

MODULE: Real Time Geospatial Applications

LESSON: Internet of Things (IoT)

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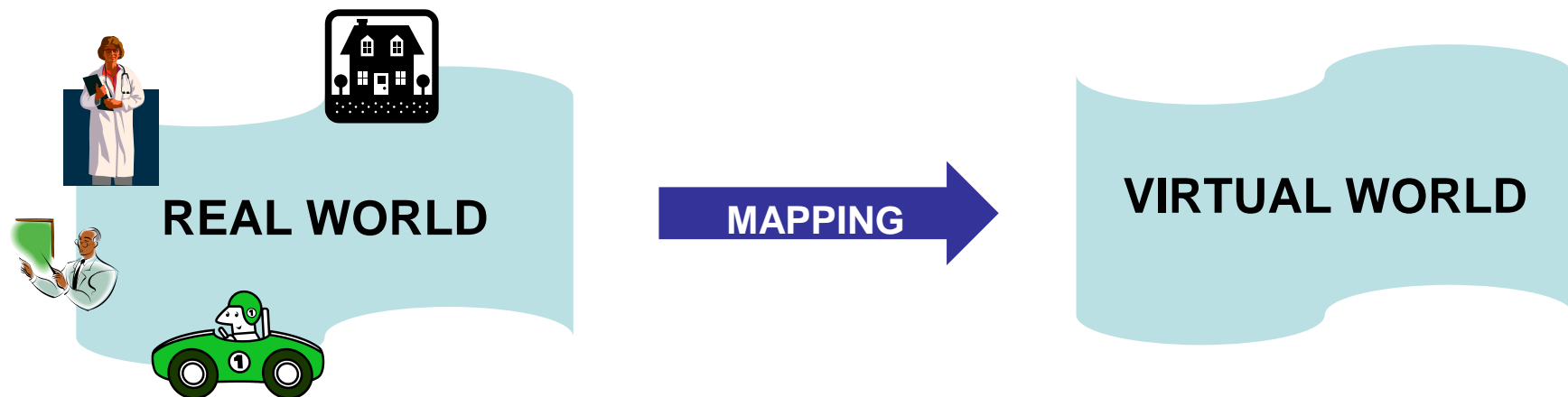
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Contents / Learning Objectives

























- Internet of Things (IoT) definition
- IoT enabling technologies
- Smart objects
 - Radio Frequency Identification (RFID) systems
 - Beacons
 - Sensors and sensor networks
 - Smartphones
- IoT & Web of Things
- IoT architecture
- IoT challenges

Internet of Things (IoT)

- As term introduced by Kevin Ashton in 1999 stating
 - We are physical and so is our environment
 - → to know about things in environment
 - → make use (tiny) computers for the things to map the real world to a virtual space by IoT, sensors and actuators embedded in physical objects



Countries by IoT devices

Rank ↕	Country ↕	Devices online ↕	Relative size ↕
1	 South Korea	37.9	<div></div>
2	 Denmark	32.7	<div></div>
3	 Switzerland	29.0	<div></div>
4	 United States	24.9	<div></div>
5	 Netherlands	24.7	<div></div>
6	 Germany	22.4	<div></div>
6	 Sweden	21.9	<div></div>
6	 Spain	19.9	<div></div>
9	 France	17.6	<div></div>
10	 Portugal	16.2	<div></div>
11	 Belgium	15.6	<div></div>
11	 United Kingdom	13.0	<div></div>
13	 Canada	11.6	<div></div>
14	 Italy	10.2	<div></div>
15	 Brazil	9.2	<div></div>
15	 Japan	8.2	<div></div>
15	 Australia	7.9	<div></div>
18	 Mexico	6.8	<div></div>
19	 Poland	6.3	<div></div>
20	 China	6.2	<div></div>
21	 Colombia	6.1	<div></div>
22	 Russia	4.9	<div></div>
23	 Turkey	2.3	<div></div>
24	 India	0.6	<div></div>

