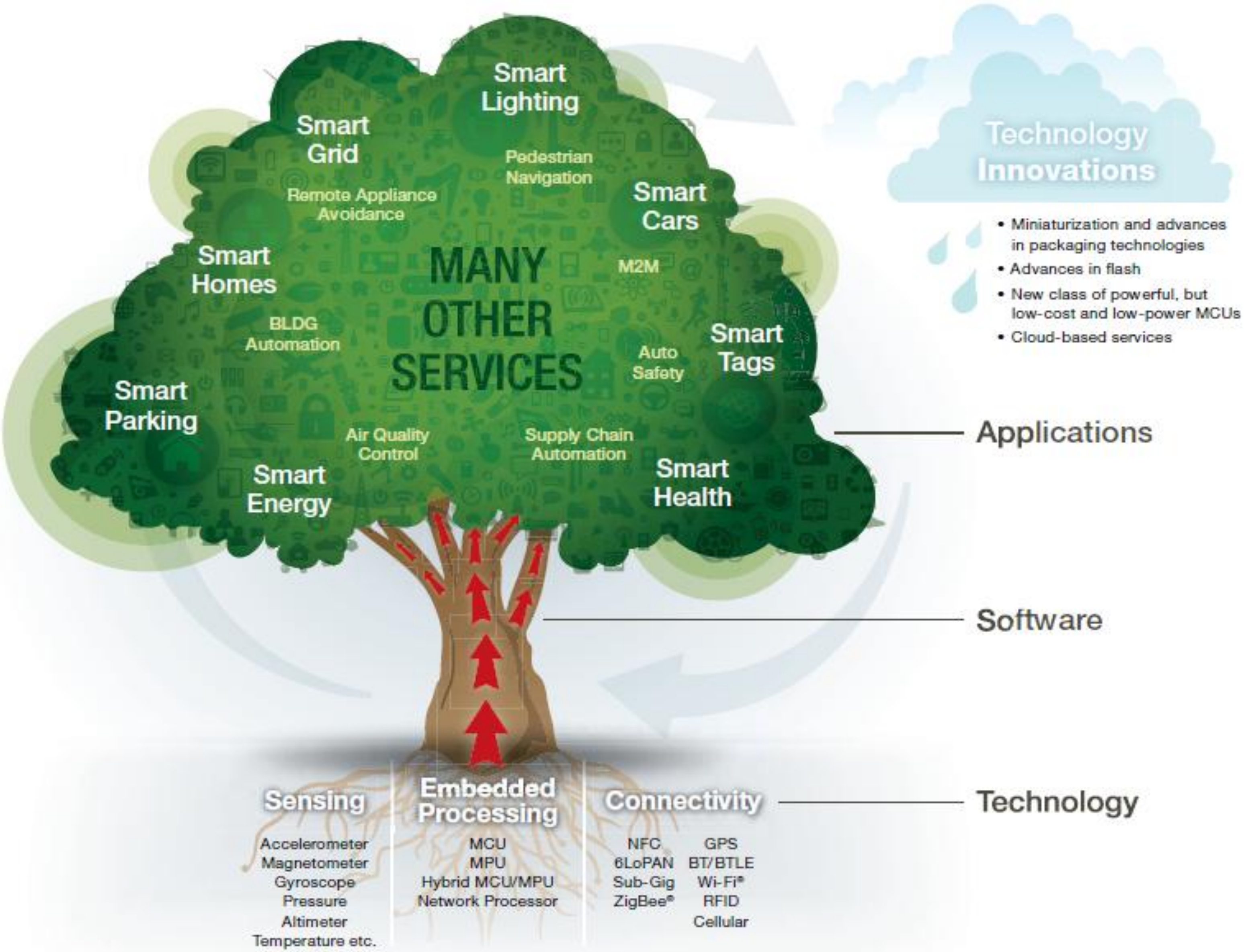


IOT-A, FP7

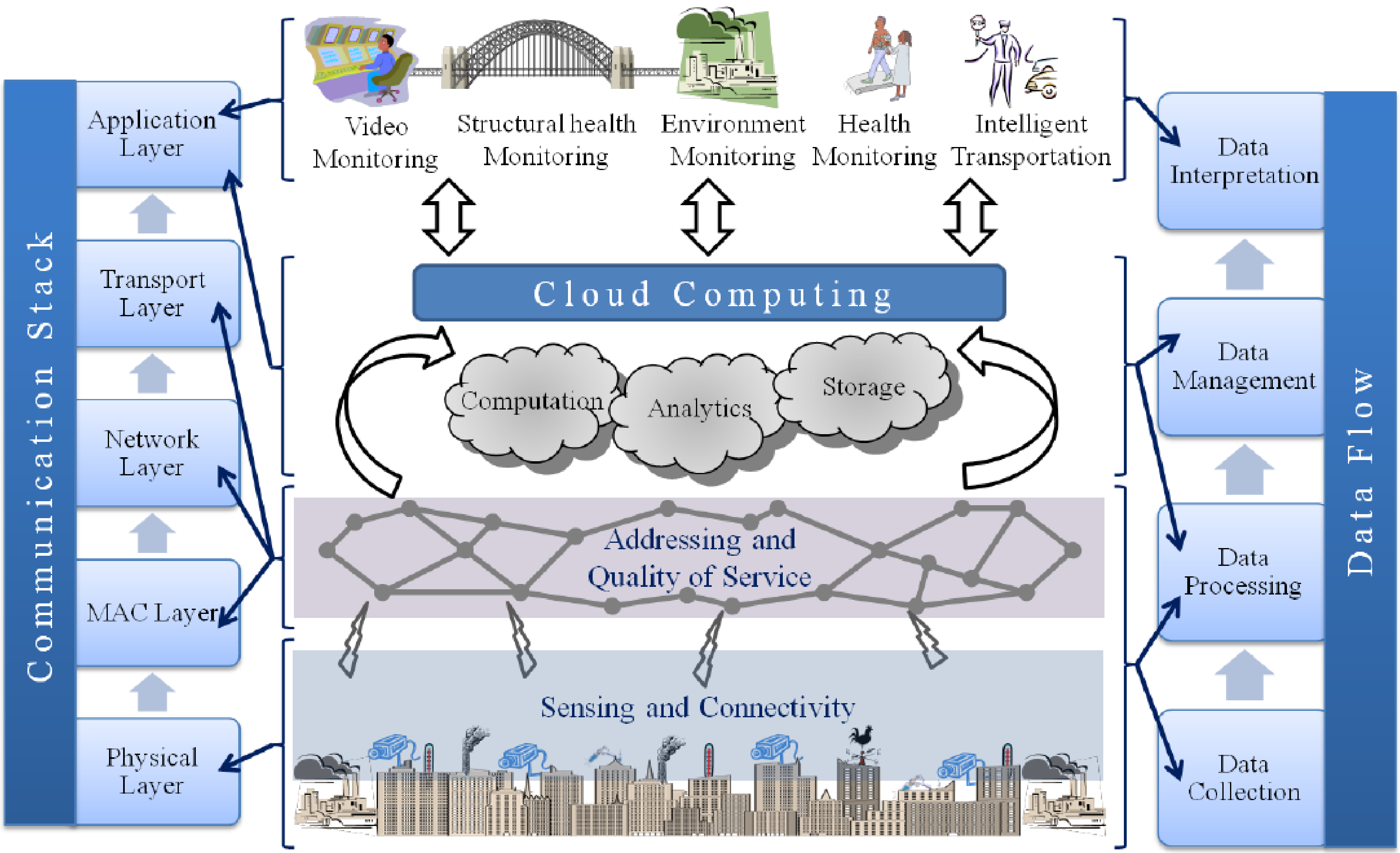
Alcatel Lucent (BE, FR),
CEA (FR), CFR (IT),
CSE (GR), FhG IML (DE),
Hitachi (UK), IBM (CH),
NEC (UK), NXP (DE, BE),
SAP (DE),
Siemens (DE),
Sapienza University of Rome (IT),
University of St. Gallen (CH),
University of Surrey (UK),
University of Würzburg (DE),
VDI/VDE-IT (DE), VTT (FI)

Freescale Reference Model

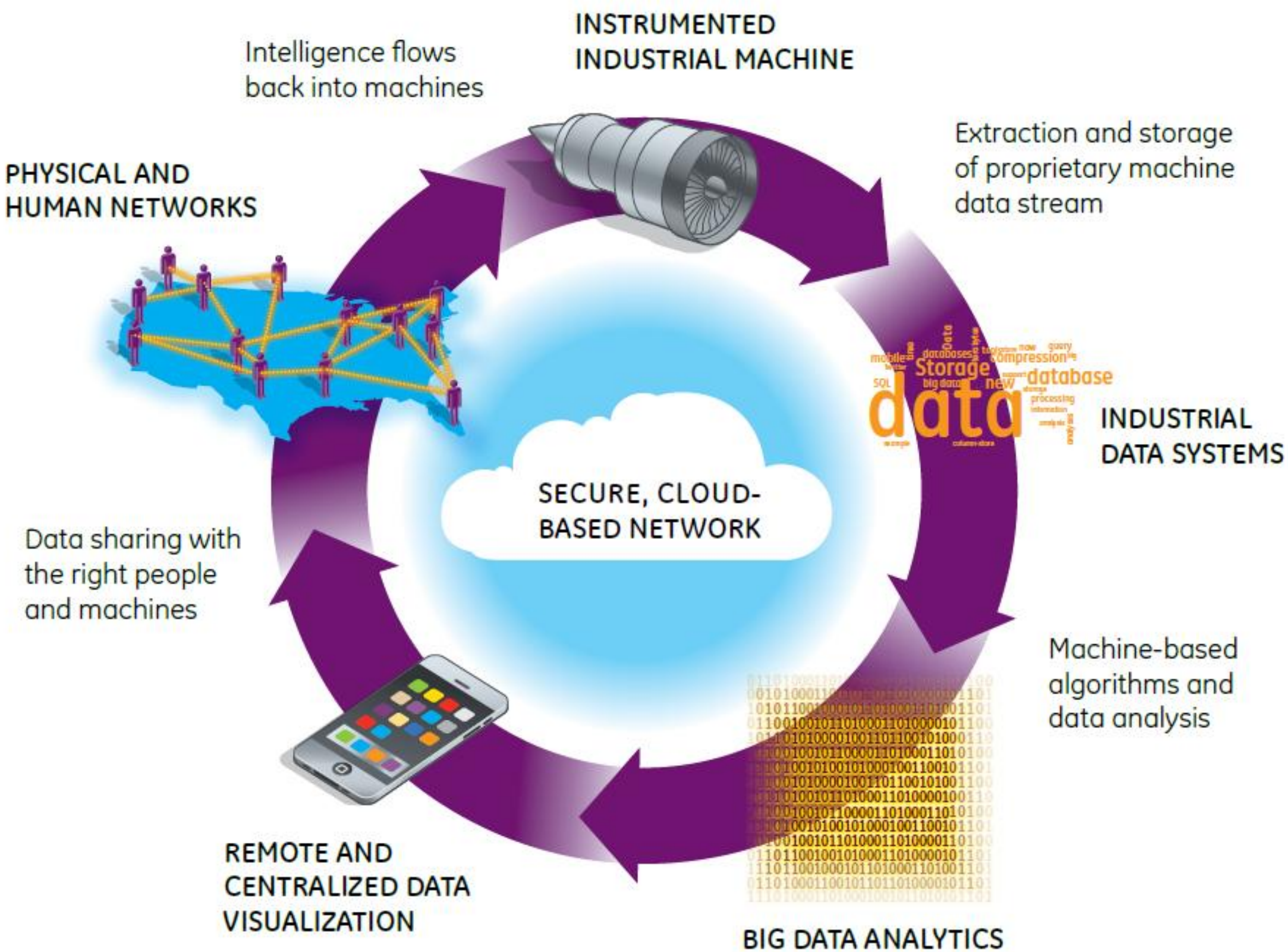
The IoT: Different Services, Technologies, Meanings for Everyone



