Wireless Network Technologies

IT in Supply Chain
Supply Chain Management, MSc

Details

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Wireless Networks

- Mobile Networks

- Global Positioning Networks

- Casting Networks

- Wireless LANs
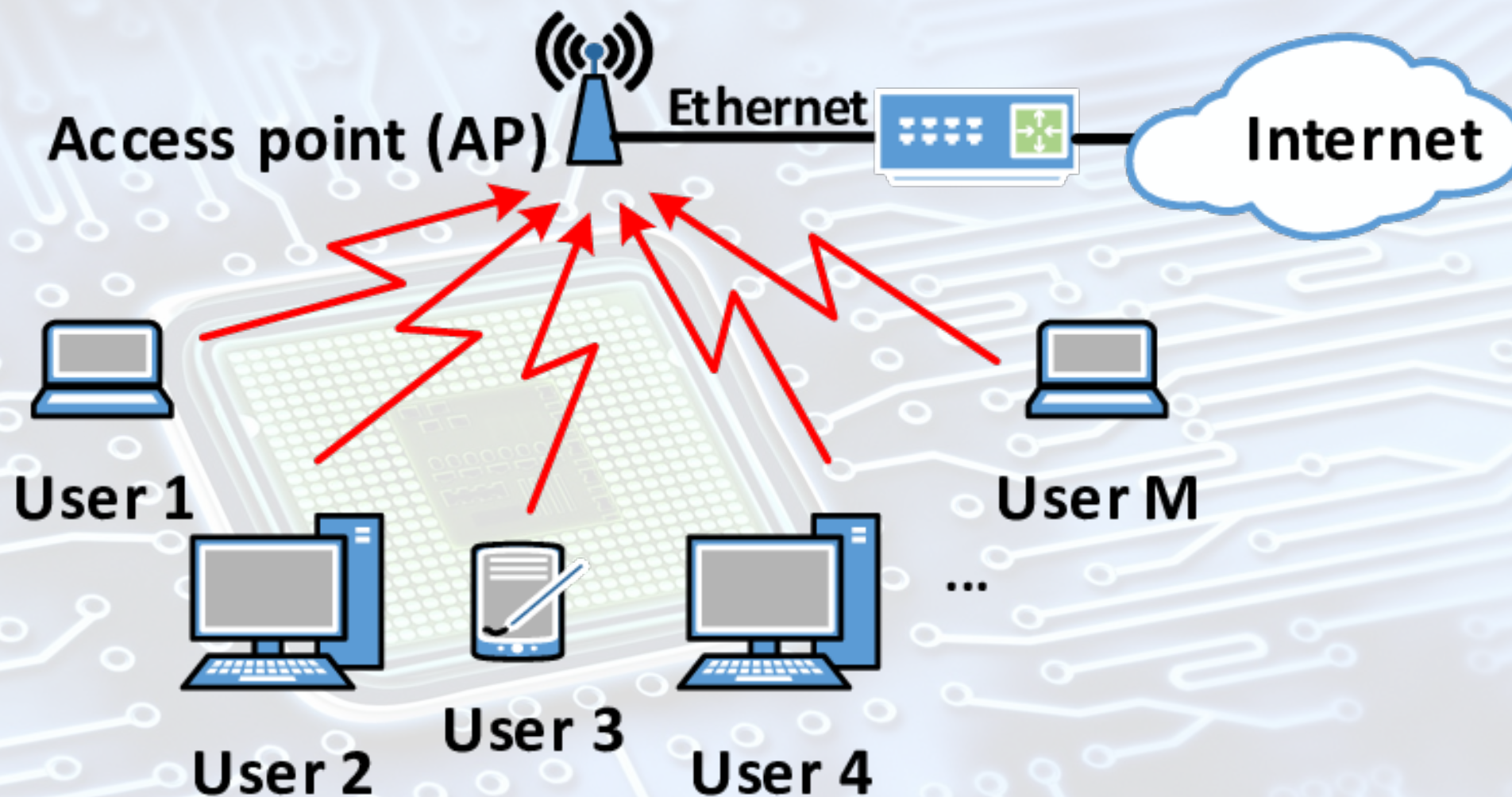
- Low Power WANs

- Wireless Mesh Networks

Mobile Networks

- 1G (analog system, just voice)
- 2G (digital system, voice and text messages)
- 2.5G (GPRS, EDGE: voice, text, small data)
- 3G (IP-based internet, ~3Mbps)
- 4G (broadband internet, ~20-30Mbps)
- LTE – Long Term Evolution (up to 100Mbps)
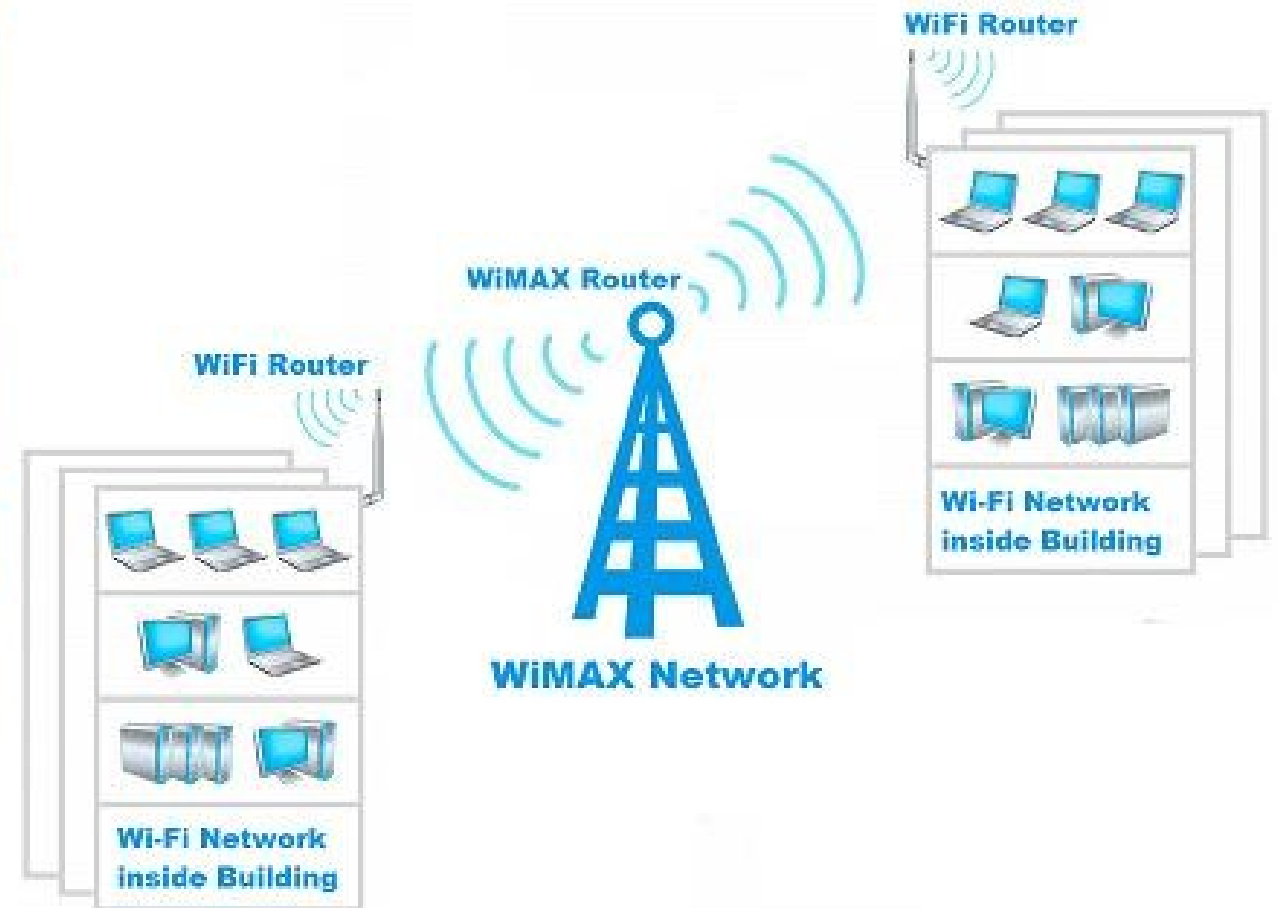- 5G (40x faster than 4G/LTE, future utilization)