Source: <https://www.linkedin.com/pulse/iot-ebrahim-dashty>

Internet of Things (IoT) definition

- „Things having **identities** and **virtual** personalities operating in **smart spaces** using **intelligent interfaces** to connect and communicate within social, environmental and user context“ (INFISO, 2008)

IoT enabling technologies

- Embedded systems
 - (Tiny) Systems designed to do a specific task
- Improved identification, sensing and communication technologies
 - Radio-Frequency Identification (RFID) technology
 - Item traceability
 - item addressability: unique, universal, ubiquitous ID
 - Wireless technologies
 - Bluetooth standard for exchanging data over short distances
 - Wi-Fi (Wireless Fidelity)

Smart objects

- „object that can be tracked through space and time throughout its lifetime and that will be sustainable, enhanceable and uniquely identified“ (Sterling, 2005)
- Examples:
 - **Tagged objects**
 - Radio Frequency identification (RFID) systems
 - QR codes
 - Barcode
 - Beacons
 - **Sensors/sensors networks**
 - **Smartphones**



Source: <http://www.robotshop.com/>

RFID systems

- Components:
 - RFID tags
 - Passive tags
 - Semi-passive tags:
 - Active tags
 - RFID readers
- Application examples:
 - Healthcare
 - RFID pet feeder
 - Retail
 - Logistics



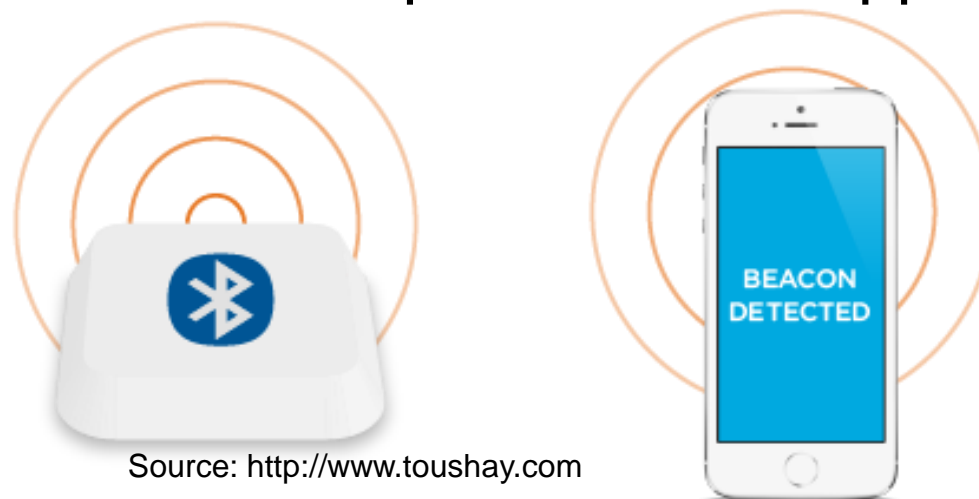
Source: <http://www.inovity.com>



Source: <http://www.wirelesswhiskers.com>

Beacons

- Signal transmitter: communication via mobile device
- Power supplied by the batteries
- Configurable with the help of a mobile app



- Examples:
 - Launch here: launch an app tied to your spot (TV-set open)

Sensors

- Track the status of things
 - Location
 - Temperature
 - Movements
- Smart sensors:
 - Wireless communication
 - Equipped with memory
- **Smarter** sensors:
 - Autonomous and proactive behavior
 - Context awareness: augment the awareness of an environment
 - Collaborative communications

