

IoT

Mobile Radio Networks

Introduction to the IoT

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Credits: 6

IoT: Definition

- **Small Environment Scenario**
- **Large Environment Scenario**

“The actual distinguishing element between the Small Environment Scenario and the Large Environment Scenario is **complexity, not only in terms of number of *Things*, but also from the *Things* ownership/management point of view.”**

“In Large Environment Scenarios complexity becomes dominant and elements like **scalability, distributed logic, etc. become essential.”**

IoT: Definition

- Small Environment Scenario

“An Internet of *Things* is a network that connect uniquely **identifiable** *Things* to the **Internet**. The *Things* have **sensing/actuation** and potential **programmability** capabilities.”

“Through the exploitation of unique identification and sensing, information about the *Thing* can be **collected** and the state of the *Thing* can be **changed** from anywhere, anytime, by anything.”

IoT: Definition

- Large Environment Scenario

“Internet of Things envisions a **self configuring, adaptive, complex** network that interconnects *Things* to the **Internet** through the use of **standard** communication protocols.”

“The interconnected *Things* have physical or virtual **representation** in the digital world, **sensing/actuation** capability, a **programmability** feature and are uniquely **identifiable**.”

“The *Things* offer **services**, with or without human intervention. The service is made available anywhere, anytime, and for anything taking **security** into consideration.”

*Towards a definition of the Internet of Things (IoT),
IEEE Internet Initiative, May 2015.*

IoT: Definition. Summary of Main Features

- **Interconnection of Things**
- **Connection of Things to the Internet**
- **Uniquely Identifiable Things**
- **Ubiquity**
- **Sensing/Actuation Capability**
- **Embedded Intelligence**
- **Interoperable Communication Capability**
- **Self-Configurability**
- **Programmability**

*Towards a definition of the Internet of Things (IoT),
IEEE Internet Initiative, May 2015.*

IoT: Sectors

Smart Agriculture



Smart Manufacturing



Connected Cars



Smart Farming



Smart Spaces

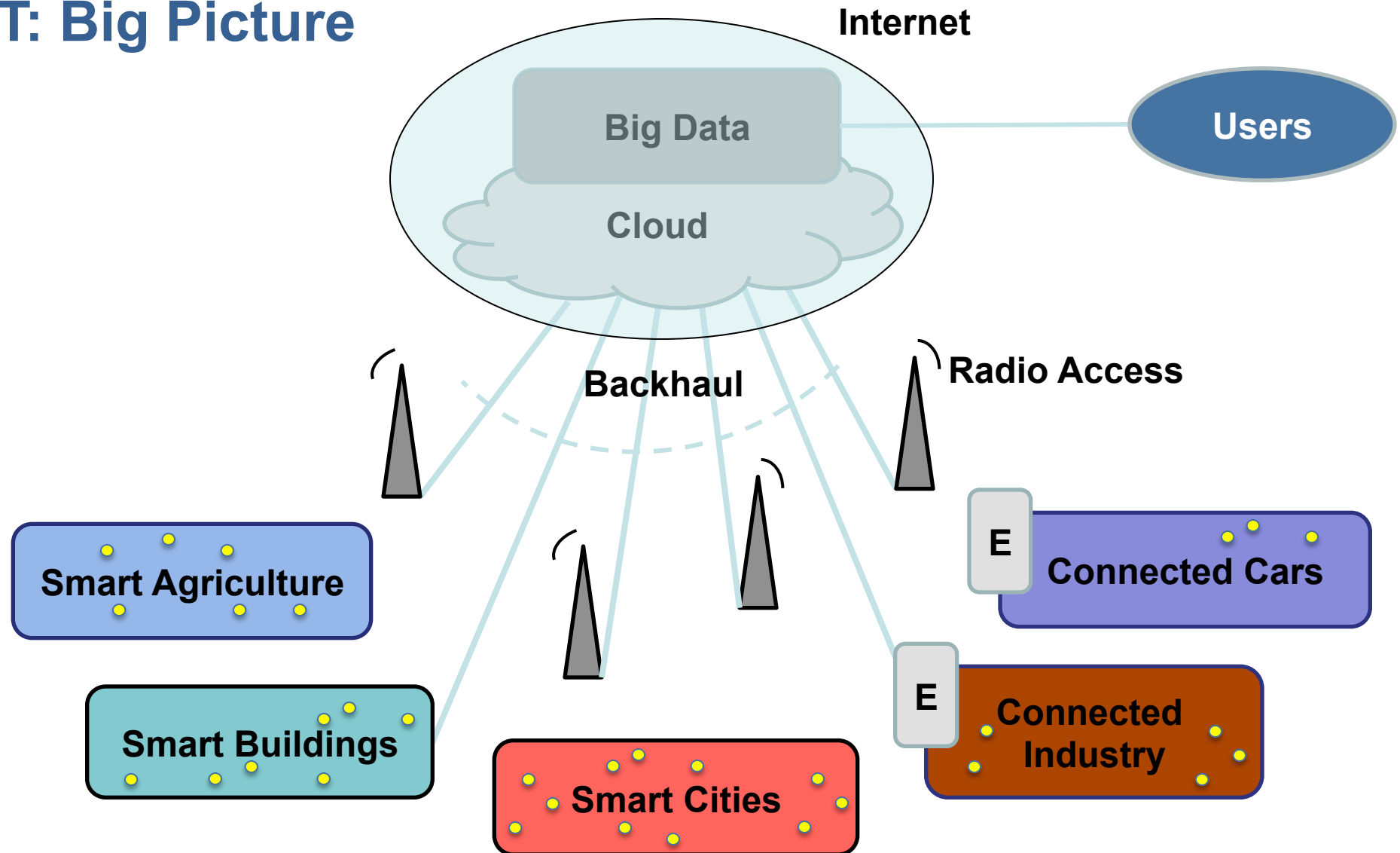


Smart Cities



Smart Buildings

IoT: Big Picture



IoT: Big Picture Things



- **Electronics and Telecommunications**
- **Any other discipline**
(e.g. biology, agronomy, chemistry, transportation, construction, ...)