Global Positioning System
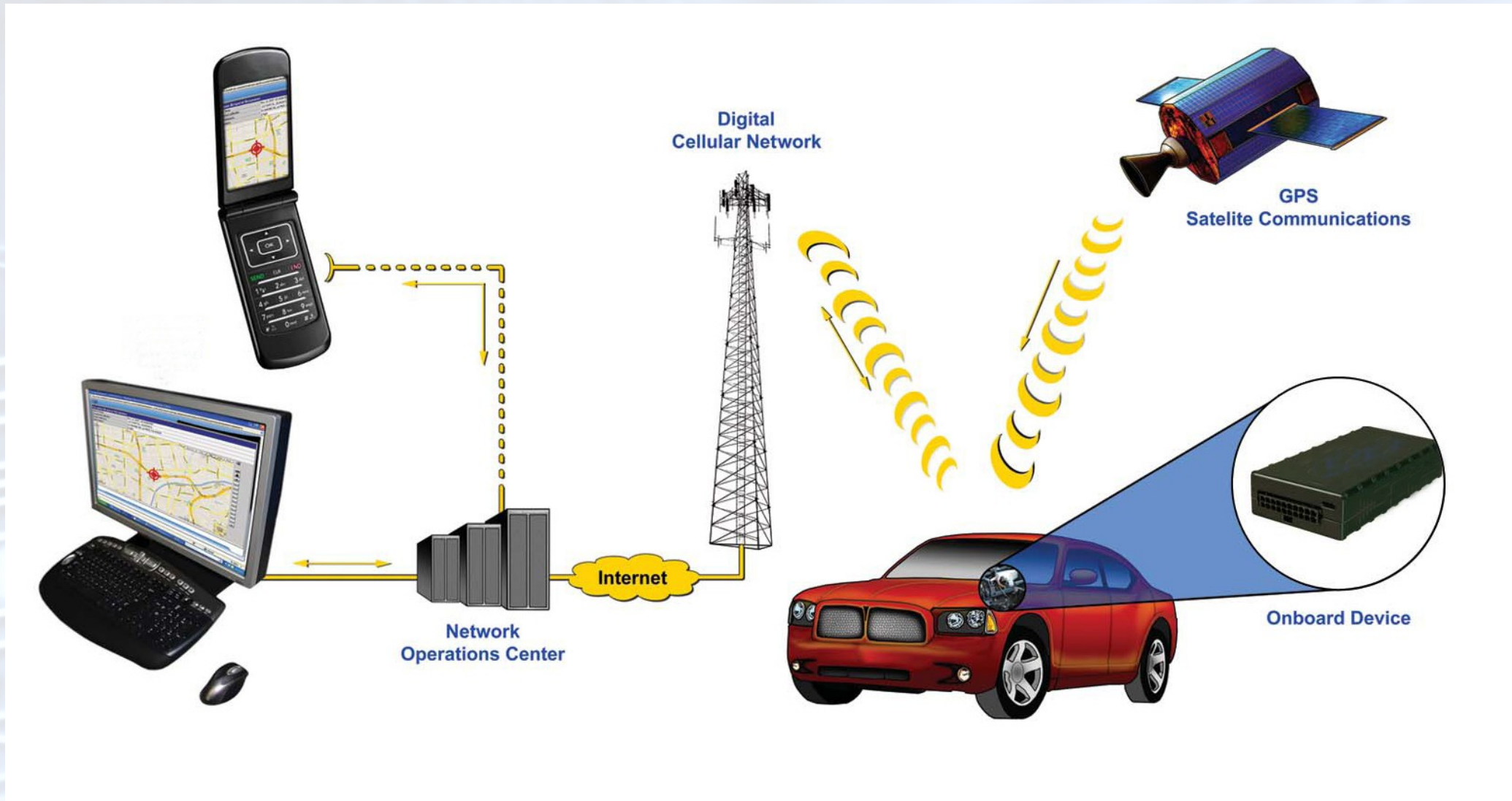
IEEE 802.11 – Wi-Fi

IEEE 802.16 – Wi-MAX

LPWANs

LPWAN technologies for IoT:

✔ Cellular technologies with licensed frequencies (EC-GSM-IoT, LTE-M, NB-IoT)

✔ Non-cellular technologies with license-free frequencies (Sigfox, LoRaWAN, Weightless, Ingenu)

LPWAN use cases

LPWA use cases

Office/factory/warehouse	Home/school/elderly care	Mountains/rivers
Remote maintenance/control, Operation optimization, staff management	Child/elderly tracking, smart meter (Electricity, Gas, Water)	Natural disasters (mudslide, flood warning, earthquake)
Public infrastructure	Transportation	Agriculture
Infrastructure/street lighting, Predictive maintenance	Cargo/palette management, Logistics management & optimization, smart parking	Water quality/temperature & humidity, live stock trucking

Cellular LPWANs

They work with licensed frequencies!

- Extended Coverage GSM for the IoT (EC-GSM-IoT)

- Narrow-band IoT (NB-IoT)

- Long Term Evolution for Machinery (LTE-M)

EC-GSM-IoT

- Based on 2.5G (eGPRS/EDGE)

- Developed before the early mobile internet era

- Can be turned on with a simple firmware upgrade (older GSM to EC-GSM-IoT)

- Compatible with 2G, 3G and 4G systems

- Low power consumption

- Wide coverage (WAN)

LTE-M

- LTE-based WAN standard for machines in the IoT

- Low power consumption

- Effectively work together with 2G, 3G and 4G systems and utilize their security and privacy benefits

- Come into general use in 2017/2018 (very new technology)

NB-IoT

- IP-based, narrow-band standard for IoT systems

- Duplex communication between smart devices

- Low power consumption, long battery life

- Secure and inexpensive devices

- Utilization of 4G/LTE technology with more simple physical layer (narrow bandwidth: 180KHz, upload: 250Kbps, download: 170Kbps, small packets)

Non-Licensed LPWANs

- LoRa

- Sigfox

- Weightless

- Telensa

- Nwave

- Bluetooth

- IQRF

} Mesh capable

LoRa

- Long Range Radio (LoRa Alliance)