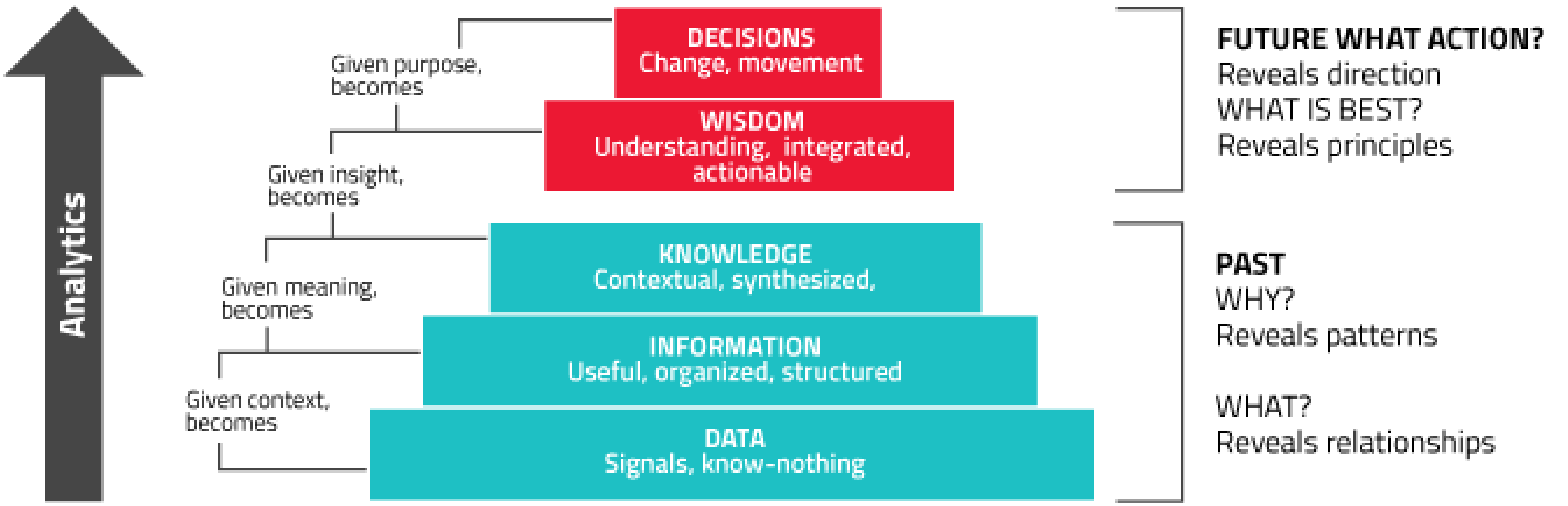
A cloud centric model



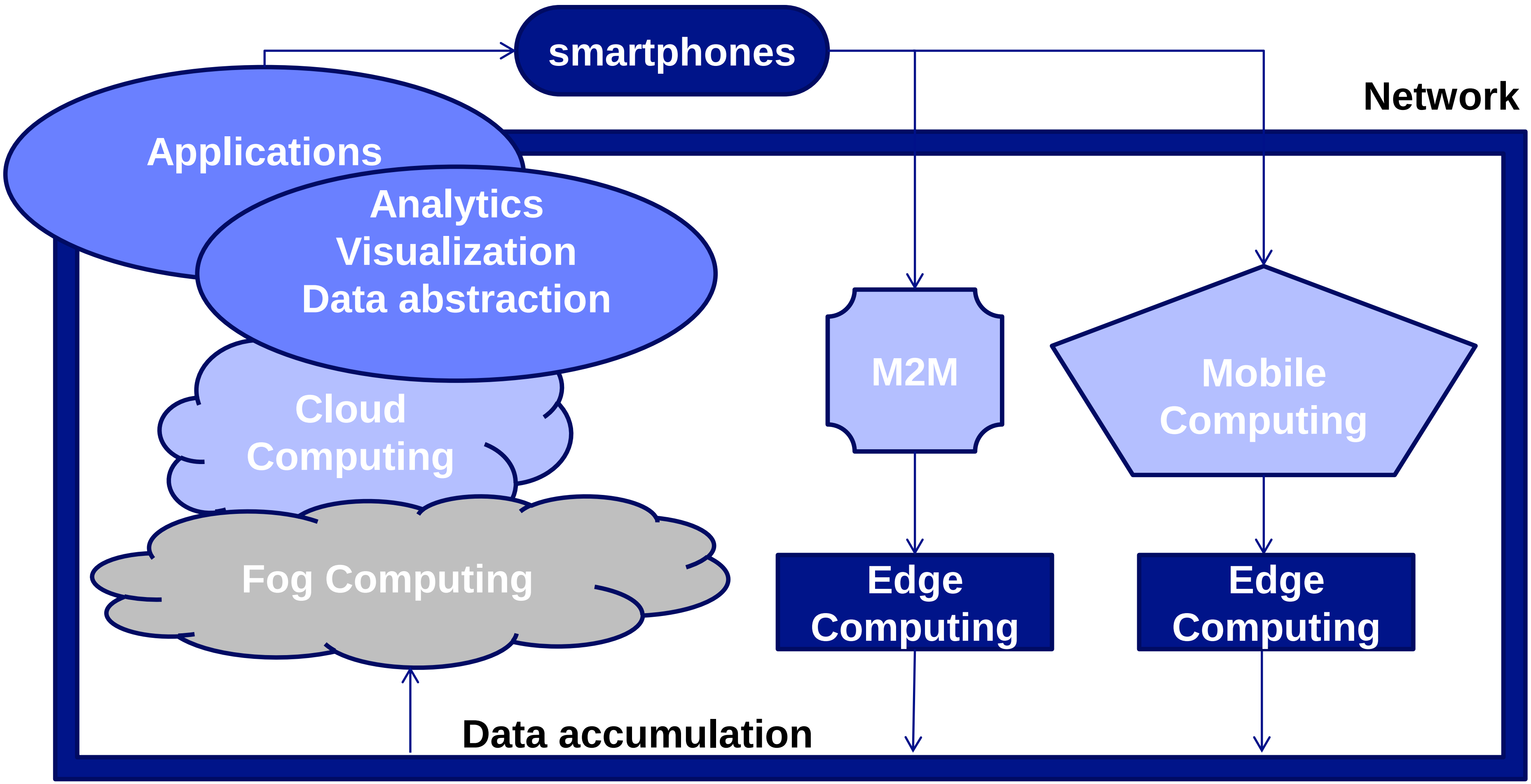
GE vision of the integration IoT + Big Data



From raw data to decision making (AGT)



IoT and Big Data



Mobile machines are *truely* sensor platforms

32 Sensors

120 Sensors

40 Sensors

Rio Tinto has ~900 HME trucks

Useful data produced by trucks

~4.9 Tb/day (fleet)*

Significant value to leverage

Stitching it all together

Vehicles are components in the wider complex mine landscape. Rio Tinto believes we have to integrate many mining systems to capture most value

Western Australia, the world's first and largest integrated Iron Ore operations centre

Collaboration

Skills leverage

Productivity

Value add

Exploit Big Data

Distance irrelevant

Human systems

Advanced models

Intelligent analytics

Network partners

Integrated global multi commodity Processing Excellence Centre

RioTinto

Mine of the Future™

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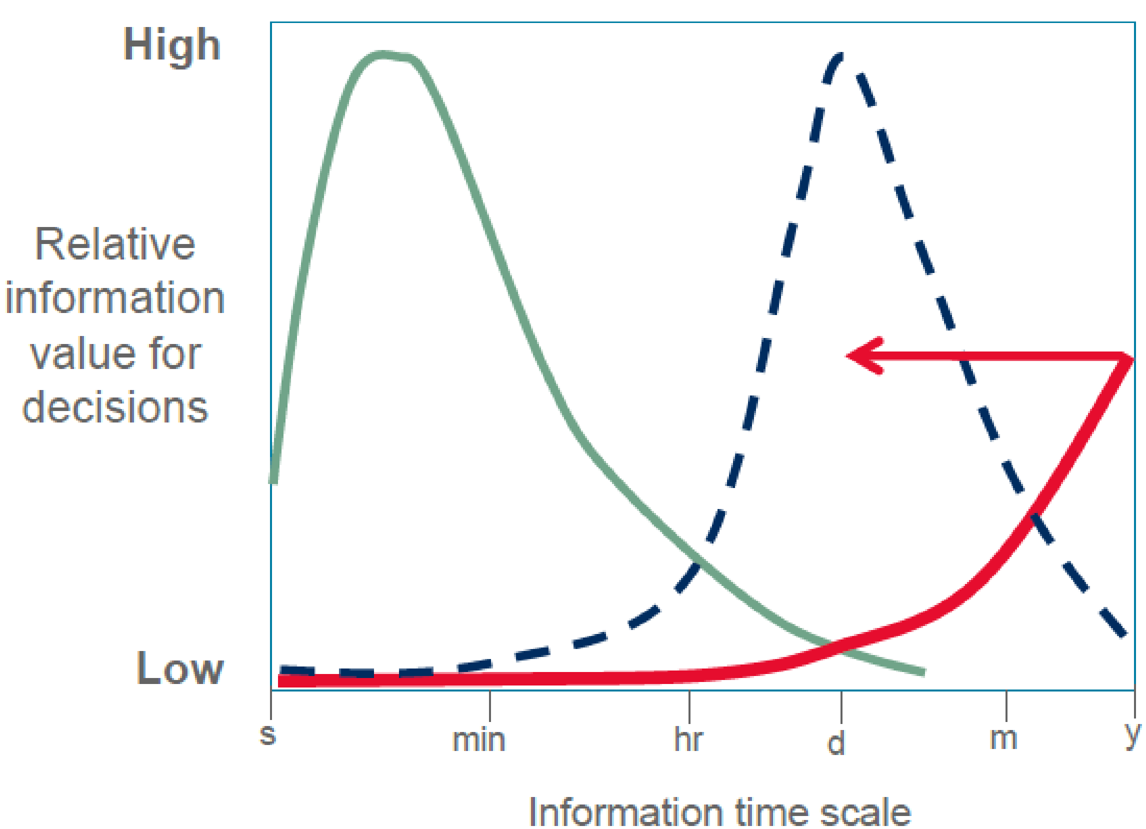
Accelerating information flow



