AUTORITÀ PER LE GARANZIE NELLE COMUNICAZIONI
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Smart Meter connectivity solutions

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A Case Study
Italian NRAs cooperation on smart metering

- AGCOM cooperates with the energy NRA to develop the performance requirements for the next generation of Advanced Metering Infrastructure: Electricity Smart Meter - Generation 2.1

- AGCOM has investigated the connectivity solutions for smart meters and related regulatory issues, with respect to competition issues, performances, network security, data confidentiality and consumer protection

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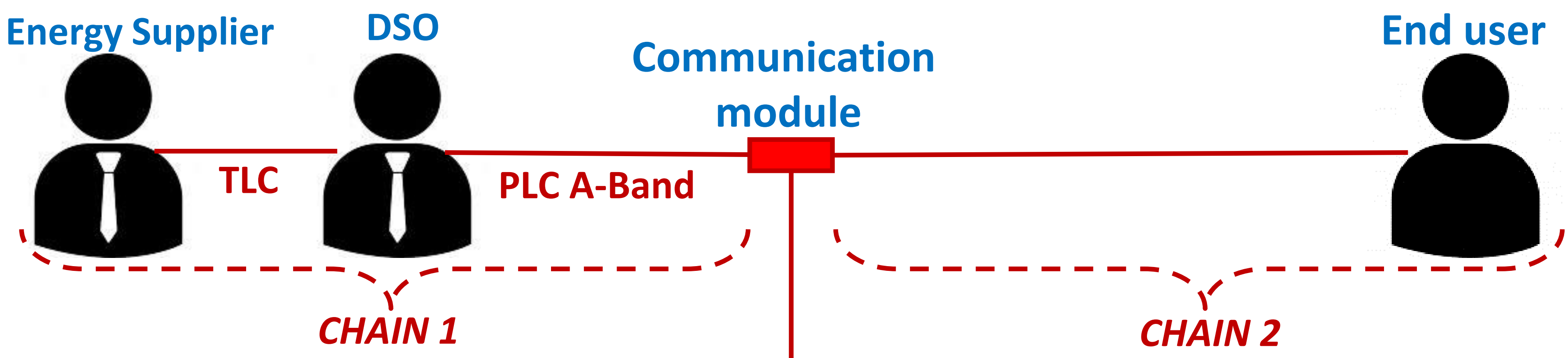
Electricity Smart Meters Requirements



Smart Meter 1.0 – chain 1
PLC - A-band + Public TLC Network

Smart Meter 2.0 – chain 1

- Two independent channels – technology selected by the distribution network operator (DNO):
  1. In case of PLC: A-band (single standard protocol at national level);
  2. In case of wireless technology:
     - WMBus @ 169MHZ
     - TLC public networks and standard protocols.
- Security measures on both channels.

