IoT

Mobile Radio Networks
Introduction to the IoT

Roberto Verdone
www.robertoverdone.org

roberto.verdone@unibo.it
+39 051 20 93817

Office Hours:
Monday 4 – 6 pm
(upon prior agreement via email)

A.Y. 2019-20
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."**

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

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."

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

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

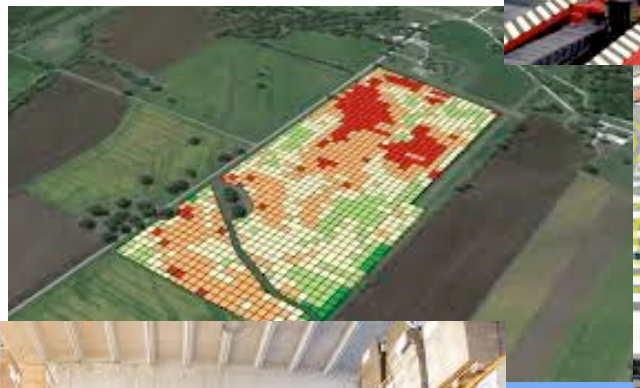
- Interconnection of Things
- Connection of Things to the Internet
- Uniquely Identifiable Things
- Ubiquity
- Sensing/Actuation Capability
- Embedded Intelligence
- Interoperable Communication Capability
- Self-Configurability
- Programmability