- Chirp spread spectrum radio modulation

- Small packets, fast transmission

- Few-dollars microchips and ~$150-200 gateways
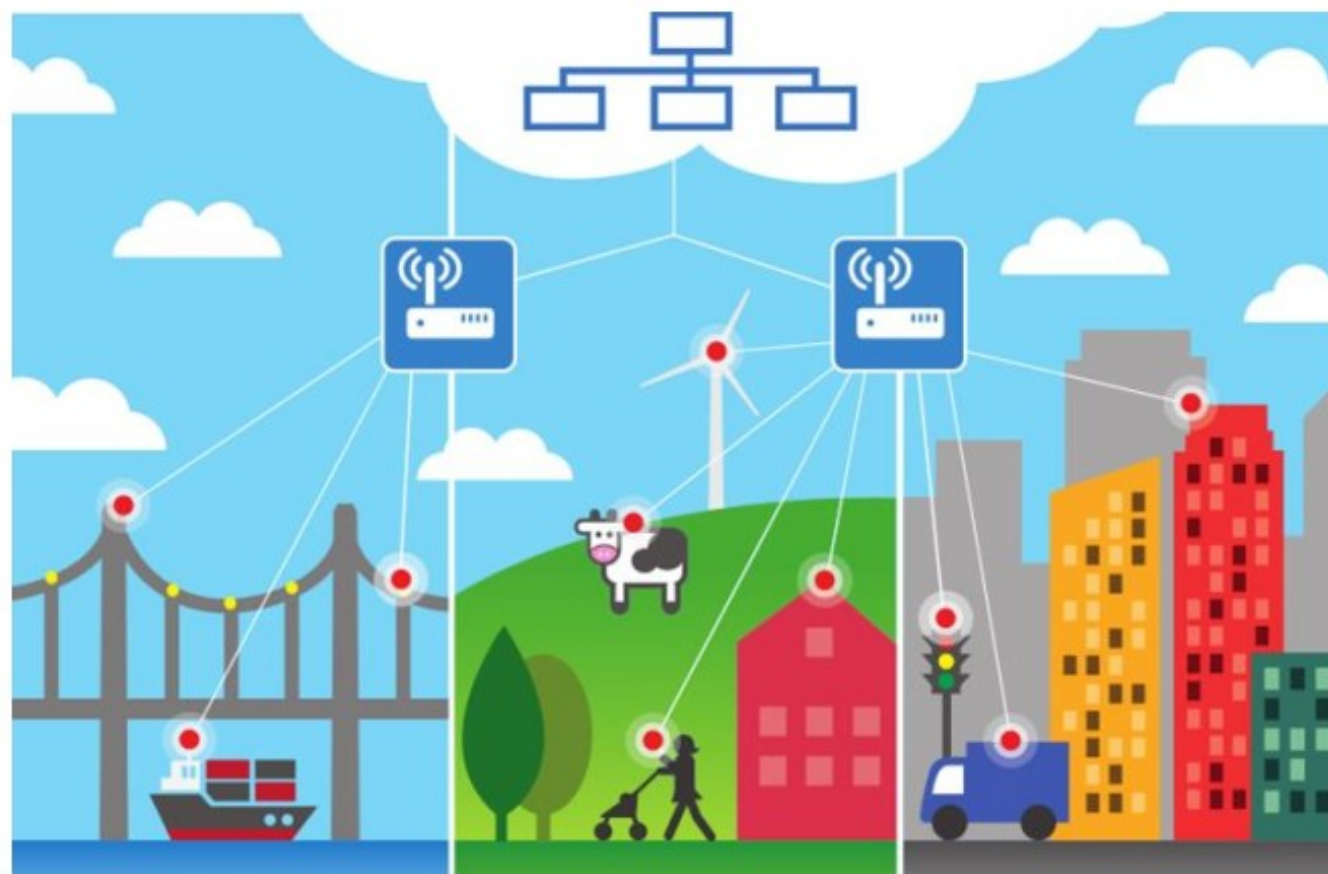
- 50 end-devices at the same time in 1 gateway

LoRaWAN

- LoRa-based WAN for IoT

- License-free frequencies (433/868/923 MHz)

- Star and/or mesh topology

- The end-devices can't talk to each other

- Low power consumption, low costs

- Data transfer with or without receipt

LoRaWAN – Topology
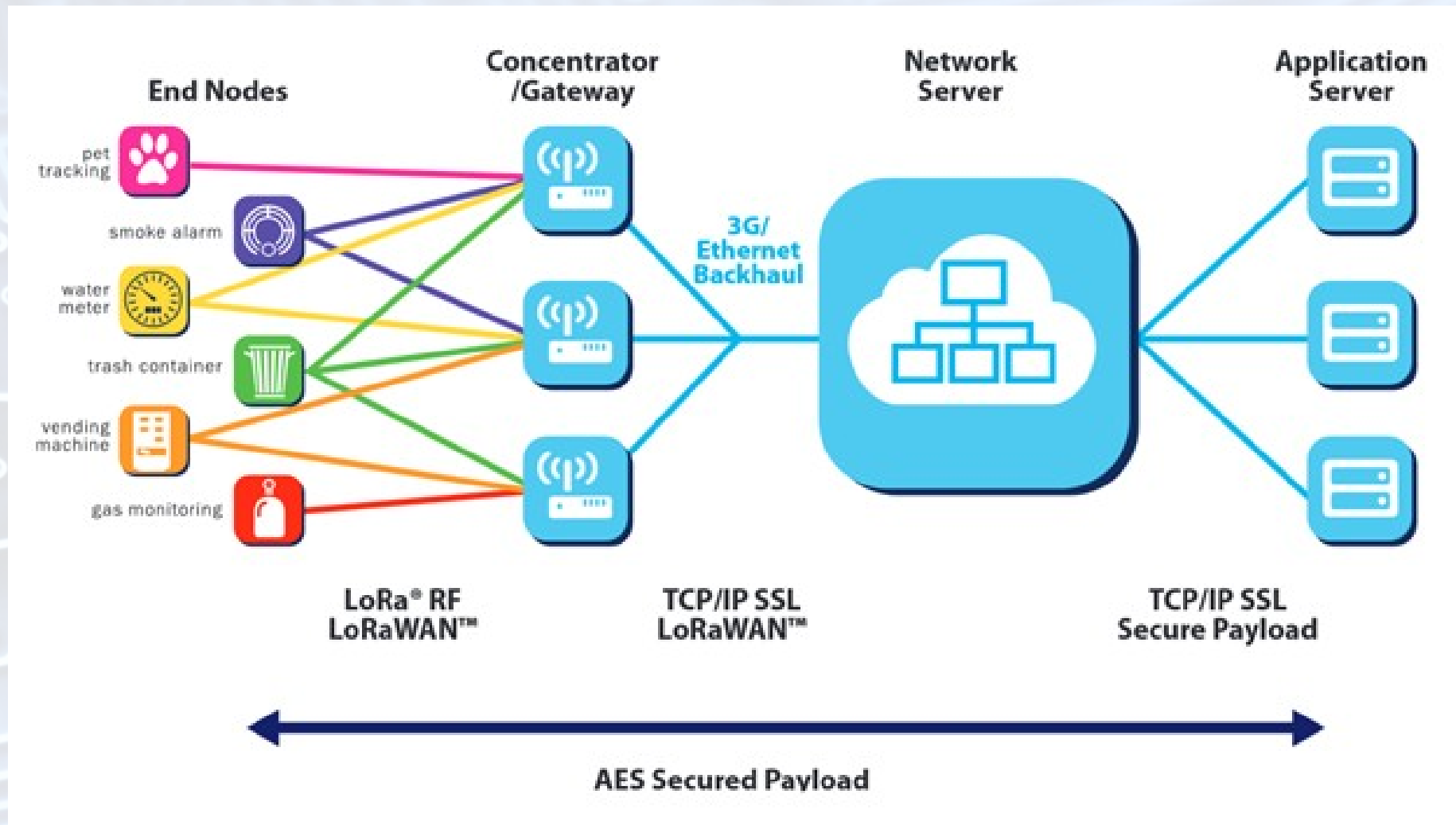
LoRaWAN – Applications