Smart Agriculture



Connected Cars



Smart Buildings



Smart Cities

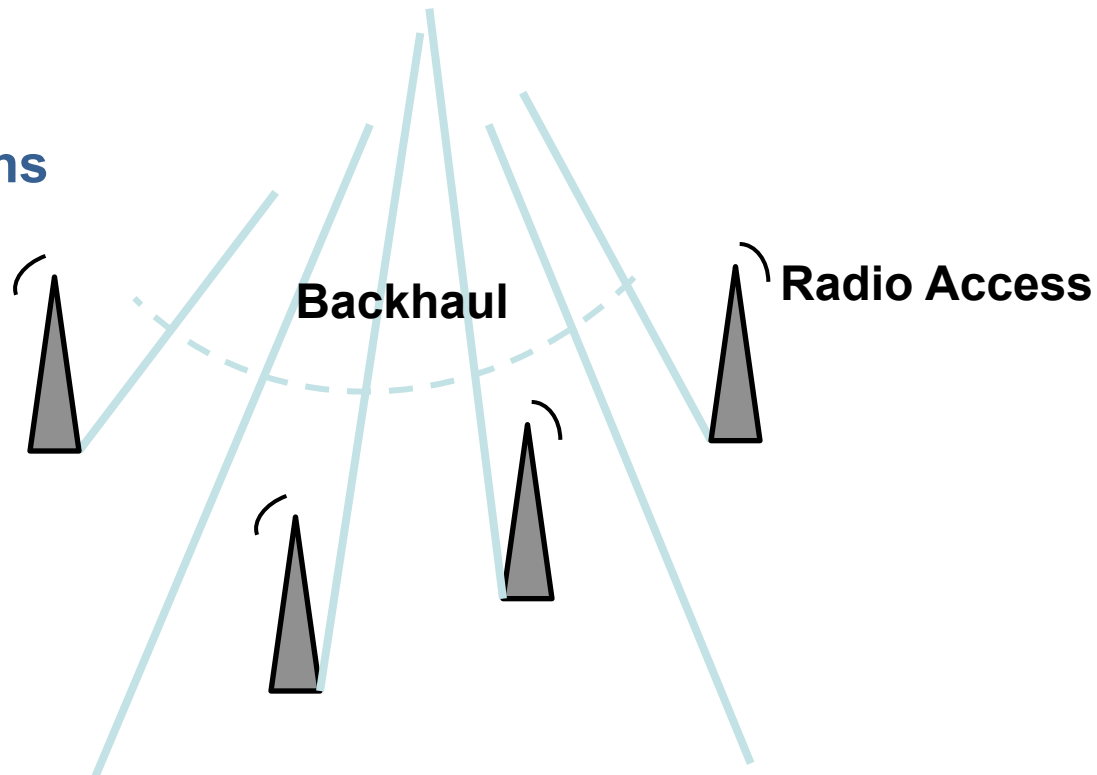


Connected Industry

IoT: Big Picture Connectivity



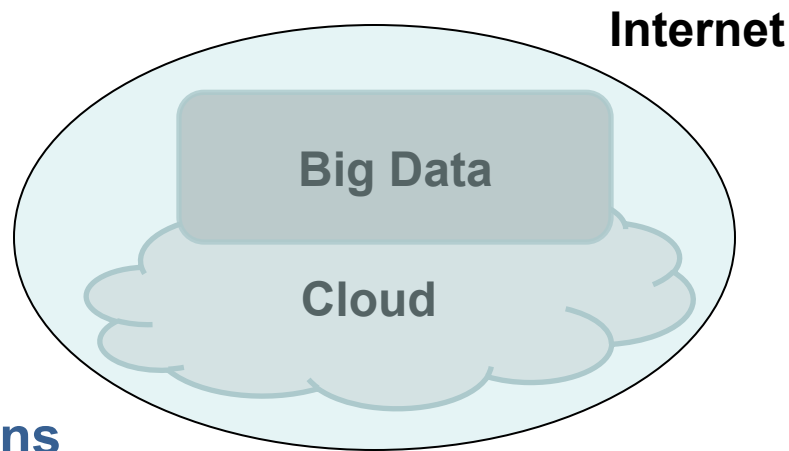
- **Telecommunications**



IoT: Big Picture Cloud



- **Computer Science and Telecommunications**



IoT: Big Picture Applications



Computer Science and Telecommunications

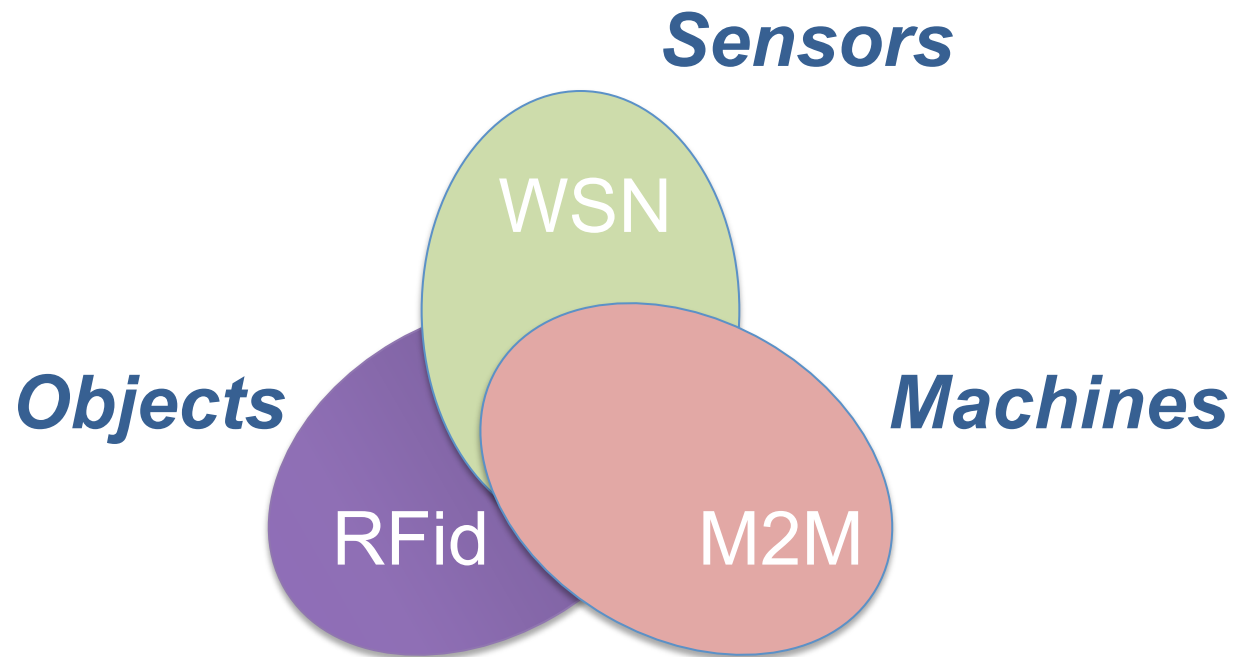
Any other discipline

(e.g. biology, agronomy, chemistry, transportation, construction, ...
sociology, psychology, law, arts, language, economy, statistics, ...)

A blue oval with a thin grey border containing the word 'Users'. A horizontal light blue line extends from the left side of the oval.

