IEE IEE2620: System Aspects in Communications

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2023/2024 kevad

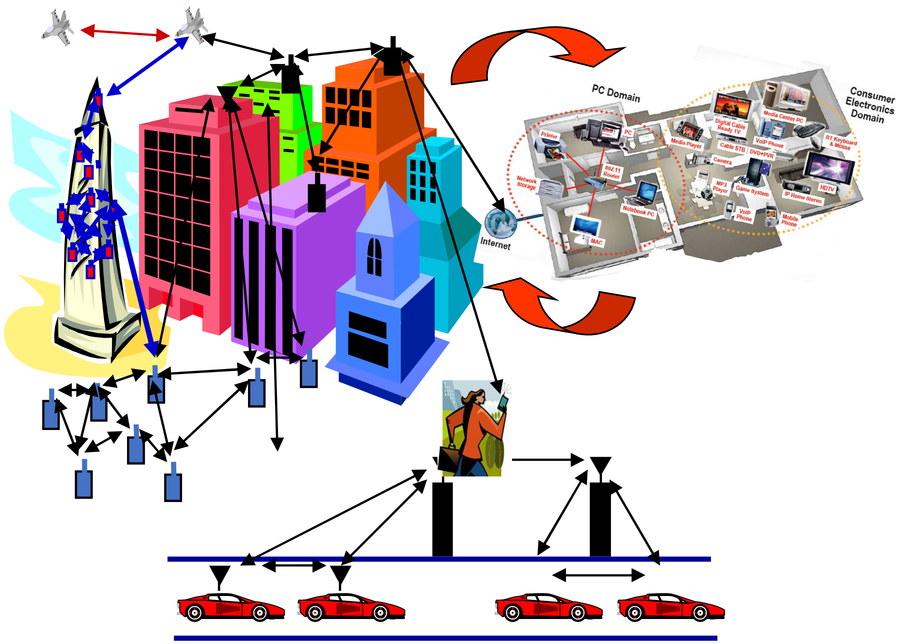
Tunniplaan | Tunniplaani kalendrivaade

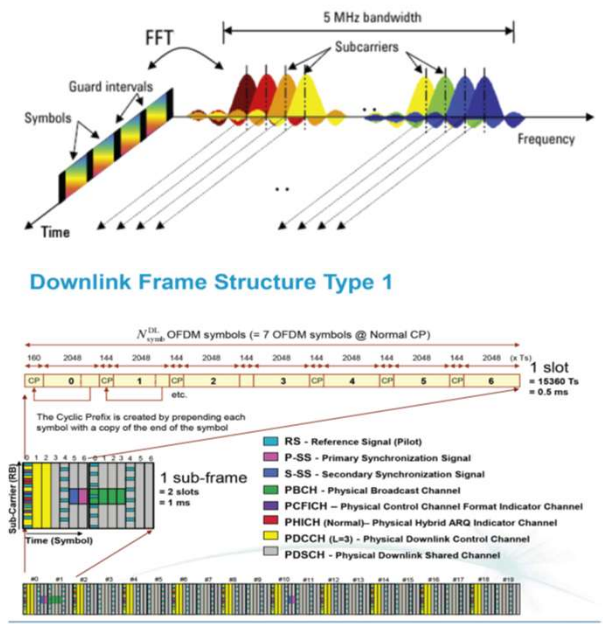
Muhammad Mahtab Alam (1-16. õppenädal)

Muu · Paaris · Paaritu · 1 - 16

Kopeeri URL · Ekspordi iCalendar fail · Nädal · Semester

Aeg	Õppeaine	Keel	Kohustuslik / Valik / Vaba	Tüüp	Õppejõud	Ruum	Õppenädalad	Rühmad	Ainekava	Kommentaar
Esmaspäev										
12:00 - 13:30	IEE2620 - Süsteemiaspektid sides	Eesti keel	valik	loeng	Muhammad Mahtab Alam (täisprofessor tenuuris)	Distantsõpe SOC-218	1-16	IAVM21	Vaata	