Monitoring / Control   **Smart Agriculture**   **Smart City**

Light Control   **Smart Energy**   **Smart Home and Security**

Sigfox

- Ultra Narrow Band Modulation

- Short messages

- Low power consumption

- Low costs and great capacity

- License-free frequency
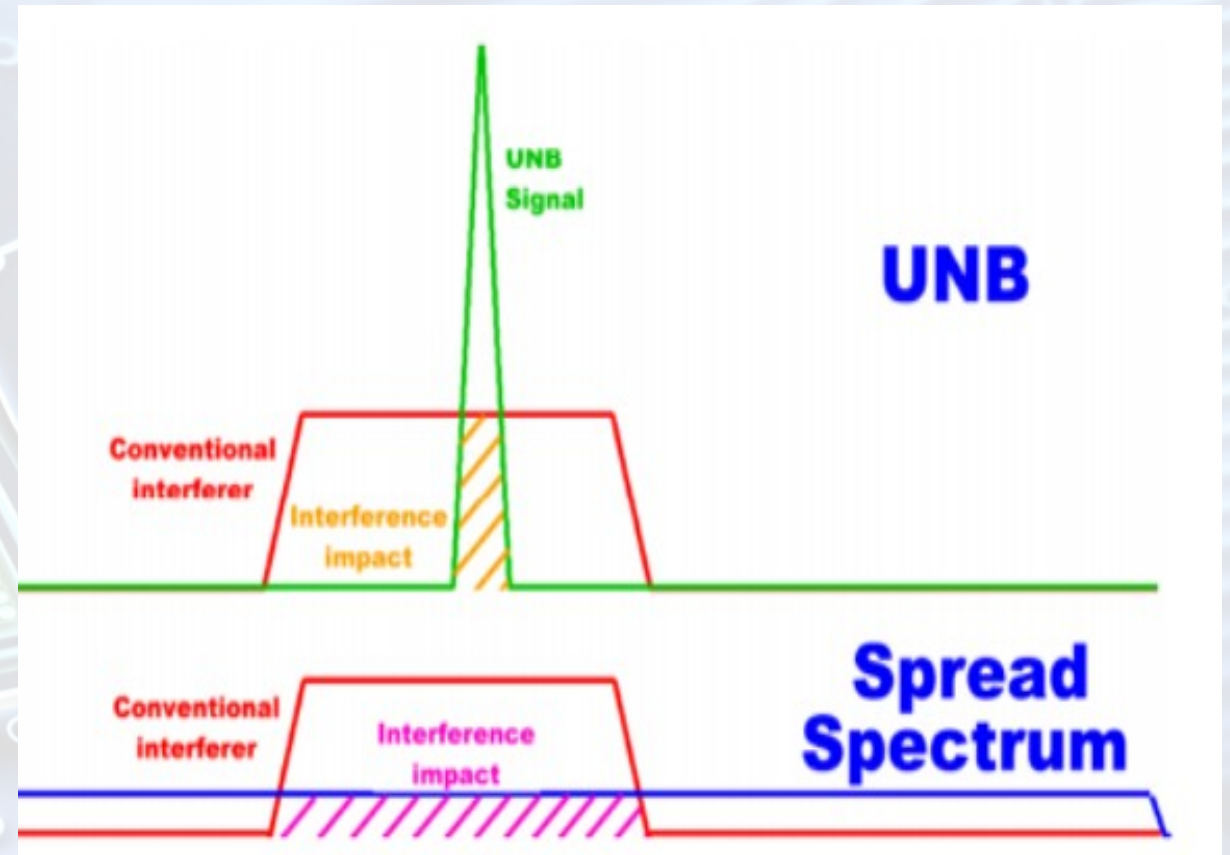
Sigfox – Messages

- Up to 12 Bytes/message

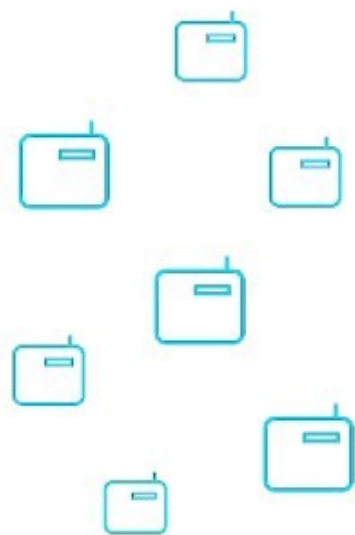- Up to 140 messages/day (depends on the agreement)
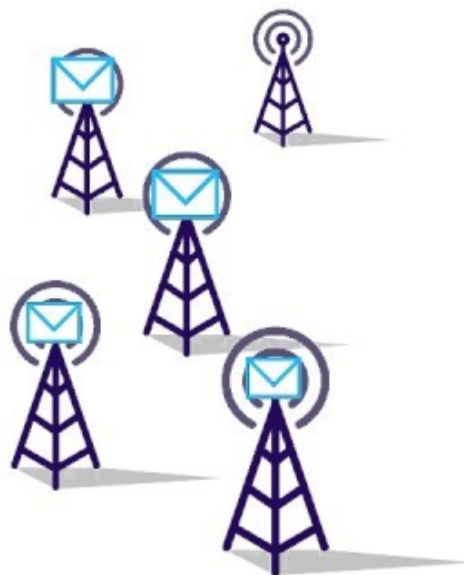
- Up to 600 bps

sigfox
12 messages
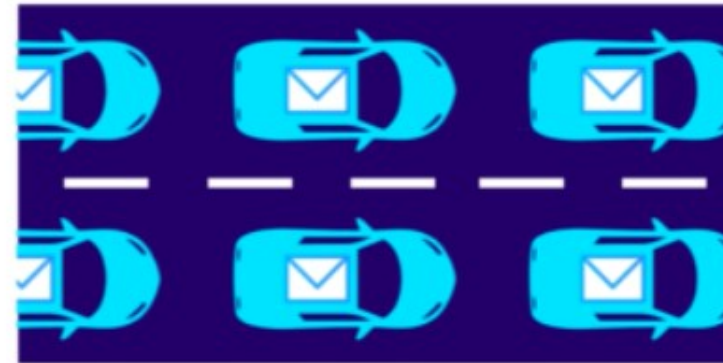
Conventional
6 messages