Users

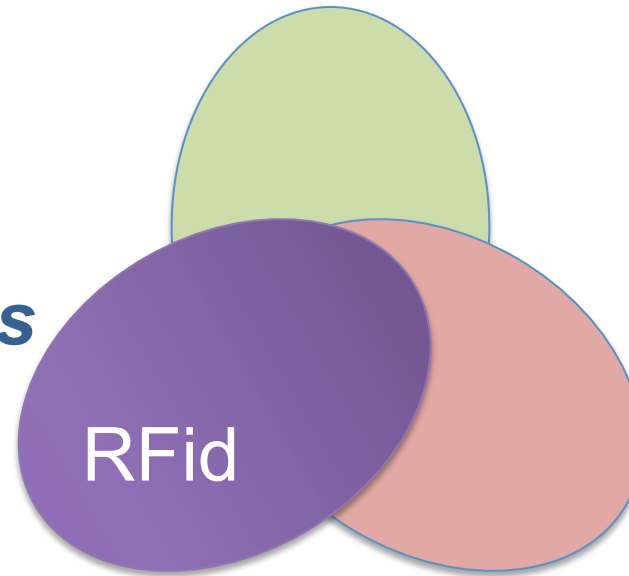
IoT: Things



IoT: Things



Objects



Objects equipped with RFid Tags:

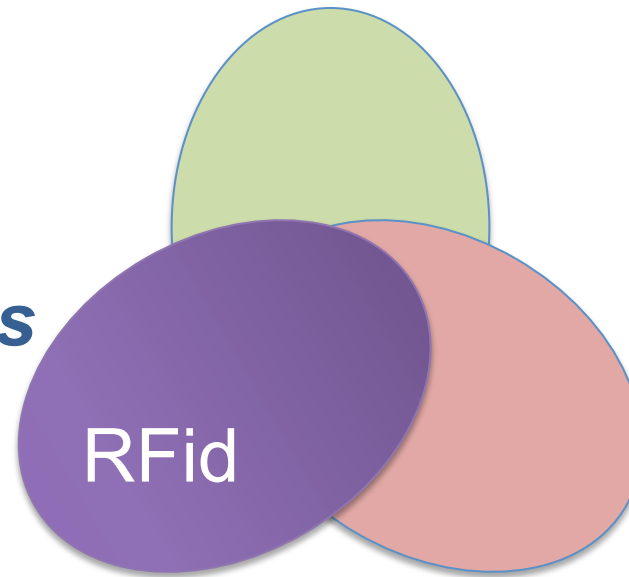
- Identification
- Passive
- No computing capabilities
- Very low cost



IoT: Things

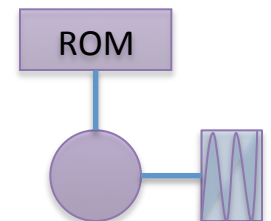


Objects



Objects equipped with RFid Tags:

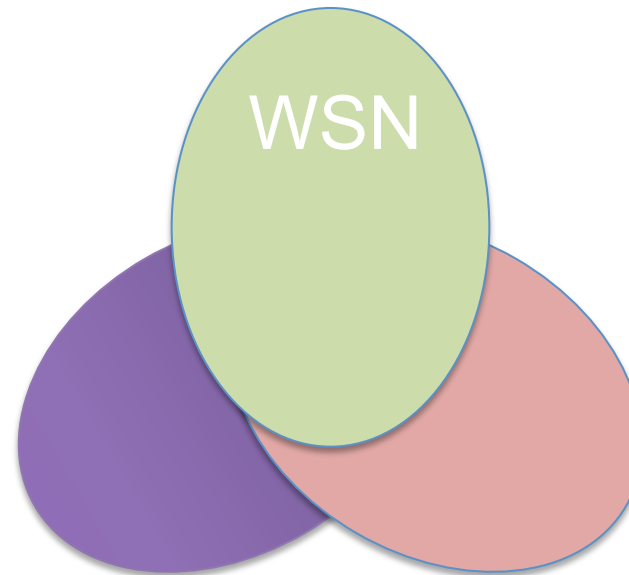
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IoT: Things



Sensors



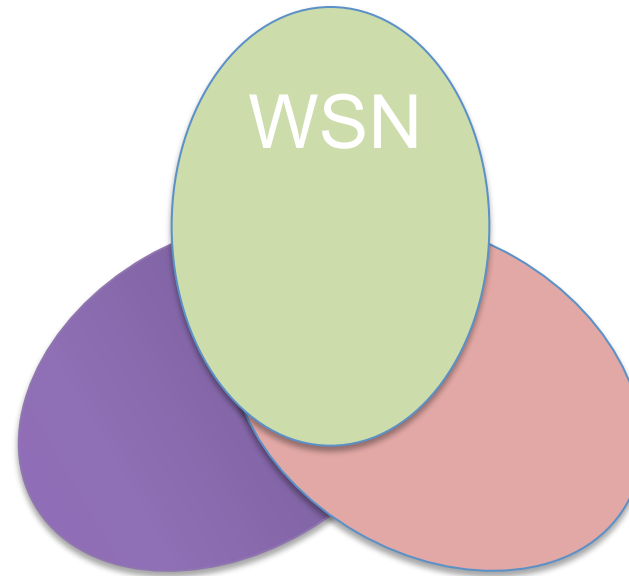
(Embedded) devices equipped with sensors:

- Sensing
- Battery or energy grid
- Some computing capabilities
- Low cost



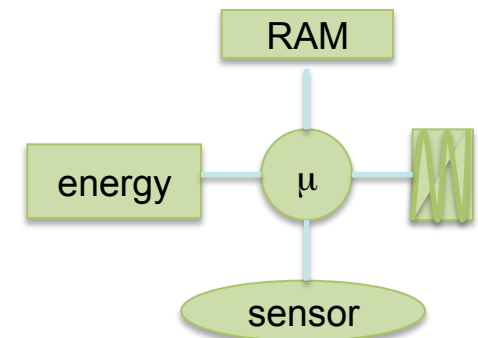
IoT: Things

Sensors

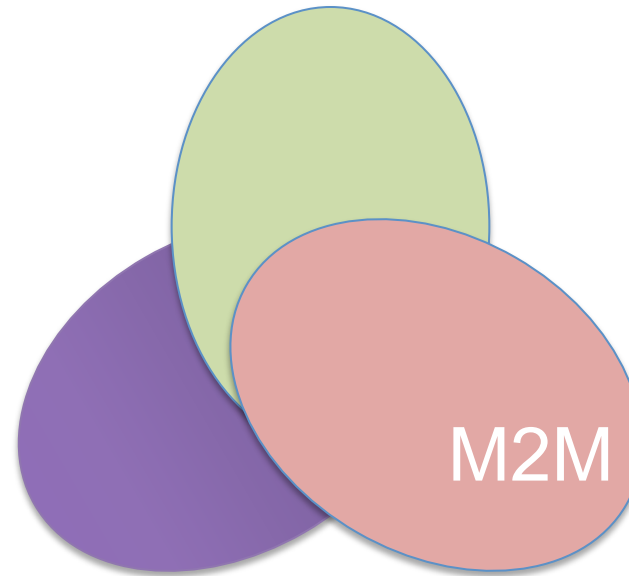


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IoT: Things



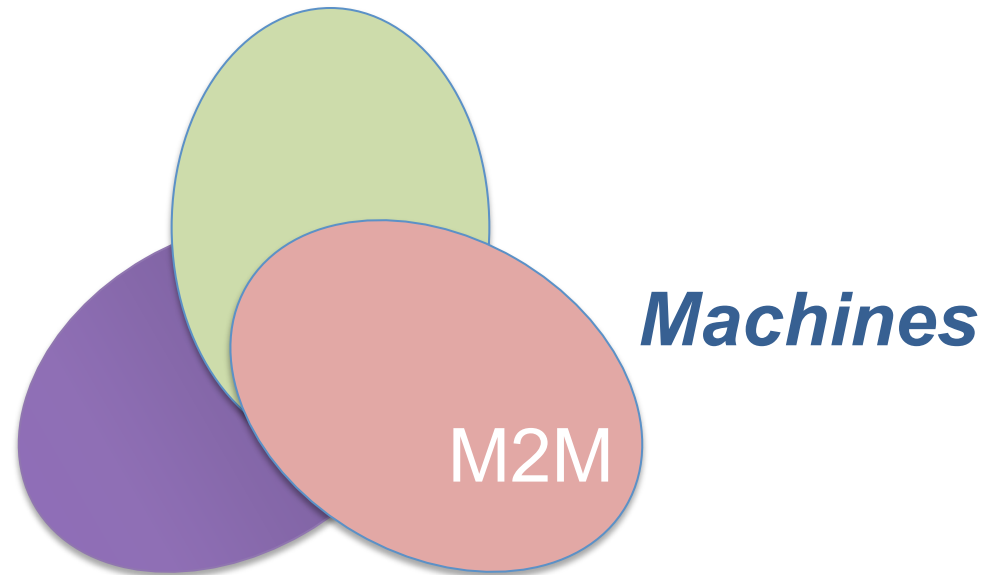
Machines

Machines equipped with sensors / actuators:

- Sensing & Actuation
- Industrial Control
- High computing capabilities
- High cost