Smartphones



Source: <http://senseable.mit.edu/co2go>

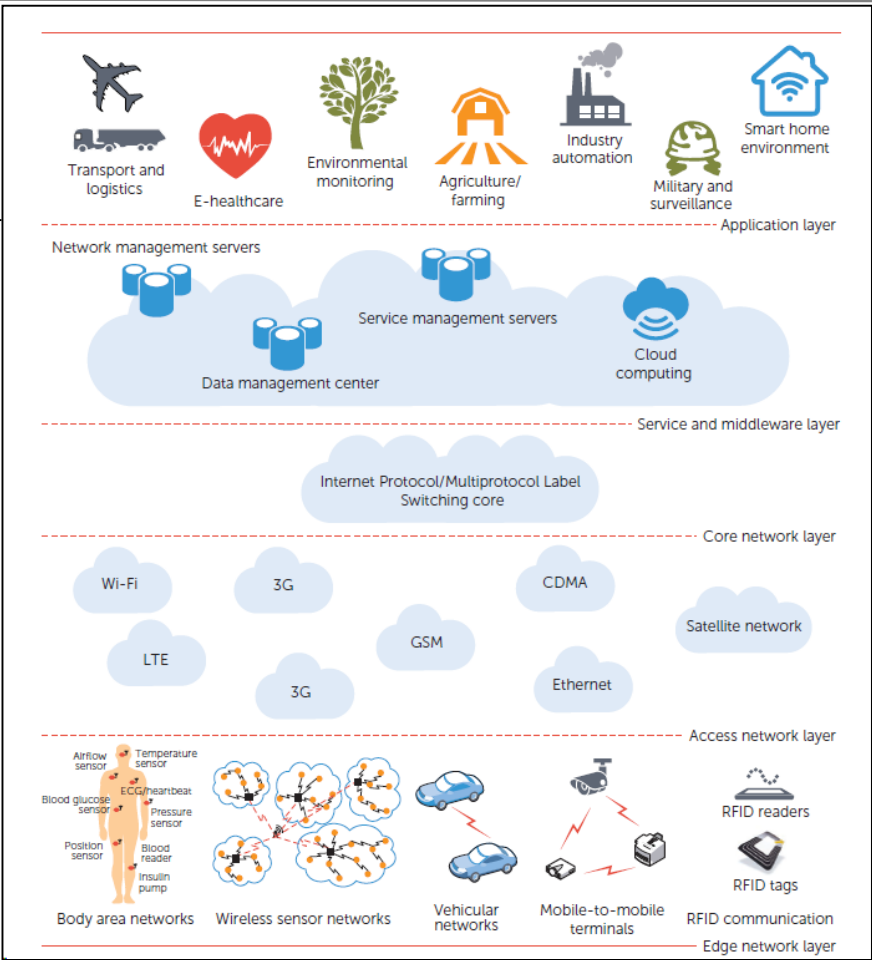
IoT architecture

This layer is related to business applications

This layer is responsible for collecting and disseminating sensed data

Communication technologies responsible for communicating with the sensors, actuators etc.