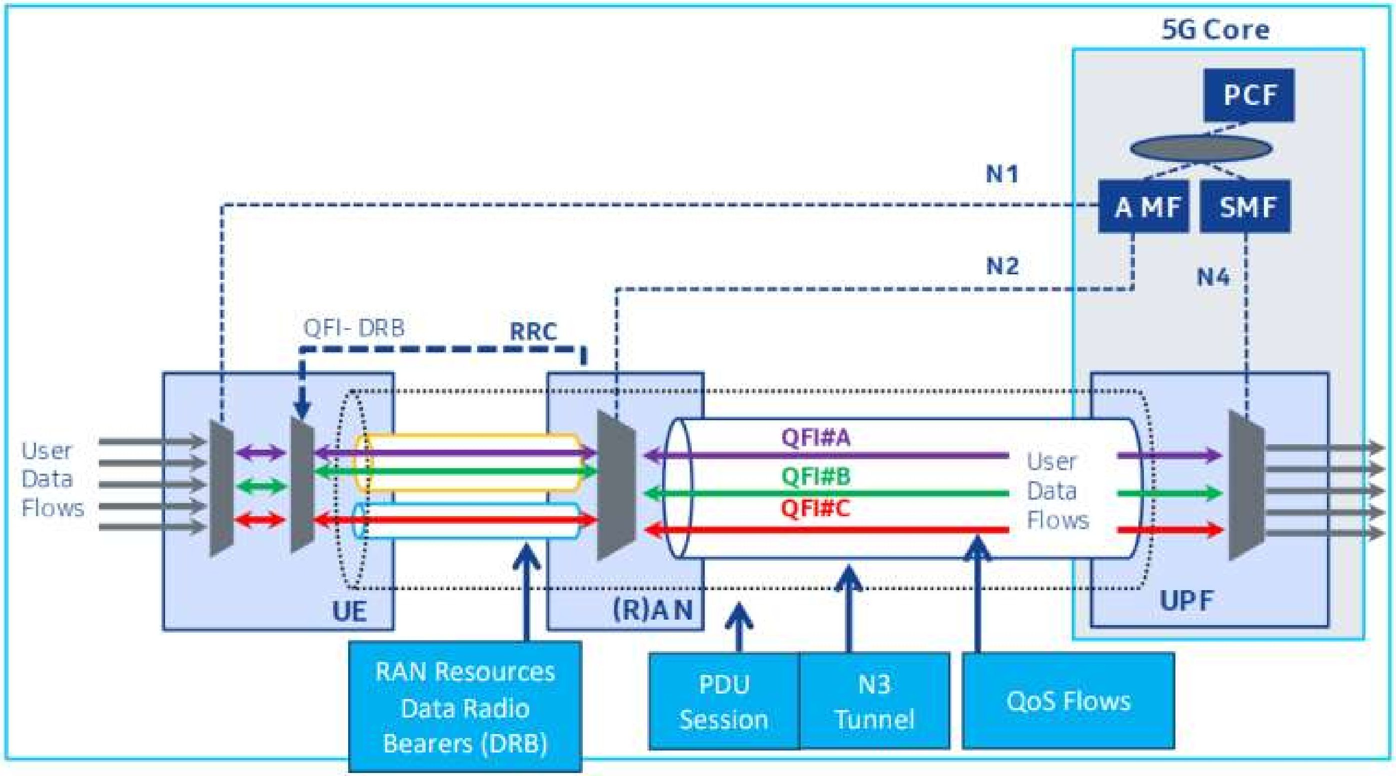




5G Core Network – Network Slicing Recap

5G QoS model

QoS flow
based framework



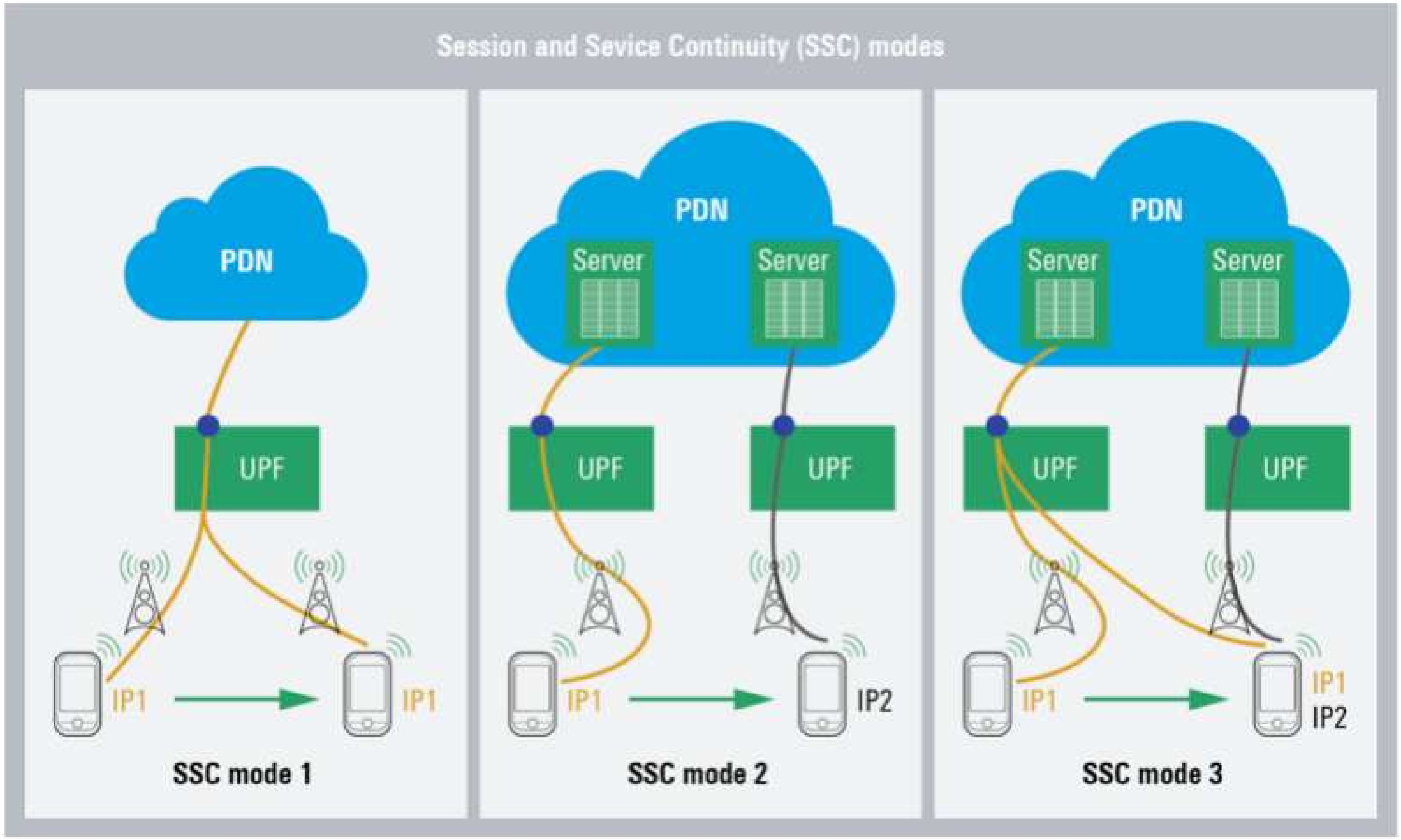
QFI – QoS flow index
DRB – Data Radio Bearer
RRC – Radio Resource Control
UPF – User Plane Function

Source: *Nokia & 3GPP*

SLICE DEFINITION BY 3GPP

- From a mobile operator's point of view, a network slice is an independent **end-to-end logical network** that runs on a shared physical infrastructure, capable of providing a negotiated service quality. The technology enabling network slicing is transparent to business customers. A network slice could span across **multiple parts of the network** (e.g. terminal, access network, core network and transport network) and could also be deployed across multiple operators. A network slice comprises dedicated and/or shared resources, e.g. in terms of processing power, storage, and bandwidth and has isolation from the other network slices.
- 5G networks, in combination with network slicing, permit **V2X customers to enjoy connectivity and data processing** tailored to the specific business requirements that adhere to a Service Level Agreement (SLA) agreed with the mobile operator. The customizable network capabilities include data speed, quality, latency, reliability, security, and services.

5G Session and Service Continuity



In SSC mode 2 network may release the IP address (PDU session type IP) as there is a new PDU session anchor point.
In SSC mode 3 a new PDU sessioon will be established before the previous connection is terminated.
SSC mode is defined by the application requirements.

Source: **Rohde&Schwarz** & 3GPP

5G and Internet of Things

INTERNET OF THINGS - HISTORY

- In the early 2000's, Kevin Ashton led the foundation of IoT at MIT's AutoID lab.
- The concept was simple but powerful.
- In a 1999 article for the RFID Journal Ashton wrote:

"If we had computers that knew everything—using data they gathered without any help from us -- we would be able to track and count everything, and greatly reduce waste, loss and cost. We would know when things needed replacing, repairing or recalling, and whether they were fresh or past their best. We need to empower computers with their own means of gathering information, so they can see, hear and smell the world for themselves, in all its random glory. RFID and sensor technology enable computers to observe, identify and understand the world—without the limitations of human-entered data."[1]

[1] http://kevinjashton.com/2009/06/22/the-internet-of-things/

INTERNET OF THINGS - HISTORY

History

- At the time, the vision of IoT required major technology improvements and need to answer question such as:
  - ✓ How would we connect everything on the planet?
  - ✓ What type of wireless communications could be built into devices?
  - ✓ What changes would need to be made to the existing Internet infrastructure to support billions of new devices communicating?
  - ✓ What would power these devices?
  - ✓ What must be developed to make the solutions cost effective?

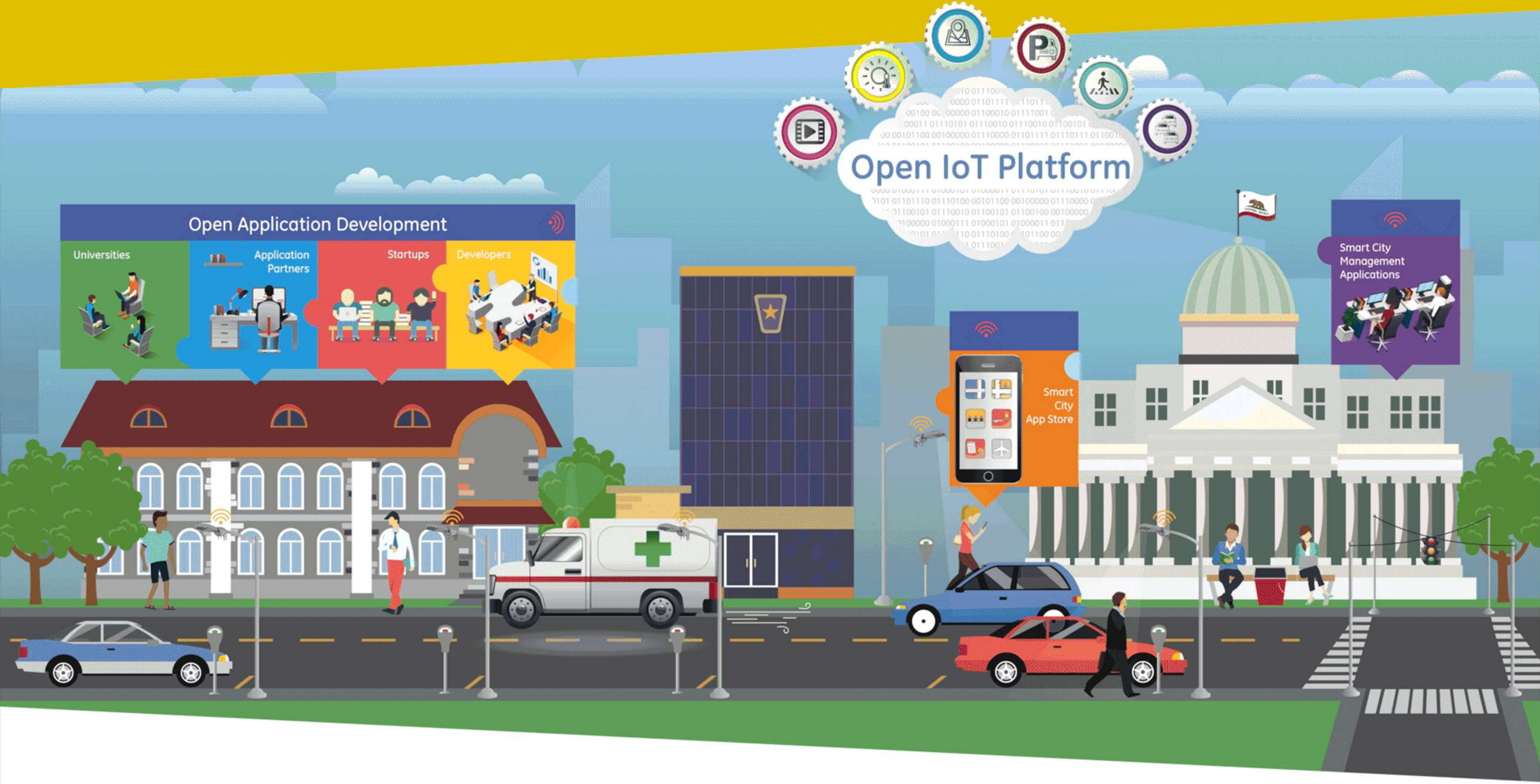
There were more questions than answers to the IoT concepts in 1999.