The information required to make the “correct” decision has a significant time driven value component

Cisco-Intel-IBM reference model

Basic Premises

Devices

send and receive data interacting with the

Network

where the data is transmitted, normalized, and filtered using

Edge Computing

before landing in

Data storage / Databases

accessible by

Applications

which process it and provide it to people who will

Act and Collaborate

Standards based approaches are required to enable the IoT industry

IoT World Forum Reference Model

Levels

7 Collaboration & Processes
(Involving People & Business Processes)

6 Application
(Reporting, Analytics, Control)

5 Data Abstraction
(Aggregation & Access)

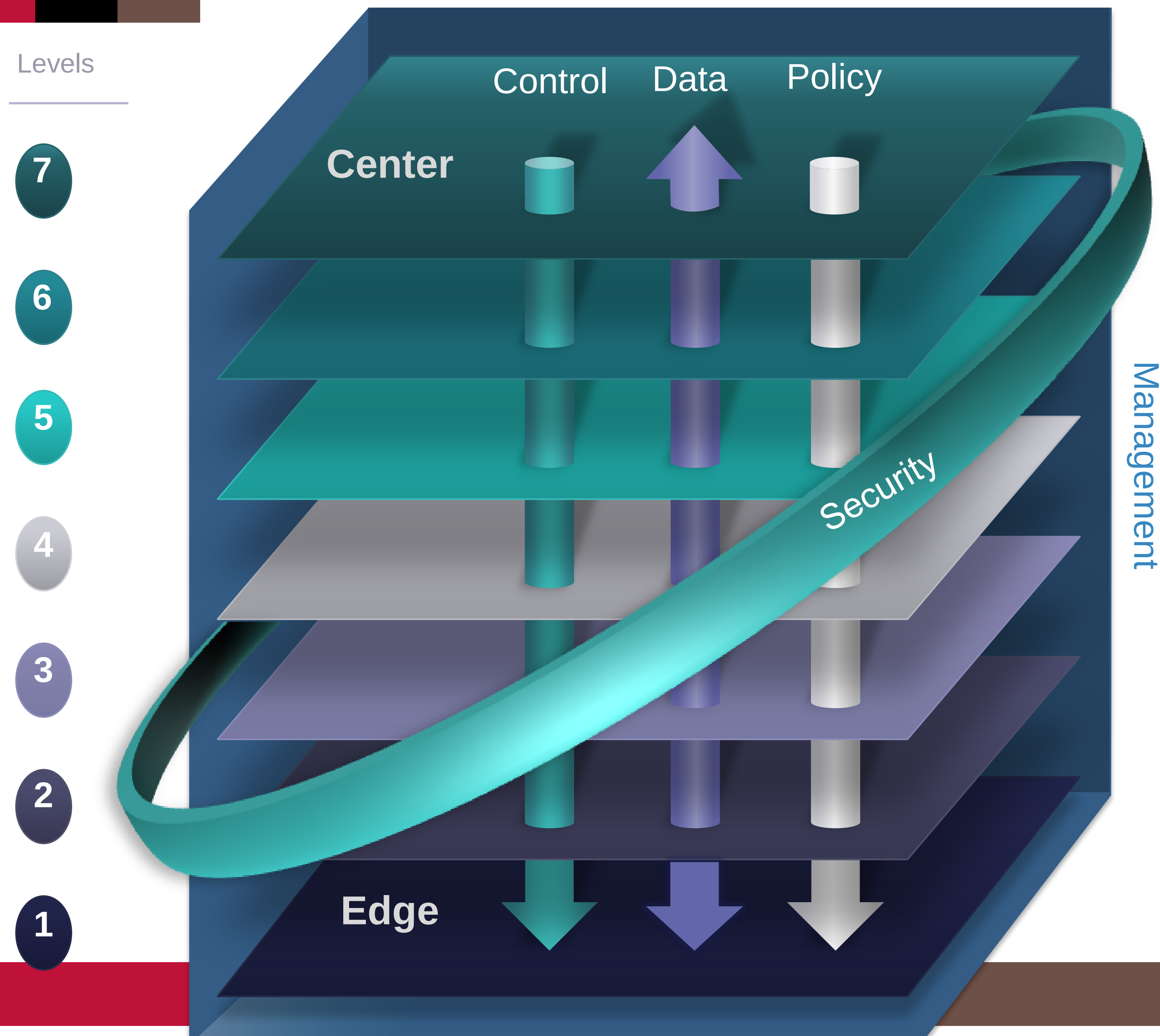
4 Data Accumulation
(Storage)

3 Edge Computing
(Data Element Analysis & Transformation)

2 Connectivity
(Communication & Processing Units)

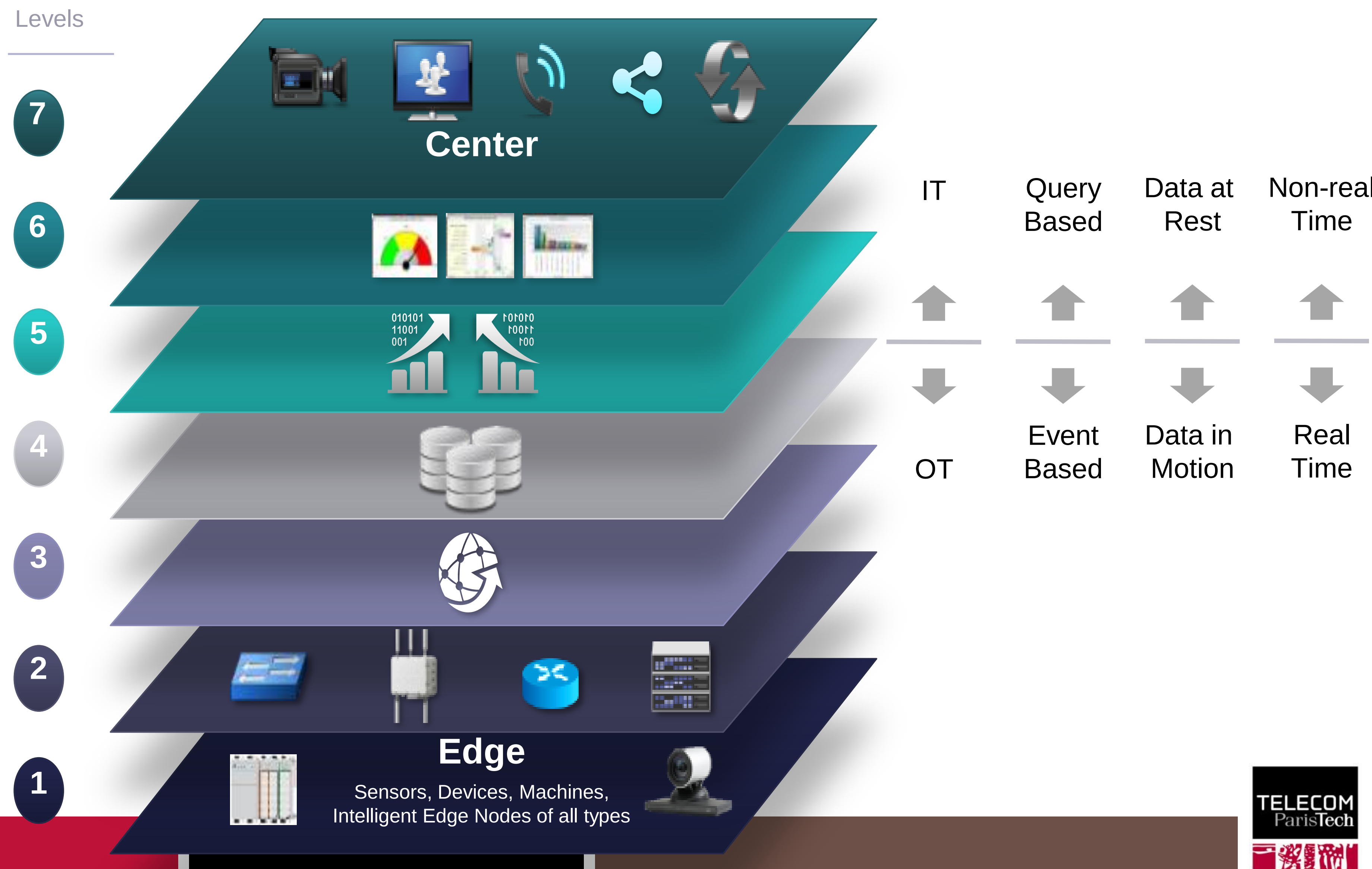
1 Physical Devices & Controllers
(The “Things” in IoT)

Internet of Things Reference Model

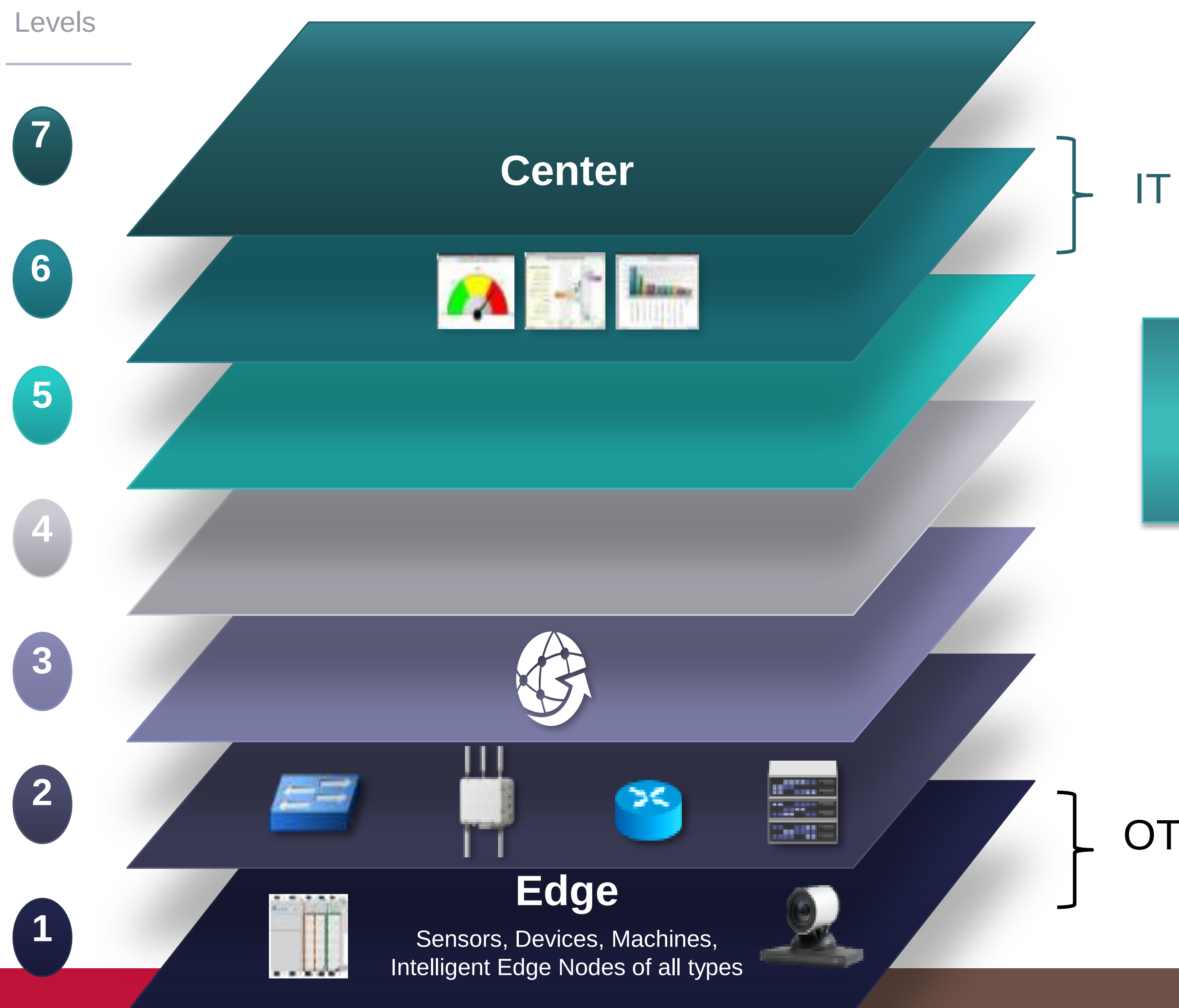


The model is based on **"Information Flow"**

Internet of Things Reference Model Objectives



Bridging IT and OT



Key Point:

IT – OT

Bridging IT and OT: Introducing IoT “Edgeware”

Device Control
- Configure (from the device provider)
- Status (from the device provider)

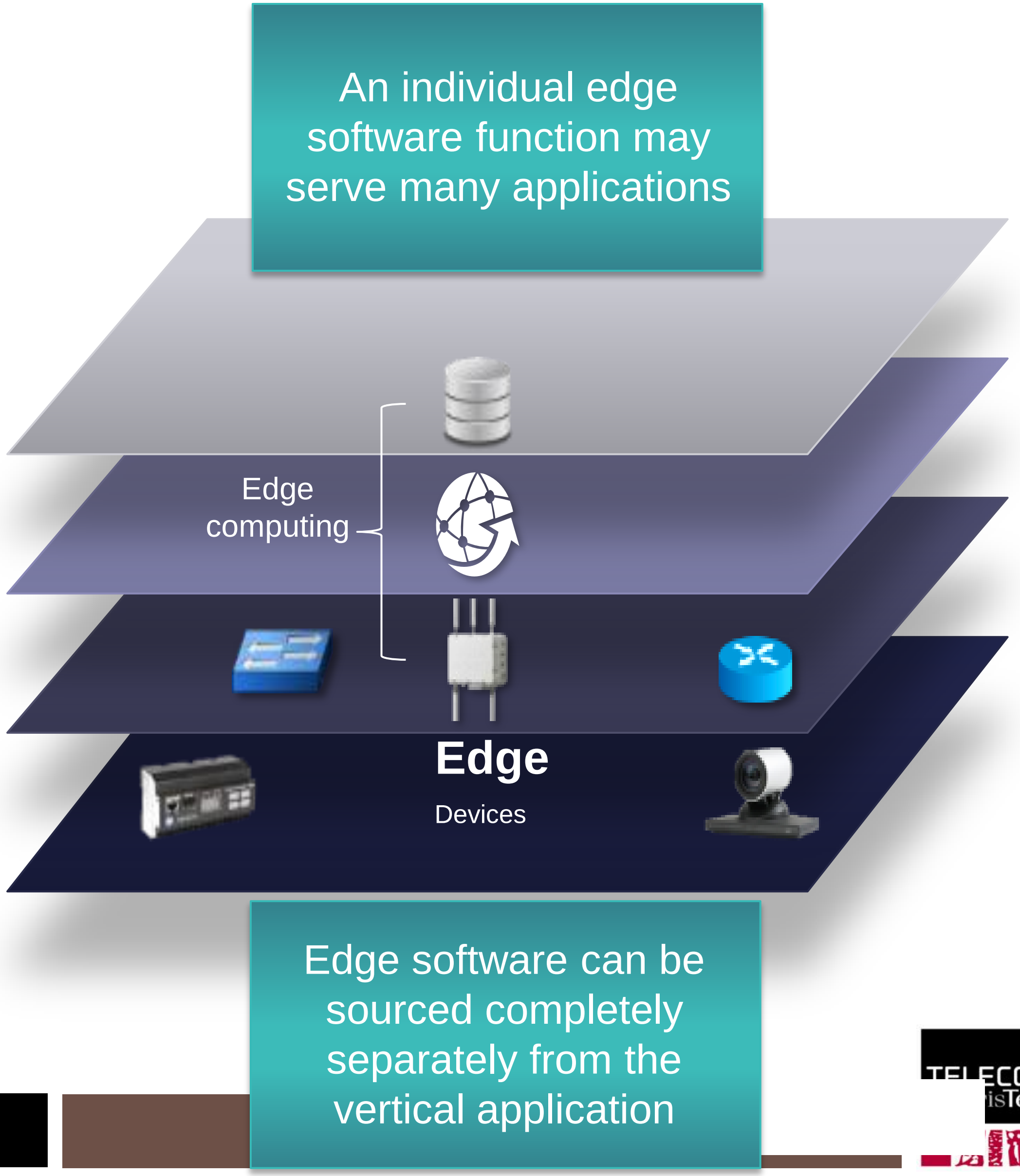
Device Interactions
- Discovery
- Addressing
- Protocol conversion

Middleware
- Listeners (Zigbee), brokers (MQTT)
- Event grouping / batch interactions

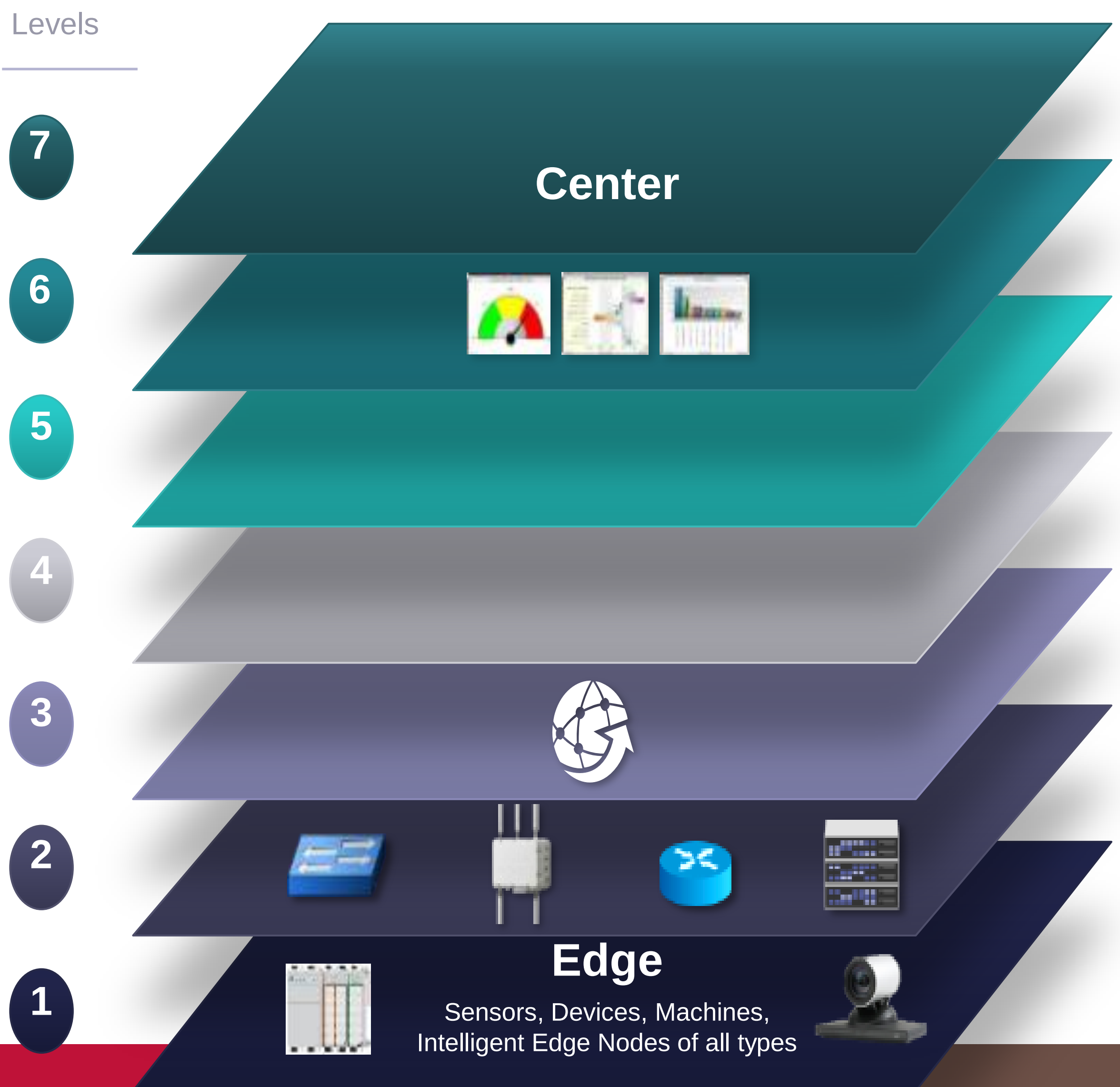
Data
- Normalize (standardize codes for the app)
- Filter (against pre-set criteria from the app)
- Expand (decode/expand cryptic codes)
- Aggregate (generate statistics)
- Notify/alert (to the app)

Combine the functions above
- Schedule (when to comm with the device)
- BPM (when multiple steps are needed)

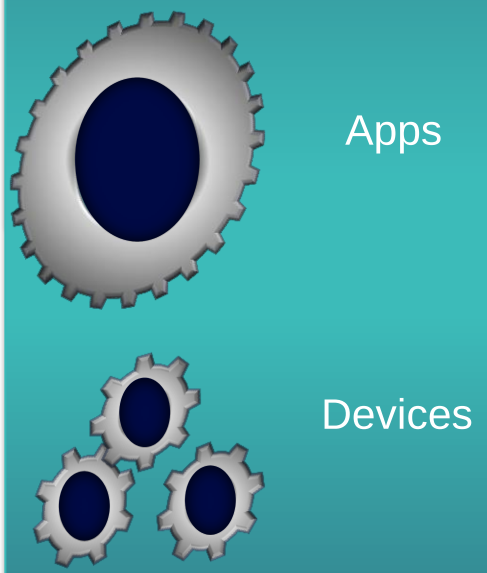
Security
- Roles
- Privileges



Bridging IT and OT: Handling the Volume of Data



Issue: Devices may generate data faster than apps can ingest it



Interoperability: Enable Edgeware and Applications from Different Vendors

Key Points:
- IT – OT
- Decoupling
  - Scalability
  - Agility
- Interoperability