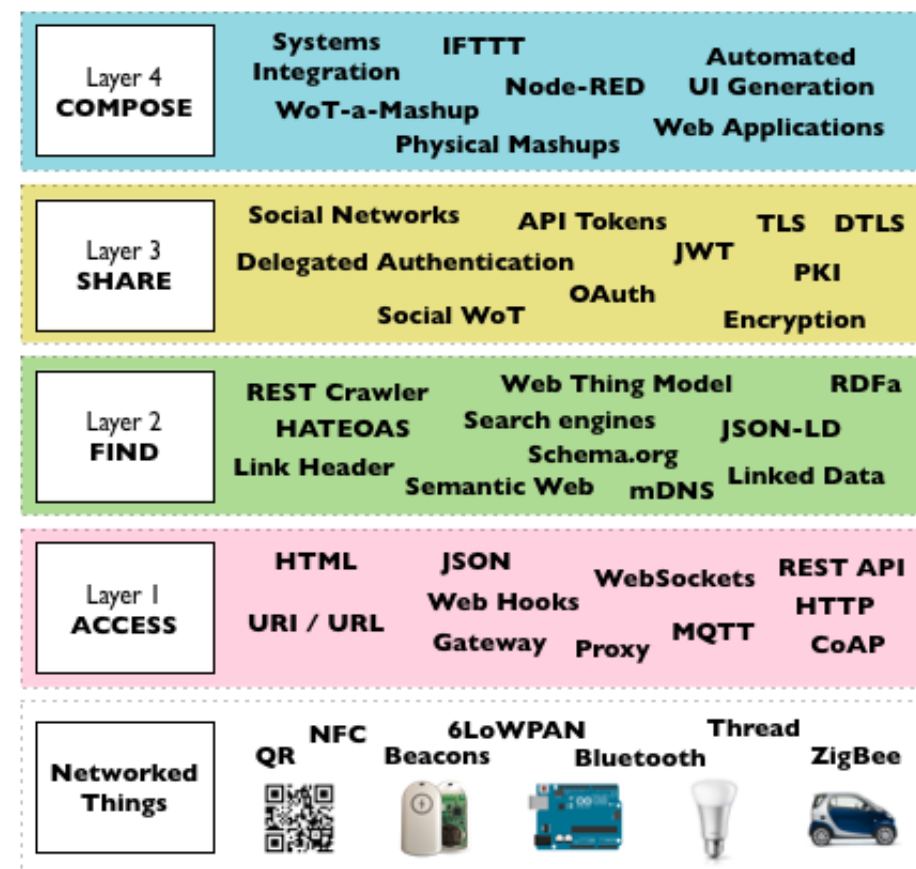
Sensors, actuators, displays



Source: Porambage et al 2016, explanations provided by Belgiu, 2016

IoT & Web of Things

- Web of Things: architectural styles & programming pattern used to create IoT vision



Source: Building the Web of Things: book.webofthings.io
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What can be(come) smart?

- Everything😊
- Smarter power distribution
- Smart cities
- Smart grids
- Smart home
- Intelligent transportation
- Hyper-target products
- Self-optimizing supply chains
- Wearables

IoT challenges

- Representing, storing, interconnecting, and organizing information generated by IoT
 - Semantic technologies for things descriptions, reasoning over data generated by IoT
 - Appropriate IT models for application deployment
- Privacy and data security issues

IT Models for applications deployment

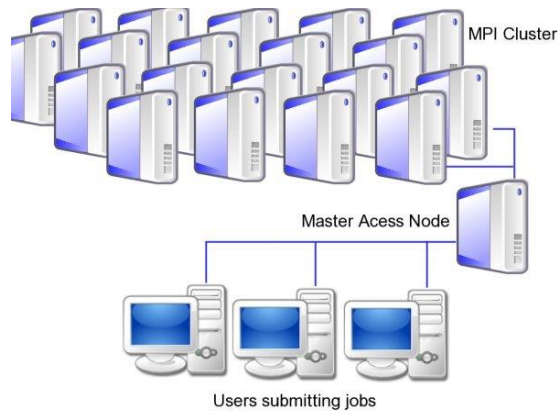
- Internal Data Center
- Colocation application deployment model
- Managed Hosting services
- Distributed computing technologies
 - Cloud computing
 - Clusters

Cloud computing definition

- “Cloud computing is a model for enabling 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 effort or service provider interaction” (Mell and Grance, 2011)

Distributed computing clusters

Clusters



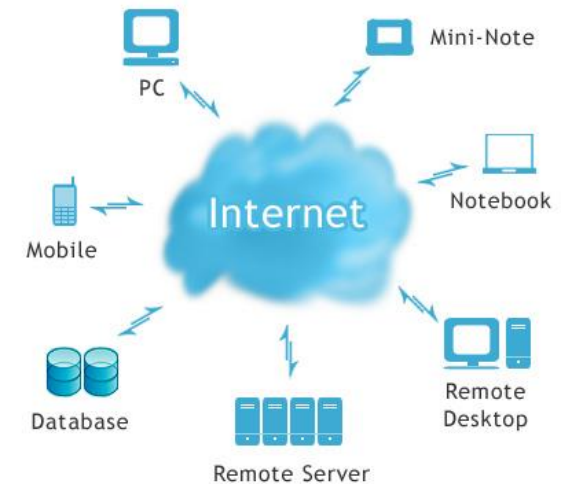
[Source: <http://ainkaboot.co.uk/cluster-architecture.php>]