INTERNET OF THINGS - TODAY

- Many of these obstacles have been solved.
  - ✓ The size and cost of wireless radios has dropped tremendously.
  - ✓ IPv6 allows us to assign a communications address to billions of devices.
  - ✓ Electronics companies are building Wi-Fi and cellular wireless connectivity into a wide range of devices.
  - ✓ ABI Research estimates over five billion wireless chips will ship in 2013.[2]
  - ✓ Mobile data coverage has improved significantly with many networks offering broadband speeds.
  - ✓ While not perfect, battery technology has improved and solar recharging has been built into numerous devices.

[2] https://www.abiresearch.com/press/over-5-billion-wireless-connectivity-chips-will-sh/

INTERNET OF THINGS



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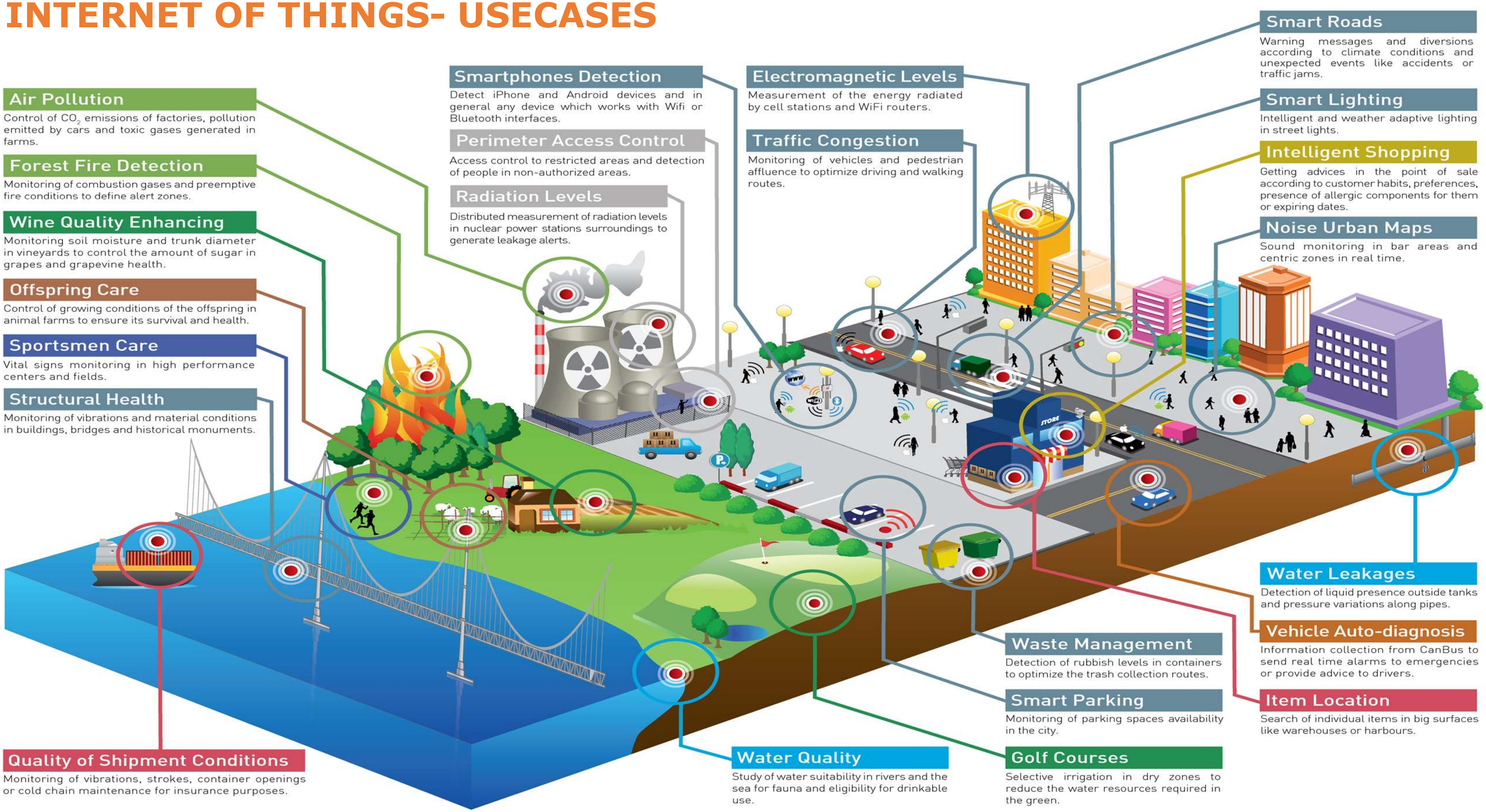
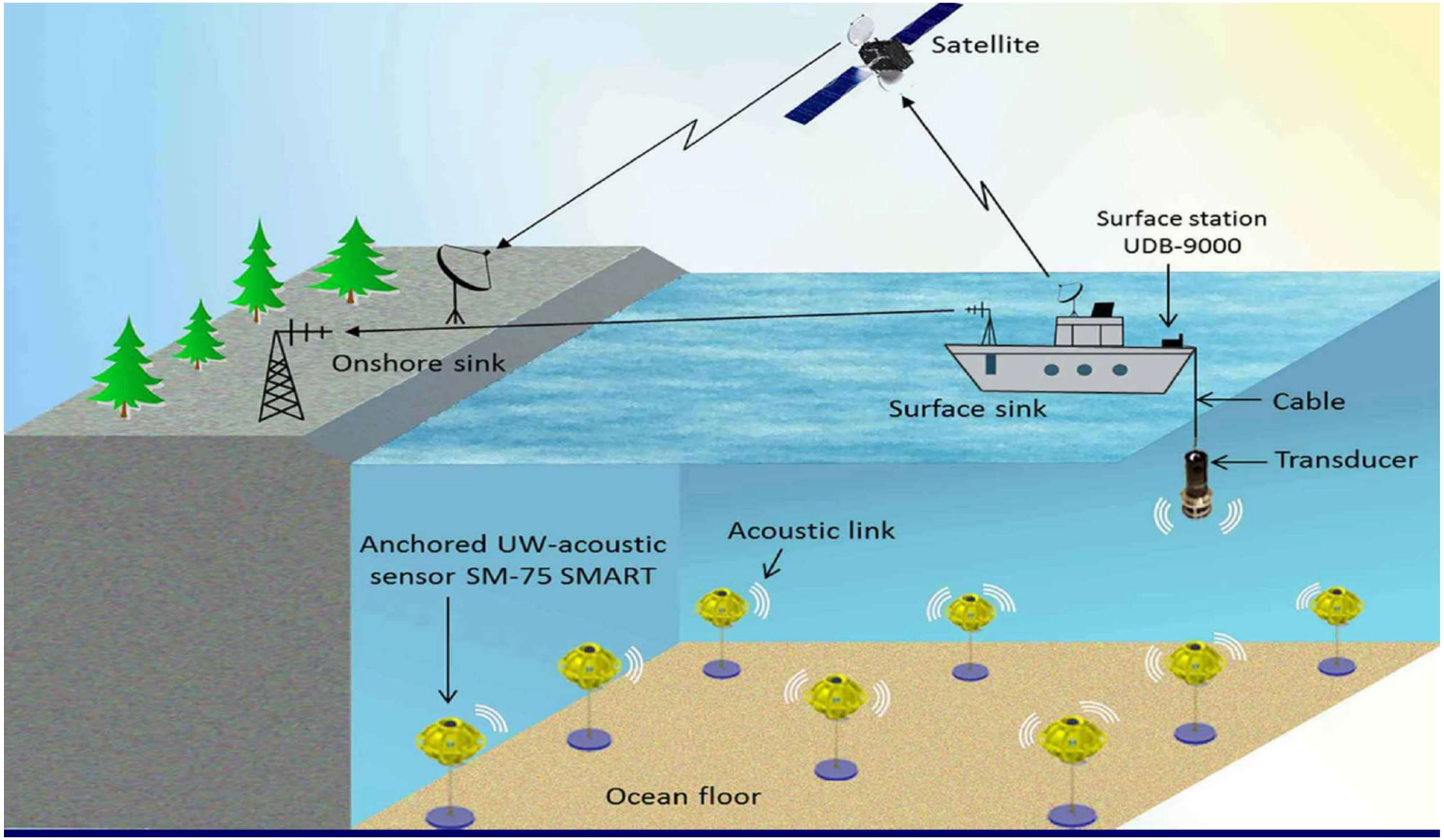
INTERNET OF THINGS- USECASES

