IoT Connectivity

IoT use cases and connectivity solutions in light of the 5G dawn and 2G/3G sunset

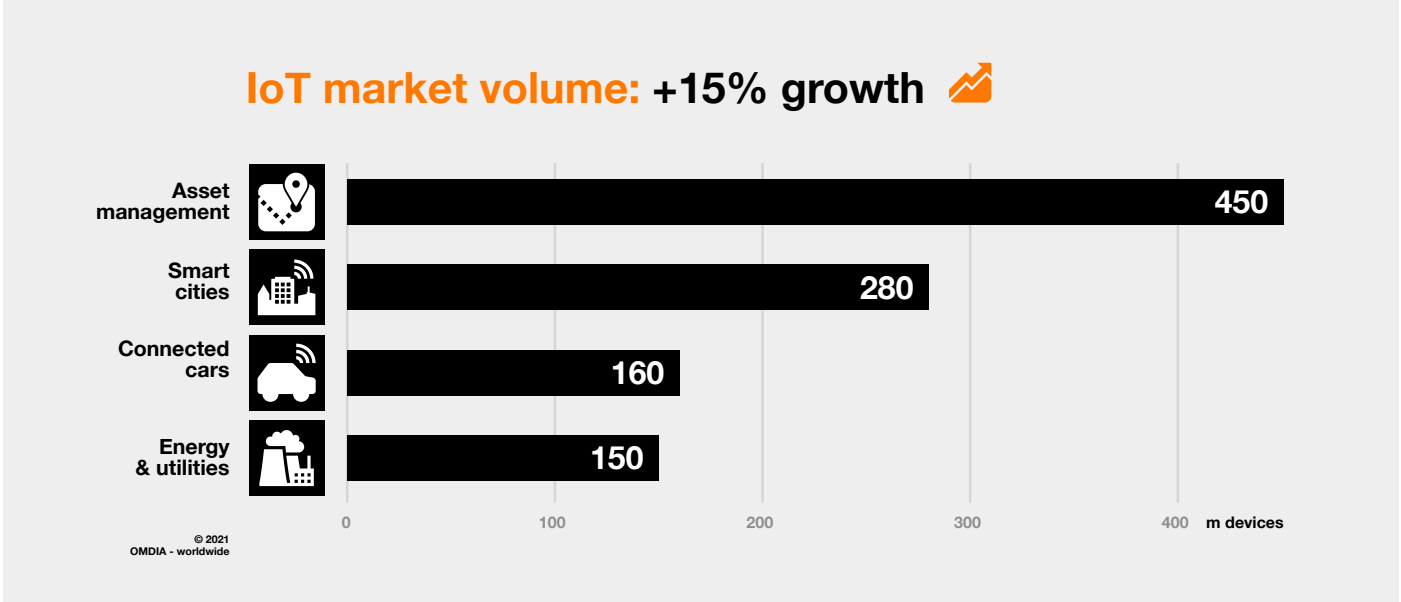


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IoT use cases and connectivity solutions in light of the 5G dawn and 2G/3G sunset

Improved, mature and future-proof connectivity is now available for IoT.

The Internet of Things (IoT) market continues to grow rapidly, with ongoing annual double-digit growth driven by several acceleration factors - such as technology maturity (blockchain, IA, edge computing, etc.), smart city initiatives, smart industry requirements and so on.



To meet the wide range of users' needs, IoT uses several connectivity technologies, with long life cycles increasing the return on investment of development and deployment costs.

With regards to longevity, we are currently in a very significant period. Some avenues are dwindling with the 2G/3G sunset announcements, some are consolidating - like mature and future-proof 4G, and 4G low-power wide-area (LPWA) standards - and some, with early 5G Technologies, are appearing.

The cellular IoT market is growing and, among cellular connectivity networks, LPWA represents a key lever for IoT acceleration thanks to its cheap and massive-scale solutions.

This is therefore the right time to draw the use case and technological landscape, and to demonstrate why the rollout of IoT should wait no longer.

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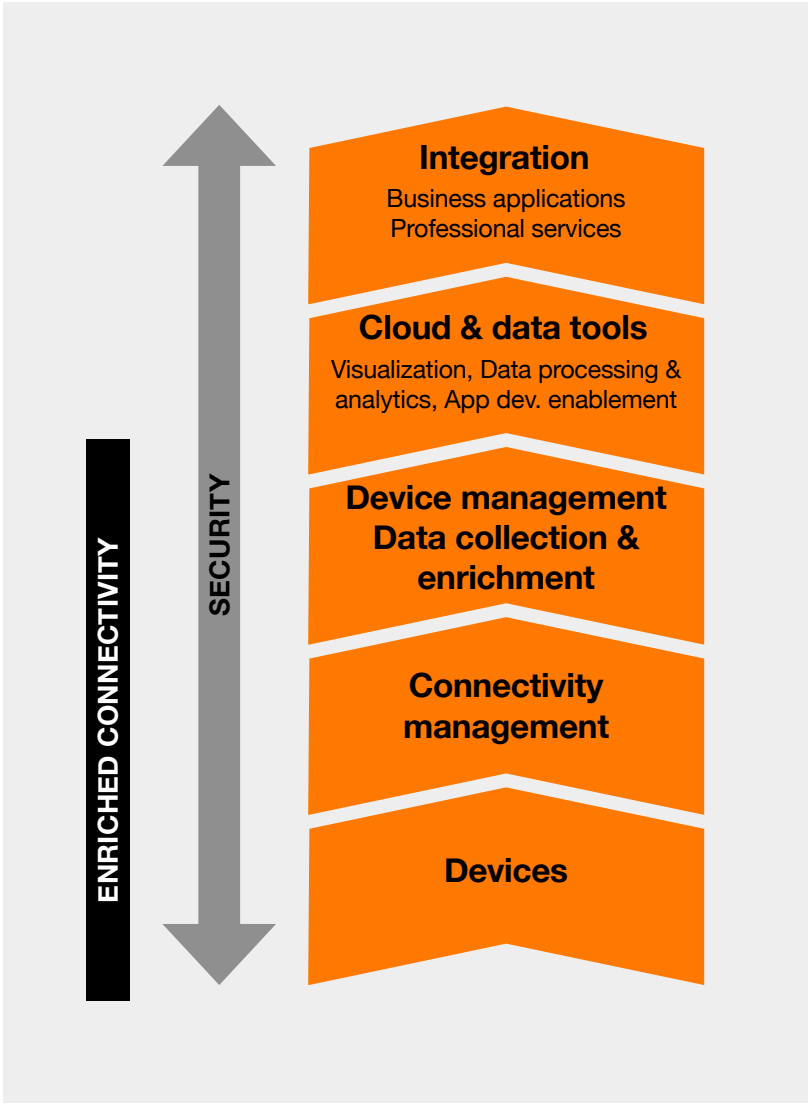
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Introduction : IoT requires that connectivity be at the heart of a well-structured end-to-end chain