Smart Meter 2.0 – chain 2

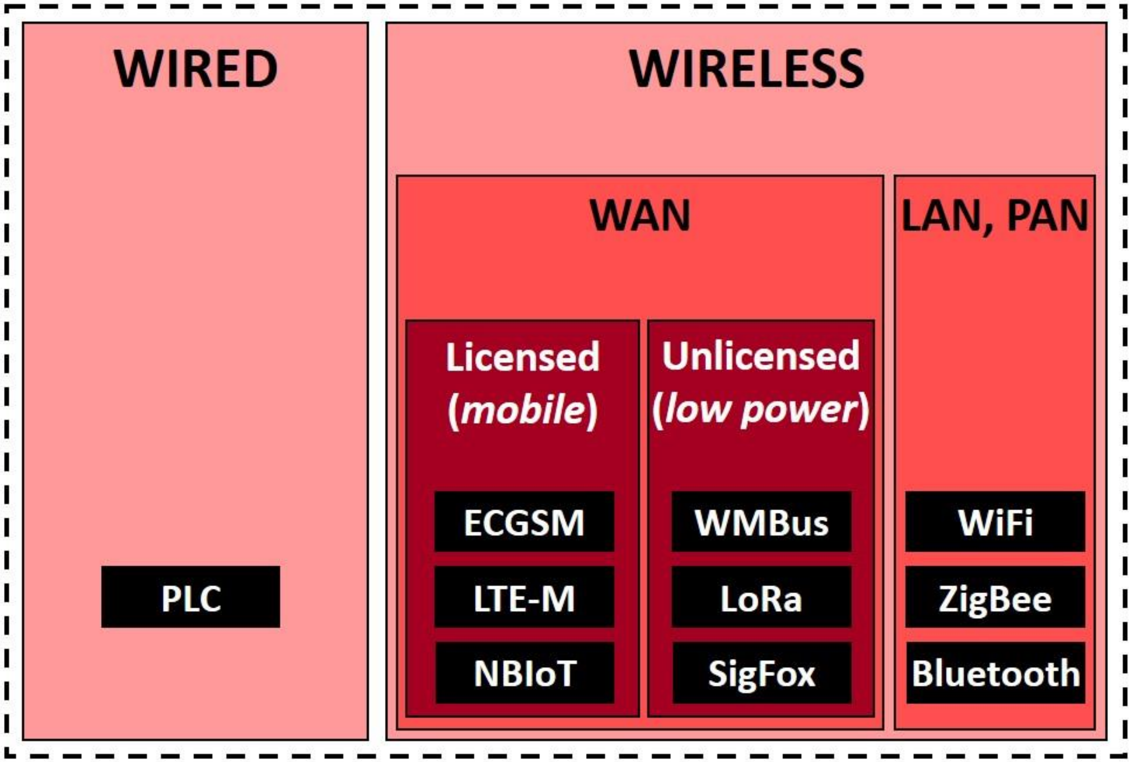
- At least one channel:
  - In case of PLC: C-band
- Single standard protocol at national level.
- Security measures envisaged

Smart Meter 2.1 – chain 2 (and possibly chain 1)

One of the two following technological option:

1. Secure physical connector with separate housing to connect a user device or a cable, including optical fiber;
2. Wireless Solution: data channel on licensed or unlicensed frequencies

Connectivity solutions



- **Comparative analysis:**
  - Operating scenarios
  - Standardization and availability of technology
  - Architecture, network deployment, scalability
  - Coverage, propagation characteristics
  - Bit rate, network capacity, latency, transmission mode, support of mobility/nomadism
  - Cost of radio access module and network costs (Capex/Opex)
  - Battery life, security, quality of service, interoperability.

Wired Solutions : PLC

- **Strengths**
  - Consolidated technology, suitable fur current service requirements
  - Very low marginal cost of the network infrastructure – Power Line-

- **Weaknesses**
  - Suitable only for **electricity** smart meters
  - Short range, however compatible with the typical extension of national low-voltage networks
  - Low level of protection from interferences, on both A-Band and C-Band
  - Limited bandwidth (operating frequencies below 150 kHz)
  - PLC on Chain 1 not suitable for use cases requiring real time or low latency (due to master-slave architecture)
  - National specification in C-Band (for chain 2) just completed. Lack of CENELEC standard

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Cellular based networks on licensed frequencies

- 3GPP and GSMA organizations have identified several standards and technical solutions for cellular based services dedicated to M2M, from high to low bit-rate.

	LTE	LTE-M			NBIoT	EC-GSM
	Cat 4	**Cat 1**	**Cat 0**	**Cat M (e-MTC)**		
LTE standardization	Release 8	Release 8	Release 12	Release 13	Release 13	Release 13
Bandwidth	20 MHz	20 MHz	20 MHz	1.4 MHz	0.2 MHz	0.2 MHz
***Peak bitrate* (*downlink*)**	150 Mbps	10 Mbps	1 Mbps	1 Mbps	0.2 Mbps	0.1 Mbps
***Peak bitrate* (*uplink*)**	50 Mbps	5 Mbps	1 Mbps	1 Mbps	0.144 Mbps	0.1 Mbps
***Modem* complexity (rif Cat 4)**	100%	80%	40%	20%	< 15%	40%