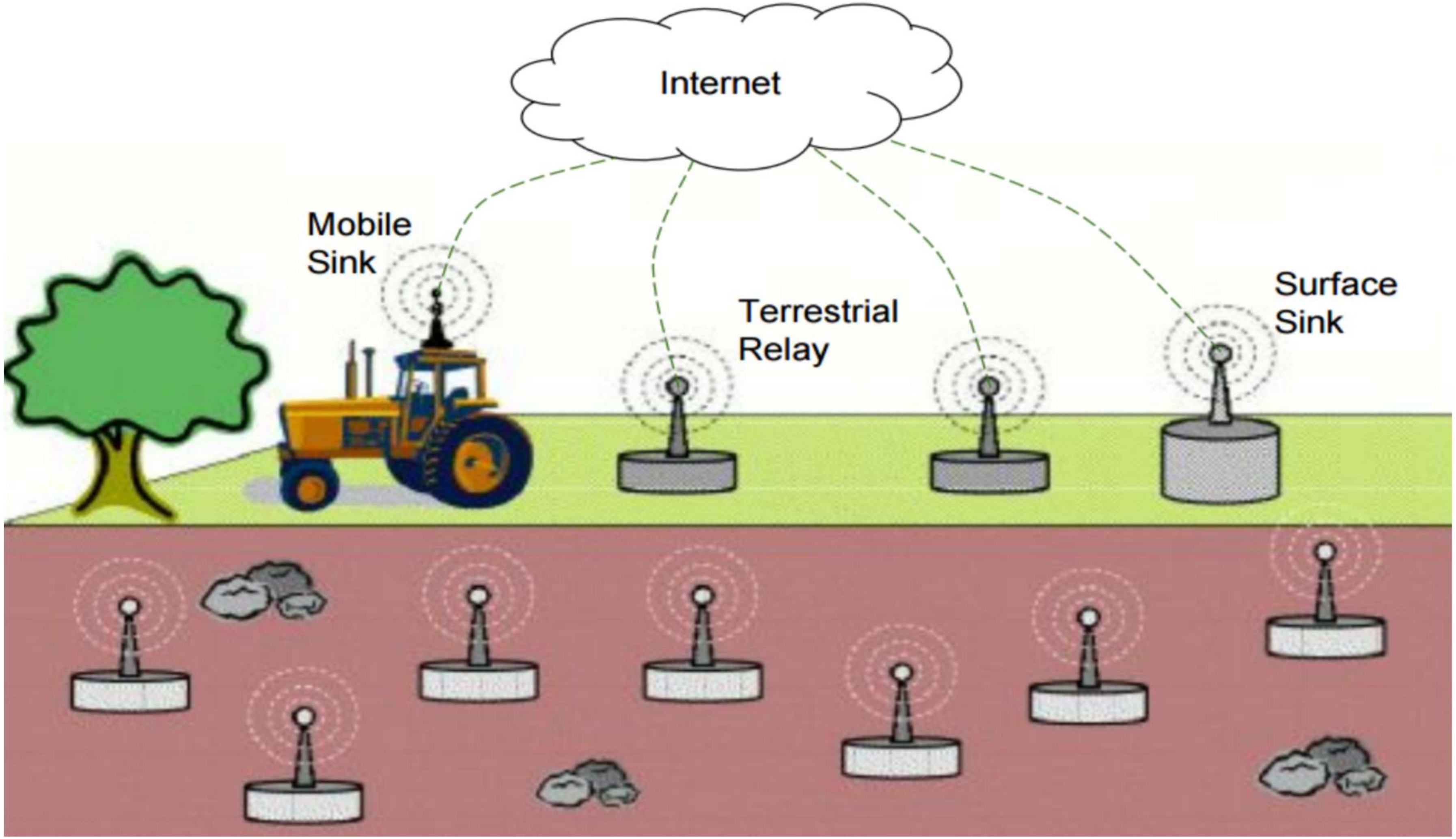


urce: http://www.libelium.com/resources/top_50_iot_sensor_applications_ranking/#show_infographic

INTERNET OF UNDERWATER THINGS

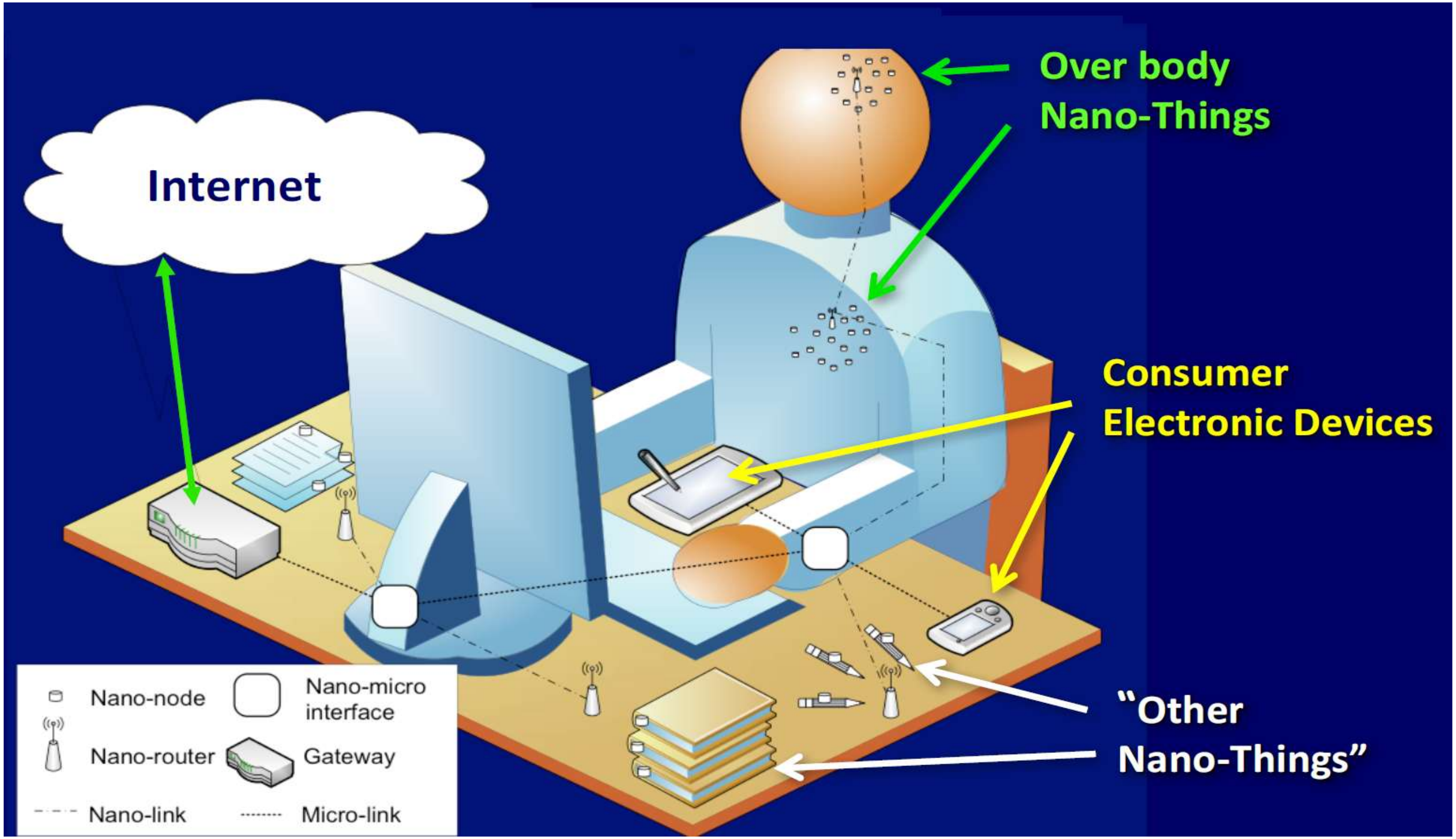


INTERNET OF UNDERGROUND THINGS



"INTERNET OF THINGS: TRENDS, DIRECTIONS, OPPORTUNITIES, CHALLENGES" by I. F. AKYILDIZ, Georgia Institute of Technology, USA

INTERNET OF NANOTHINGS THINGS



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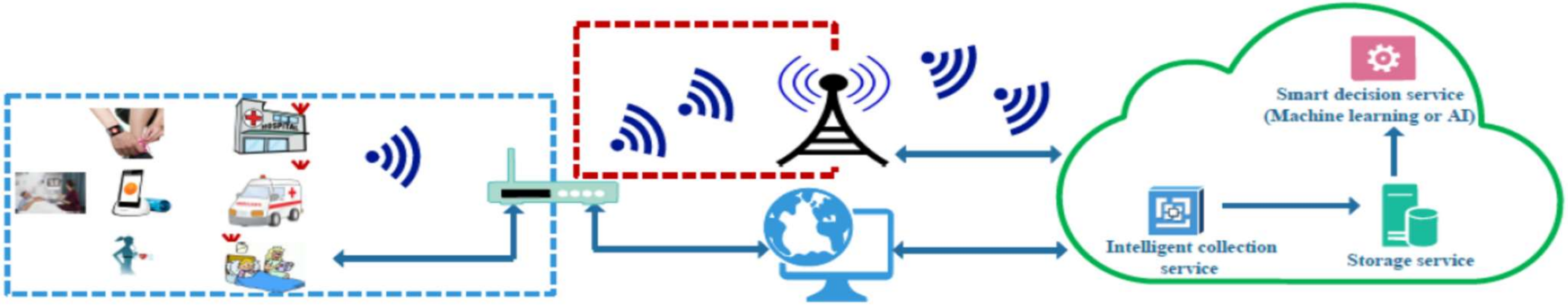
ELEMENTS OF IoT