A secure chain, from sensors through to applications, that can be managed and supervised.



The “Internet of Things” is a term that describes the use of connected devices to interact with the real world through sensors and actuators, and to communicate these interactions to another device or person. This can potentially involve bidirectional data transfers. This data journey is carried out by several infrastructural elements which require specific skills and knowledge:

- **Devices** (i.e. things).
- **Multiple communication methods**, to transfer data between infrastructure elements.
- Self-service portals and APIs have to be provided for the customer to **manage and supervise the data journey**: the provision of connectivity technology, SIM Cards and devices, activation and invoice management, suspicious behavior alerts for SIM Cards or devices, device firmware management (configurations and updates), etc.
- **Cloud and edge capacities**, to store and process data, before and/or after storage, and deliver it through internet-standard APIs.
- **Business applications**, to make this data usable by other machines or humans, providing data visualization, analyses, and triggering actions.

To safeguard this data journey and its infrastructure, **security** must be applied at every level. In IT and production systems, data collected from IoT can be very sensitive, so all IoT components are required to be highly secured. Security must therefore be integrated from the very start and fully manageable end-to-end. For more information about IoT Security, please look at our IoT Security whitepaper and our whitepaper about Getting IoT security right - a CXO survival guide]

A chain consisting of different technologies adapted to every use case need and context.

The success of an IoT project relies on the ability to first identify needs and requirements, and then use the relevant technologies to address them.

- Needs are related to the targeted communication type (one/two-way), volume (frequency, data rate), reactivity (latency), expected reliability (coverage, quality of service) and sensitivity (security).
- Requirements are linked to location (deep-indoor/ outdoor, in-mobility, roaming) and the power supply (on-plug/battery) of devices.

Every element of the IoT infrastructure depends on, and is impacted by, these needs and requirements, as well as the connectivity layer.

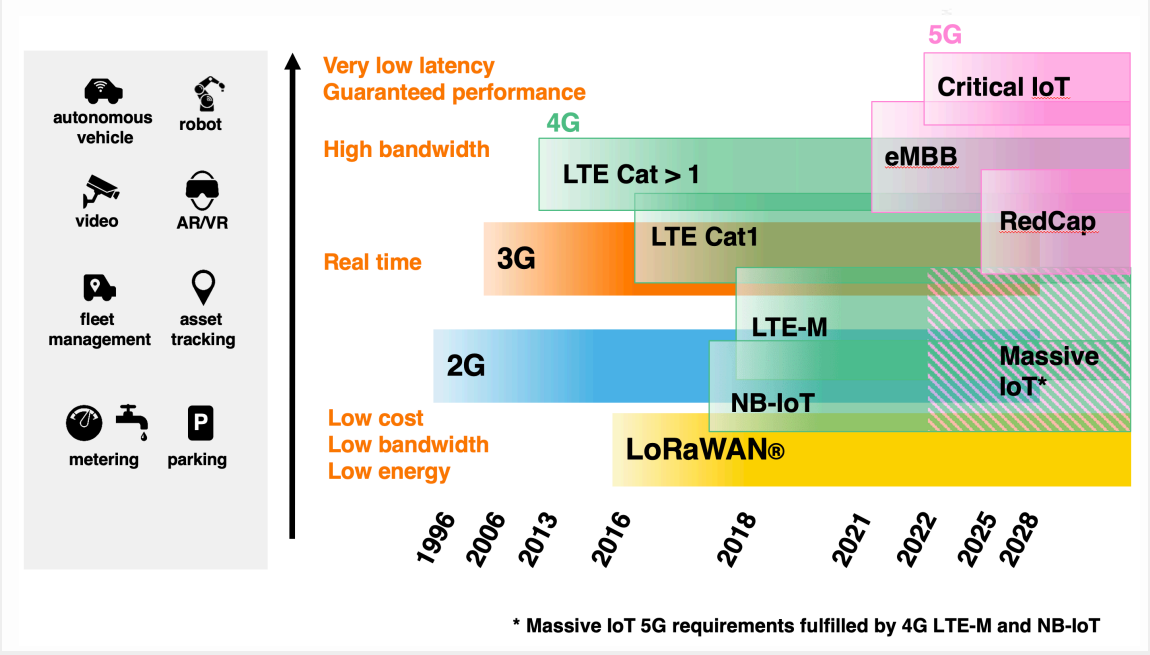
A chain where no single connectivity suits all applications.