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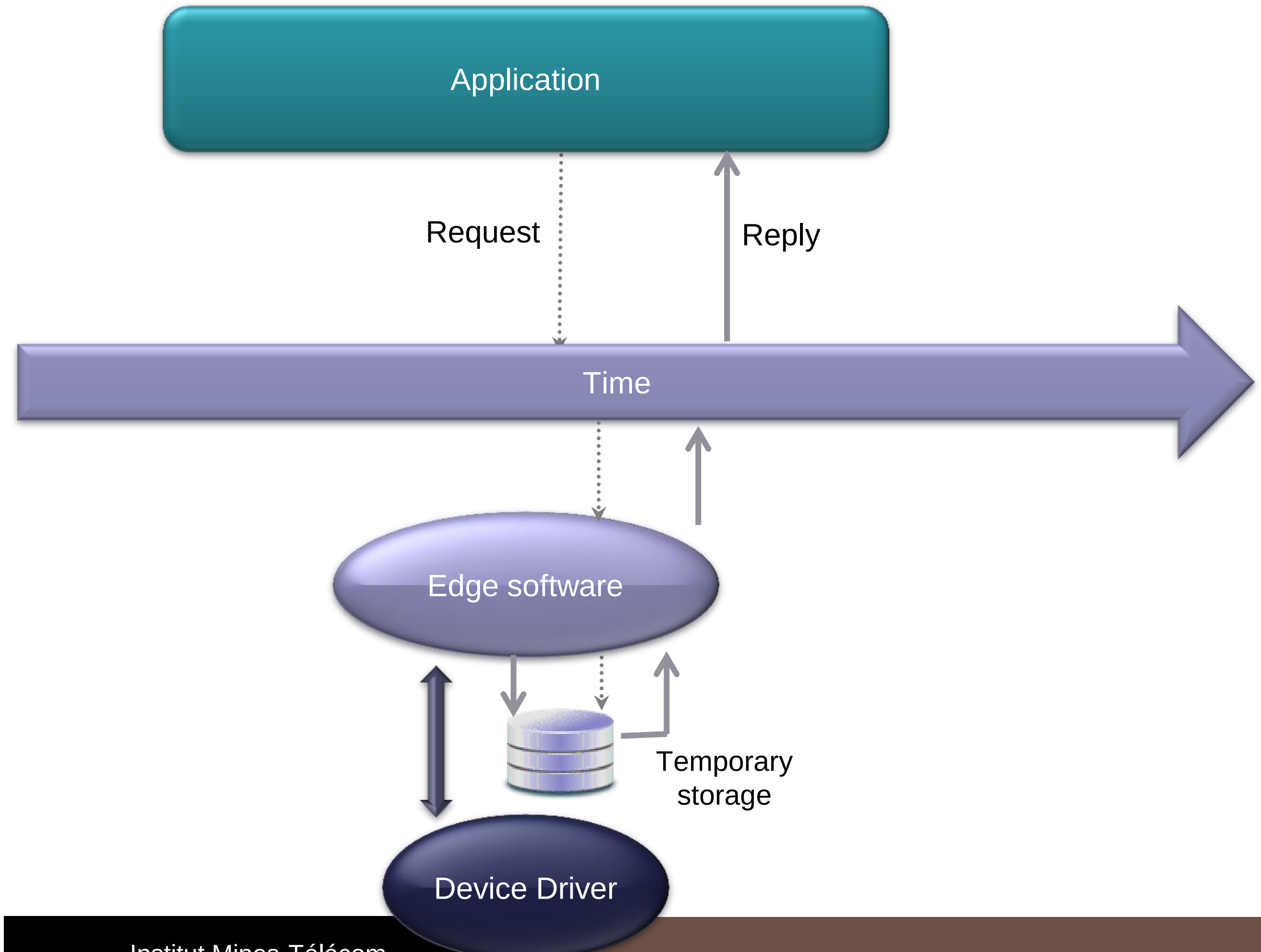
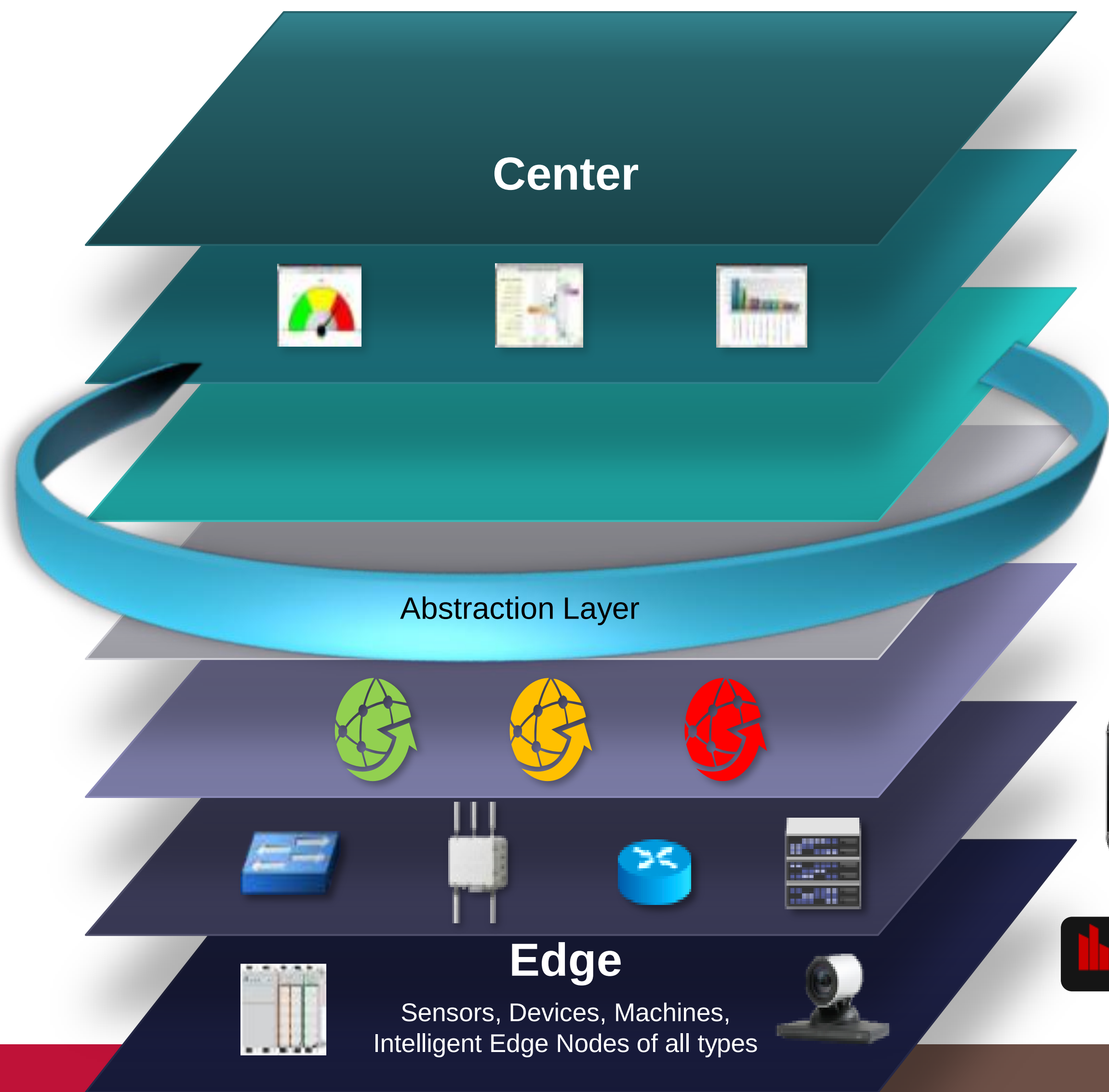
The "Cache and Batch" Sequence Pattern (decouple the application from the data capture)