Sigfox – Topology
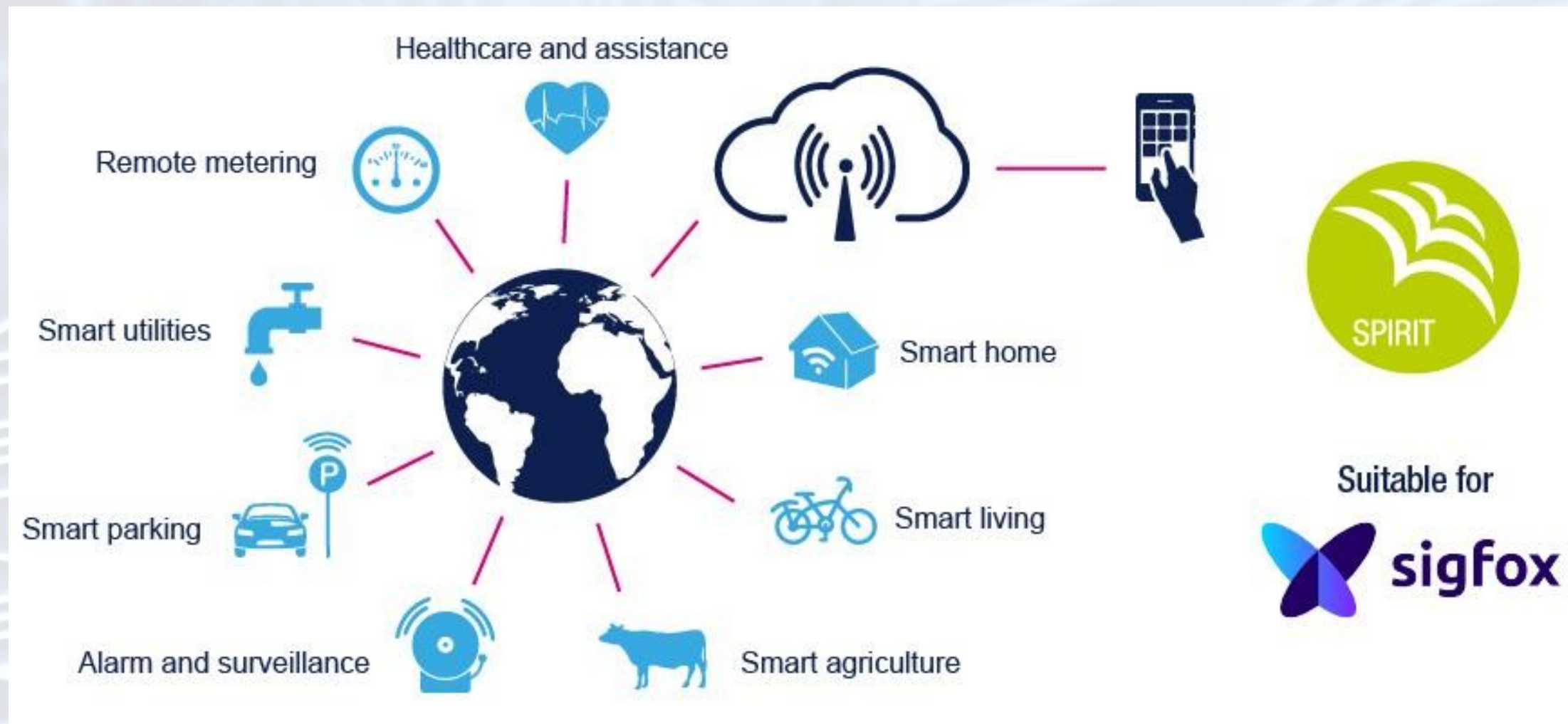

Objects — Sigfox stations — Sigfox CLOUD™ — Customer IT
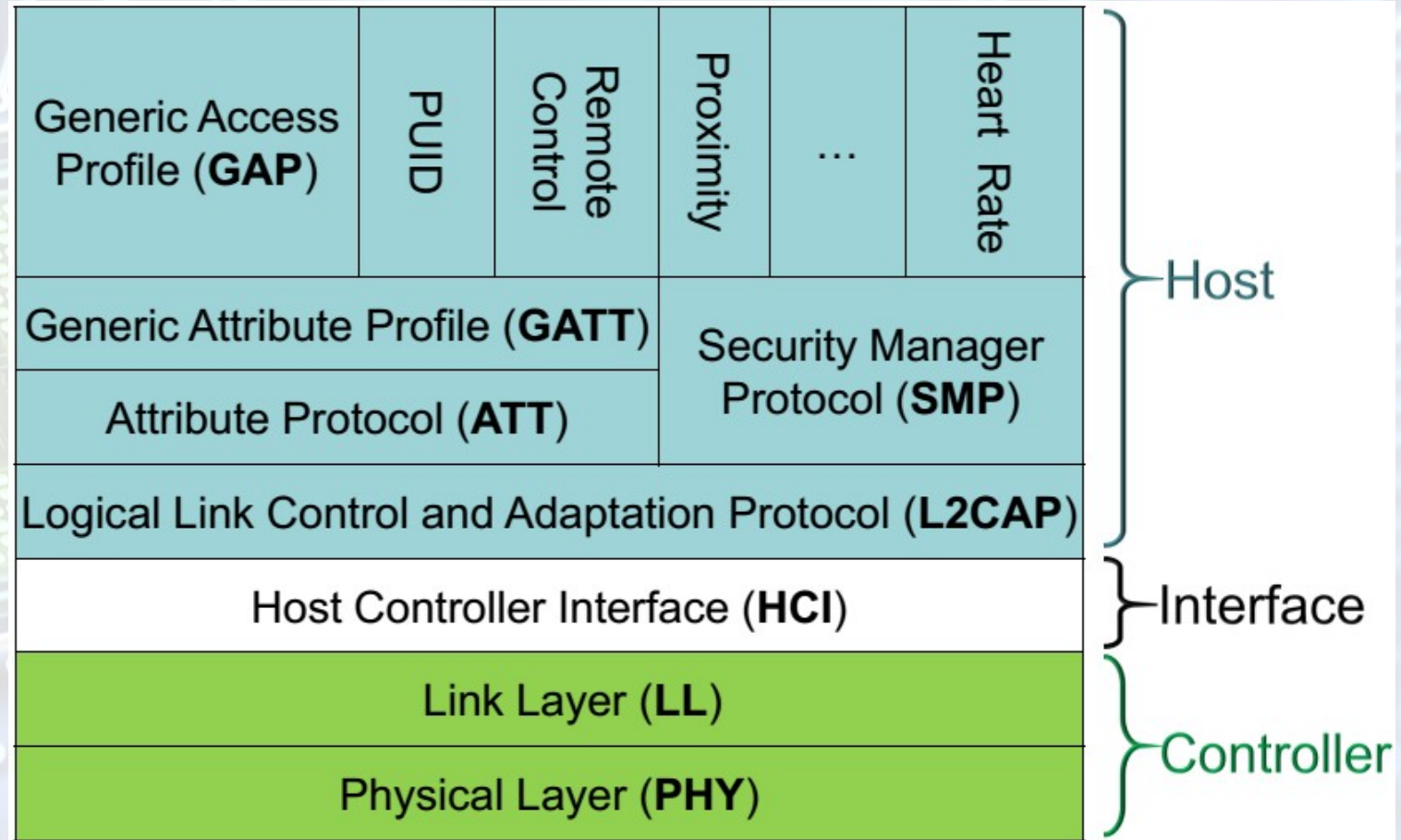
sigfox

Sigfox – Applications

Bluetooth

- Short range radio technology

- 2.4 GHz ISM band

- Up to 250 meters (Bluetooth 5)

- Simplex and duplex communication

Bluetooth – Core Stack

- Bluetooth Classic

- Bluetooth Low Energy

Generic Access Profile (GAP)	PUID	Remote Control	Proximity	…	Heart Rate		Host
Generic Attribute Profile (GATT)			Security Manager Protocol (SMP)				
Attribute Protocol (ATT)							
Logical Link Control and Adaptation Protocol (L2CAP)							
Host Controller Interface (HCI)							Interface
Link Layer (LL)							Controller
Physical Layer (PHY)							