Just like different animals require different food types for nutrition, communication needs are specific to each IoT use case.

- A water meter, a temperature or a parking sensor is only required to transfer few bytes several times a day, but should last on battery for 10 years (because of on-field operational costs) and should be able to communicate even in underground conditions.
- At the other end of the use spectrum, robots in industry, autonomous cars and drones require very low, sometimes guaranteed, latency and can generate a huge amount of data. But they have a value that permits more complex hardware and higher communication costs.

For years now, it has been recognized throughout the entire IoT ecosystem that a single communication technology cannot, and will never be able to, respond to every requirement of the different IoT use cases.

For this reason, and because new needs and technology capacities have developed over time, communication technologies have evolved - from 2G in 1992 to emerging and future 5G technology - to better answer user requirements and to cover the whole spectrum of usage.



* Massive IoT 5G requirements fulfilled by 4G LTE-M and NB-IoT

1. For years, LPWA use cases have been using mature technology

LPWA use cases require little communication, low battery consumption and high coverage.

Low Power Wide Area (LPWA) is a generic name for low-end IoT use cases and technology where little communication, low battery consumption and high coverage are required.

A lot of use cases have been identified as ways for companies and administrations to have a better vision of a certain situation in the field, in order to optimize their internal processes and improve their services to customers and citizens.



Orange experience:
Helpévia health building monitoring relying on LPWA [French]

Examples include: detecting and informing about parking availability, monitoring waste tanks to optimize collection, remotely measuring water, gas and electricity consumption to inform the customer more often and detect potential issues in resource distribution, monitoring building metrics to improve comfort and save energy, monitoring crops and optimizing irrigation and fertilizers supply and demand, and so on. The cases are numerous in every domain.

All these use cases have in common:

- The need of little communication - only several messages per day - of around 50-100 bytes,
- A need for battery powered devices with a life duration over 5 years due to the cost of field intervention to change the battery or device,
- A higher need of coverage to reach devices in extreme conditions such as indoors, underground or in remote countryside.

LoRaWAN®, NB-IoT, LTE-M, completed by LTE Cat 1, are mature solutions to answer these needs.

The second part of the 2010s has seen the rise of Lower Power Wide Area (LPWA) use cases and technology, initially driven by non licensed technology, such as Sigfox and LoRaWAN®, but also through 3GPP standardization by telco operators. LTE-M and NB-IoT were defined and first released in June 2016 (release 13) as LPWA 4G evolutions. Non-LPWA LTE Cat 1 completes the portfolio. As of early 2022, LoRaWAN®, NB-IoT and LTE-M (completed by LTE Cat 1) are mature solutions. Each technology has to be well chosen, bearing in mind the design and capacities in the field:

	LoRaWAN®	NB-IoT	LTE-M	LTE Cat 1 (Cat 1 & Cat 1 bis)	LTE
Max. bandwidth	5 Kbps ↓↑	200 Kbps DL ↓ 144 Kbps UL ↑	2 Mbps DL ↓ 3.5 Mbps UL ↑	10 Mbps DL ↓ 5 Mbps UL ↑	1 Gbps DL ↓ 300 Mbps UL ↑
Transmitted Data	Raw/Intermittent Mesures, texte	Enriched/real time Data, [SMS]	Enriched/real time Data, SMS [voice]	Enriched/real time Data, SMS, voice	Enriched/real time Data, SMS, voice
Energy consumption		(with PSM, eDRX)	(with PSM, eDRX)		
Spectrum	Shared	Licensed	Licensed	Licensed	Licensed
Frequency (Europe)	SRD 868 MHz (125KHz band)	LTE 800/1800 MHz (180KHz band)	LTE 800/1800 MHz (1.4MHz band)	LTE 800/1800/ 2100/2600 MHz (5,10,15,20MHz band)	LTE 800/1800/ 2100/2600 MHz (5,10,15,20MHz band)
Coverage	Deep indoor	Deep indoor (with Extended Coverage)	Deep indoor (with Extended Coverage)	Indoor	Indoor
Mobility	Stationary/low	Stationary/low	High	High	High