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Cellular Based Networks

Strengths

- Coverage of the national territory almost completed
- Use of licensed frequency bands
- Guaranteed QoS SLA
- Standardization by ETSI (2G) or 3GPP (3G / 4G)
- Maturity of the ecosystem (economies of scale)
- Flexibility to support a wide range of applications
- Network security, authentication, privacy of user data
- Service and connectivity provider portability without replacement of the physical SIM, thanks to *embedded* SIM (e-SIM) technology and *Over The Air* (OTA) provisioning platform.

Weaknesses

- Costs and battery life for 3G and LTE-M communication modules
- Uncertainty about actual time to market of NBIoT- enabled devices (2017?)
- Uncertainty about the time of full availability of embedded SIM technology (e-SIM) and of OTA

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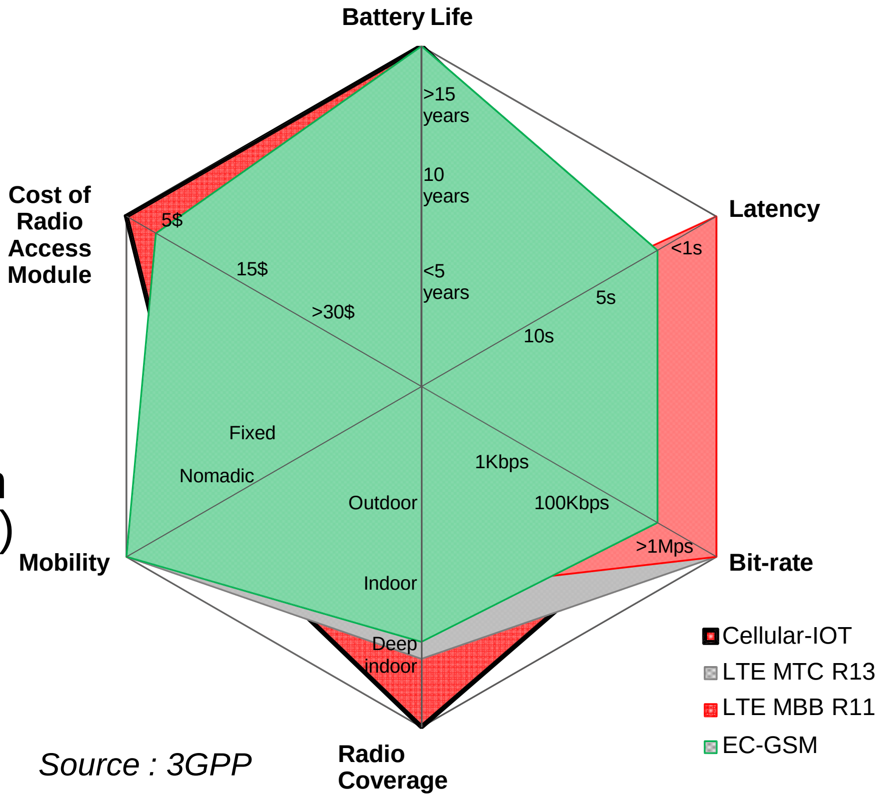
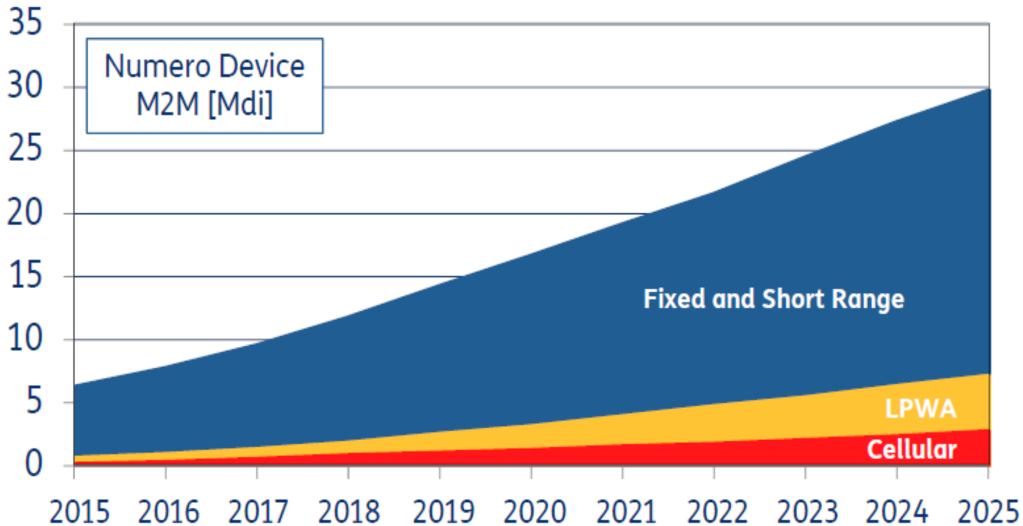
Cellular Based Networks: NB-IoT