Bluetooth – Channels

- 37 Data channels

- 3 Advertising channels

- 2.4 GHz ISM band, 2 MHz wide channels
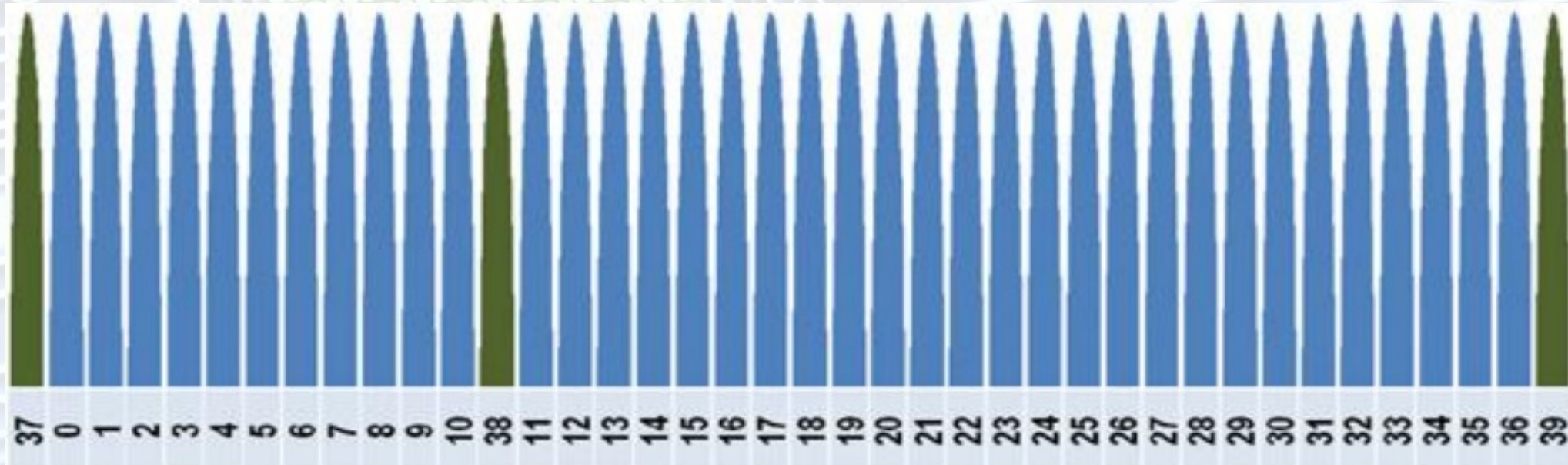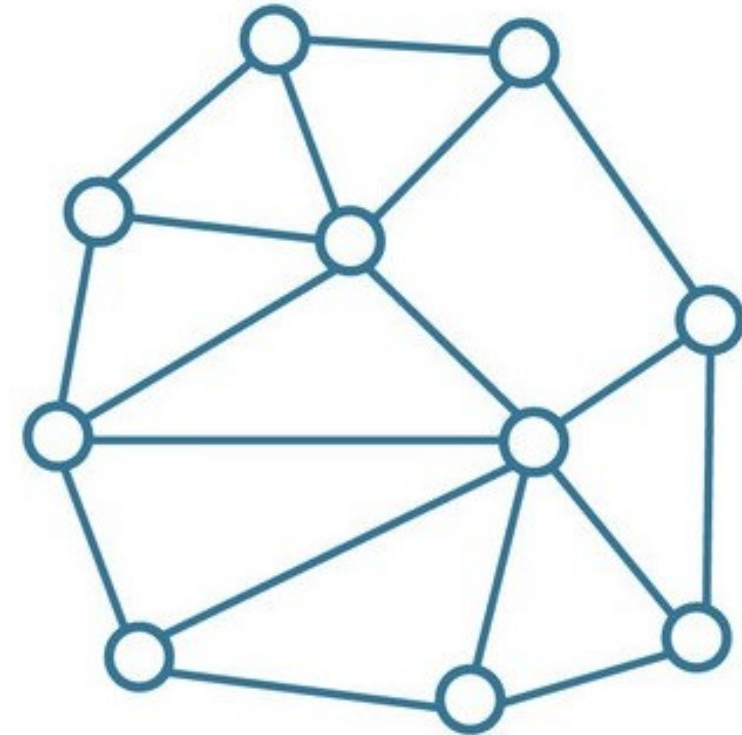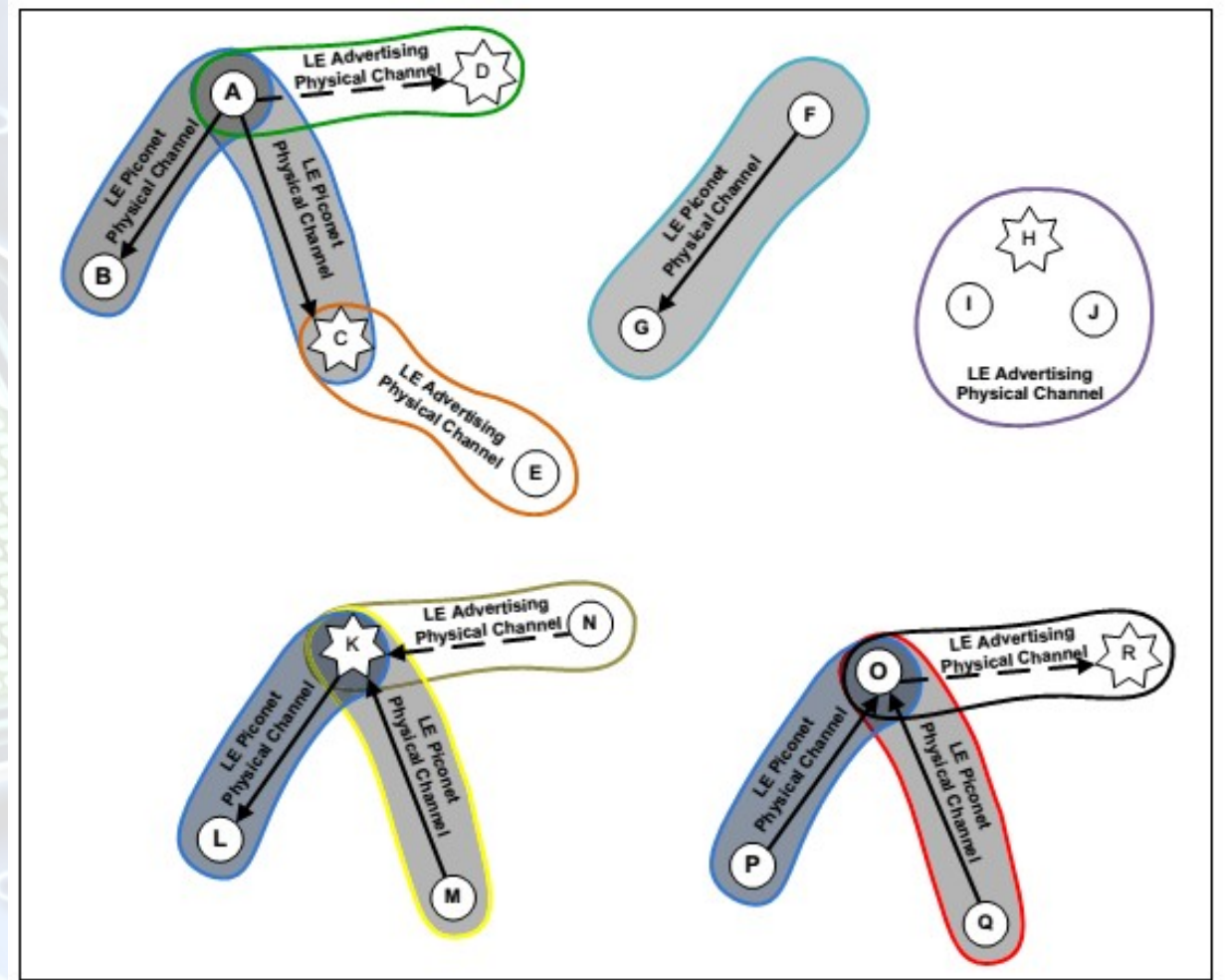
Bluetooth – Topology