Network description	Orange experience
Optimized for static and constrained use cases, **LoRaWAN®** is the fastest growing unlicensed LPWA technology, handled for several years by telecom operators for public networks and by local players for private use. Activity at the LoRa Alliance shows recent interest from hyperscalers such as Microsoft and Amazon (who are now sponsor members). Thanks to its popularity, its use of a non-licensed spectrum and low-cost infrastructure, **LoRaWAN®** has been widely deployed in private mode, especially in France.	Thanks to its deployment characteristics and optimized performance, **LoRaWAN®** is perfectly adapted to static and very constrained use cases and is a very effective complementary solution to LTE-M, which can cover higher data rates. We expect for the coming years that a hybrid model will: ▪ Combine the advantages of both local-private and global-public infrastructures for application on moving objects or increased coverage. ▪ Bring more attention to version upgrades and security.
NB-IoT is a cellular alternative to LoRaWAN®, dedicated to low-end verticals. **NB-IoT** has been designed by the 3GPP to cover the IoT's lowest end use cases such as metering, parking, building and agriculture monitoring.	Among cellular solutions, **NB-IoT** offers the best energy efficiency, the deepest building penetration and the lowest module cost. While a little less optimized for battery consumption, **NB-IoT** addresses the same use cases as LoRaWAN®.
LTE-M is a low-cost solution well suited to mobility. This technology offers modularity between several technical requirements: long battery life, deep indoor coverage, SIM/eSIM security. **LTE-M** is power efficient with the highest data rate of any LPWA technology and offers medium latency. It also suits static (patient monitoring, smart grid etc.) and in-mobility use cases (transportation, asset management, etc.).	After operating for several years, we are convinced that this technology is increasingly relevant and fully operational on its key features. The device portfolio is growing, and the past 3 years have seen strong evolutions in field deployments. Constant enhancements to **LTE-M** (and NB-IoT) are proposed in 3GPP releases that ensure its coexistence and cooperation with 5G networks and position this connectivity as a future-proof solution (see chapter 3 – Massive IoT details).
LTE Cat 1, non-LPWA, is a good complement for voice and higher data rates. It has been designed as a LTE solution for scenarios that are not dependent on high-speed data transmission but still require the reliability of the 4G network. **LTE Cat 1 bis** is a more recent simplification (single antenna) of this standard, decreasing the cost of the device. Both Cat 1 and Cat 1 bis natively inherit LTE capacities (SMS, voice, security, roaming).	Pushed by China, by cost-effectiveness and by a transparent use of 4G networks, **Cat 1**, and especially **Cat 1 bis**, are increasingly used by modules and device makers for energy wired (non-LPWA) use cases.

Beyond terrestrial solutions, satellite networks also exist as a complementary alternative. There are specific use cases that could benefit from this technology, particularly in certain areas not covered by the terrestrial network, but it is necessary to clearly define the interest because these new networks also require adoption across the entire IoT ecosystem. All conditions must be met to ensure the solution's successful roll-out, especially in terms of device capacities and price of both modules and connectivity. This technology also still needs to evolve in order to define common standards, to address industrial use cases and to ensure compatibility with other networks.

Each technology has to be chosen well knowing specified and on-field capacities.

Network description	Orange experience
Data rate and latency: LoRaWAN®, NB-IoT, LTE-M and LTE Cat 1 are, by definition, on an increasing scale of data rate and decreasing scale of latency. All these technologies are bi-directional.	LTE-M data rate and latency cover a wide spectrum of use cases. NB-IoT and LoRaWAN® are optimized for use cases that need little communication and simple metric monitoring, such as gas/water metering, parking. Over-the-air firmware updating is still an issue for LoRaWAN® due to very low data rates, and is device dependent for NB-IoT.
Battery consumption: Power Saving Mode (PSM) and Extended Discontinuous Reception (eDRX) modes have been defined for LTE-M and NB-IoT and are now widely deployed in networks to limit the consumption of low power devices that stay silent for long time periods and transmit only when needed.	PSM and eDRX mechanisms are deployed on Orange networks. But tests continue with device makers who are slowly adopting these mechanisms, preferring the classic ON/OFF mode for battery saving (more maturity is seen in the US market.) To benefit from these advanced features on LTE-M and NB-IoT, device choice is key. For very short messages, in-the-field measurements show that LoRaWAN® is able to consume 10 times less than MQTT/LTE-M, and a little less than NB-IoT.
Coverage: LTE-M and NB-IoT can use a mechanism based on repetitions called Extended Coverage (EC) to increase coverage in 2 modes, A and B, which define the maximum repetitions. On NB-IoT, tradeoffs and narrower spectral width give additional coverage.	Extended Coverage mode A is operational, providing better indoor coverage, verified in the field, of +8dB. Mode B is still being tested and theoretically provides a gain of 15 to 18 dB, equivalent to the loss caused by penetrating the wall of a building. Orange neither recommends nor deploys mode B; the excessive number of potential repetitions is counterproductive (for battery and network signalization). Even with LTE-M, NB-IoT or LoRaWAN® coverage gains, experience shows that coverage issues may continue to affect underground devices, for instance. The ability to add on-demand nano-gateways is also a convenient way provided by LoRaWAN® to address coverage in smart buildings, smart cities and industry.
In-mobility and positioning: in the same way, specific features such as TDOA (timestamp triangulation), or E-CID (cell id positioning), have been defined and now deployed, bringing benefits for tracking use cases.	With TDOA methodology, the system calculates the transmitter's (object) position from the relative arrival times of the signals at three receivers and, with cell-id positioning, uses the cell identification code forwarded by the Base Station (eNodeB).