Grids



[Source: <http://www.gridcafe.org/grid-in-30-sec.html>]

Clouds

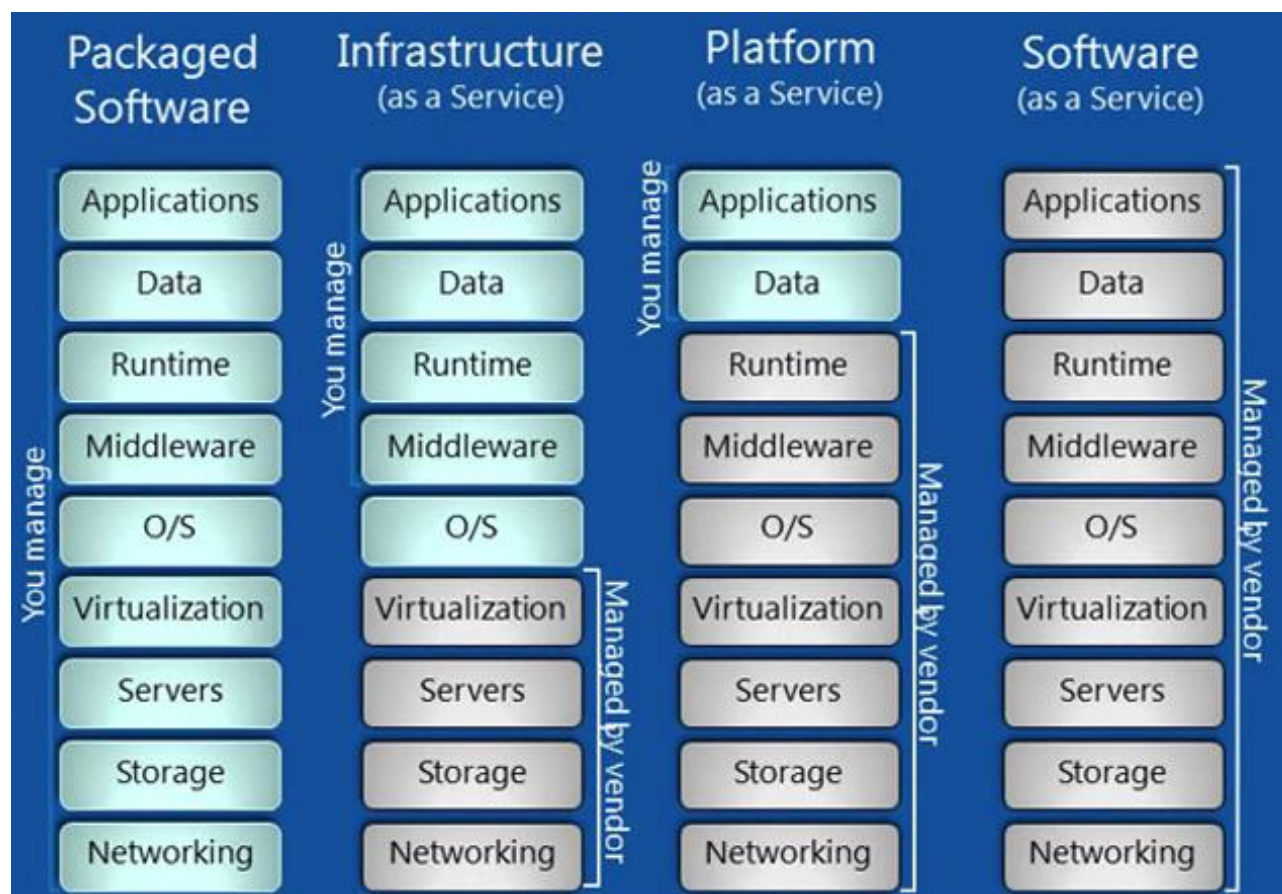


[Source: <http://www.onbile.com/info/what-cloud-computing-means/>]