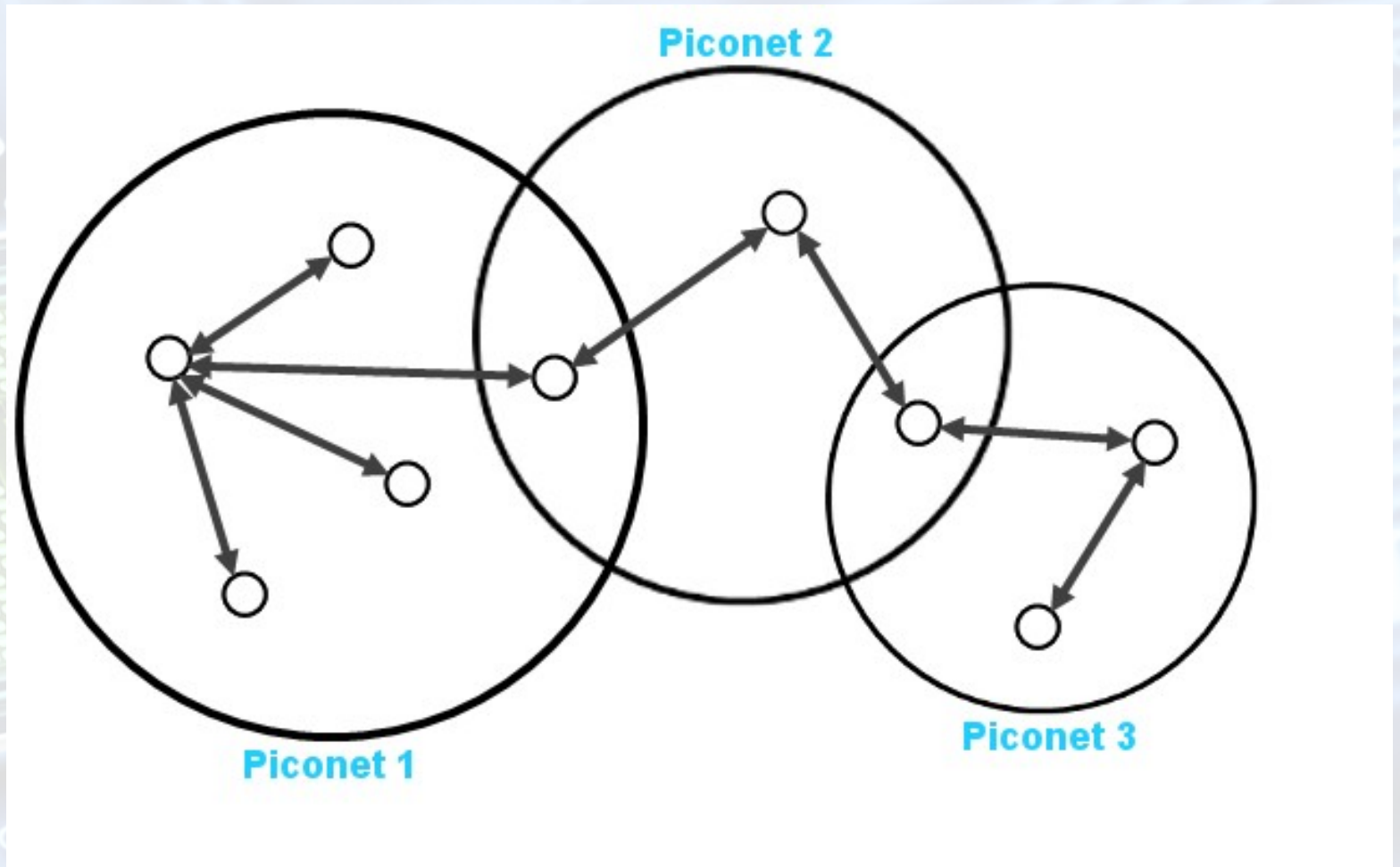Pairing   Broadcasting   Mesh

Bluetooth – Piconet

Piconet:

- 1 master

- 7 active slaves
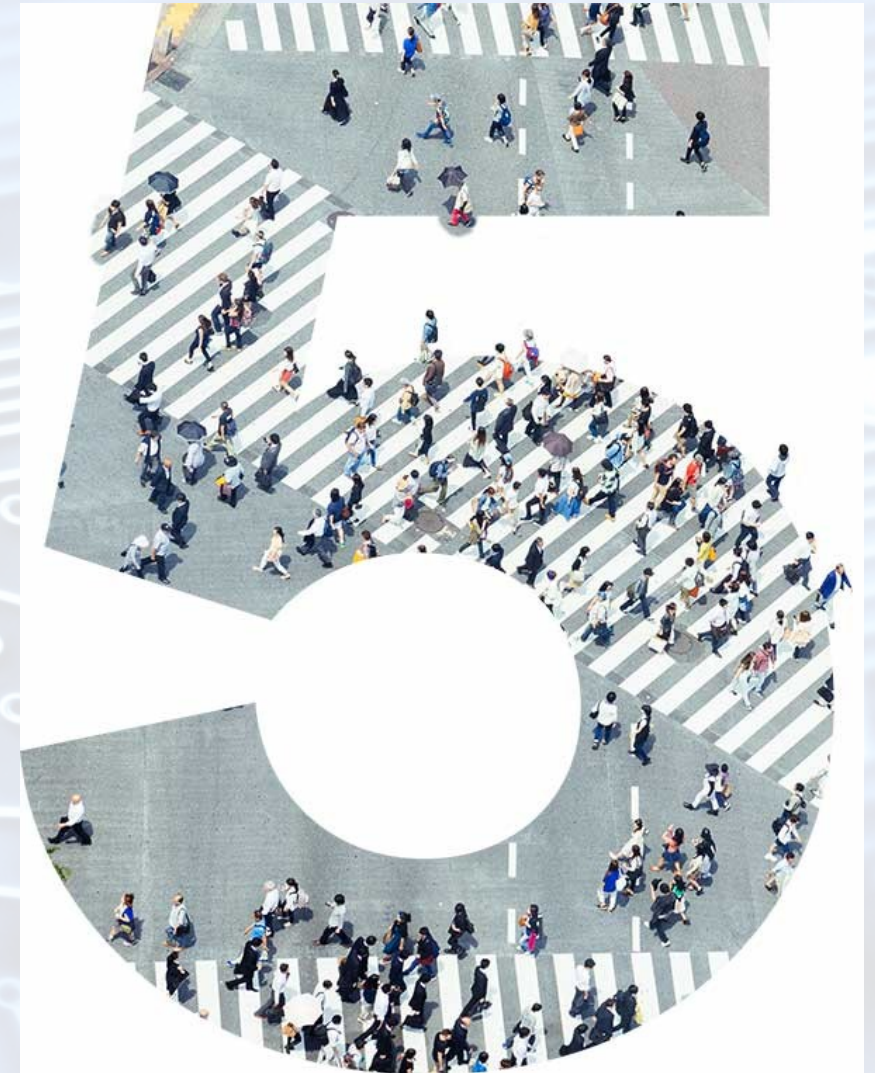
- 255 waiting slaves

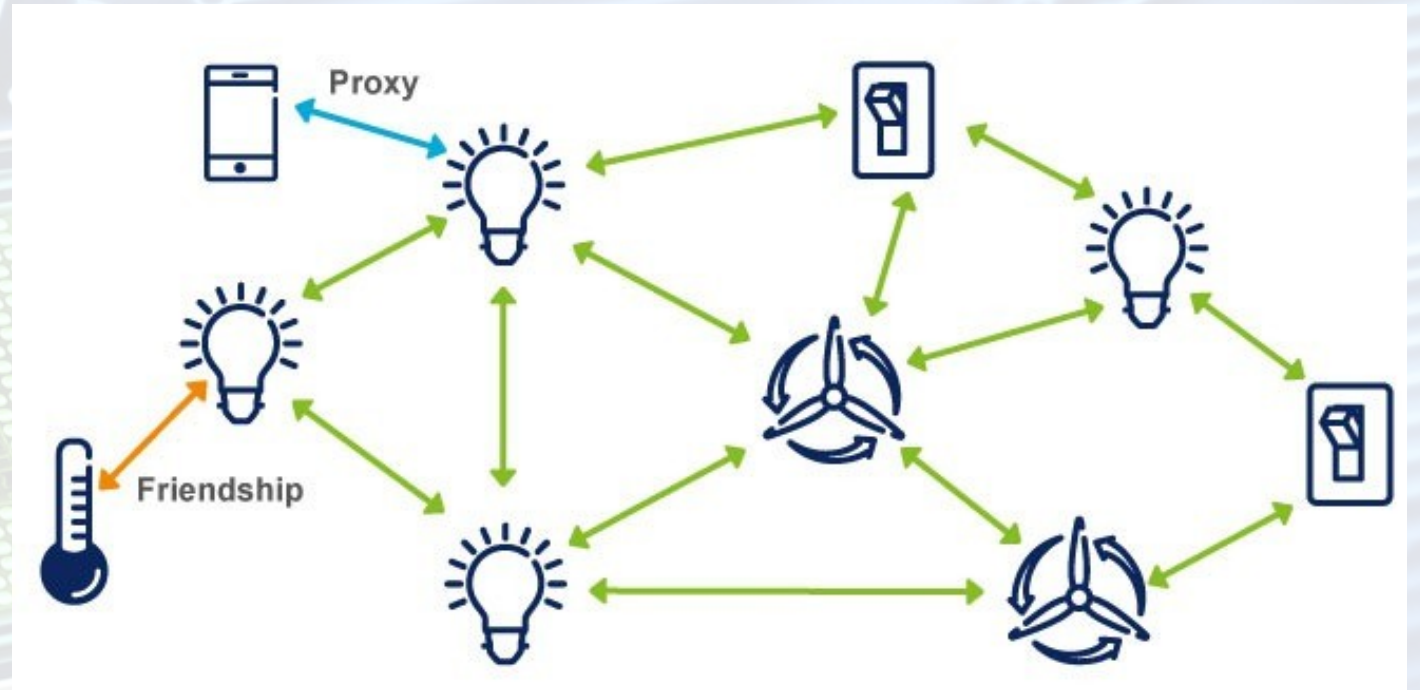# Bluetooth – Scatternet

Connected
Piconets

Bluetooth 5

- Up to 2x speed
- Up to 4x distance
- Up to 8x throughput
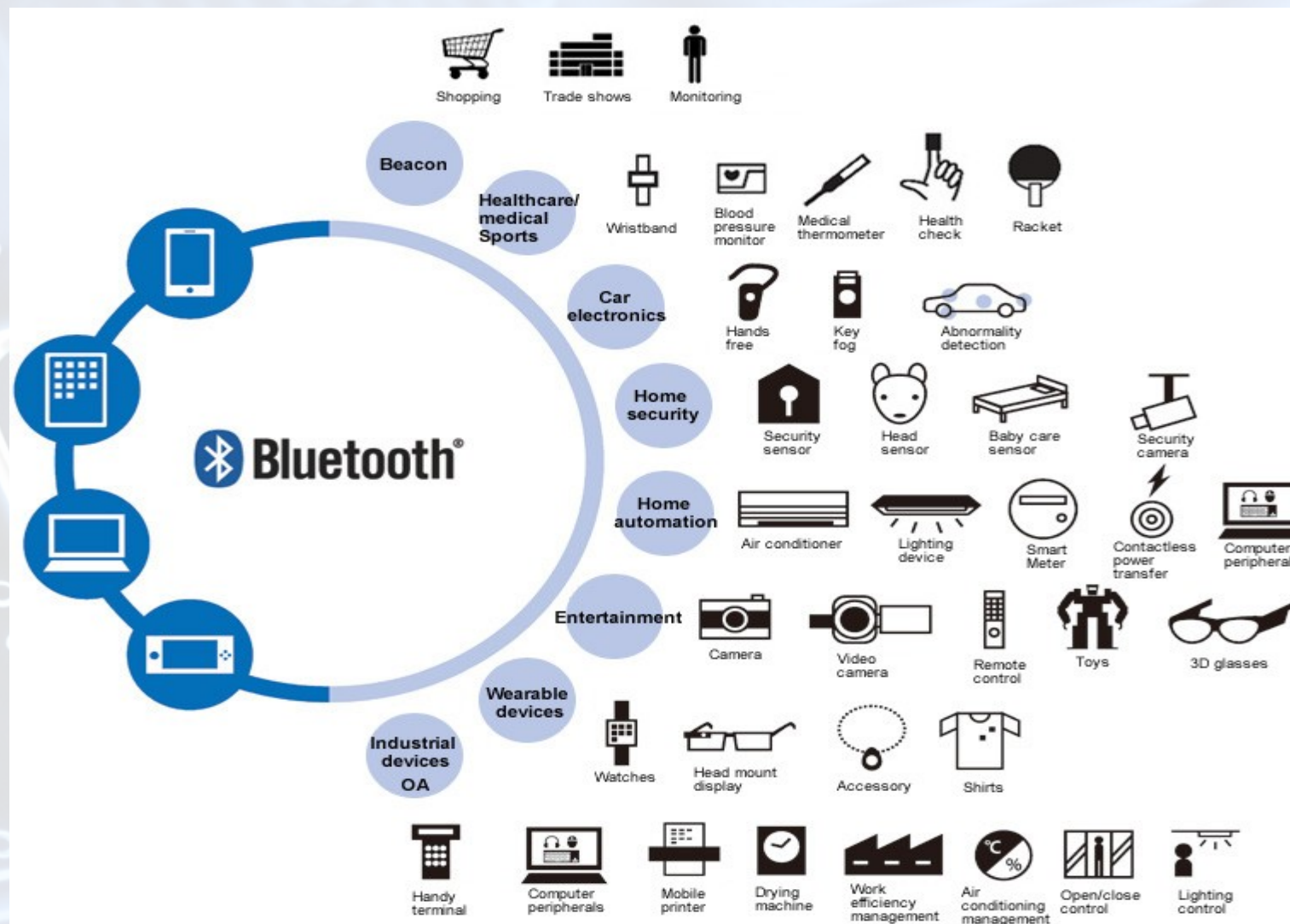- + wireless coexistence

Bluetooth – Mesh Network

- Many-to-Many

- Flooding

- Publish-subscribe

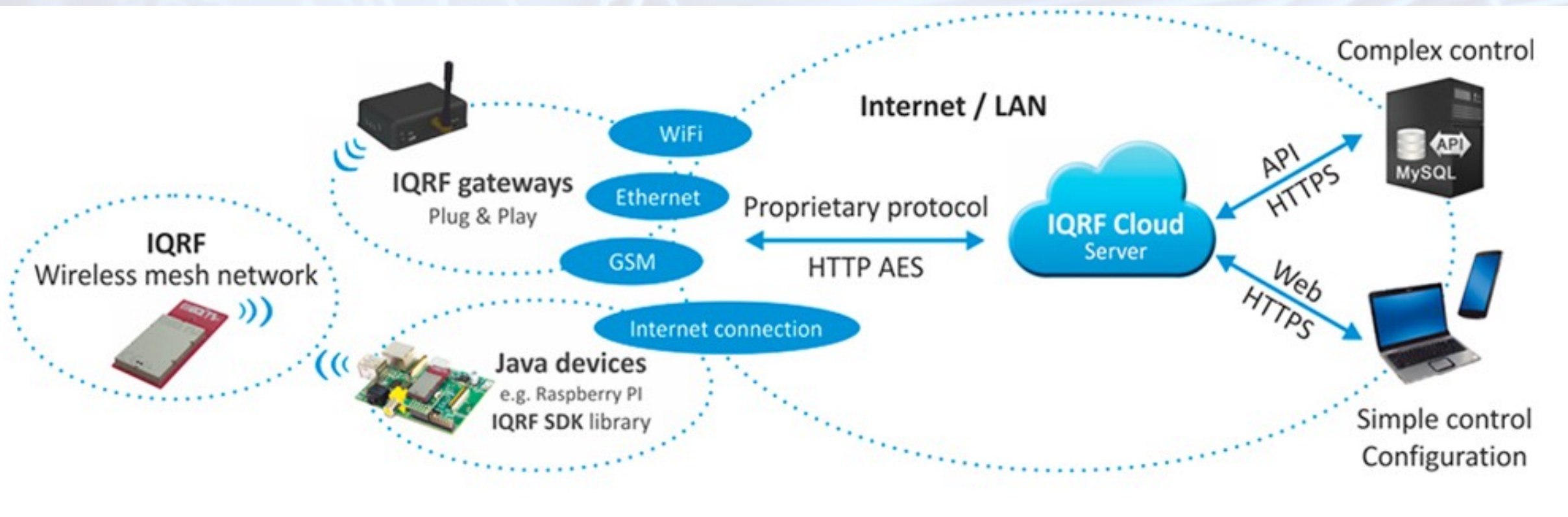- Relaying

- Energy optimization

Bluetooth – Application

IQRF

- Wireless radio technology especially for low power mesh networking

- Point-to-Point or Multipoint-to-Multipoint communication

- Own Operation System

- Low power, low data rate, small packets (64 Byte)

- Up to 65.000 end nodes
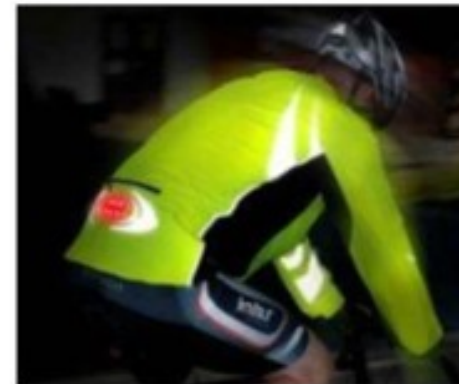
- License-free frequencies (433/868/916 MHz)

IQRF – Topology

IQRF – Applications

- Controlling
- Telemetry
- Monitoring
- Smart systems
- IoT, etc.

Thank you for your attention!