Network description	Orange experience
Roaming: on LTE-M and NB-IoT, the use of advanced features such as PSM, eDRX depends on remote operators and geographical roaming agreements. For Cat 1, native 4G agreements are applied. On LoRaWAN®, roaming has been defined for years by the LoRa Alliance.	LTE-M, and especially PSM and eDRX, are still not widely deployed around the world. Pan-European use of cellular LPWA has to be considered in detail. On LoRaWAN®, Orange has also established network links and agreements for hybrid private and public network usage. This is dealt with on a case-by-case approach.
Capacity: Today's capacity with multicarrier operation allows LTE-M and NB-IoT to connect a huge number of objects per square km (up to 1 million objects according to a 3GPP traffic model).	LTE-M and NB-IoT scalability is enough to meet needs in the coming years. Capacity is not an issue for LoRaWAN® deployments, and will continue not be in the coming years.
Flexibility: Additional enhancements for easier operation and installation are proposed as well as multiple communication protocols adapted to IoT use (CoAP, LWM2M, MQTT, TCP, UDP, PDP).	To look further into protocols, the reader can refer to Connectivity, protocols, security and IoT needs: how to find the right path.
Voice is neither enabled in LoRaWAN® nor in NB-IoT. Voice over LTE-M has been specified by 3GPP. Voice comes natively in LTE Cat 1.	Voice over LTE-M presents some challenges to become a reality: Voice requires good coverage conditions, as repetitions brought by EC cannot be used, latency remains too high and efficient voice codecs are still too rare. For use cases which require voice, such as elevator call and lone worker safety, LTE Cat 1 is preferred.
SMS comes: ▪ Natively for LTE-M and LTE Cat 1. ▪ As an option in NB-IoT specification.	Operators still rarely offer SMS on NB-IoT, but this should change since firmware update triggering and eSIM provisioning generally require SMS. Module makers also propose dual connectivity modules that can offer SMS use when necessary. For SMS uses, NB-IoT devices should be chosen with caution.
Security is at the heart of cellular communication and is evolving with each generation: encryption of the communication and data, use of a SIM Card as a secure element, possibility of private APN integrated with IPVPN, etc. End-to-end security has been also provided from the start by LoRaWAN®.	With important assets on connectivity layers, security needs and levels have to be constantly assessed. The Orange by-design approach is regularly audited, also by leveraging support from the ecosystem (ex. Bug Bounty on Q4 2021).

Focus — IoT Devices portfolio

When it comes to device prices, the current shortage of electronic components has an impact on cost. Module prices started to increase in mid-2021 and this may continue over the next months.

In the long term, we can anticipate a price decrease (15% per year). Note that most LTE-M modules are compatible with NB-IOT networks.

2G	3G	LoRaWAN®	NB-IoT	LTE-M	LTE Cat 1 bis	LTE Cat 1	LTE Cat > 1	5G eMBB
≈3,5-5 USD	≈13-15 USD	≈2,5-4,5 USD	≈4,5-6 USD	≈9-11,5 USD	≈9,5-14 USD	≈20-25 USD	> 30 USD	>200 USD

Orange offers an IoT catalogue dedicated to business use cases, involving a range of equipment as well as the best modules and solutions selected from our partners. To find more information, visit our IoT Journey webpage.

Orange experience: IoT Continuum to accelerate the mass deployment of cellular IoT

Orange has launched IoT Continuum, a new partnership program with major players from the industry: Sierra Wireless, Lacroix and ST Microelectronics.

The program addresses the difficulties encountered by IoT makers in prototyping, industrializing and scaling-up their use cases due to the fragmented and complex IoT ecosystem.

IoT Continuum brings a new value proposition: to accelerate Massive IoT over LTE (including LTE-M + Cat 1) and 5G. For customers, IoT Continuum accelerates IoT projects while minimizing costs and operational risks. A three-step approach is proposed to accelerate the adoption of wide-scale cellular IoT: 1. Start, 2. Prove, 3. Deploy & Scale. IoT Continuum is a continuity offer that guarantees the same pre-integrated and pre-certified components are employed all along the project, and takes full advantage of integrated support from the partners.

2. LPWA technology and LTE CAT 1 will improve and perpetuate 2G/3G-based uses cases

IoT is an important and still growing market strongly based on 2G and 3G network.

2G/3G use cases have been operating for many years now on a large scale and in numerous domains and use cases, such as automotive, building, energy, security and so on. This market is still growing, despite a slowdown during the last past months due to the pandemic. When it comes to connectivity, we can see that:

- Growth still mainly concerns 2G and 3G; especially 2G for its availability, low cost and probably also because deployments involves increasing the volume of existing solutions.
- At the same time, some players have moved to 4G in order to benefit from more advanced features.

2G/3G networks are set to be phased out in order to reuse the spectrum for more efficient cellular technologies.

2G and 3G networks are over a decade old now, and are being progressively phased out around the world to make way for more advanced cellular technologies. The move will accelerate, since several countries and operators, including Orange, have announced the end of 2G/3G in every region of the world:

- In North America (US and Canada), AT&T closed its 2G network at the end of 2016 and has migrated more than 16 million devices off the 2G network. No North-American operator kept 2G open after the end of 2020. In parallel, the 3G sunset started, with a complete stop planned for end 2022.

  Note that LTE-M has been widely open at the same time on the 4G network in North America, and provided an efficient migration target to 2G- and 3G-based usages.
- In Europe, the main operators have now announced the end of 2G and 3G, with final dates between 2025 and 2030
- In Asia, China Telekom has begun to gradually shut down 2G networks and will migrate 2G IoT services to its NB-IoT and LTE-M networks.
- In Africa, Vodacom and MTN have also announced the 2G sunset in the coming years.

Moving from 2G/3G to LoRaWAN® and 4G technologies will offer better performance.

4G technologies brings features that can improve M2M use cases operation:

- In the automotive industry, data rate needs are increasing. If 2G or 3G were enough for the first telematic uses, infotainment now requires a much higher data rate. 4G is now widely preferred on all automotive use cases, including eCall through its evolved Next Generation eCall.
- In construction and energy, where indoor coverage is an issue and only a low data rate is needed, LTE-M, NB-IoT and LoRaWAN® are already widely used.
- For all video-based use cases, demand for quality has grown in parallel with technology evolution. State-of-the-art use cases use 4G, and will soon use 5G, in order to benefit from higher data rates and capacity.