THINGS

- ✓ Measure values
- ✓ Send raw data
- ✓ Low power

GATEWAY

- ✓ Get data from sensor
- ✓ Process data
- ✓ Send data to cloud
- ✓ Store data locally if needed

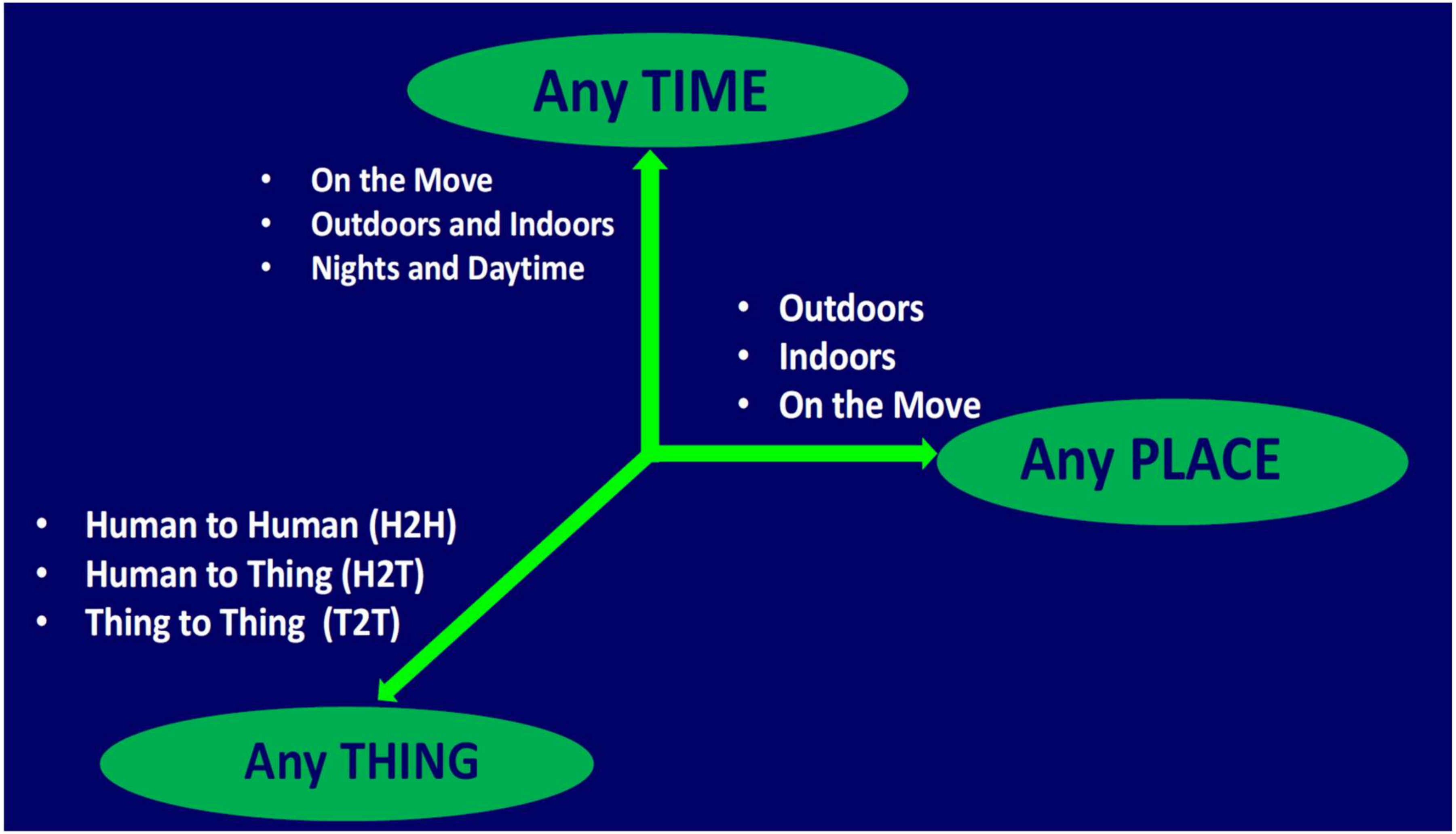
COMMUNICATION NETWORK

- ✓ Transfer data to cloud
- ✓ Low power
- ✓ Low data rate
- ✓ Low latency
- ✓ Secure and reliable

CLOUD/DATA ANALYTICS PLATFORM

- ✓ Aggregate data
- ✓ Process and analyse data
- ✓ Make decisions on data
- ✓ Store data