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

IoT: Sectors

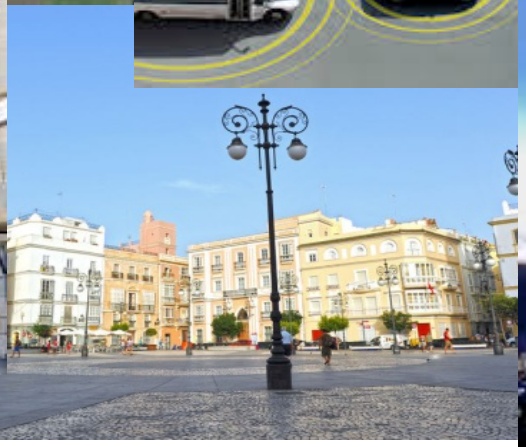
Smart Manufacturing

Smart Agriculture



Connected Cars

Smart Farming

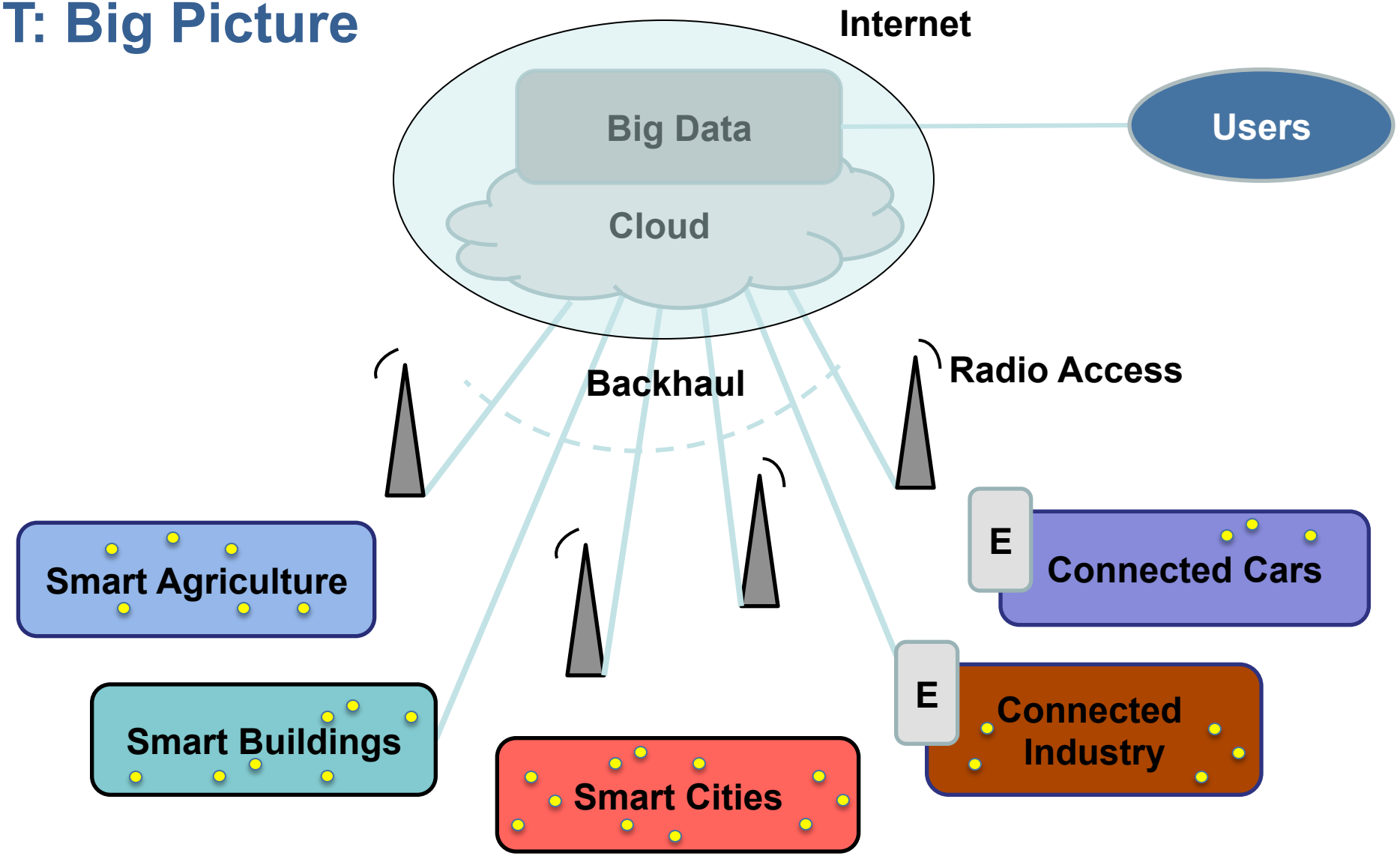


Smart Spaces

Smart Cities

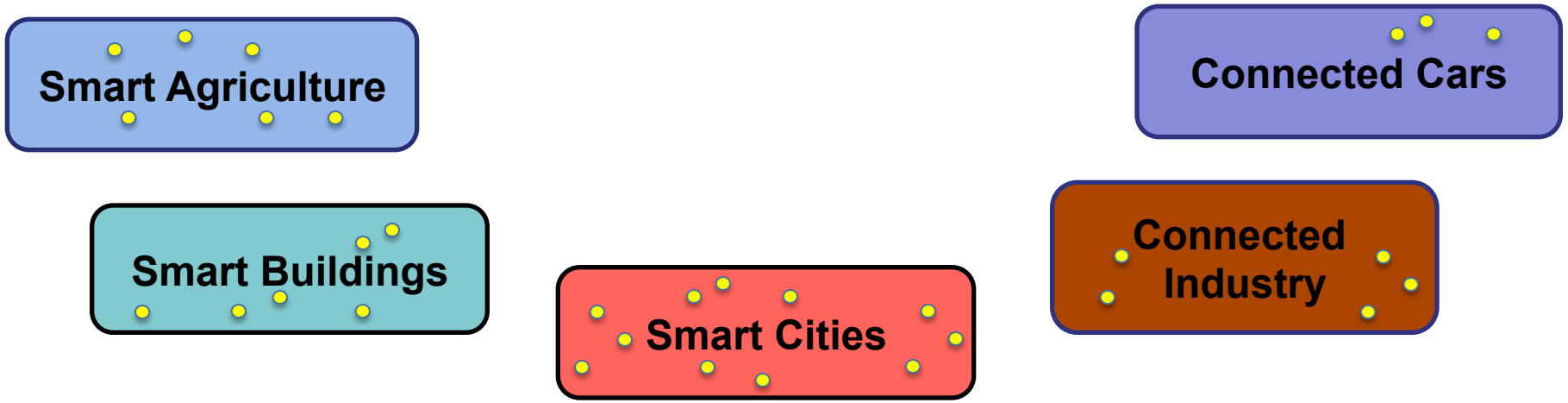
Smart Buildings

IoT: Big Picture



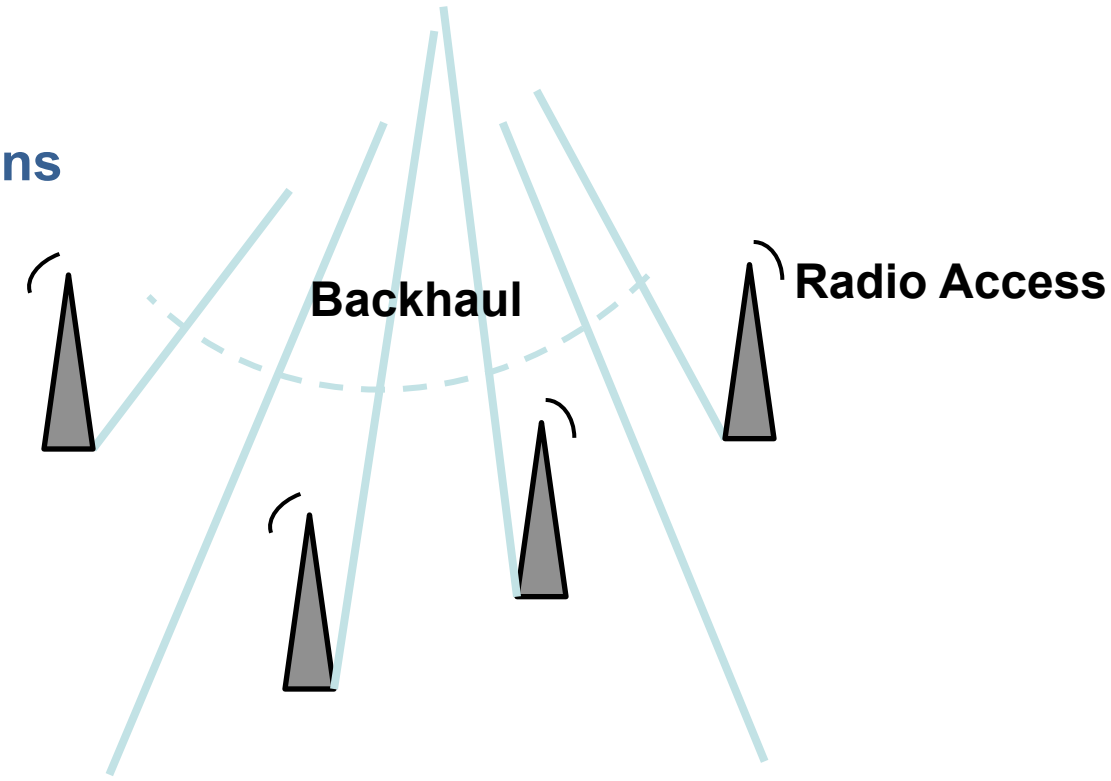
IoT: Big Picture
Things

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

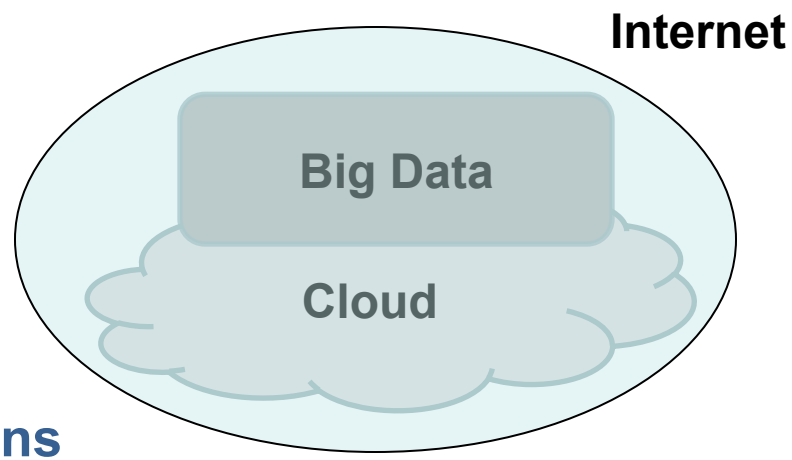


IoT: Big Picture Connectivity

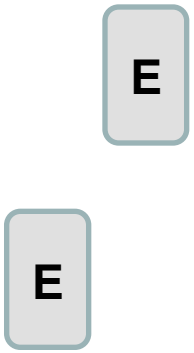
- Telecommunications



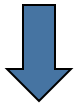
IoT: Big Picture Cloud



- Computer Science and Telecommunications



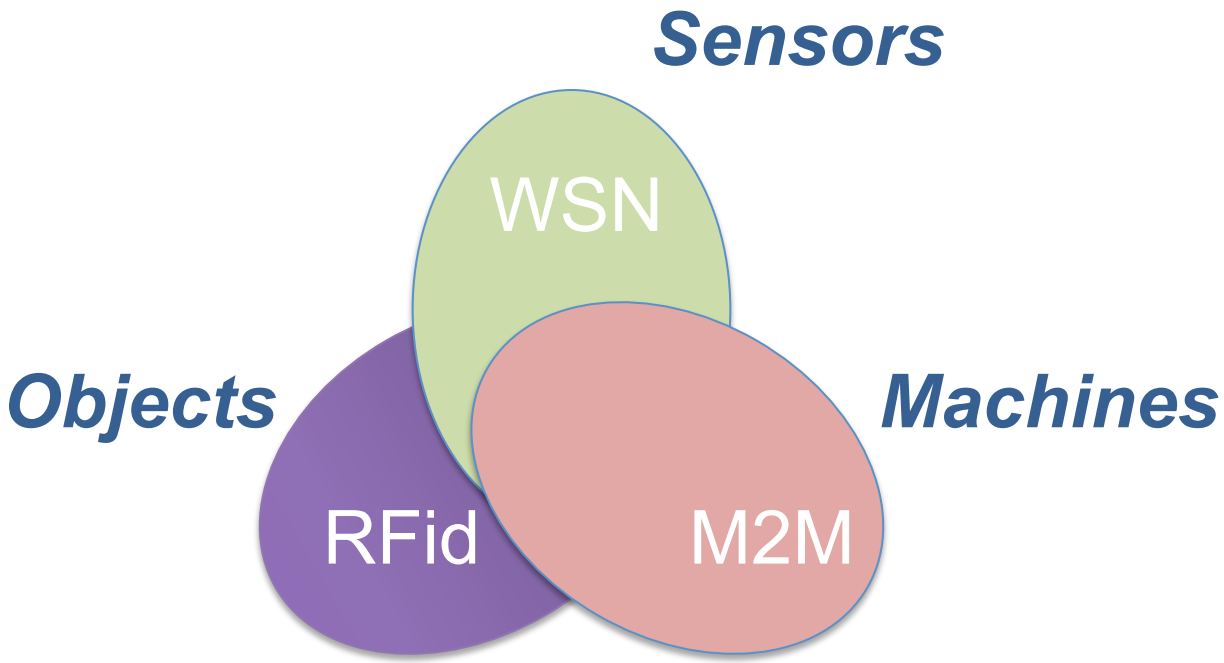
IoT: Big Picture
Applications



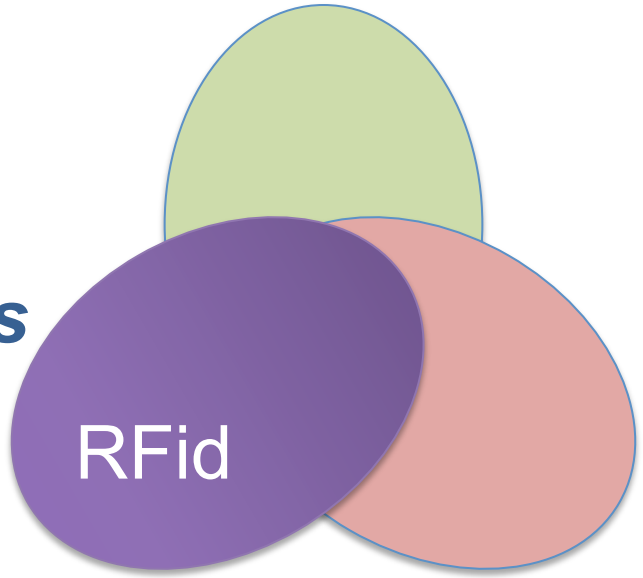
Users

Computer Science and Telecommunications
Any other discipline
(e.g. biology, agronomy, chemistry, transportation, construction, ...
sociology, psychology, law, arts, language, economy, statistics, ...)