This move to newer technologies is also an opportunity for some players to change software implementation, such as protocol:

- To find an alternative to text messaging, which had the advantage of simplicity but which brought neither guaranty nor native way to verify delivery, for instance.
- To replace proprietary protocols by standard ones, such as Lightweight M2M, in order to facilitate the factory-to-field deployment process (through Bootstrap) and integration with collect and device management platforms, while leveraging on light overheads but better security mechanisms.

Orange experience: from connectivity to enriched connectivity

Moving to new network technologies is an opportunity to benefit from the enriched connectivity offered by the new IoT environment. Users can operate multi-connectivity solutions and get, not only SIM Card management, but also full device management designed for secure and large-scale deployments. These enriched connectivity services provide a full set of features which will industrialize the IoT's lifecycle: Plug'n play cellular devices, standard Bootstrap services, IA-based proactive monitoring, SIM and advanced network diagnostics.

Some migration paths should be highlighted for a smooth transition.

Most 2G/3G devices only have 2G and/or 3G modules embedded, and will therefore not be able to communicate on 4G or 5G networks. To avoid service disruption, companies have to plan the transition to newer technology. The diagram below shows recommendations for 2G/3G substitution, focusing on main use cases observed on the IoT market.

Orange experience: recommended migration paths from 2G/3G connectivity



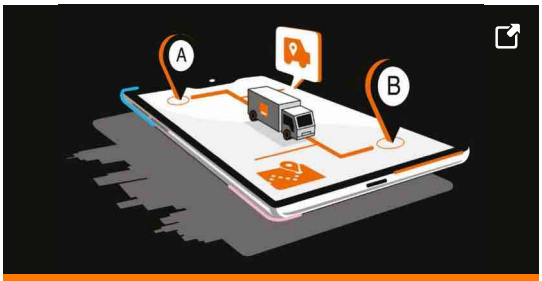
Time and costs can be saved by studying and building IoT projects with experts. Beyond the connectivity expertise summarized in this document, Orange works closely with the IoT ecosystem, especially with module and device providers, shedding light on a wide catalogue of references. OBS experts support this evolution from 2G/3G to 4G and, when necessary, to 5G technology.

3. 5G will continue to progressively complete 4G solutions to high end use cases

As it was with 4G, the 3GPP standardization of 5G offered the first improvements for mobile usage through Enhanced Mobile Broadband (eMBB) with a greater data rate and more capacity to respond to the ever-increasing demands of human use. Using 4G experience, IoT has been taken into account from the start in both high end (Critical IoT) and low end (Massive IoT) directions. After a few years of works, 3GPP members realized that, as with Cat 1 / Cat 1 bis in 4G, a compromise could be useful: which is where we find the RedCap (Reduced Capability) specification.

4G has been covering high data rate demands for years.

Many IoT use cases requiring high data rates are already operating in the field on 4G:



Orange experience:
Alerte Vidéo Transport
4G value added for security in transport

- In-car infotainment and telematic services in the automotive sector are widely deployed on 4G, offering added digital value to car manufacturers and to their customers.
- Video monitoring in cities, construction and transport uses 4G to gather on-demand and real-time HD video capture that, in addition to local storage, can be viewed remotely by security teams. Orange offers a real-time protection solution using 4G technology with its “Alerte Vidéo Transport” service.
- Industrial process monitoring uses 4G to operate real-time HD video capture with slow motion and zoom to allow humans to control production lines remotely and to provide global responsiveness and flexibility and improve manufacturing quality.

Focus Tech — 5G starts from radio (Non-Standalone) to core network (Standalone).

5G deployments have started in Non-Standalone (NSA) mode, connecting 5G New Radio (NR) infrastructure (antennae and base stations), to existing 4G core networks. Deployments will progressively evolve in / to Standalone (SA) mode (in 2022 on mainly private networks, then public ones from 2023), with the connection of this New Radio to a new 5G core network.

What is already present in NSA mode?

- Data rate and latency: the main progression towards 4G is led by radio (including 2.3-4.7 GHz, followed by 24-47 GHz in 2023). NSA, to a large extent, provides these technological improvements.

What will come with SA mode?

- Slicing - the capacity to offer a dedicated level of service (data rate, bandwidth, reliability) - is mainly a 5G core network feature. It will in time come with SA mode. Slicing is viewed to be more widely used on private networks (also facilitated by 5G network softwarization), than on public ones, because of the necessity to keep a large capacity for public usage.
- 5G network APIs (Network Exposure Function (NEF) are also mainly a core feature and are linked with 5G SA mode. NEF APIs provide partners with programmatic ways to interact with and receive information from networks, useful for remote SIM and device management, and key features for IoT.

What has to be considered in the NSA-to-SA move?

- Depending on the features used by a 5G device for communication and management, provided first by radio and/or core parts of a NSA network, the move to SA can require changes: not for antennae, modules or SIM level, but on features used by embedded code. A device running on 5G NSA may need a firmware upgrade to be operational on 5G SA.

5G eMBB improves experiences and capacity on use cases already addressed by 4G.

Enhanced Mobile Broadband (eMBB) was the first 5G standard deployed by operators, first in Non-Standalone (NSA) mode [see the focus above on Non-Standalone / Standalone].

The first objective of eMBB is to meet the increasing capacity and data rate demand of mobile end-consumers, while controlling the resource consumption of network infrastructures.

For IoT, eMBB follows as a technological evolution of 4G:

- Downlink data rate improved to 1.4 Gbps (versus 1Gbps in 4G).
- Latency reduced to 1-5 ms (versus 50 ms in 4G).
- Local cell capacity improved tenfold.