INTERNET OF THINGS: COMMUNICATION PRESPECTIVE



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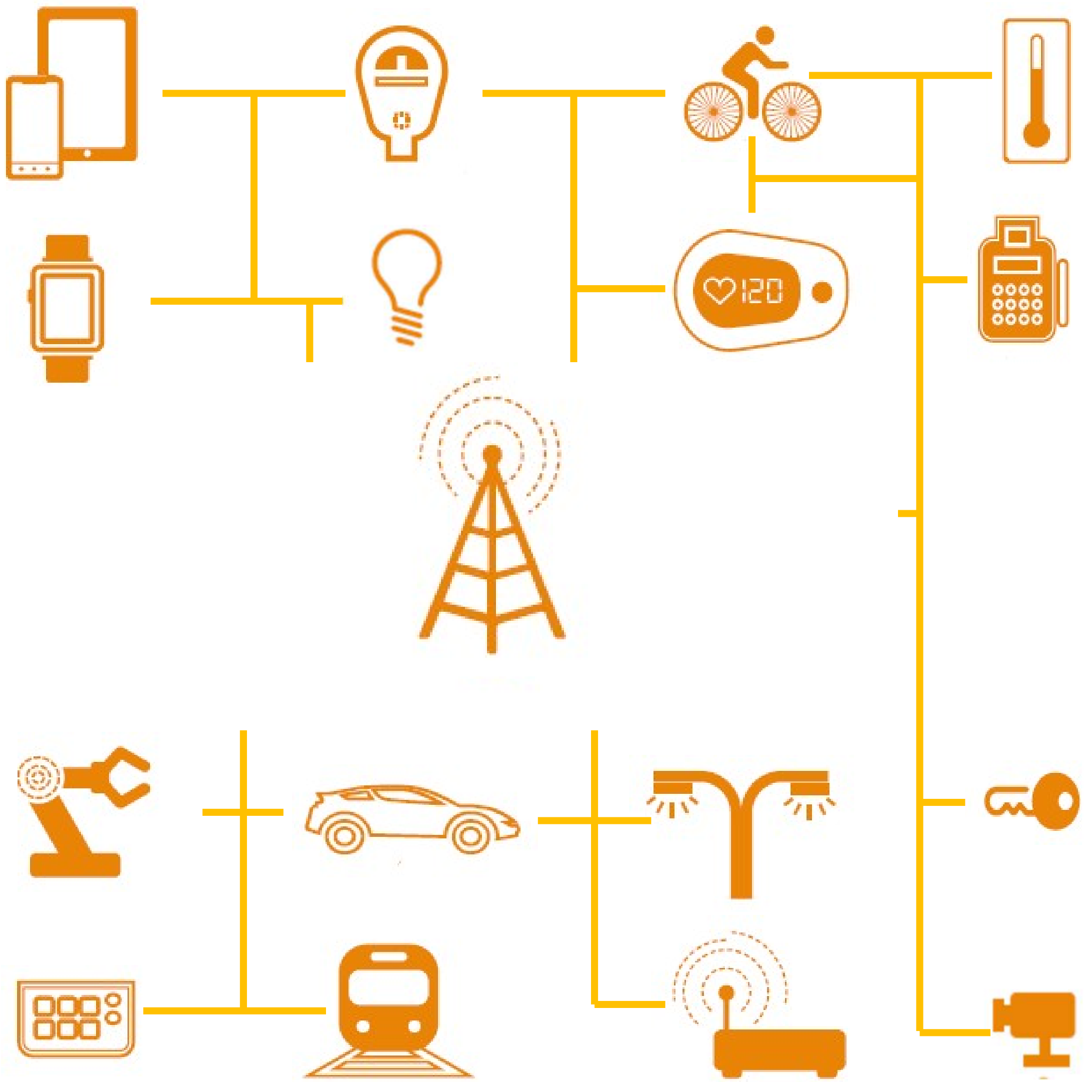
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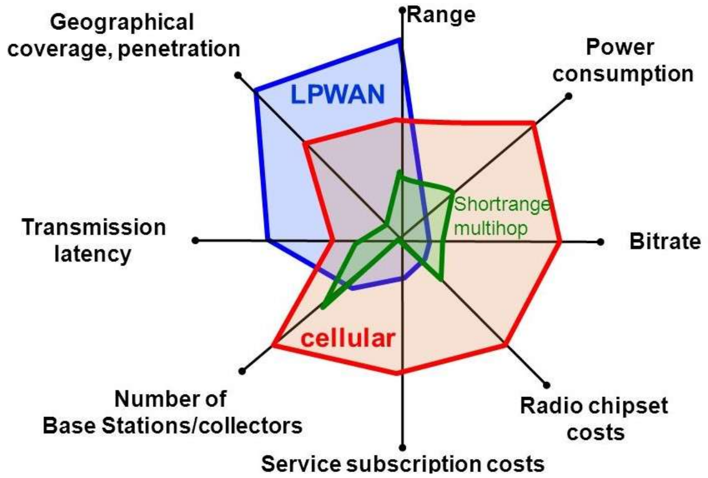
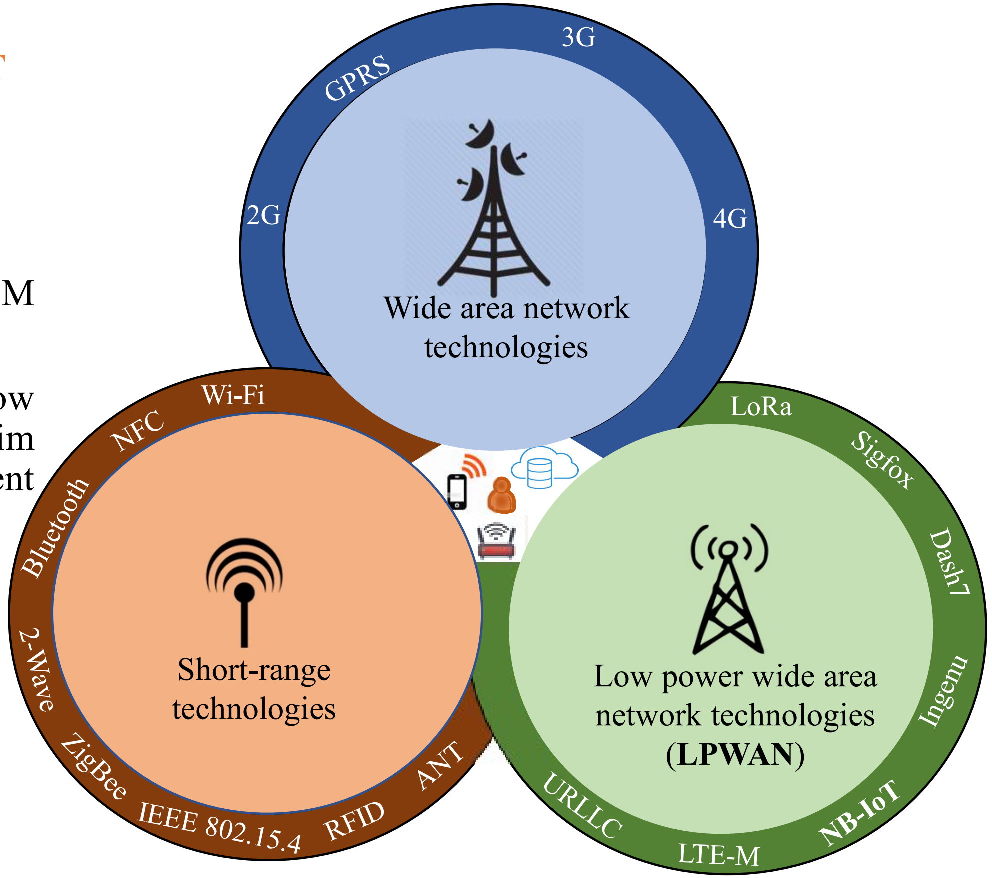
COMMUNICATION TECHNOLOGIES

- Existing long-rang networks (2G/3G/LTE/WiFi) will meet the applications that need long range and high data rates. (**10% OF IOT MARKET VOLUME**)
- Existing short-range technologies such as ZigBee, RF Mesh (802.15.4), PLC, WiFi, etc.. will be used for short range applications such as smart meter, smart home, smart parking, etc…. A GW or aggregator can be used to aggregate and send the data to the IoT/M2M platform. (**30% OF IOT MARKET VOLUME**)
- NEW LPWA network to meet long range coverage, low power, low data rate and low cost of end device in unlicensed bands as an interim and complementary solution and to avoid niche deployment competition. (**60% OF IOT MARKET VOLUME**)





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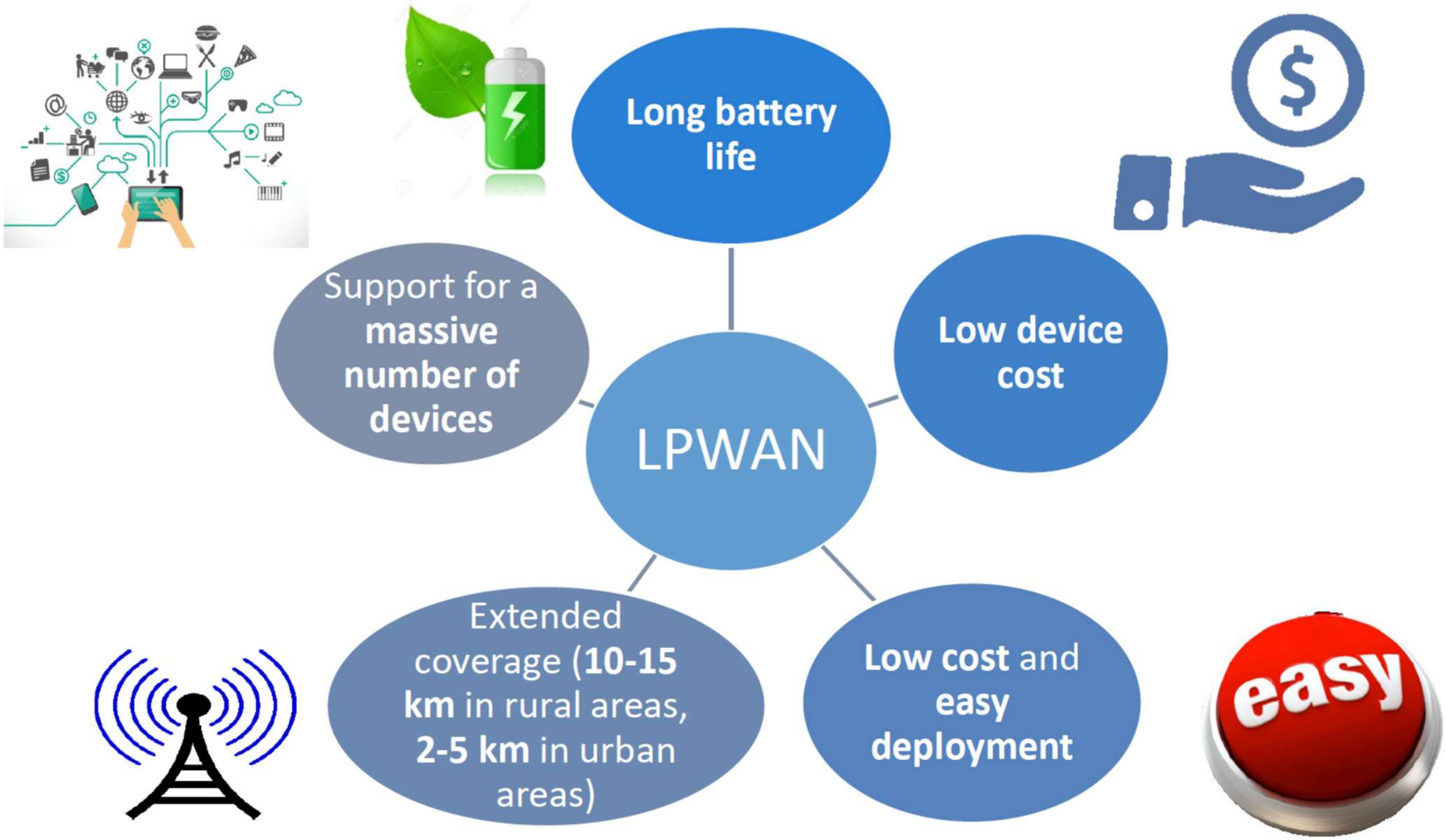
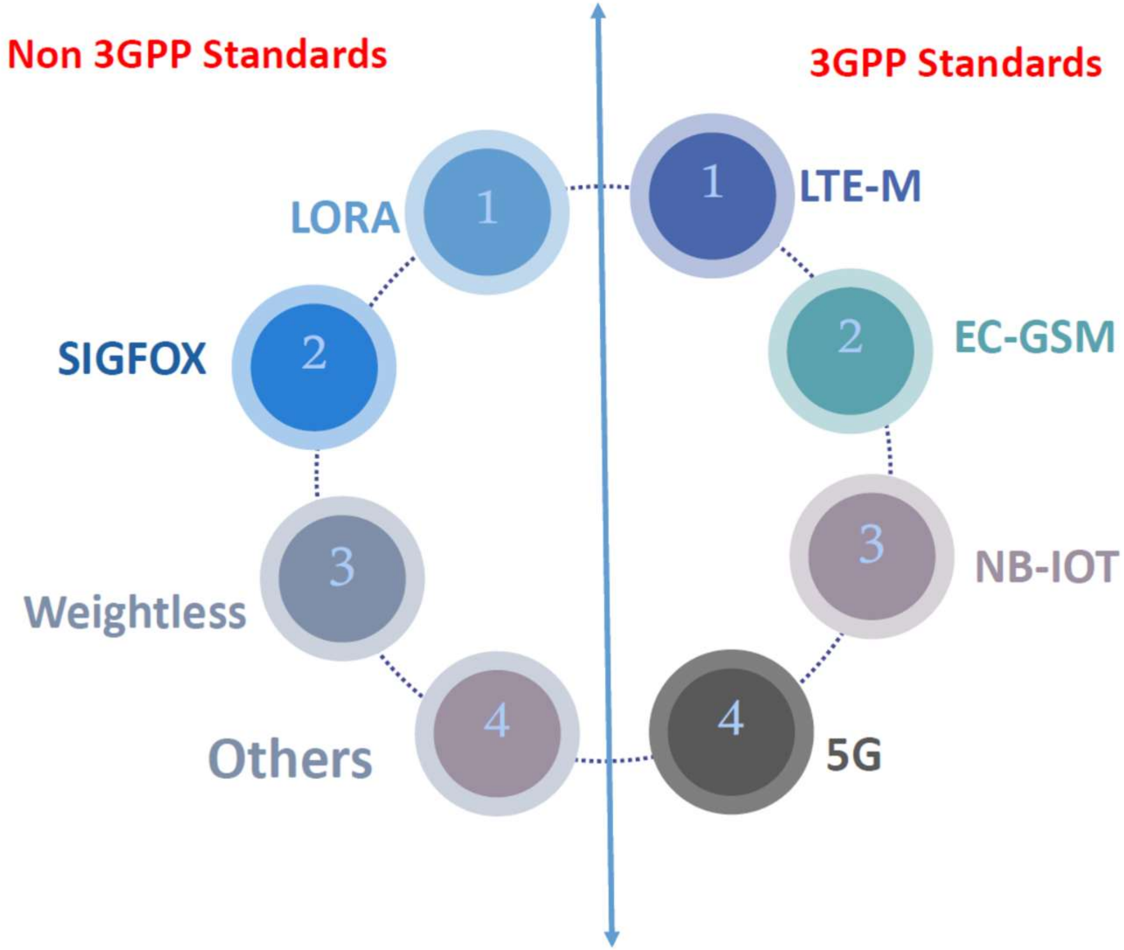
LPWAN REQUIREMENTS