IoT: Things

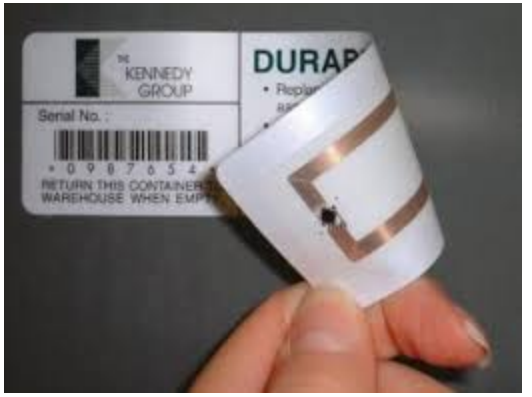


IoT: Things



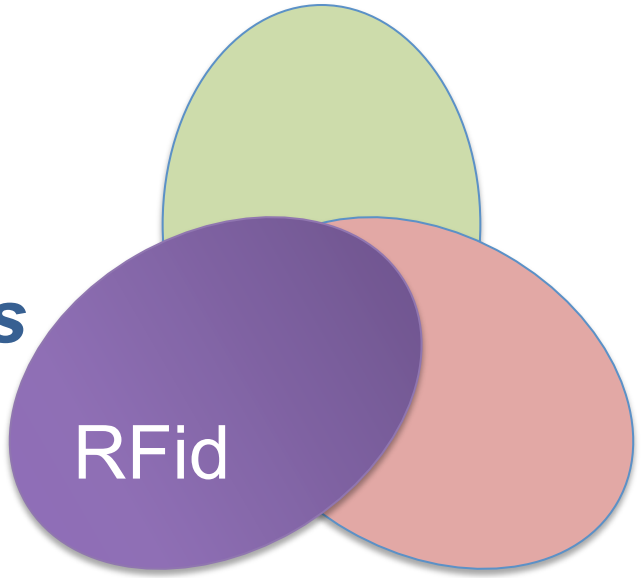
Objects equipped with RFid Tags:

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



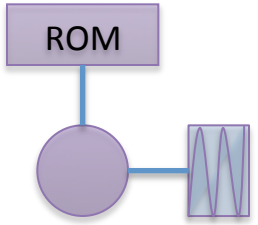
IoT: Things

Objects

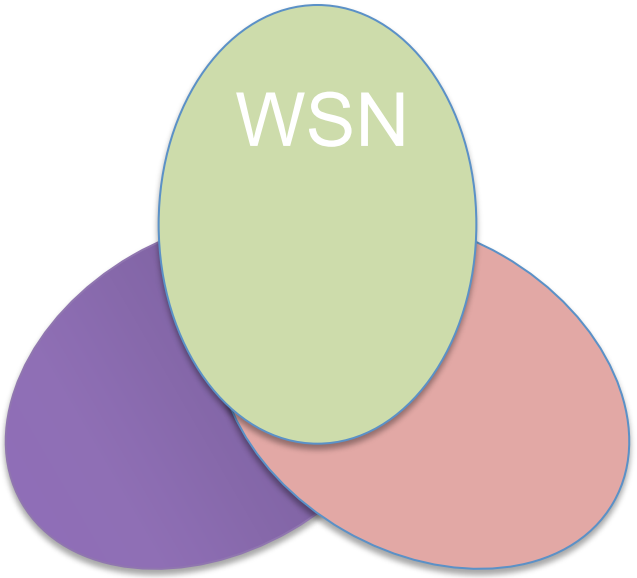


Objects equipped with RFid Tags:

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



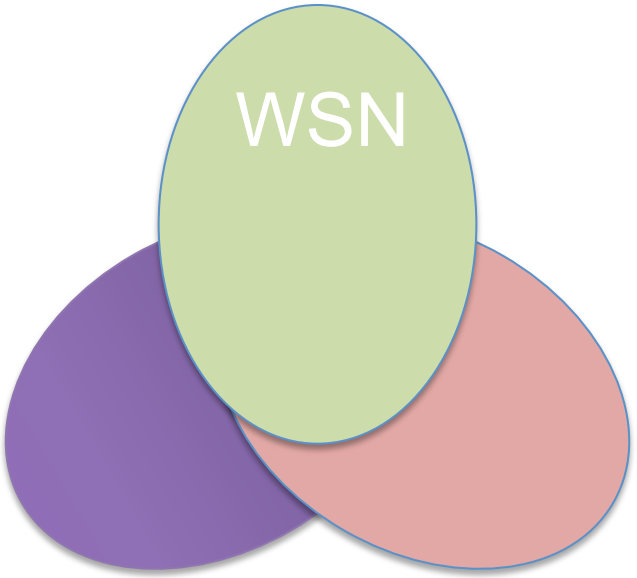
IoT: Things



(Embedded) devices equipped with sensors:

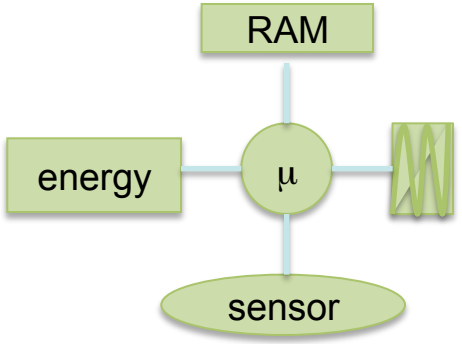
- Sensing
- Battery or energy grid
- Some computing capabilities
- Low cost

IoT: Things

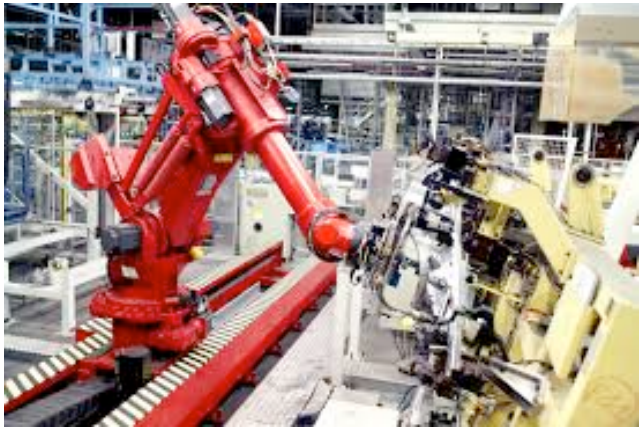


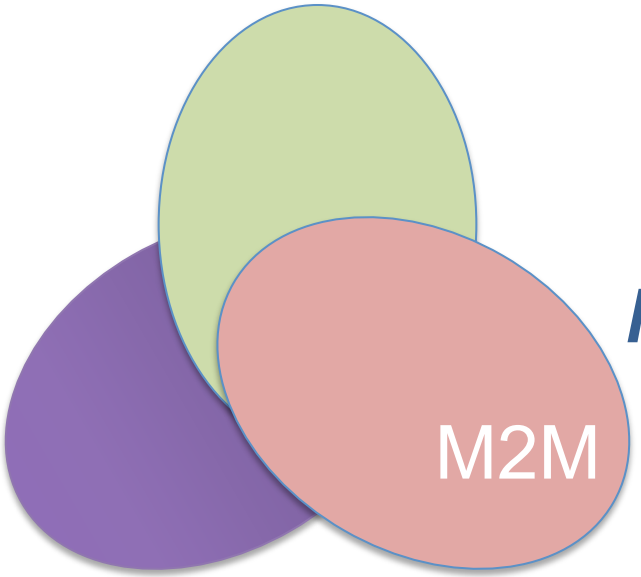
(Embedded) devices equipped with sensors:

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



IoT: Things

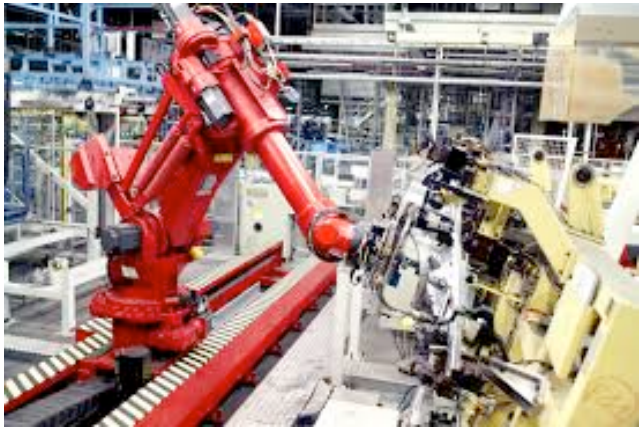


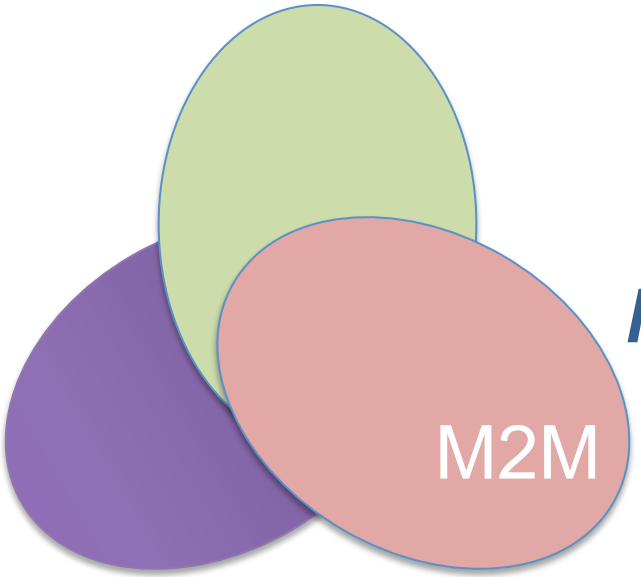


Machines equipped with sensors / actuators:

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

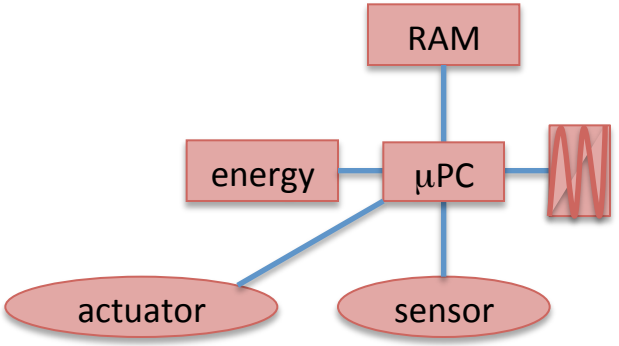
IoT: Things



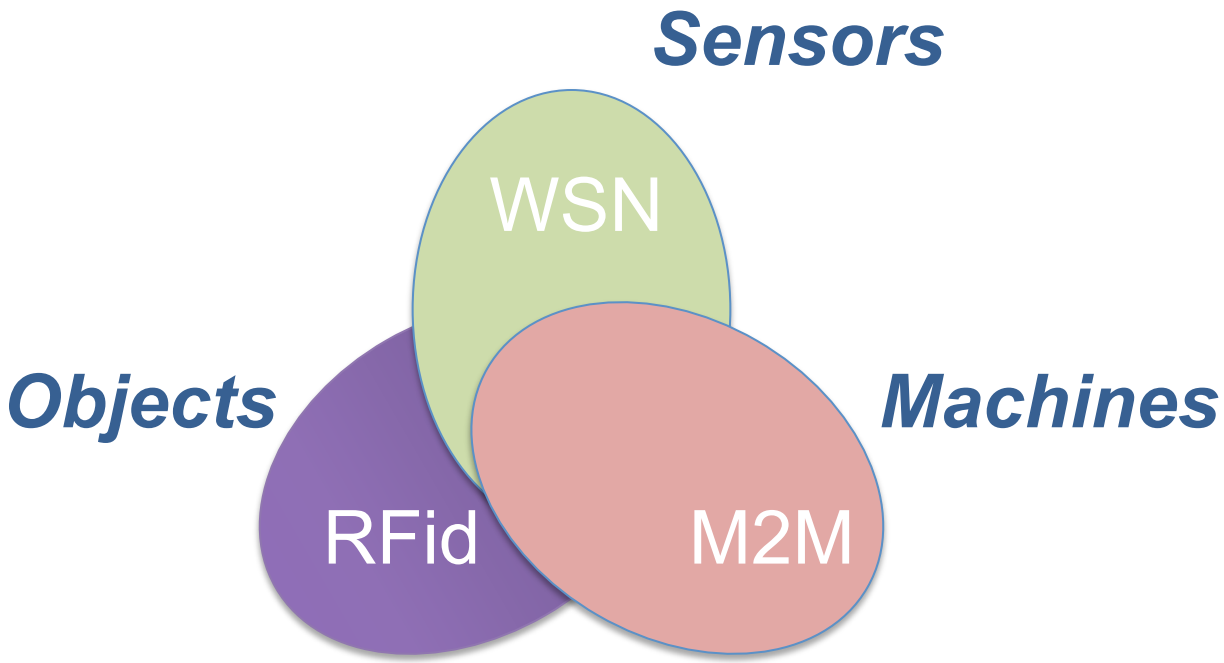


Machines equipped with sensors / actuators:

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



IoT: Things

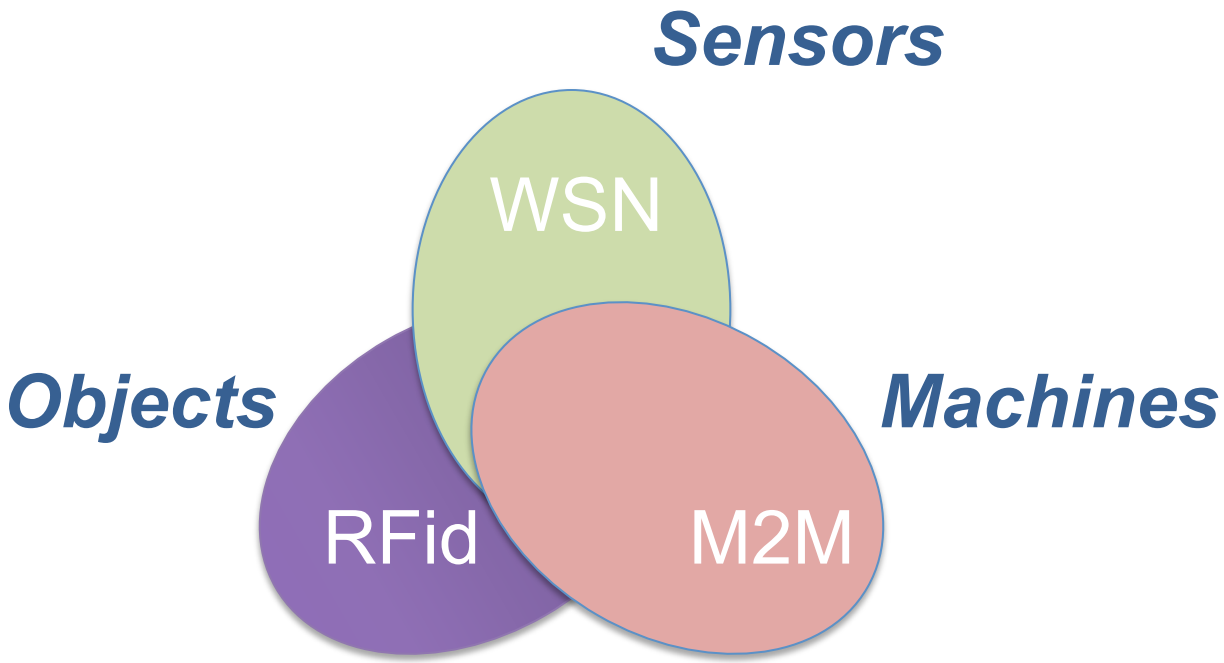


The IoT intends to connect to the Internet, wirelessly,

***unmanned* devices**

of very different nature, complexity and capabilities.