This enables state-of-the-art use cases existing on 4G:

- Real-time 4k video flow for remote and increased quality image analysis for security in buildings and cities.
- Multi-video flow real-time streaming with in-mobility use.
  This is the case, for instance, in Anvers harbor, where 5G supports tugboat operations which require a great deal of precision and experience. Thanks to a moving camera on the tugboat, images are sent to the control room in real time helping drivers to manage operations.
- Remote monitoring and command of machine or robot, with almost real-time responsiveness.
- Augmented reality for maintenance, allowing technicians, while capturing on-site video, to get real-time virtual data linked to machines, production lines or the entire factory. And, with all this information, to track field operations and send real-time reports, as done by Covestro.



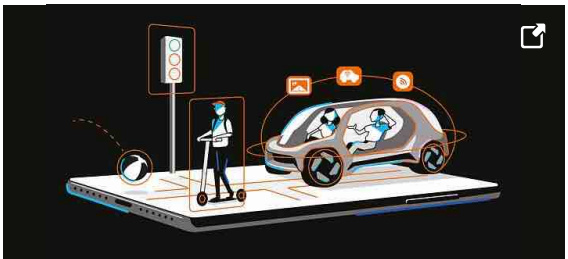
Orange experience: Real-time video flow
Use of 5G by the Port of Antwerp



Orange experience: Augmented field operator
Use of 5G by Covestro

5G Critical IoT, with very high reliability and very low latency, opens a new range of use cases.

5G Critical IoT standard represents a real rupture in terms of on-demand reliability of the capacities delivered by the network. Where, on the previous 3GPP standard, including 5G eMBB, low latency and/or data rates are achieved on a best-effort basis, Critical IoT delivers data within specified bounds, and with specific guaranteed levels. For instance, latency drops to 1ms and reliability of up to 99.9999% can be requested.



Orange experience: Future use of 5G for automotive safety
European 5GCroco project

5G Critical IoT uses 5G network core features (5G standalone mode), especially reduced latency and network slicing, which provides high capacities and reliability on a part of the network. 5G Critical IoT will be enabled in the field from 2022.

5G Critical IoT performances will enable the use of radio for services previously considered too sensitive for this type of communication, and for new in-mobility services:

- Remote machine and robot real-time command and management, in industry or for surgery.
- Real-time communication of vehicles with their environment (city and road signal infrastructure – Vehicle to Infrastructure (V2I)) or with other vehicles (Vehicle to Vehicle (V2V)), for emergency alert transmission, opening the door to autonomous vehicles.

In parallel to Critical IoT deployment on the network, these new use cases are under development. Projects and technological improvements are accelerating: we are just at the beginning of this creative journey.

Focus : Reliability and security on private networks to accelerate the Industry 4.0 transformation

Developed on cellular technologies, Private Mobile Networks (PMR) were initially a solution for voice needs in critical communications. Reglementary and critical needs, especially for emergency and priority communications, requested these deployments and specific operator configurations.

In industry, one of the objectives is to respond to very critical uses in terms of IT and processes. Industrials have high requirements for the security of networks transmitting information and action orders in the context of IoT. Public safety (critical communications) and industry use cases represent the largest demand for 4G Private Networks today.

Needs are evolving: voice and data, security and business models, as well as local computing capacity (edge), are at the center of the expectations for Mobile Private Network (MPN), planned for use in industry for system and control management, but also in hospitals and buildings.

4G and 5G address these needs:

- Local capacity for execution and control for critical systems,
- Local core elements interconnected to public networks,
- Guaranteed SLAs and minimum latency for critical operations,
- Easy evolution of scalability and capacity without significant investment,

Different approaches can be offered in order to suit different levels of security, local deployment and interaction with public networks:

- A Standalone Mobile Private Network will mean the use of strictly local resources, with a dedicated and local core network. It provides complete isolation and may be requested for security and confidentiality reasons.
- A Virtual Mobile Private Network, based on operator resources and frequencies, offers a dedicated SLA, controlled by the operator, and the flexibility to adapt coverage to customer need.
- A Hybrid Mobile Private Network, based on private and secure resources combined with operator resources, provides a compromise between security and openness to public networks, for mobility and/or the extension of coverage while using the same terminals.

Orange experience: Private Mobile Network for Industry - Butachimie

Orange Business Services and Nokia have deployed a Private Mobile Network at the Butachimie Factory of the Future. This network is designed to respond to the challenges of Industry 4.0.

This ensures that Butachimie teams have control of, and efficient access to, IT applications and enables them to use new services through wireless connected equipment in real time. Both the equipment and the data collected have a high level of network availability (greater than 99.99%) making it possible to anticipate disruptions and ensure continuous production within the plant.

Massive IoT is already delivered by 4G.

Massive IoT (known also as mMTC – Massive Machine Type Communication) has been one of the three main use cases (with Critical Communication and Enhanced Mobile Broadband) covered by 3GPP 5G requirements, from release 14 (2015). These requirements defined expectations in terms of improved network coverage, long device operational lifetime and a high density of connections.

LTE-M and NB-IoT have been designed, from release 13 (2014) and for use on 4G, to address these types of requirements.

The 3GPP decided that, with the evolutions specified in release 15 (mid-2018), LTE-M and NB-IoT fulfill the 5G Massive IoT requirements. Started as part of 4G, the 3GPP then agreed that evolutions of NB-IoT and LTE-M will be part of 5G specifications, and that these specifications will also cover their interactions with the 5G core network.

Additionally, 5G New Radio has been designed to be able to support LTE-M and NB-IoT transmissions incorporated into the 5G frequency band, in order to allow the coexistence of LTE-M and NB-IoT alongside other 5G modes.