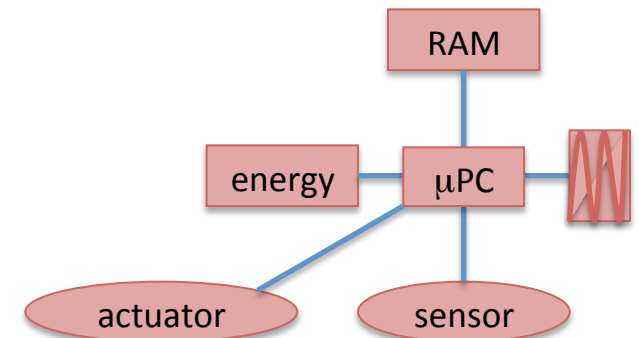


IoT: Things

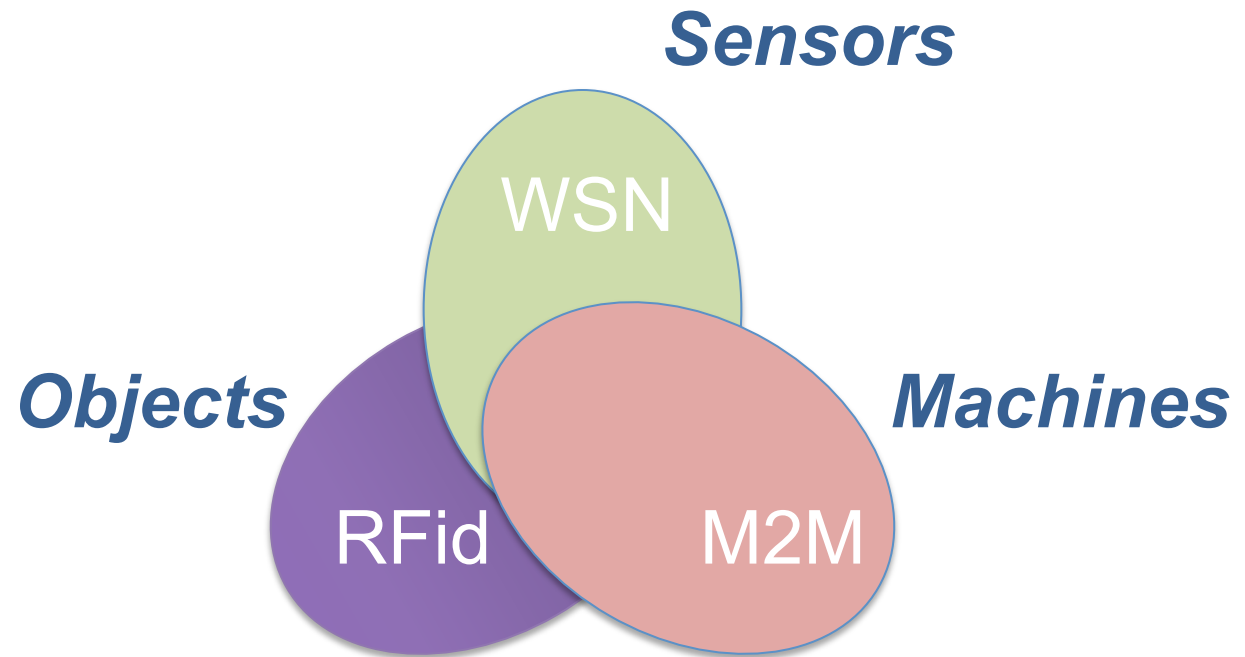


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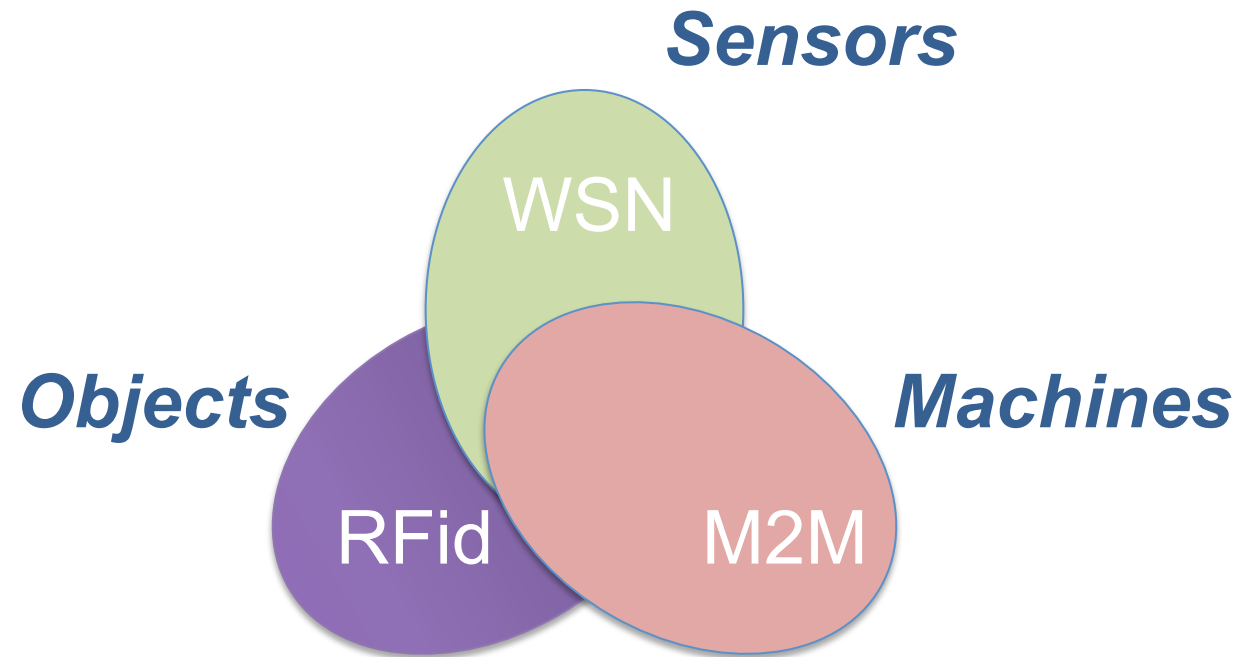


IoT: Things



The IoT intends to connect to the Internet, wirelessly, *unmanned* devices of very different nature, complexity and capabilities.

IoT: Things



Heterogeneity

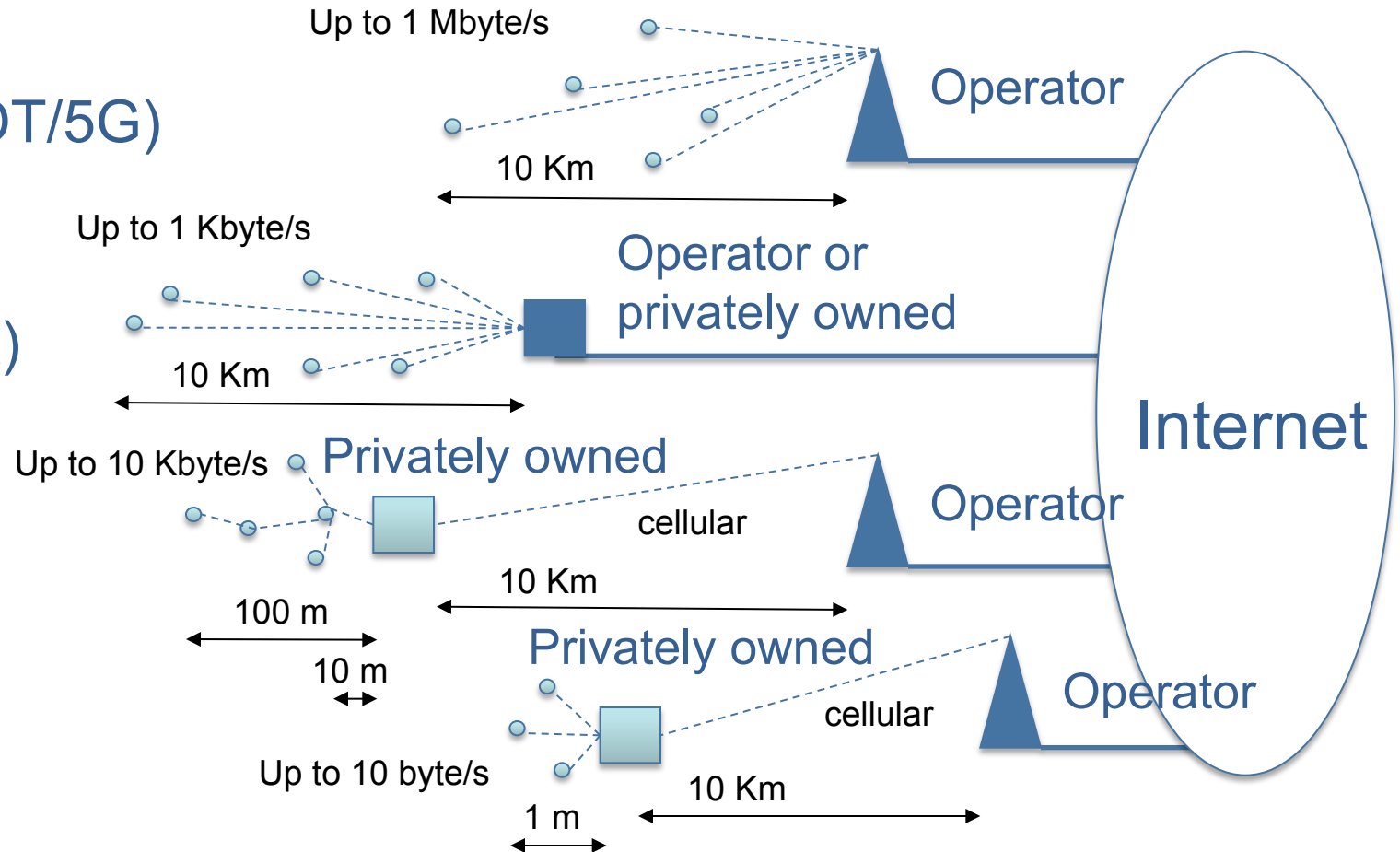
IoT: Connectivity

Cellular
(GPRS/NB-IOT/5G)