IoT: Things



Heterogeneity

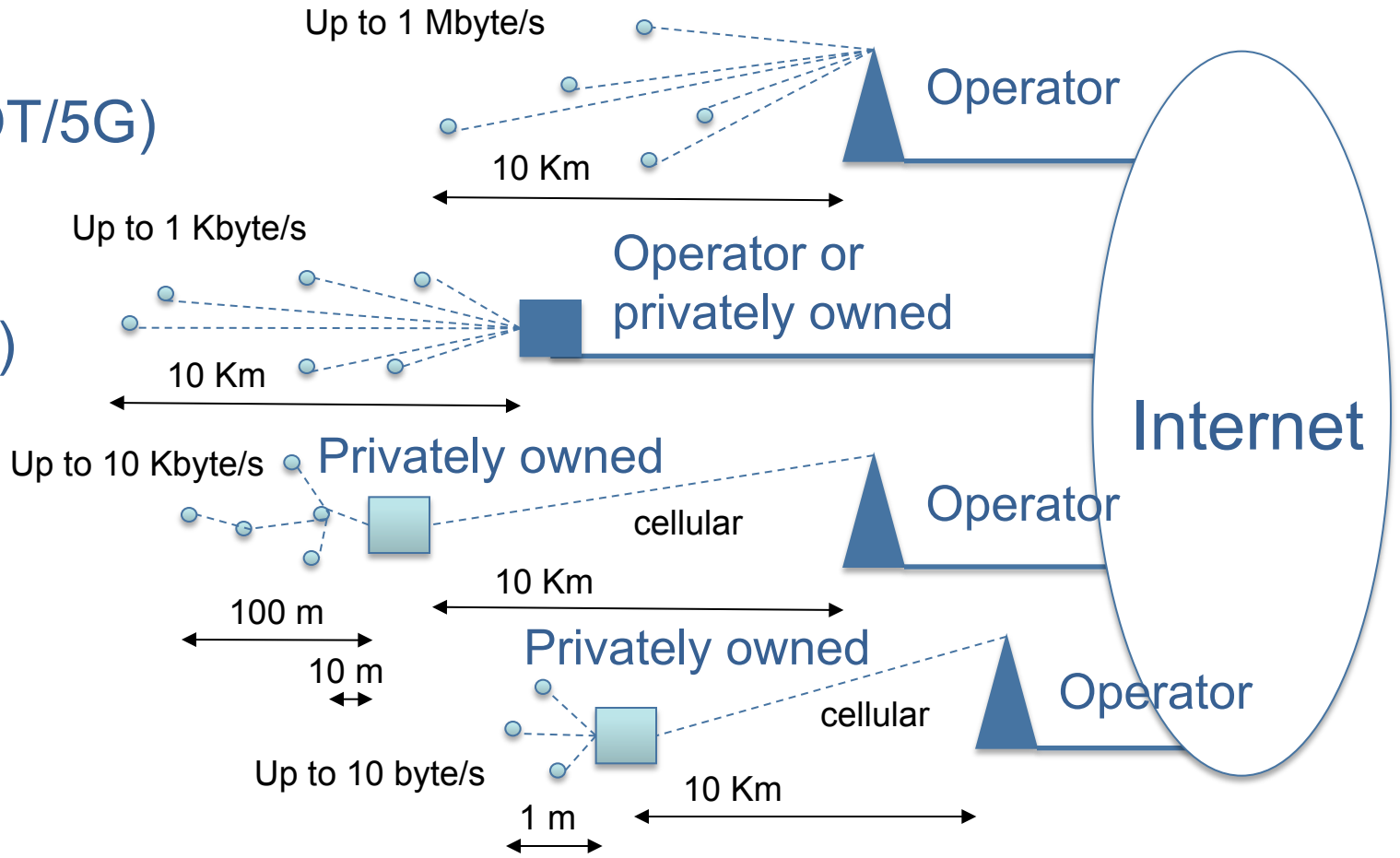
IoT: Connectivity

Cellular (GPRS/NB-IOT/5G)

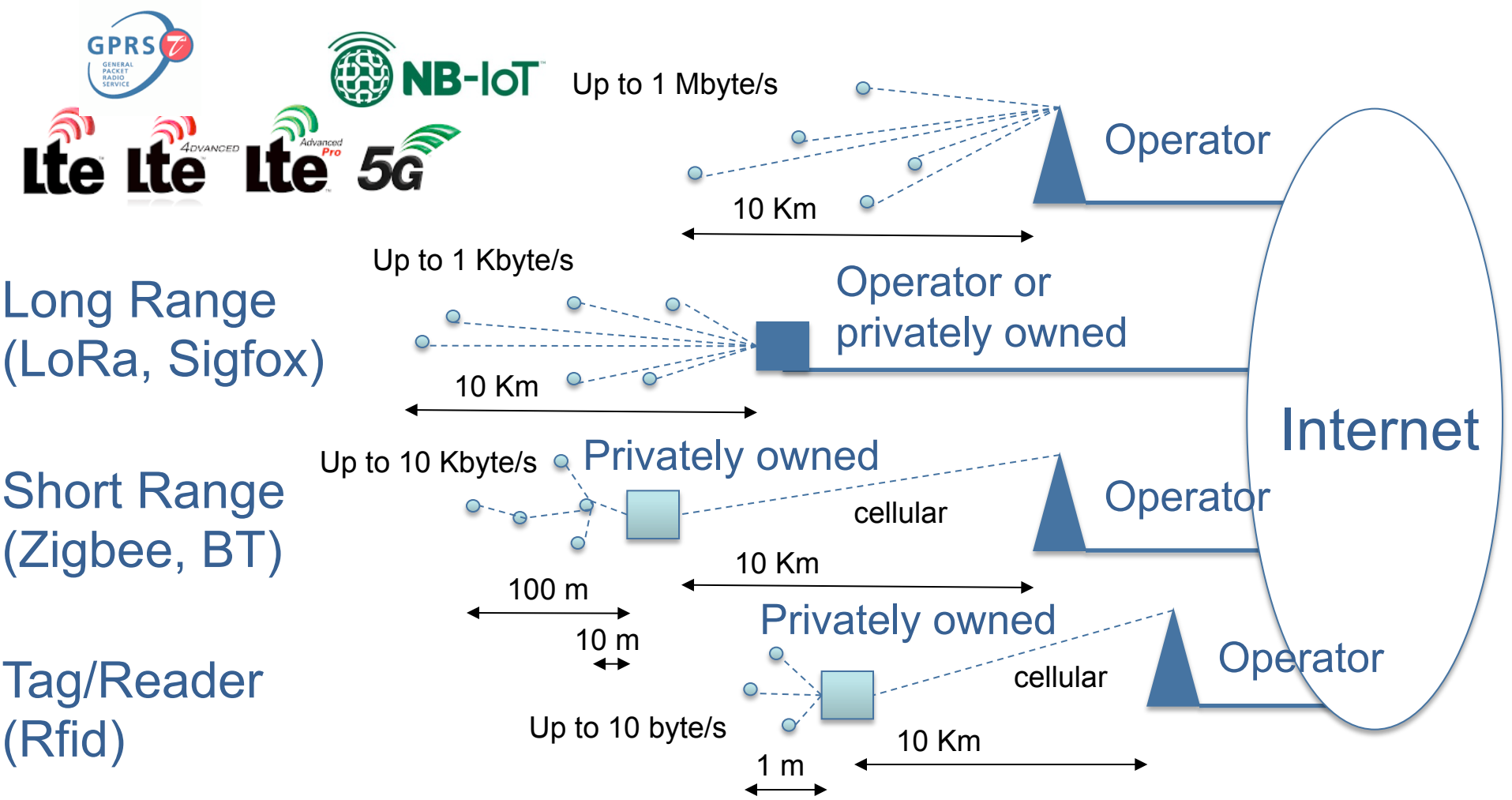
Long Range (LoRa, Sigfox)