LPWAN TECHNOLOGIES

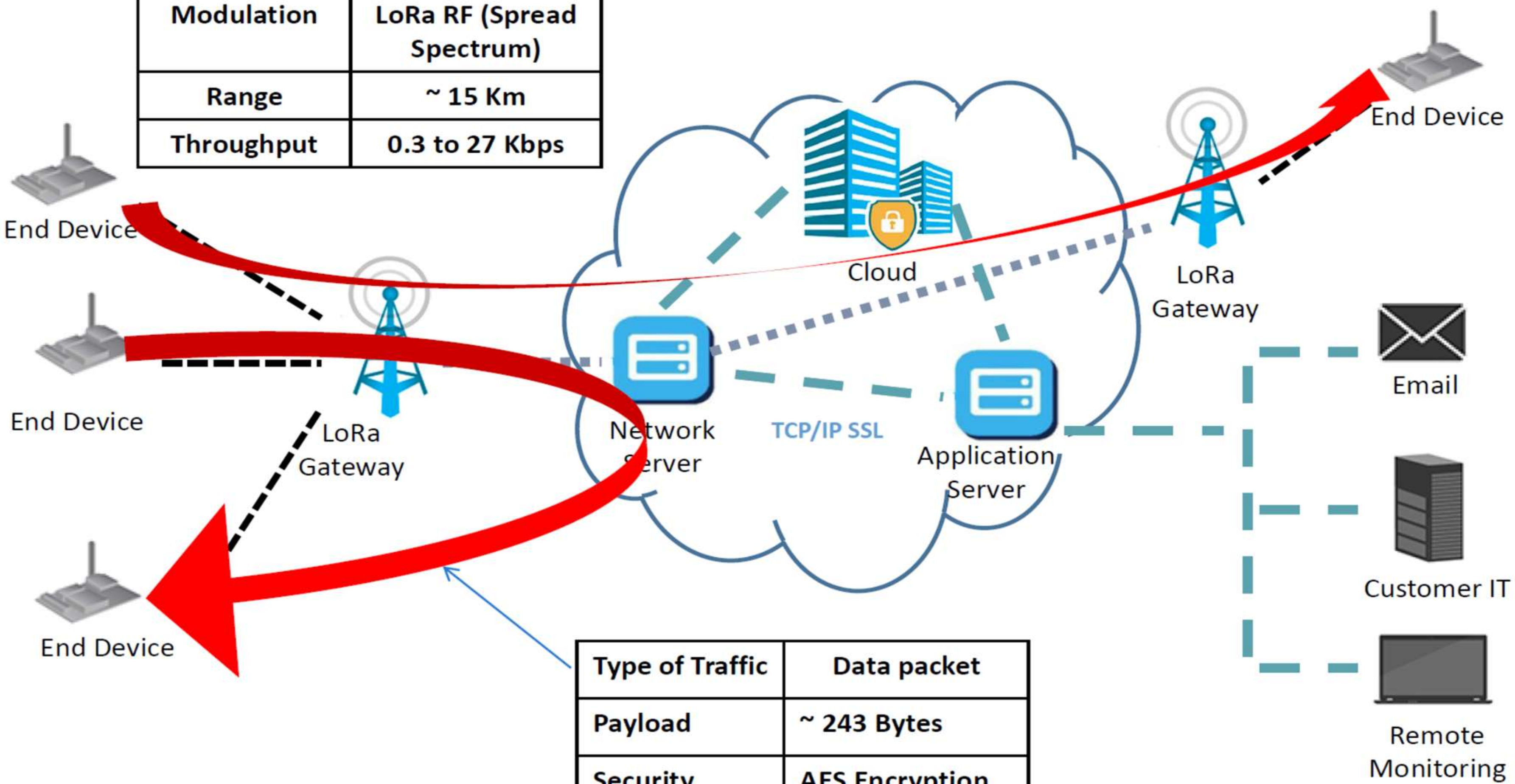


LORAWAN

- LoRaWAN is a *Low Power Wide Area Network*
- LoRa modulation: a version of Chirp **Spread Spectrum** (CSS) with a typical channel **bandwidth of 125KHz**
- High **Sensitivity**(End Nodes: Up to **-137 dBm**, Gateways: up to **-142 dBm**)
- Long range communication (up to **15 Km**)
- Strong indoor penetration: With High Spreading Factor, Up to **20dB** penetration (**deep indoor**)
- Occupies the entire bandwidth of the channel to broadcast a signal, making it **robust** to channel noise.
- **Resistant** to Doppler effect, multi-path and signal weakening.