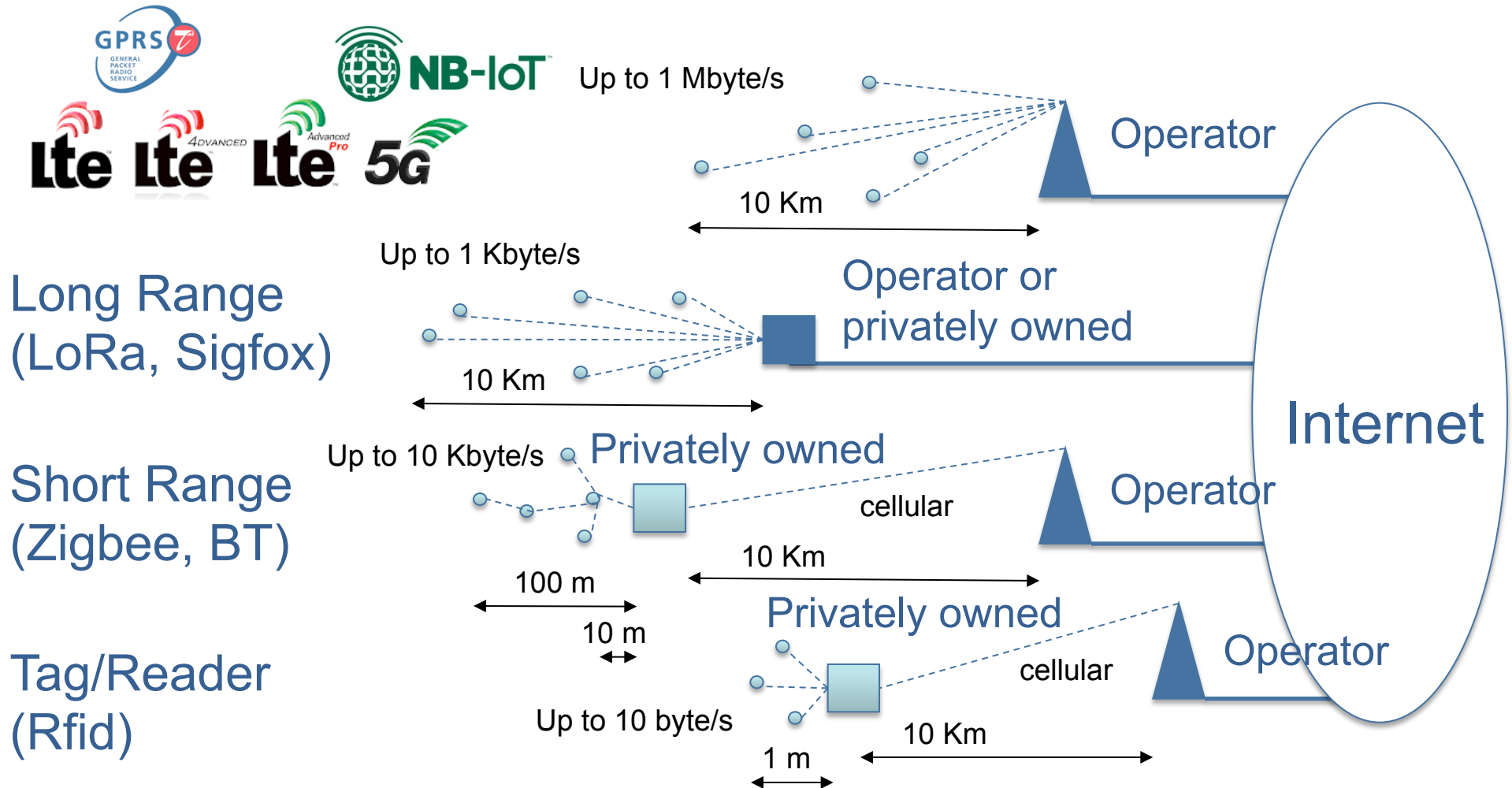
Long Range
(LoRa, Sigfox)

Short Range
(Zigbee, BT)

Tag/Reader
(Rfid)



IoT: Connectivity



Logos for GPRS (General Packet Radio Service), NB-IoT (Narrowband Internet of Things), and various LTE (Long Term Evolution) and 5G services.



Diagram illustrating a network topology where a group of nodes (represented by blue circles) is connected to a central node (represented by a blue square) labeled "Operator of privately owned". The distance between the group of nodes and the central node is indicated as 10 Km.

Up to 10 Kbyte/s  Privately owned

Short Range (Zigbee, BT)

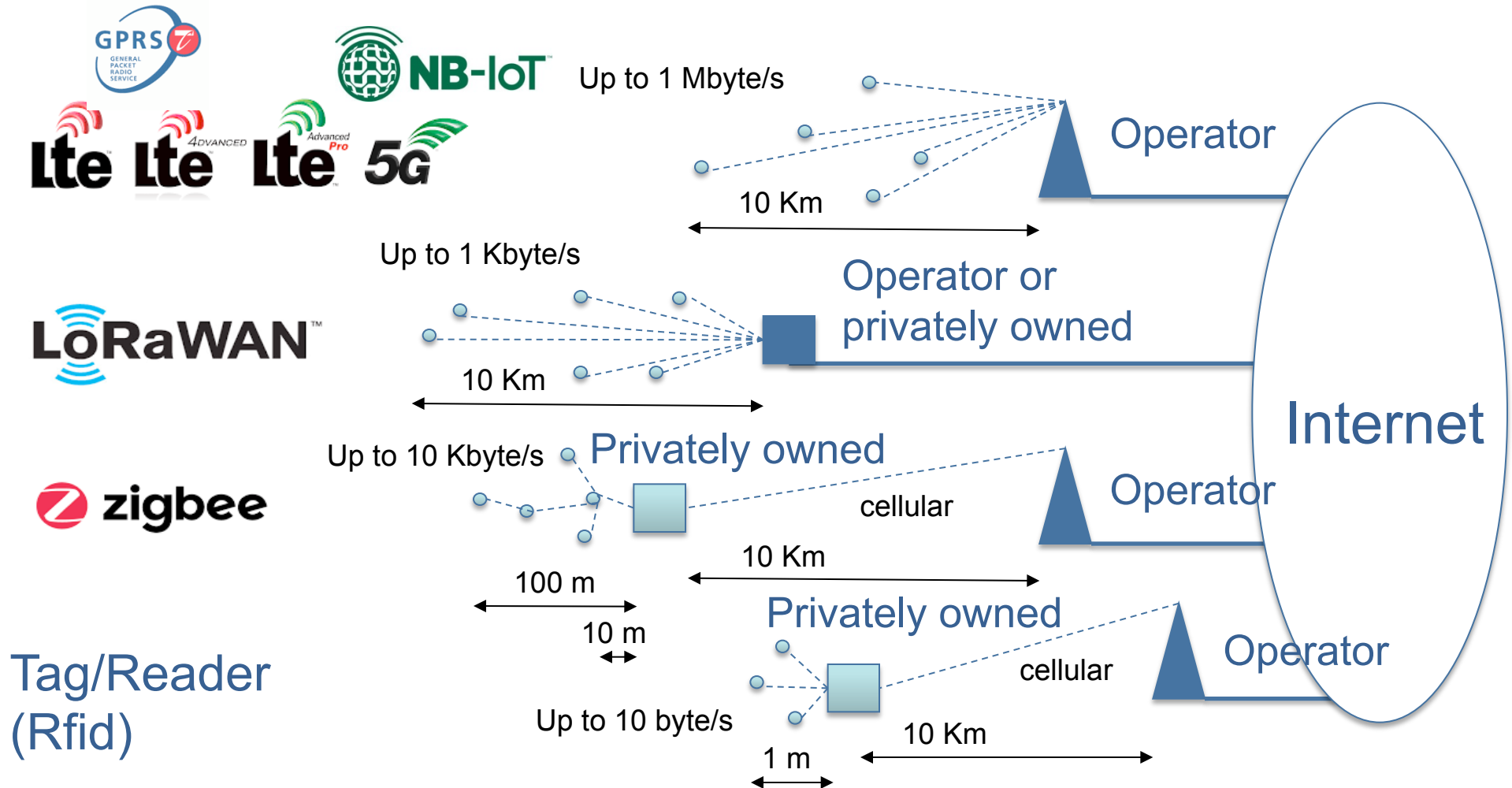
Tag/Reader (Rfid)

Diagram illustrating the scale of the problem. It shows a cellular network area (10 Km) and a privately owned area (100 m and 10 m).