Short Range (Zigbee, BT)

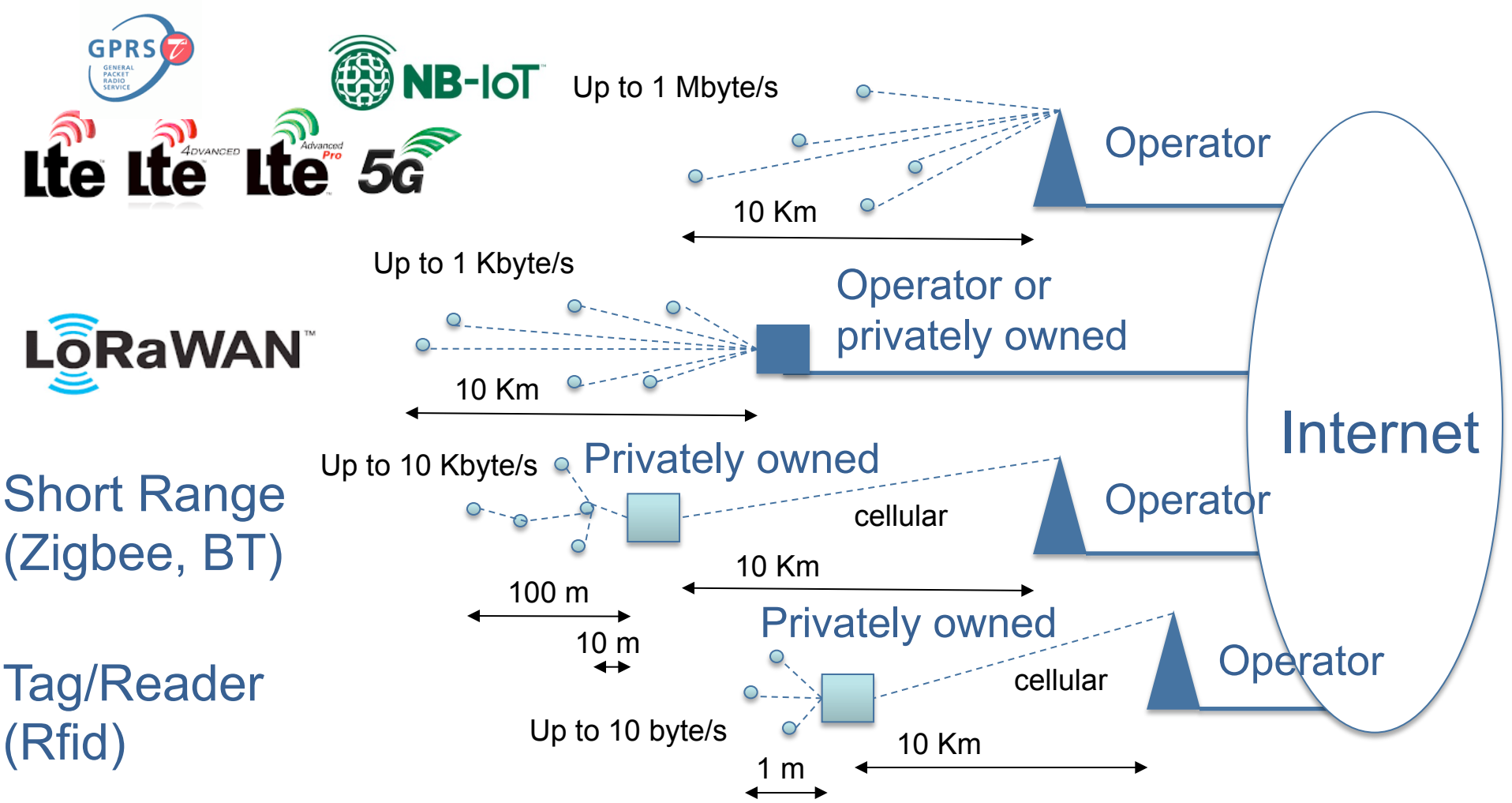
Tag/Reader (Rfid)