- The **NB-IoT** technical solution represents the LTE (4G) evolution suited for several applications, included in particular smart metering.
  - Standardization by 3GPP
  - Cellular architecture, based on existing LTE infrastructure
  - Flexibility of development
  - Licensed frequencies
  - Up to 100.000 devices per cell
  - Scalability
  - Extended coverage of up to 20dB with respect to LTE (deep indoor coverage)
  - Bit-rate: up to 200 Kbps per device
  - Ability to support real time services
  - Reduced costs for the Radio Access Module (<5$)
  - Low Power
  - Battery life up to 15 years



Source : 3GPP

LP-WAN on unlicensed frequencies



Source : Machina Research

M-Bus wireless LoRa SIGFOX

Strengths:

- Extensive geographical coverage;
- Low energy consumption;
- High network scalability;
- Low cost of radio access module;
- Low infrastructural costs (infrastructure sharing).

Weaknesses:

- Usage of unlicensed frequencies on a non-exclusive, non-interference and non-protected basis;
- Limited interoperability.

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WMBus

- ETSI standard (EN13757-4) specifying the RF link between the meters and the central systems
- Defined for 868 MHz band, later extended to 169 MHz and 433 MHz
- 6 data channels (mono and bi-directional) at 4.8 kbps or 2.4 kbps
- Good coverage at 169 MHz (10 km in outdoor LOS) and indoor signal penetration
- Star network topology with a high number of gateways (scarce scalability)
- Multi-service logic (energy + gas)
- Low cost radio access modules, medium to high costs of gateways (economic sustainability in high density areas)
- 10 years battery life

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LoRa

- Proprietary protocols at PHY and DLC layer; open protocols at higher layers (LoRaWAN) by LoRa Alliance
- Unlicensed band at 868 MHz (867-869 MHz) used in Europe
- High scalability: 10 channels on different sub-bands; bitrates ranging from 0.3 kbps to 50 kbps (system adaptive rate)
- Good coverage (15 km in outdoor LOS) and deep indoor signal propagation
- “Star-of-stars“ network topology: meters are connected via single hop to gateways, communicating to servers in a cloud platform via backhauling (cellular, WiFi, Ethernet, satellite)
- Cost of radio access module about 8 $
- Battery life from 10 to 20 years
- Security at network and application layer
- Interoperability between LoRa networks: LoRa Alliance Program for device certification and compliance with LoRaWAN specifications

SigFox

- Proprietary PHY and upper layer protocols.
- Open API
- Business model based on exclusive license assigned by SigFox to one national operator for 10 years for the management of the Radio Access network
- Unlicensed band at 868 MHz
- Maximum number of 140 messages (of 12 bytes each) per day in uplink - One way data transmission (uplink)
- Good coverage (15 km in outdoor LOS) and deep indoor signal propagation
- Redundancy in space and in the frequency domain to improve interference robustness
- Cost of the radio access module of about $ 9
- 12 years battery life