Cloud computing characteristics

- Pooled computing resources available to any subscribing users
- Virtualized computing resources to maximize hardware utilization
- Elastic scaling up or down according to needed computing resources
- Automated creation of new virtual machines or deletion of existing ones
- Resource usage billed according to the usage

Cloud Computing Services - Overview



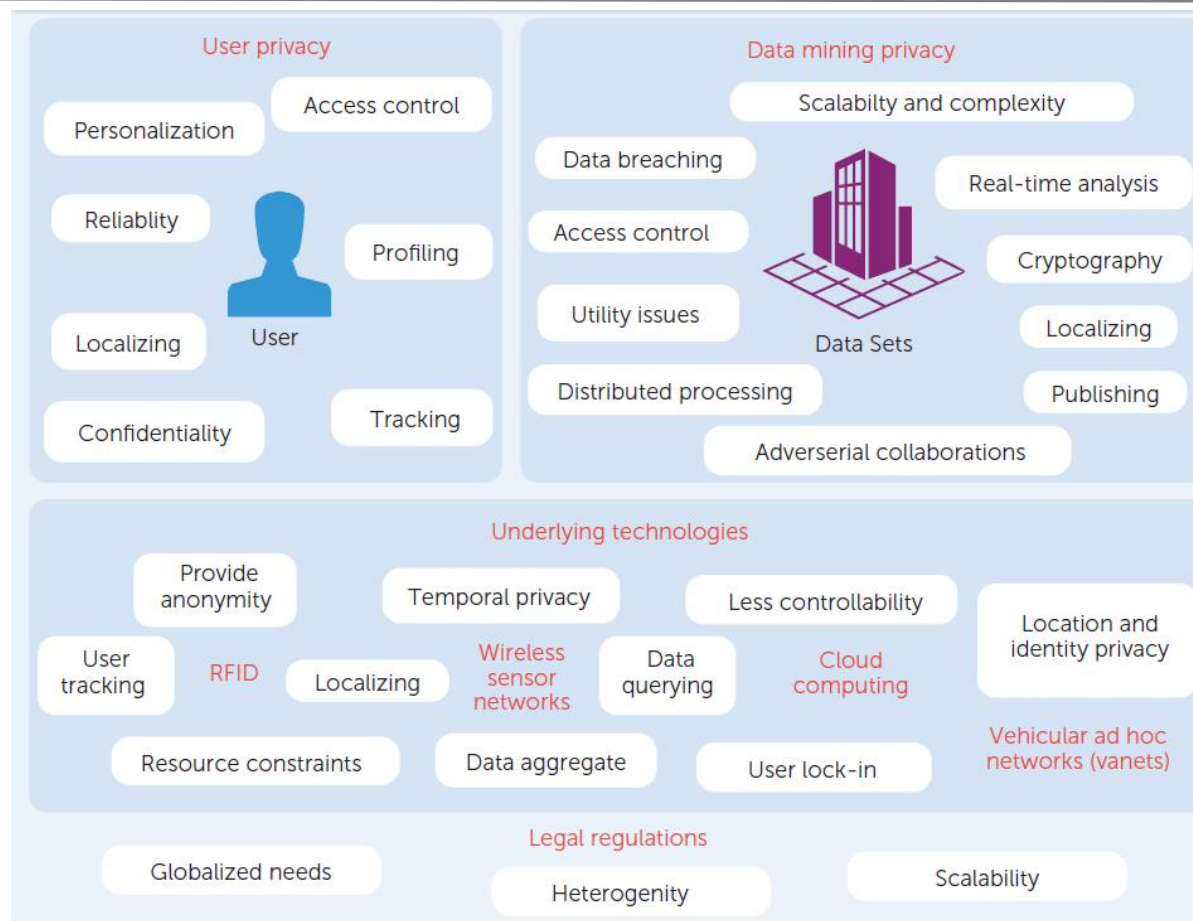
Source: <http://venturebeat.com/2011/11/14/cloud-iaas-paas-saas/>