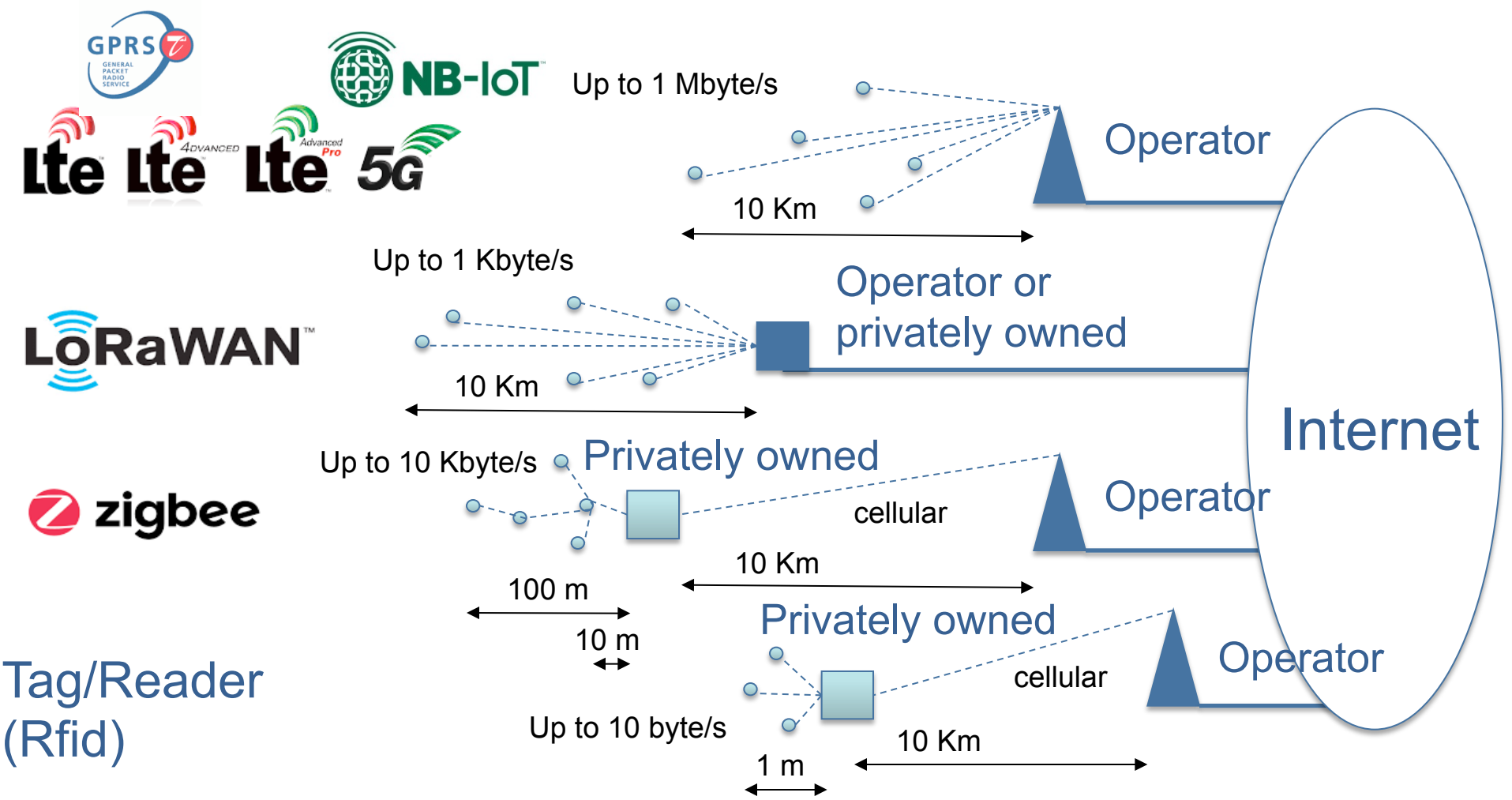
IoT: Connectivity



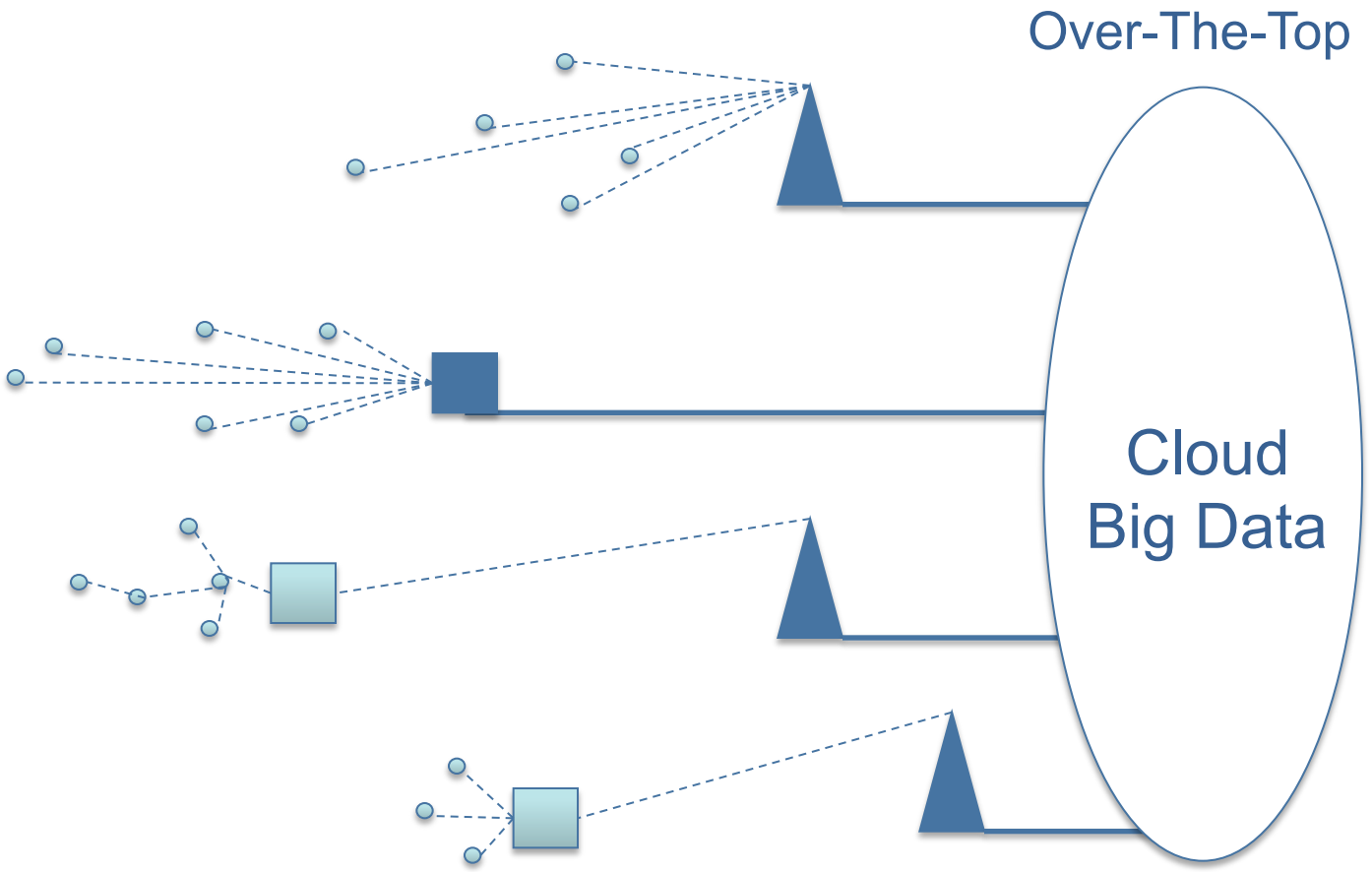
IoT: Connectivity



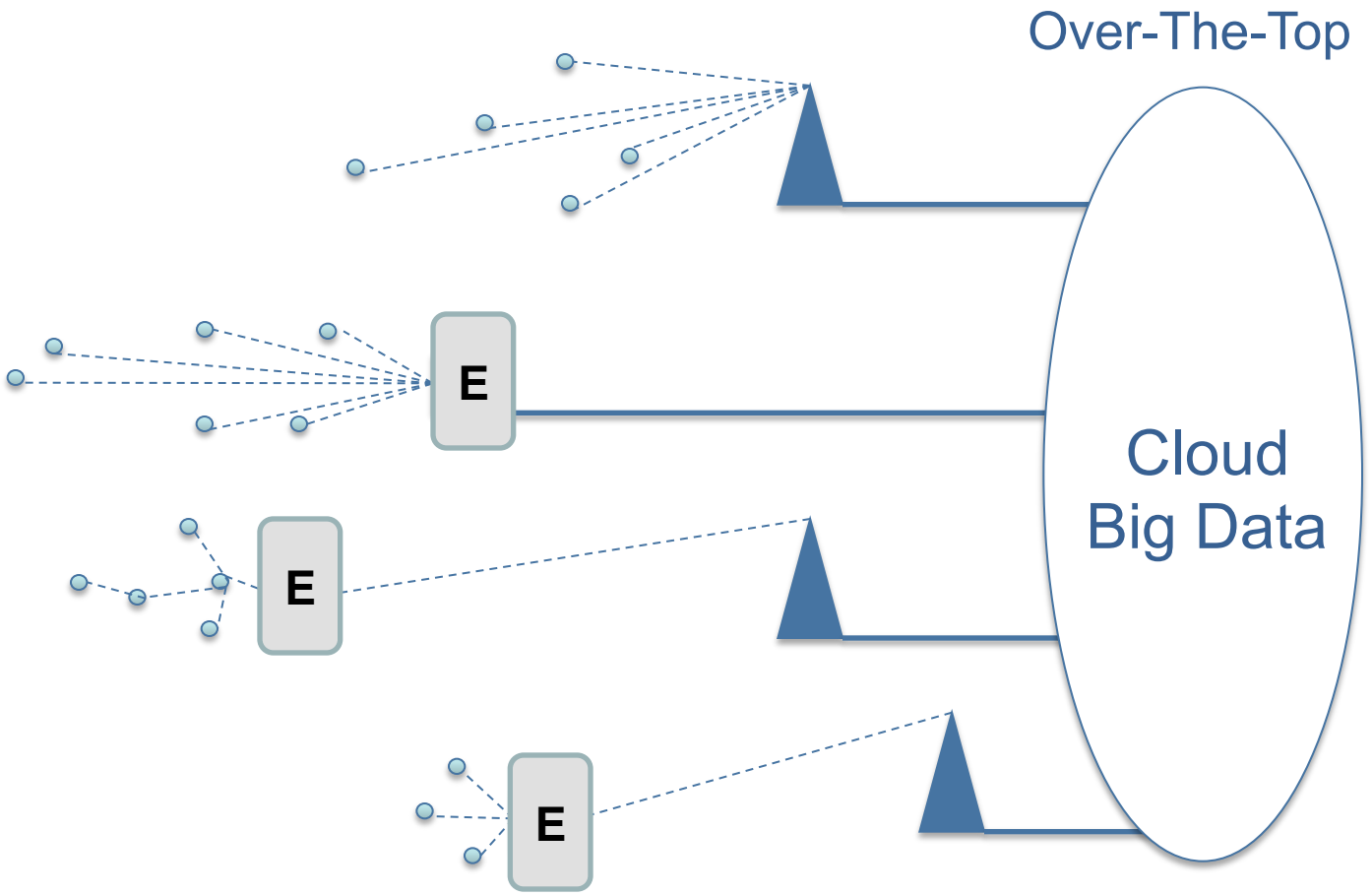
IoT: Connectivity



IoT: Cloud

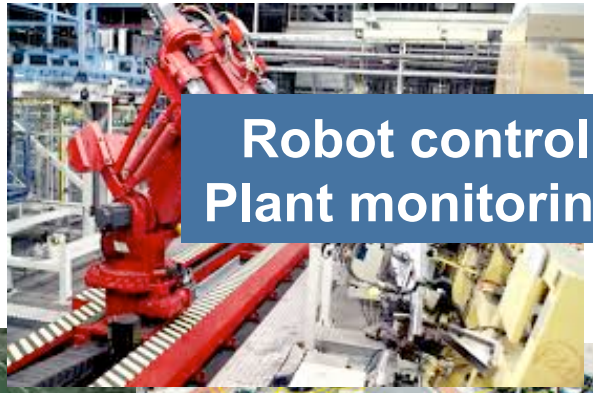


IoT: Cloud



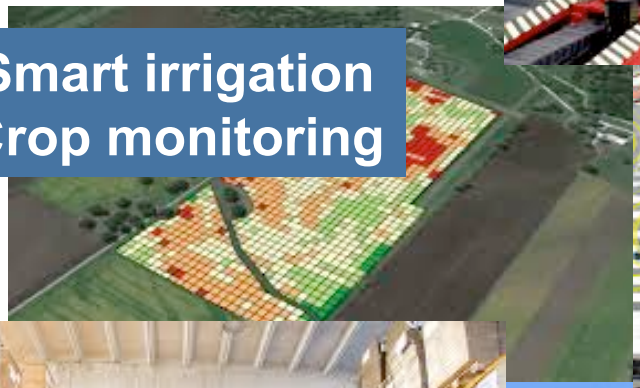
IoT: Applications

Smart Manufacturing



Robot control
Plant monitoring

Smart Agriculture



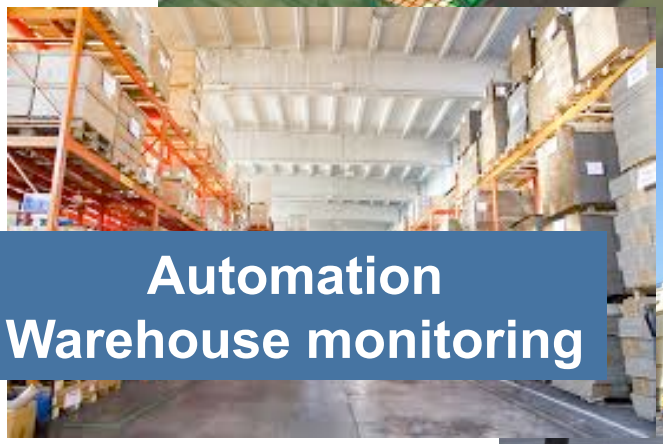
Smart irrigation