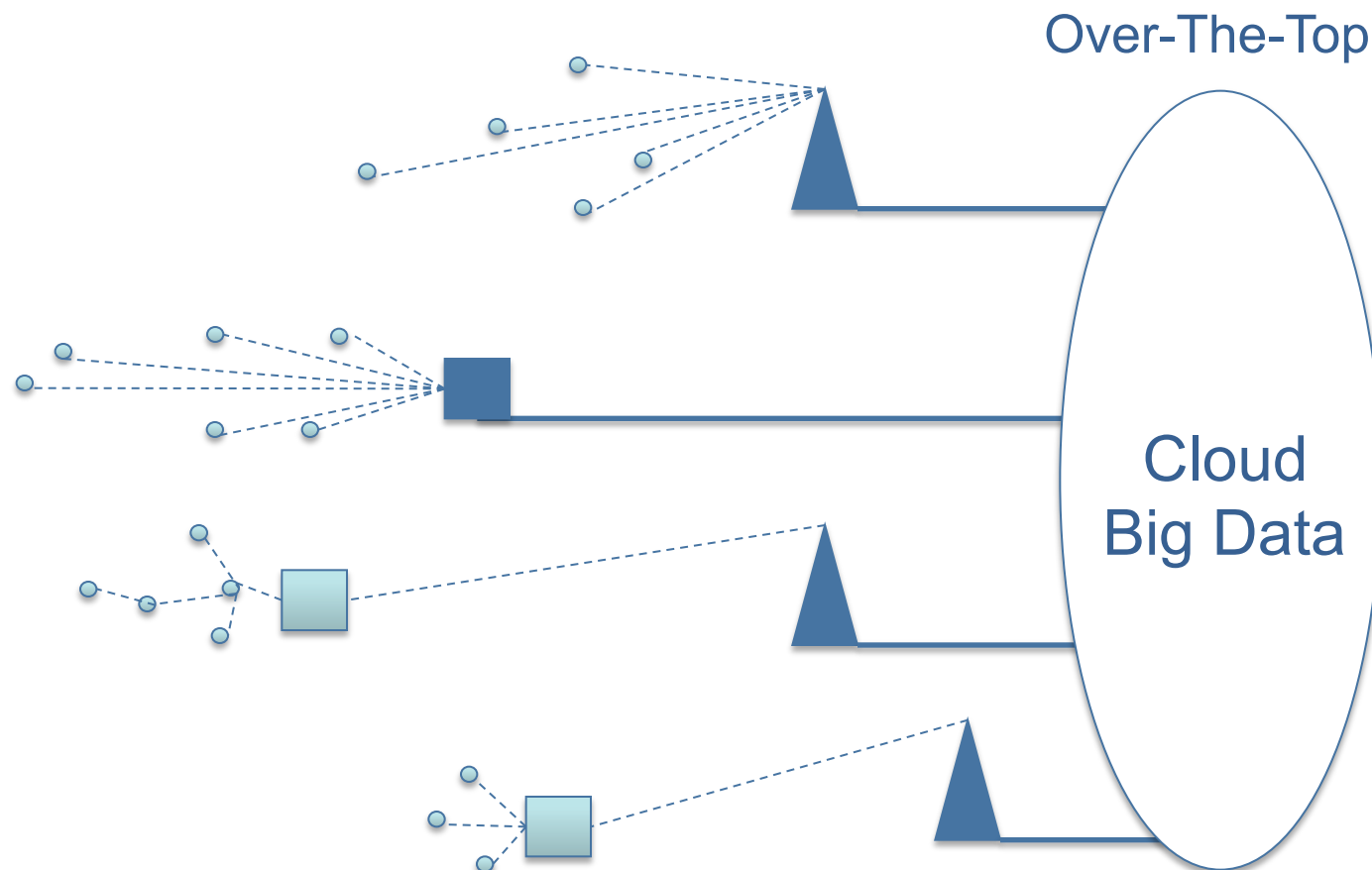
Up to 10 byte/s

The diagram illustrates a network topology. On the left, a blue square represents a 'Privately owned' base station. It is connected via a dashed line labeled 'cellular' to a blue triangle representing the 'Operator's' network. A scale bar below the base station indicates a distance of '1 m' between its components. A larger scale bar below the 'cellular' link indicates a distance of '10 Km' between the base station and the operator's network.