Interoperability: The Next Step is Defining Interfaces, Prototyping, and Testing



CISCO
intel
IBM
PLAT·ONE
synapse
LOGIK
machineshop
The Internet of Service
OMNI TROL NETWORKS
IOT TECHNOLOGY SOLUTIONS
Ayla
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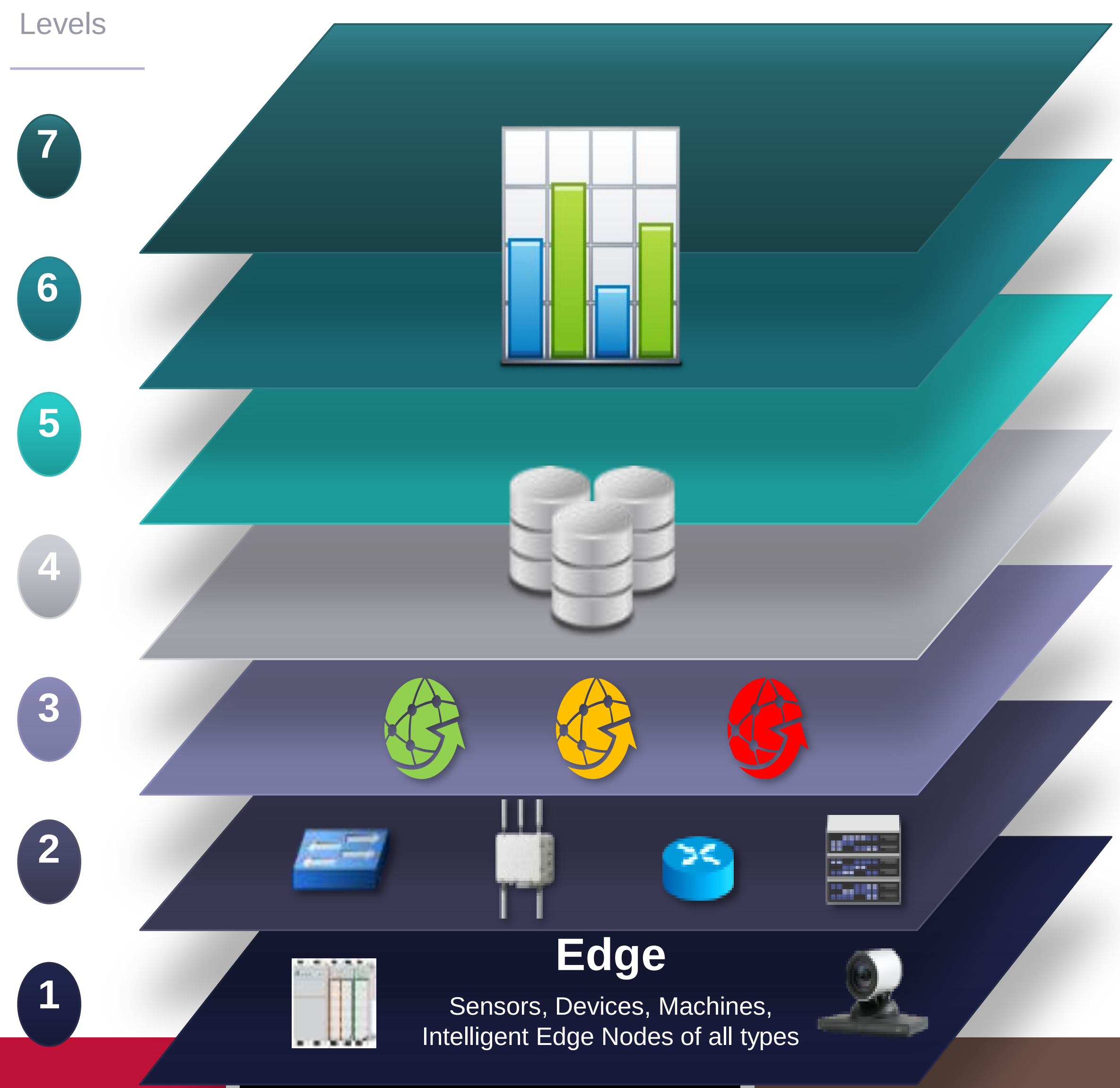
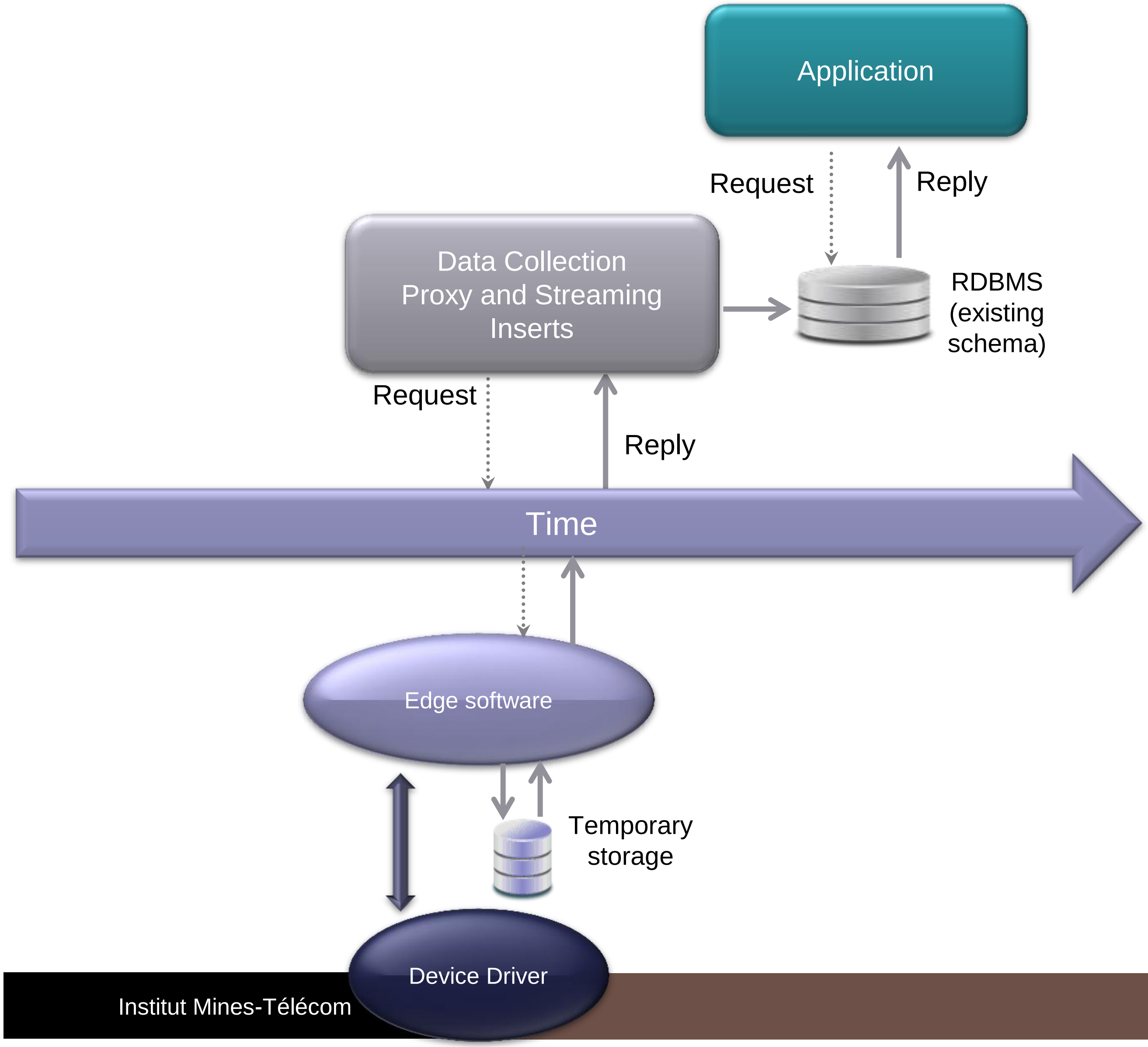
Embracing Legacy Applications



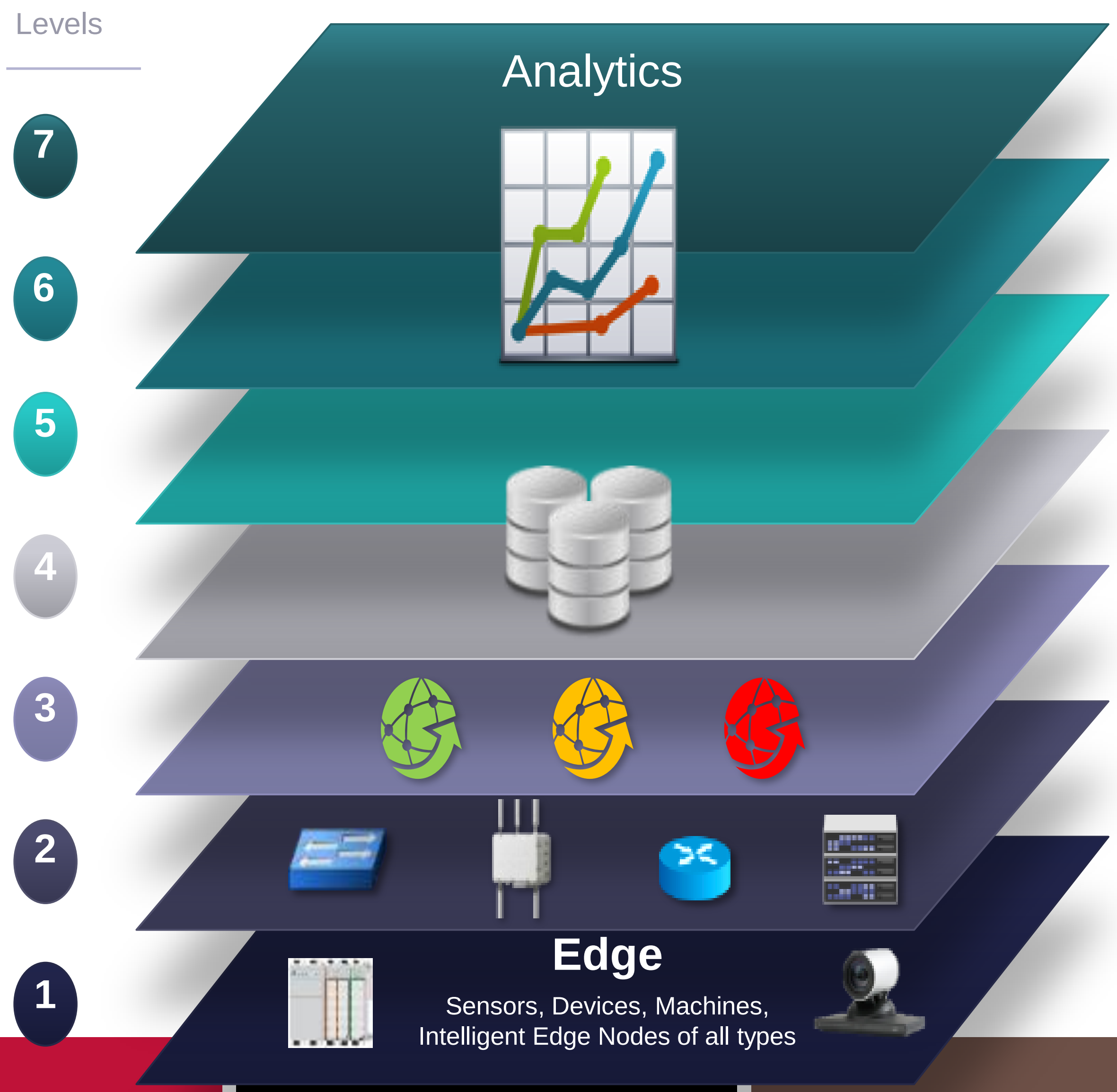
Key Point:

- IoT Enablement of Legacy Applications

The Legacy Application Compatibility Sequence Pattern (use the existing DB and schema)



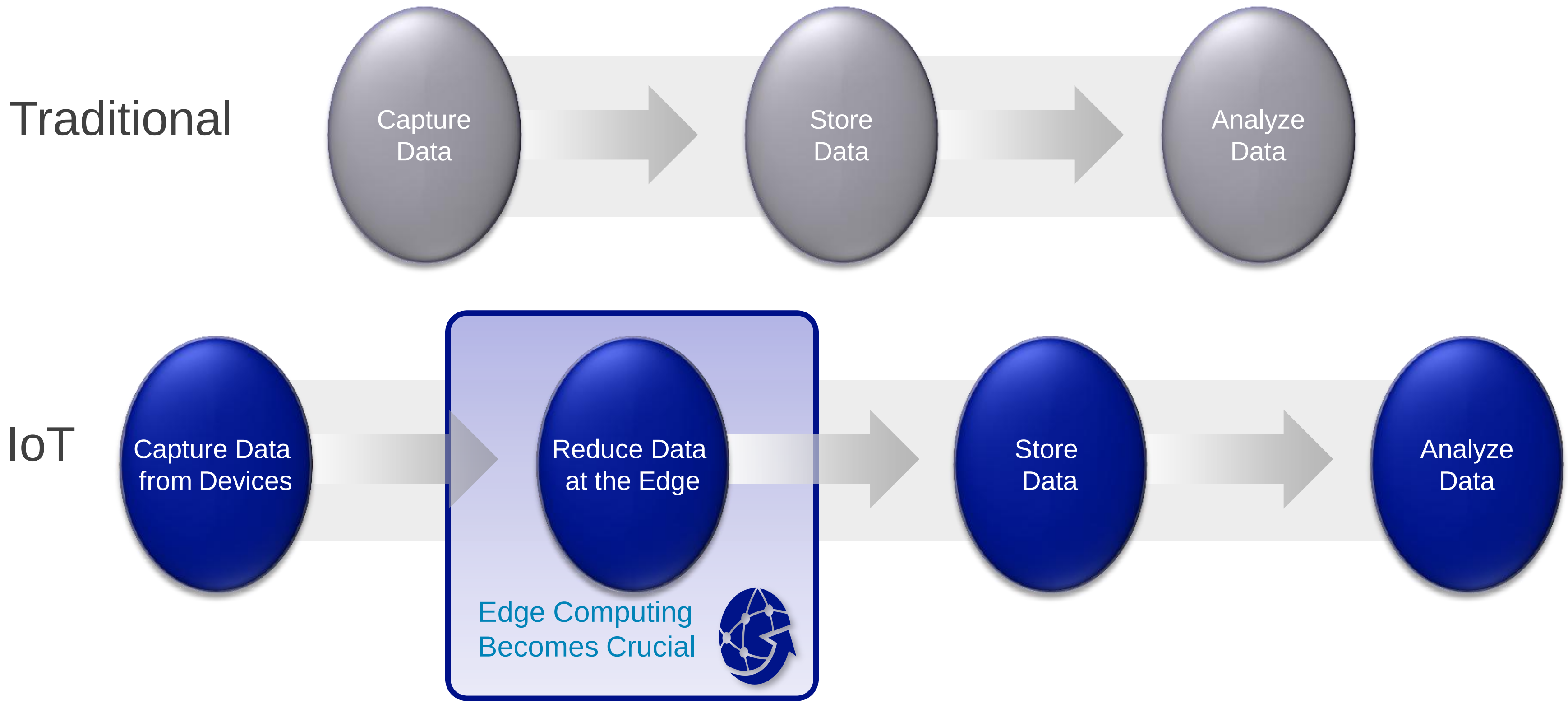
The Internet of Things and Analytics



Key Point:

- Enabling IoT Analytics

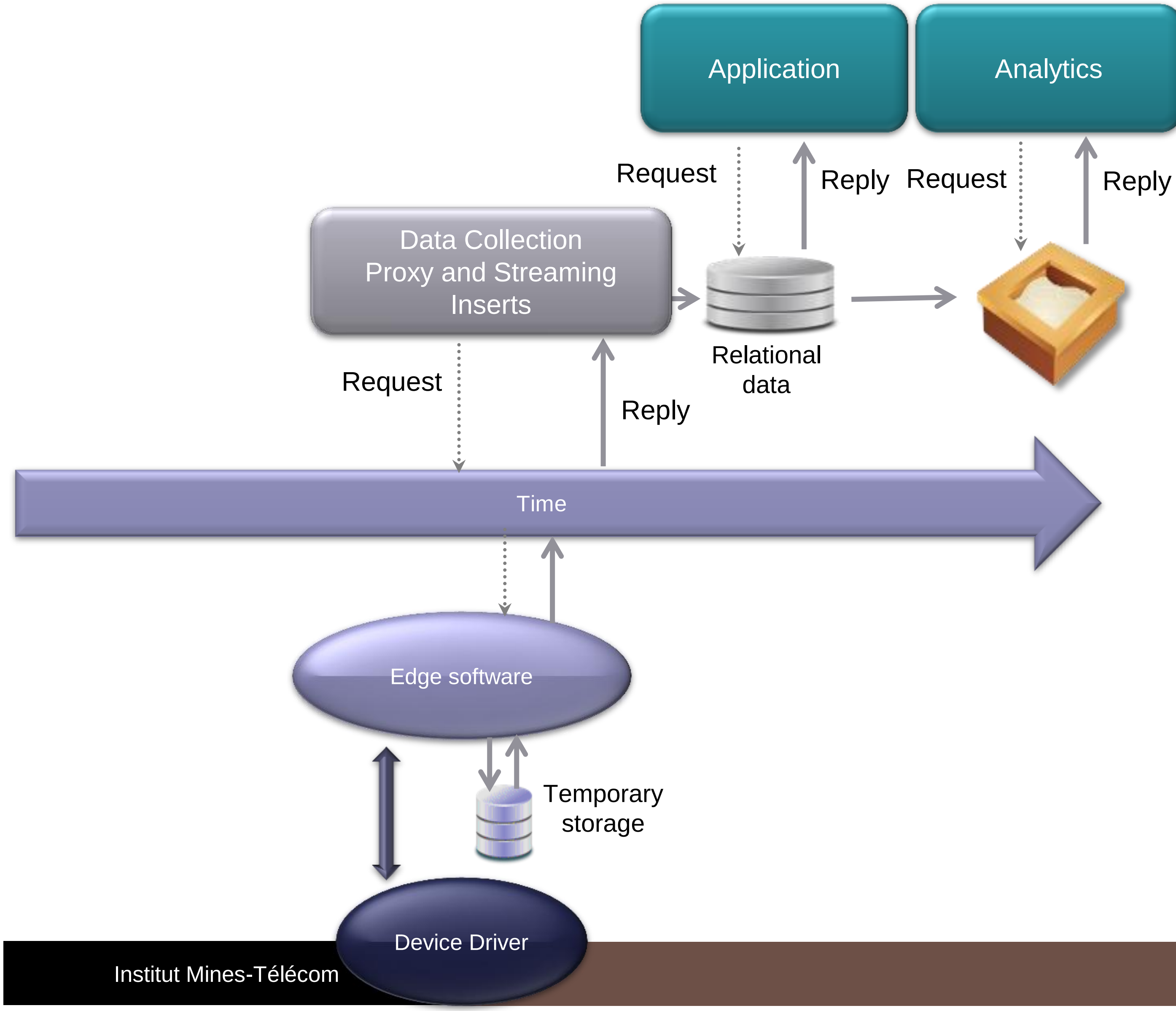
IoT Analytics Introduces New Complexities to Analytics



Key Issues:

- The velocity and volume of data may be huge
- In some cases, most of the data is unimportant