Crop monitoring

Connected Cars

Extended sensing
Driverless cars

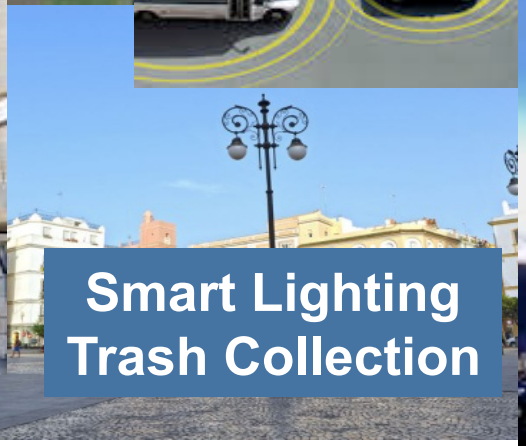
Health control
Improved quality

Smart Farming



Automation
Warehouse monitoring

Smart Spaces



Smart Lighting
Trash Collection

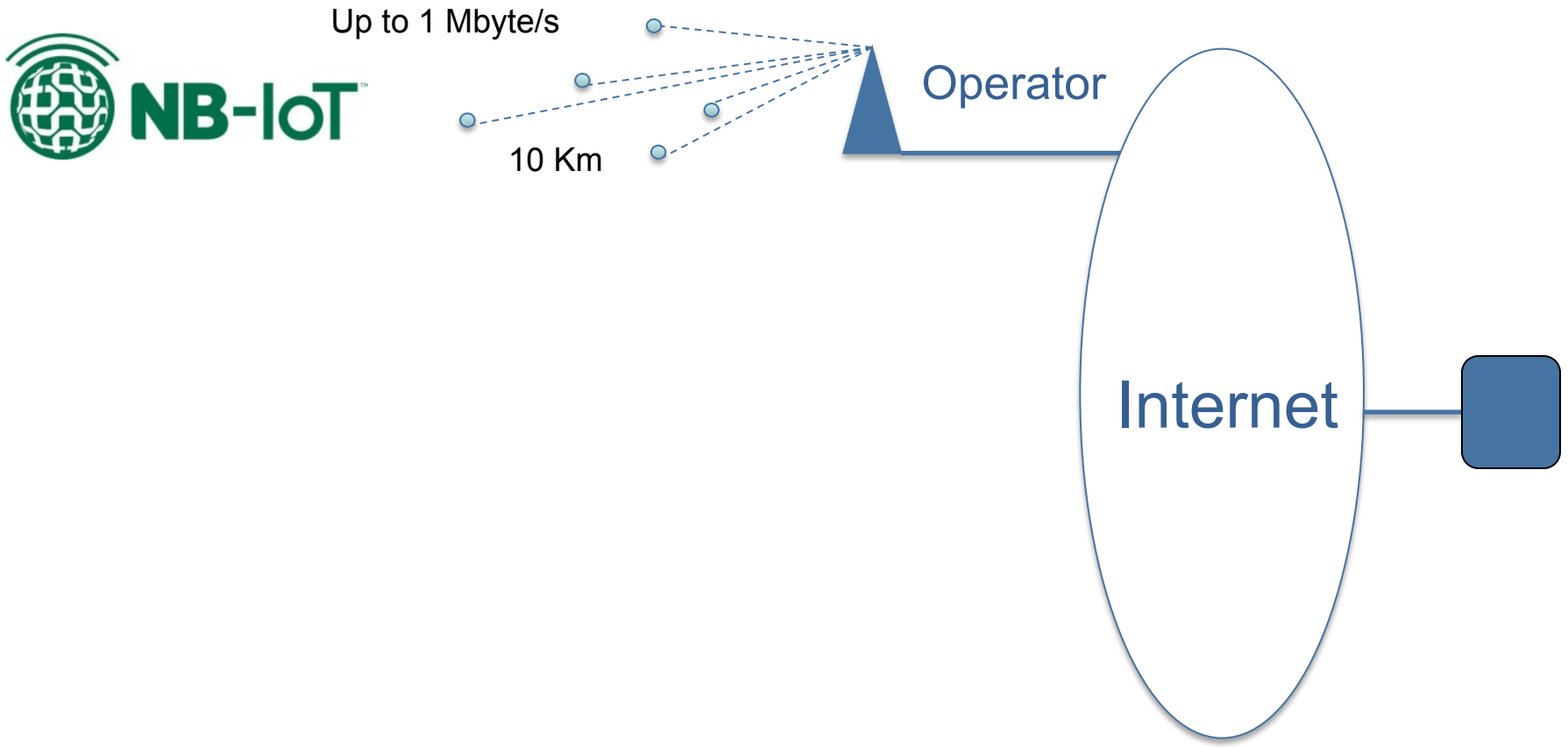
Smart Cities

Home control
Metering

Smart Buildings

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
- 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

via TEAMS