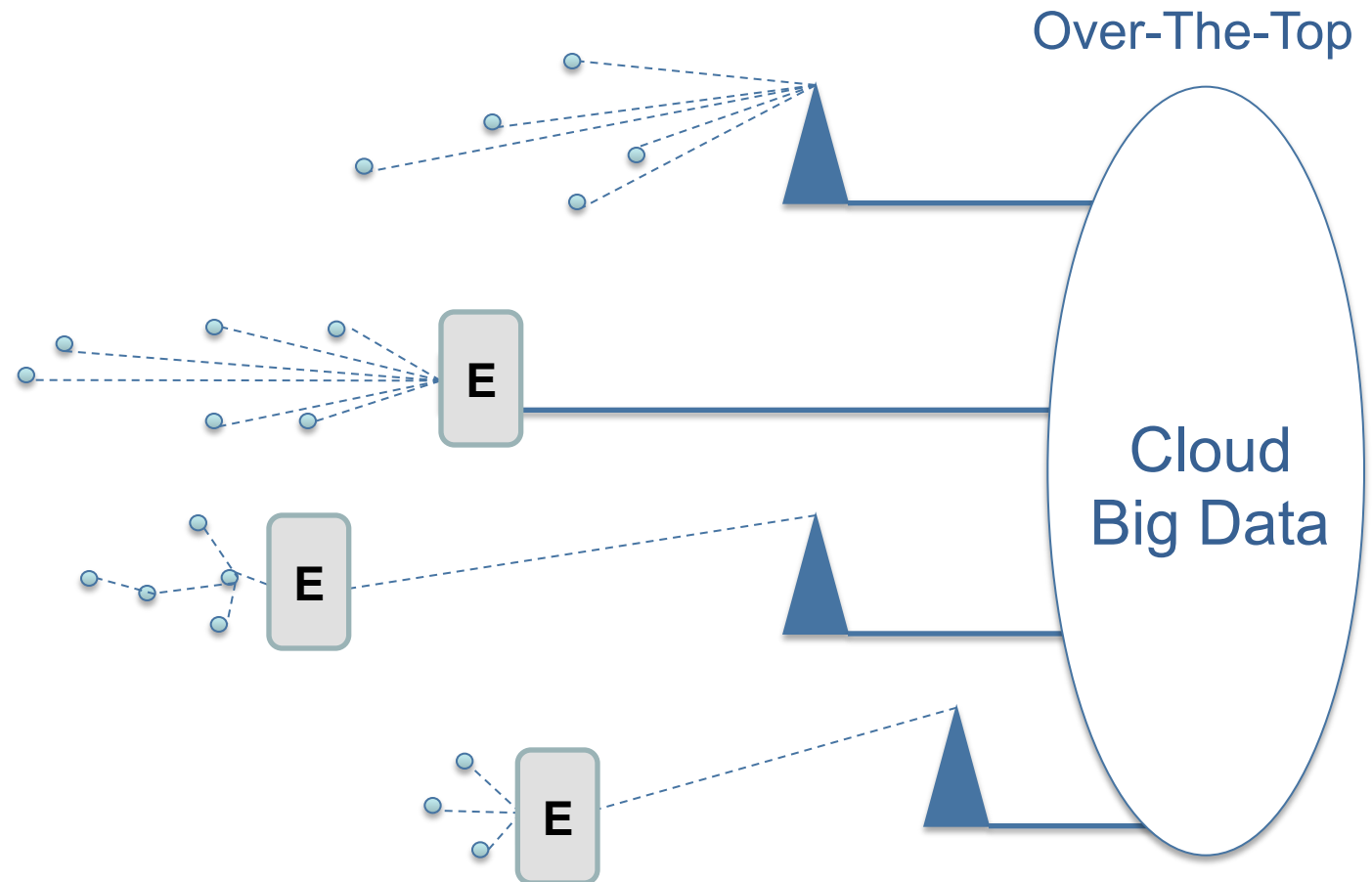
IoT: Connectivity



IoT: Cloud



IoT: Cloud



IoT: Applications

Smart Manufacturing

Robot control
Plant monitoring

Smart Agriculture

Smart irrigation
Crop monitoring

Connected Cars

Extended sensing
Driverless cars

Health control
Improved quality

Smart
Farming

Automation
Warehouse monitoring

Home control
Metering

Smart
Buildings

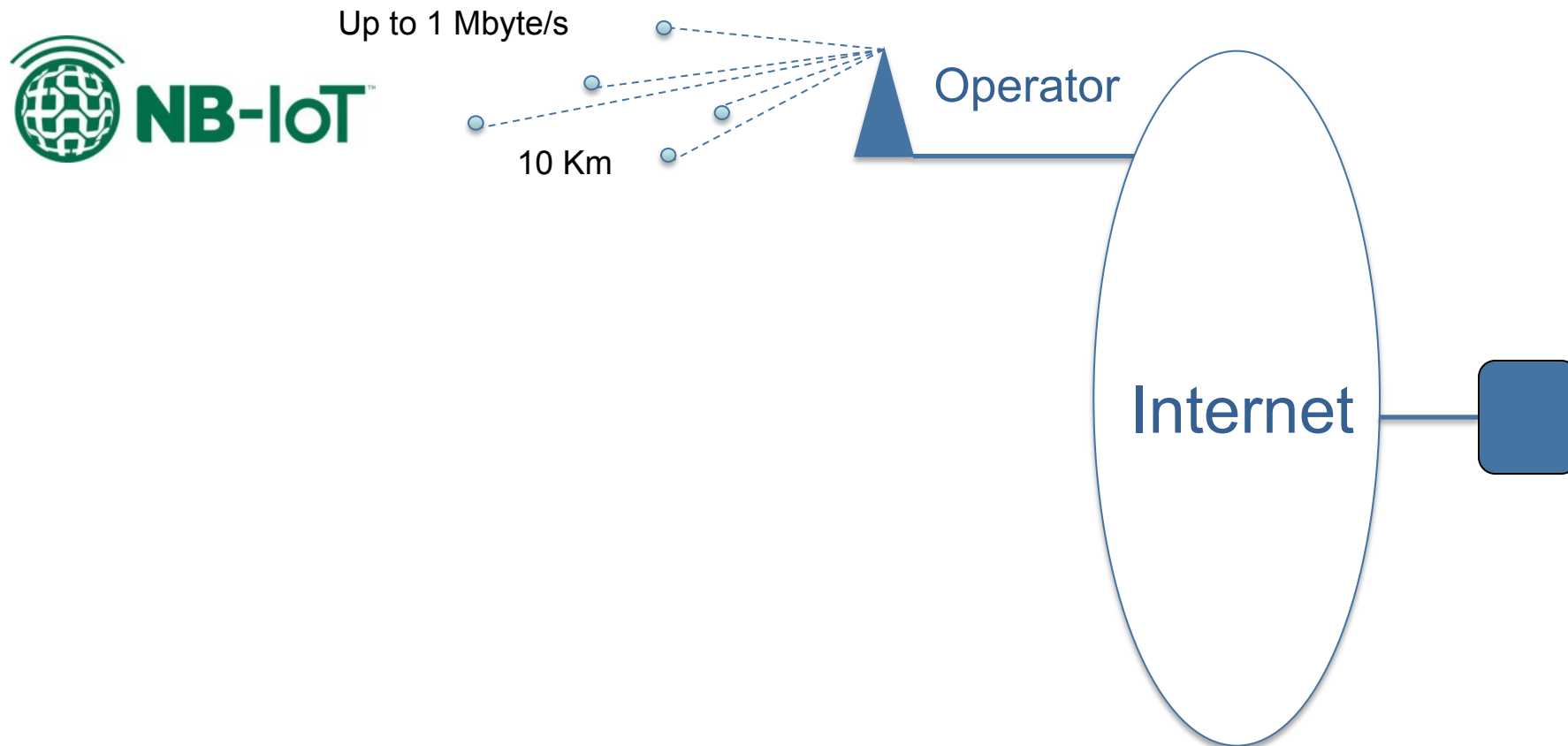
Smart Lighting
Trash Collection

Smart Cities

Smart Spaces

2020 Hackathon on IoT with NB-IOT

2020 Hackathon on IoT with NB-IoT



2020 Hackathon on IoT with NB-IoT



- **Last week-end of October (Fri 7 pm – Sun 7 pm)**
- **Bologna and Oulu (Finland)**
- **TIM NB-IOT network**
- **International Industry Committee to select the winner**
- **At home, groups of up to four participants**
- **Devices and SIMs made available by WiLab & TIM**
- **IoT Applications**
- **NB-IOT network performance assessment**

2020 Hackathon on IoT with NB-IoT



- Last week-end of October (Friday 7 pm – Sunday 7 pm)

- Bologna and Oulu (Finland)
 - TIM NB-IoT network
- # via TEAMS

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