LORAWAN ARCHITECTURE

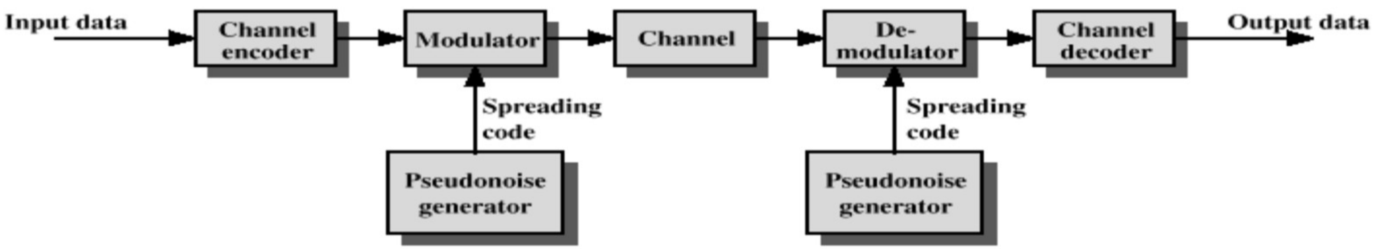
Modulation	LoRa RF (Spread Spectrum)
Range	~ 15 Km
Throughput	0.3 to 27 Kbps



Type of Traffic	Data packet
Payload	~ 243 Bytes
Security	AES Encryption

SPREAD SPECTRUM: BASIC

- Spread Spectrum is a means of transmission in which the data sequence occupies a bandwidth in excess of the minimum bandwidth necessary to send it.
- Effectively the signal is mapped to a higher dimension signal space
- Signal spreading is done before transmission by using a spreading sequence. The same sequence is used at the receiver to retrieve the signal
- Spread Spectrum is most effective against interference (intentional or non-intentional) with fixed energy.
- Gained popularity by the needs of military communication
- Proved **resistant** against hostile jammers
- Ratio of information bandwidth and spreading bandwidth is identified as spreading gain or processing gain
- Processing gain does not combat white Noise



LORAWAN: DEVICE CLASSES

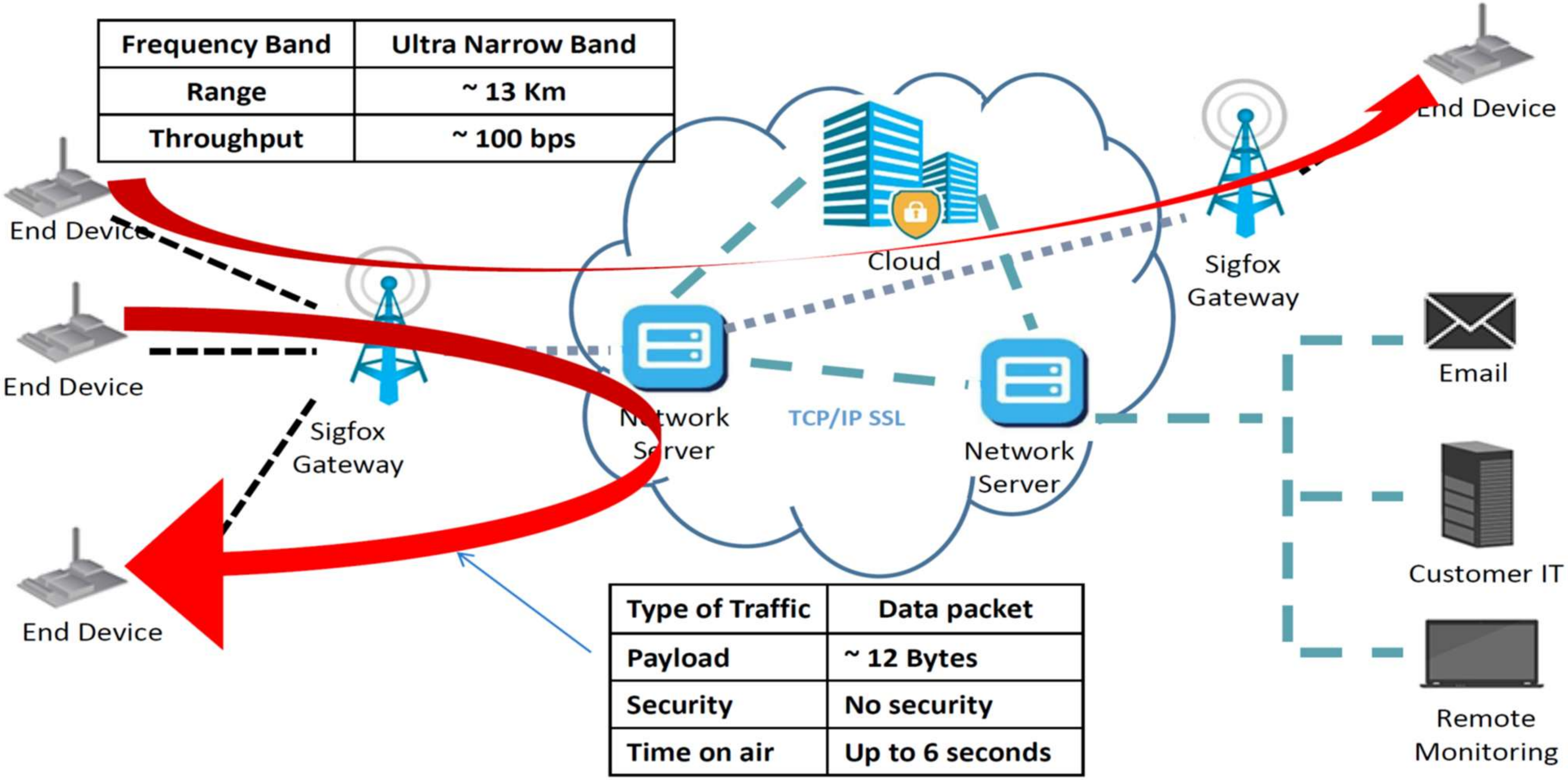
Classes	Description	Intended Use	Consumption	Examples of Services
A (« **all** »)	**Listens only after end device transmission**	Modules with **no latency constraint**	The **most economic** communication Class energetically.. **Supported by all modules.** **Adapted to battery powered modules**	• **Fire Detection** • **Earthquake Early Detection**
B (« **beacon** »)	The module listens at a **regularly adjustable frequency**	Modules with **latency constraints** for the **reception of messages of a few seconds**	**Consumption optimized.** **Adapted to battery powered modules**	• **Smart metering** • **Temperature rise**
C (« **continuous** »)	Module **always listening**	Modules with a ***strong reception latency constraint*** (less than one second)	Adapted to **modules on the grid** or with **no power constraints**	• **Fleet management** • **Real Time Traffic Management**

➔ **Any LoRa object can transmit and receive data**

SIGFOX

- First LPWAN Technology
- The physical layer based on an Ultra-Narrow band wireless modulation
- Proprietary system
- Low throughput (~100 bps)
- Low power
- Extended range (up to 50 km)
- 140 messages/day/device
- Subscription-based model
- Cloud platform with Sigfox –defined API forserver access
- Roaming capability

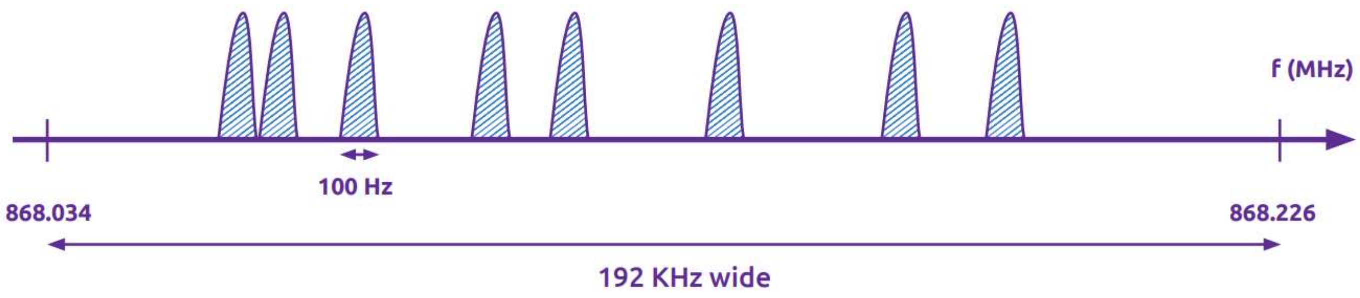
LORAWAN ARCHITECTURE



By default, data is conveyed over the air interface without any encryption. Sigfox gives customers the option to either implement their own end-to-end encryption solutions.

SIGFOX: SPECTRUM

- Narrowband technology
- Standard radio transmission method: binary phase-shift keying (BPSK)
- Takes very narrow parts of spectrum and changes the phase of the carrier radio wave to encode the data.
- Sigfox is using 192KHz of the publicly available band to exchange messages over the air.
- The modulation is Ultra-Narrow band. Each message is 100 Hz wide and transferred with a data rate of 100 or 600 bits per second depending on the region



LPWAN TECHNOLOGIES

	LoRa	Sigfox	NB-IoT	LTE-M
Spectrum	Unlicensed	Unlicensed	Licensed	Licensed
Bandwidth	125 kHz	100 Hz	180 kHz	1.4 MHz
Coverage (dB)	157	149	~164 dB	~156 dB
Data Rate	50 kbps	100 bps	250 kbps	1 Mbps
Scalability	Medium	Low	High	High
Location support	Yes	No	Yes	Yes
OTA upgrade	Yes	-	Yes	Yes
Battery Life	10 year +	10 year +	10 year +	10 year +

Licensed Technologies (e.g. **NB-IoT**) outperform in terms of LPWAN network support due to their global outreach, existing infrastructure, high data rate, extended coverages, etc.