Apache Hadoop framework



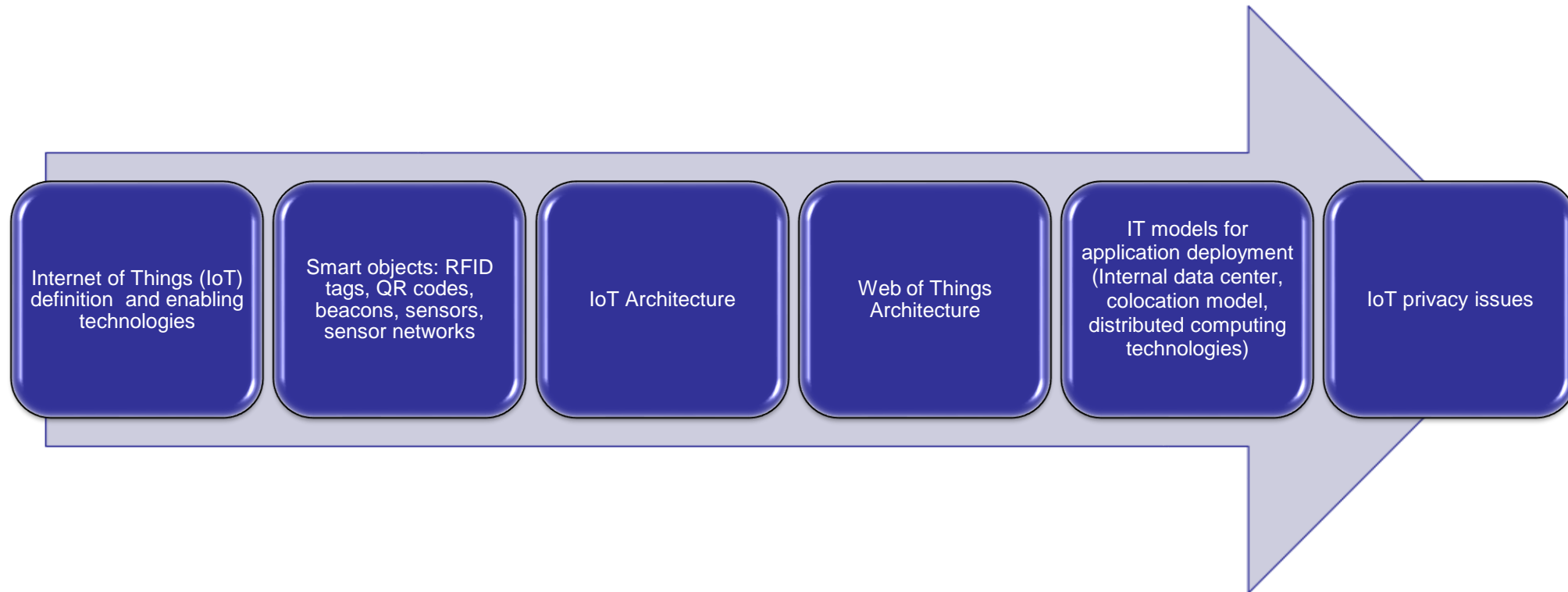
- Framework for distributed storage and computing of big data on computer clusters
- Hadoop modules:
 - Hadoop Common: libraries and utilities required by other modules
 - Hadoop Distributed File System (HDFS): storage module
 - Hadoop YARN: module for managing computing resources in clusters
 - MapReduce: Processing module

The quest of privacy and security in IoT



Source: Porambage et al 2016

Summary



Summary questions

- What are the enabling technologies of the IoT?
- What is the difference between IoT and Web of Things?
- What is the difference between RDFI systems and beacons technology?
- What is a smart object?
- Please give a few examples of application where IoT became a disruptive technologies

References

- Partners in ERASMUS+ Project 'GeoServices-4-Sustainability'



Xinjiang Institute of Ecology and Geography
Chinese Academy of Sciences



Palacký University
Olomouc



HNE
Eberswalde
Hochschule für nachhaltige Entwicklung



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- Please see full list of references in the notes section