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LAN/PAN on unlicensed frequencies

- ***IEEE standard for wireless LAN:*** *extended range* Wi-Fi (IEEE 802.11ah) optimized to support an extended coverage range, power efficiency, low cost of user equipment and network scalability.
- ***IEEE standard for wireless PAN***

STANDARD	MAXIMUM COVERAGE	PEAK BITRATE	OPERATING FREQUENCIES	MAXIMUM POWER (IN EUROPE)
ZigBee (IEEE 802.15.4)	30 m	20 kbit/s 40 kbit/s 250 kbit/s (LDR)	868 MHz 902 – 928 MHz 2,4 GHz	25 mW 20 mW
Bluetooth (IEEE 802.15.1)	10 m	1 Mbit/s (MDR)	2,4 GHz	100 mW (power class 1)

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Preliminary results of technology comparison (1/3)

- **Availability**
  - Wireless solutions on unlicensed frequencies such as WMBus, LoRa and SigFox offer today an undeniable advantage over cellular technologies, such as EC-GSM and NBIoT, in terms of technology availability
- **Quality of service**
  - Technologies operating on licensed frequencies are proved to be "future proof" solutions, able to support current and future requirements for smart meter applications
  - Technologies operating on unlicensed frequencies meet current requirements for smart metering applications. However QoS cannot be guaranteed over a certain treshold

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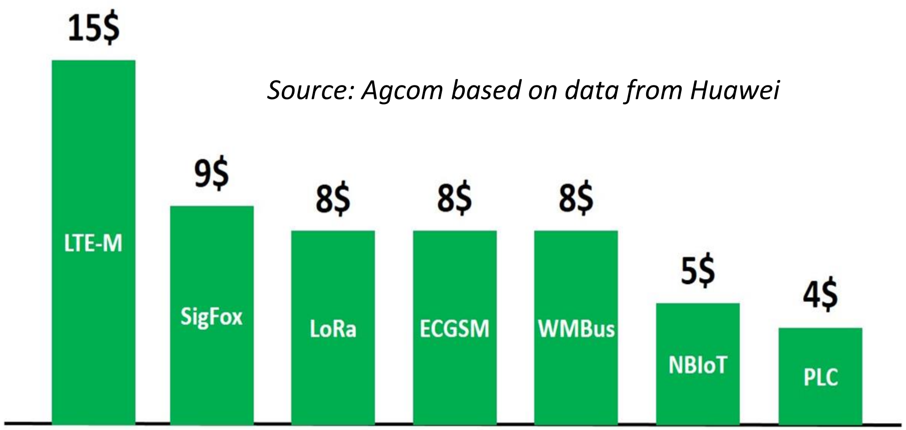
Preliminary results of technology comparison (2/3)

- **Network Interoperability :**
  - Low power cellular networks operating on licensed band present advantages in terms of openness and interoperability, since they are based on open standards
  - A certain degree of interoperability is also guaranteed by network/service providers of unlicensed wireless networks:
    - LoRa Alliance program for certification and compliance to LoRaWAN specifications;
    - SigFox open APIs;
    - Technical specifications for WMBus devices interoperability and interchangeability.

Preliminary results of technology comparison (3/3)

Radio Access Module costs



Infrastructural costs (capex)

- **Infrastructure Sharing**
  - Possible for EC-GSM and NB-IoT (nationwide coverage)
  - Possible for WMBus, LoRa and SigFox technologies, through sharing of broadcasting sites and coverage extension by a limited number of local gateways
- **Service level adoption**: P2MP network topologies (including access points/gateways) are more suitable for high density areas.
- **Multiservice logic:** cost savings could be achieved by e.g. WMBus at 169 MHz

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Thanks for your attention

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