Sampling and Analytics Sequence Pattern

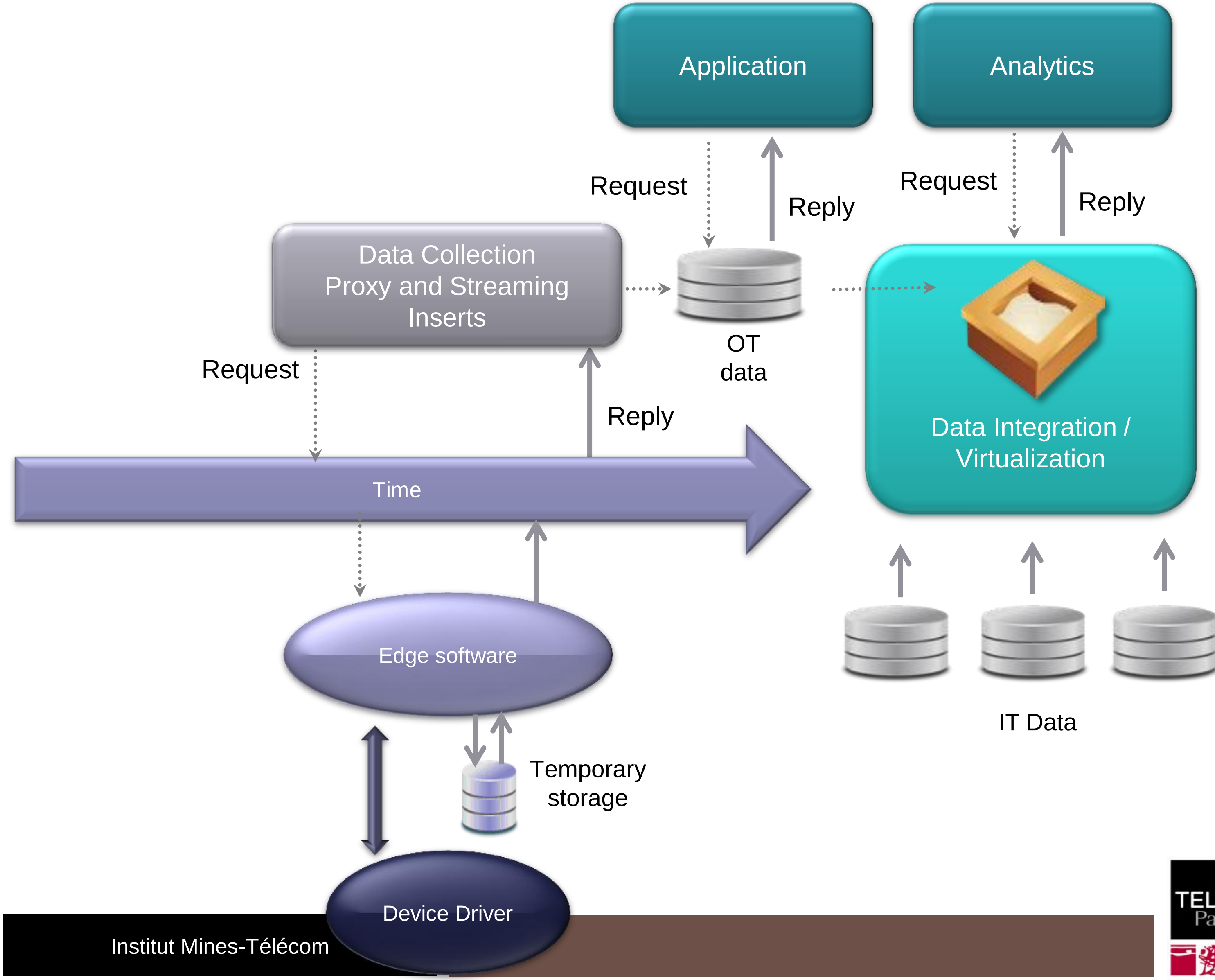


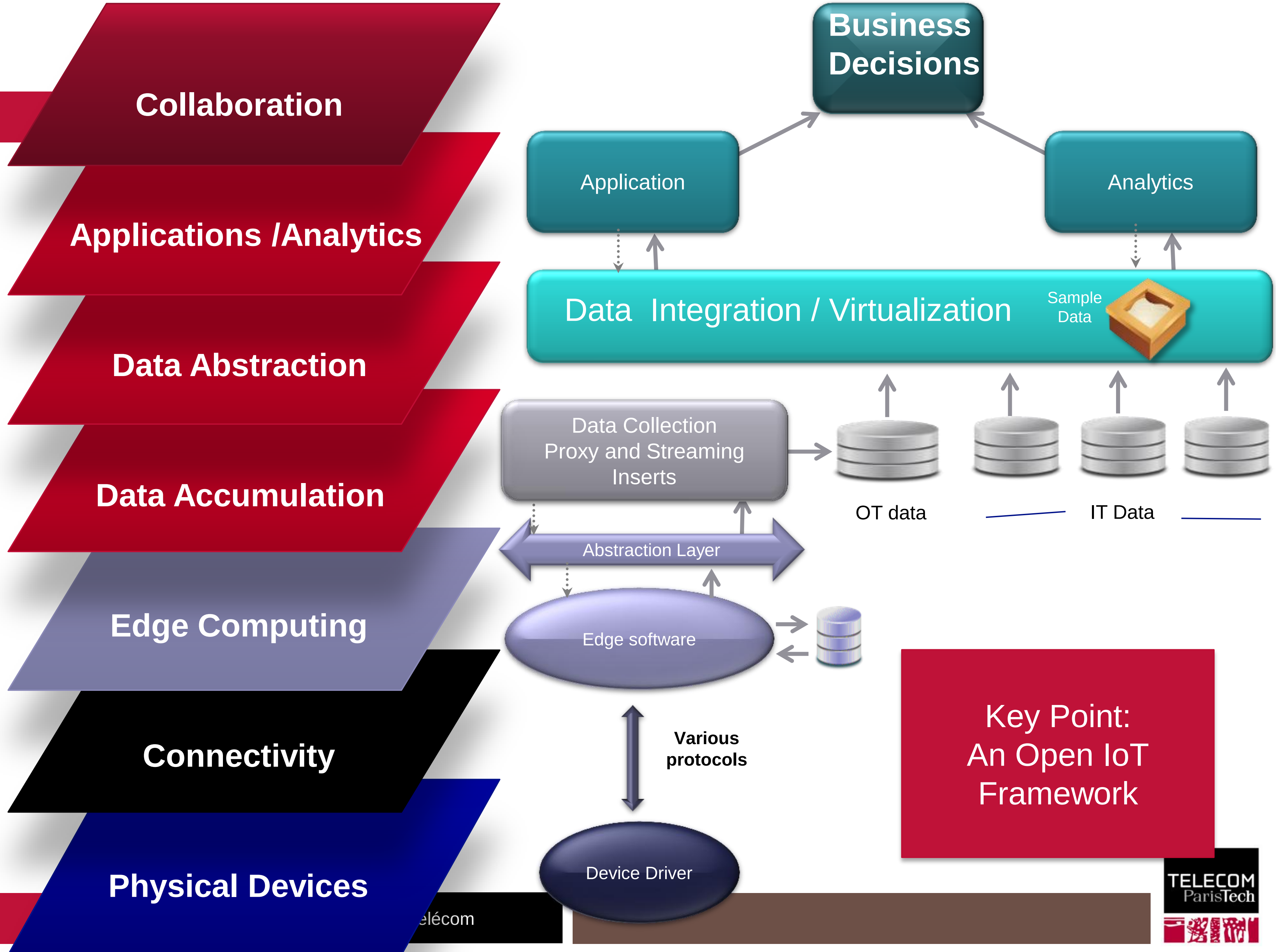
Analytics Using Both OT and IT Data

Key Point:

- Integration with the Enterprise

Analytics on Mixed OT and IT Data Sequence Pattern




Collaboration
Applications /Analytics
Data Abstraction
Data Accumulation
Edge Computing
Connectivity
Physical Devices
Business Decisions
Application
Analytics
Data Integration / Virtualization
Sample Data
Data Collection Proxy and Streaming Inserts
OT data
IT Data
Abstraction Layer
Edge software
Various protocols
Device Driver
Key Point:
An Open IoT Framework
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The Complete IoT System

Key Points:

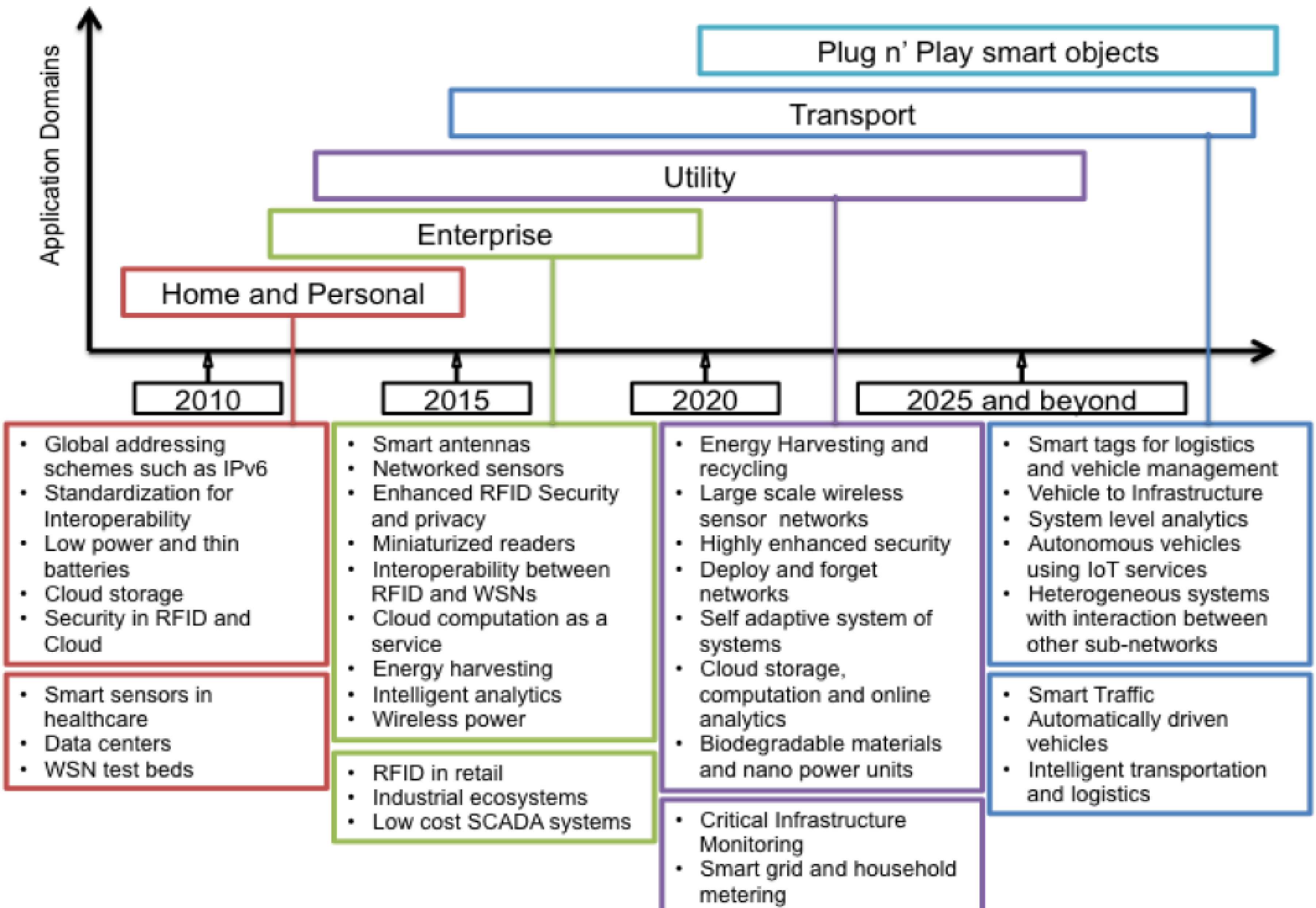
- IT – OT
- Decoupling
  - Scalability
  - Agility
- Interoperability
- Legacy Compatibility
- Analytics
- Integrated with the Enterprise

Technical Challenges

IoTWF Challenges

Challenges	Trends	Companies
'Quadruple trust' :security, privacy, protection, safety	TLS, Authentication,	All, IEEE
Interoperability, heterogeneity Updates & Legacy	Composition Openness	IBM Freescale
Scalability IT, OT, CT convergence	True distibution, Edge/Fog Computing, RT analytics	Cisco AGT, Schneider
Sensor/actuator	Improvement, cost effectiveness, energy saving	Schneider Rockwell
Mobility	Use of tablet or smartphone as control devices	Shell
Ease of use, QoE, Acceptance	**Smartphone as a remote control** **'Small steps', 'be intiutive'**	**VMWare**
BM IoT is transformational	**Global**	**Schneider**

Roadmap



Application Domains
Plug n' Play smart objects
Transport
Utility
Enterprise
Home and Personal
2010
2015
2020
2025 and beyond
• Global addressing schemes such as IPv6
• Standardization for Interoperability
• Low power and thin batteries
• Cloud storage
• Security in RFID and Cloud
• Smart sensors in healthcare
• Data centers
• WSN test beds
• Smart antennas
• Networked sensors
• Enhanced RFID Security and privacy
• Miniaturized readers
• Interoperability between RFID and WSNs
• Cloud computation as a service
• Energy harvesting
• Intelligent analytics
• Wireless power
• RFID in retail
• Industrial ecosystems
• Low cost SCADA systems
• Energy Harvesting and recycling
• Large scale wireless sensor networks
• Highly enhanced security
• Deploy and forget networks
• Self adaptive system of systems
• Cloud storage, computation and online analytics
• Biodegradable materials and nano power units
• Critical Infrastructure Monitoring
• Smart grid and household metering
• Smart tags for logistics and vehicle management
• Vehicle to Infrastructure
• System level analytics
• Autonomous vehicles using IoT services
• Heterogeneous systems with interaction between other sub-networks
• Smart Traffic
• Automatically driven vehicles
• Intelligent transportation and logistics

	Smart Home/Office	Smart Retail	Smart City	Smart Agriculture/Forest	Smart Water	Smart transportation
Network Size	Small	Small	Medium	Medium/Large	Large	Large
Users	Very few, family members	Few, community level	Many, policy makers, general public	Few, landowners, policy makers	Few, government	Large, general public
Energy	Rechargeable battery	Rechargeable battery	Rechargeable battery, Energy harvesting	Energy harvesting	Energy harvesting	Rechargeable battery, Energy harvesting
Internet connectivity	Wifi, 3G, 4G LTE backbone	Wifi, 3G, 4G LTE backbone	Wifi, 3G, 4G LTE backbone	Wifi, Satellite communication	Satellite Communication, Microwave links	Wifi, Satellite Communication
Data management	Local server	Local server	Shared server	Local server, Shared server	Shared server	Shared server
IoT Devices	RFID, WSN	Smart Retail	RFID, WSN	WSN	Single sensors	RFID, WSN, Single sensors
Bandwidth requirement	Small	Small	Large	Medium	Medium	Medium/Large
Example testbeds	Aware Home [31]	SAP Future retail center [32]	Smart Santander[33], CitySense [34]	SiSViA [35]	GBROOS [36], SEMAT [37]	A few trial implementations [38,39]

References

- ierc@internet-of-things-research.eu
- EU-China Joint White paper on Internet of things Identification, EU-China Advisory Group, 2014
- http://iotforum.org/wp-content/uploads/2014/09/120613-IoT-A-ARM-Book-Introduction-v7.pdf
- J. Gubbi, R. Buyya, S. Marusic, M. Palaniswami "*Internet of Things(IoT):A vision, architectural elements, and future directions*" Future Generation Computer Systems 29(2013) Elsevier pp 1645–1660

MERCI

Table 2: Potential IoT applications identified by different focus groups of City of Melbourne

Citizens	
Healthcare	triage, patient monitoring, personnel monitoring, disease spread modelling and containment - real-time health status and predictive information to assist practitioners in the field, or policy decisions in pandemic scenarios
Emergency services, defence	remote personnel monitoring (health, location); resource management and distribution, response planning; sensors built into building infrastructure to guide first responders in emergencies or disaster scenarios
Crowd monitoring	crowd flow monitoring for emergency management; efficient use of public and retail spaces; workflow in commercial environments
Transport	
Traffic management	Intelligent transportation through real-time traffic information and path optimisation
Infrastructure monitoring	sensors built into infrastructure to monitor structural fatigue and other maintenance; accident monitoring for incident management and emergency response coordination
Services	
Water	water quality, leakage, usage, distribution, waste management
Building management	temperature, humidity control, activity monitoring for energy usage management Ð Heating, Ventilation and Air Conditioning (HVAC)
Environment	Air pollution, noise monitoring, waterways, industry monitoring