Orange experience: Massive IoT is both a current and future reality

The consequences of these standardizations are the following:

- From release 15 onwards LTE-M and NB-IoT are compliant to 5G requirements.
- Mechanisms like eDRX, PSM, Extended Coverage defined in the 4G standard will continue to live in future 3GPP releases: competency developed to use these advanced features is future-proof.
- 4G LTE-M and NB-IoT devices will continue for years to run on 4G core network and 5G in-band radio. 4G device deployments are future-proof.

The 3 points above explain why LTE-M and NB-IoT are described by some as “5G ready”, but:

- 4G LTE-M and NB-IoT devices will continue to run on 4G.
- So far, even if specified by the 3GPP, the industrial ecosystem does not plan to implement LTE-M and NB-IoT link on 5G core network.

To conclude, Massive IoT is a 5G requirement with 4G solutions:

- From release 15 onwards, 4G LTE-M and NB-IoT are Massive IoT (fulfilling 3GPP requirements).
- Massive IoT will continue to be covered by 4G networks in coexistence with 5G.

In the future, RedCap will offer an interesting compromise on 5G, like Cat 1 on 4G.

RedCap (Reduced Capability) has been recently described by the 3GPP in release 16 (called initially NR-Lite), as a compromise between other 5G variations: good reliability and acceptable latency, at an improved cost. Note that this compromise is brought by Cat 1 / Cat 1 bis on 4G.

RedCap is especially designed for industrial wireless sensors (latency < 100ms, bitrate < 2Mbps, a few years on battery), video surveillance (latency < 500 ms, 2.5-7.5 Mbps bitrate, plugged) and wearables (5.50/2.5 Mbps in DL/UL, 1 or 2 weeks on battery).

RedCap is expected to be seen on networks around 2025 (according to operator roadmaps on 3GPP standards releases).

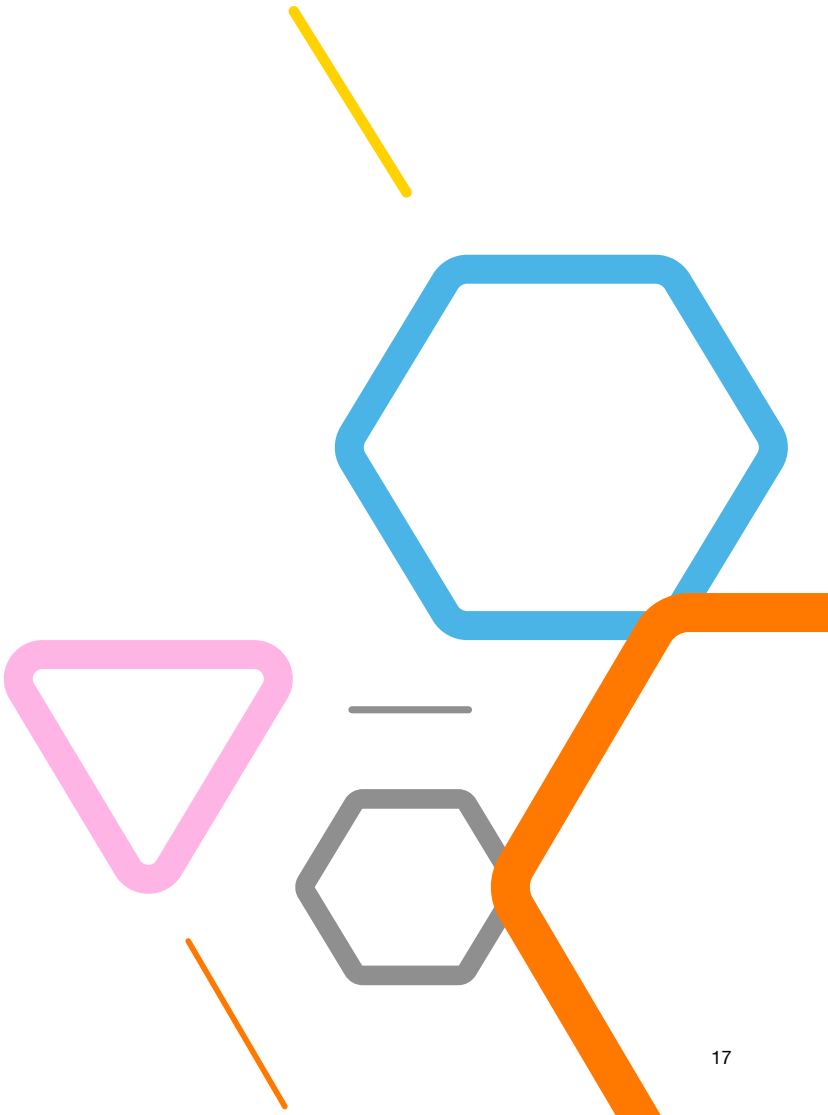
Conclusion

Connectivity for IoT is multiple in order to cover the wide variety of use cases with their many different specificities and requirements.

This multiplicity of technologies is an opportunity to improve and optimize efficiency, security and the performance of use cases. Technologies evolve over time, some are in the process of being phased out to make way for new, more efficient technologies, others continue to be enriched and new technologies open up new experiences.

The extinction of a technology requires a transition and adaptation phase but, as it was observed on the US market, the 2G/3G sunset has been an opportunity to upgrade existing solutions, with mature and future proof technologies.

To benefit from the evolution of technology and the arrival of new solutions, Orange is at your side to accompany you with the optimal solution to best drive your projects.





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