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SINERGIA

Symbiotic Convergence of M2M Wireless Communications and the 5G

Convergencia de las comunicaciones inalámbricas M2M y la 5G

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5G Requirements for M2M

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Executive Summary

The current and the future envisaged explosion of M2M communications within the framework of the IoT has opened up new market opportunities. However, this positive context has encouraged countless initiatives to define new standards (3GPP and non-3GPP standards) for this appealing market niche, thereby fragmenting the IoT technologies ecosystem.

In this deliverable, a compilation of use cases and potential requirements defined by 3GPP has been established as the basis of the SINERGIA project.

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1. Introduction

The envisaged increase of the cellular traffic, which according to [1] is expected to reach 30.6 exabytes per month by 2020 at a compound annual growth rate (CAGR) of 53%, imposes new capacity challenges to the fifth generation (5G) cellular networks. Specifically, this ever-increasing trend in data traffic demand will force 5G networks to meet a 1000×capacity increase, densities of up to 1 million devices/km2 and latency below 1msec, mainly based upon three pillars: the improvement of the spectral efficiency, the allocation of new spectrum bands, and the densification of the Radio Access Network (RAN) [2]. In order to better define the envisaged scenarios and their associated requirements, ITU-R and 3GPP have recently defined three families of usage scenarios for 5G[1] [3]:

i) enhanced Mobile BroadBand (eMBB)
ii) massive Machine Type Communications (mMTC)
iii) Ultra-Reliable and Low Latency Communications (URLLC)

This classification of scenarios is often illustrated with Figure 1, where each vertex defines one of the three families of usage scenarios and where specific use cases are located according to their requirements.

[1] According to ITU terminology, 5G can be also denoted by IMT 2020 and beyond

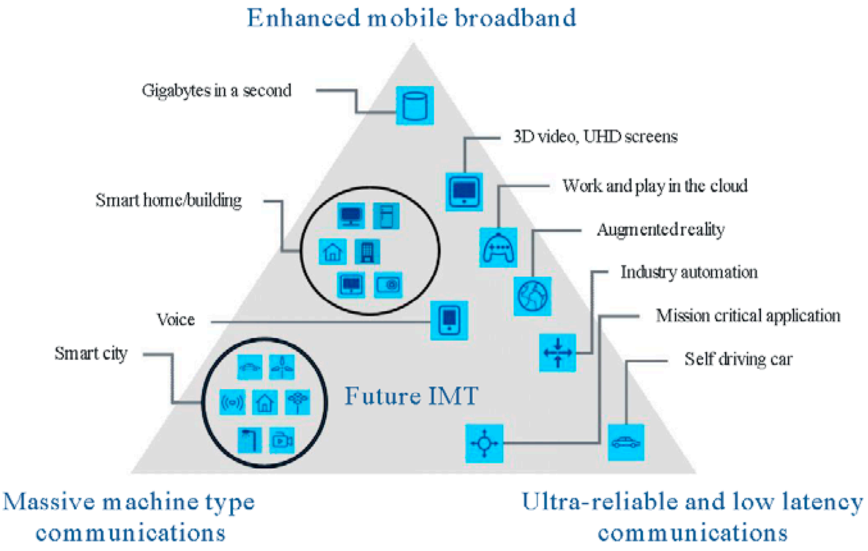

Figure 1. Usage scenarios of IMT for 2020 and beyond [4].

Based on ITU-R definitions [4], eMBB addresses human-centric communications, with a clear focus on multimedia content delivery, high data rates and little energy consumption constraints. This family of scenarios is basically aimed to capture the increasing demand for high data rate services, especially in urban hotspots with low mobility. In the opposite side of the picture in terms of required data rate, mMTC poses the need for extremely dense deployments of devices with limited computational capability, strict energy consumption requirements, low volumes of transmitted data and relaxed latency bounds. However, these scenarios will have to provide massive connectivity services to 1 million devices per km2. Finally, URLLC encompasses use cases with stringent requirements of latency, reliability or availability. Use cases such as industrial control loops, transportation safety, etc are grouped under the coverage of URLLC.

Also in [4], ITU-R identifies the set of capabilities required in each of the usage families, which are summarized in Figure 2.

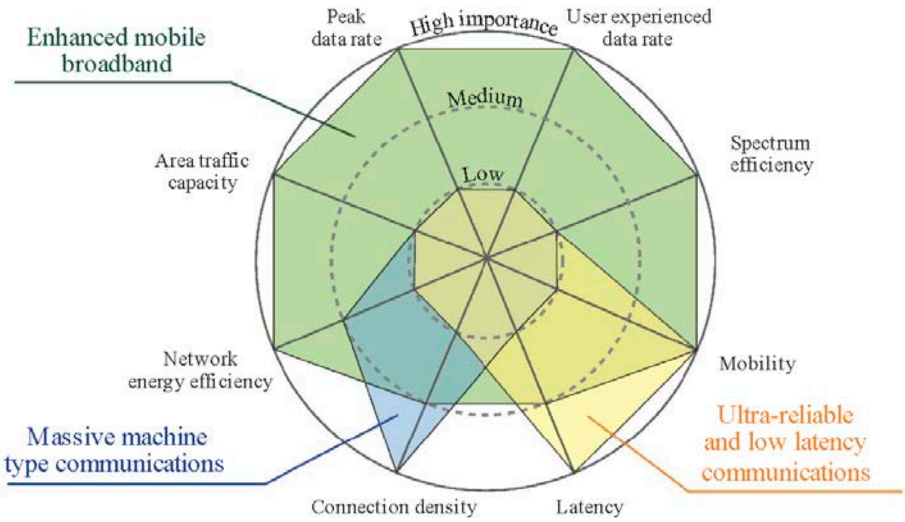

Figure 2. Key capabilities for 5G use cases [4].

According to the definitions and Figure 2, the classification of usage families defined by ITU-R clearly shows how the potential market niche has shifted from human type communications, tightly coupled with eMBB, to Machine-Type-Communications (also known as M2M), more connected to mMTC and URLLC. This paradigm shift has been mainly fuelled by the irruption of the so-called Internet-of-Things (IoT), which in turn has fostered the interest for IoT enabling technologies. For this reason, mMTC is also known as Massive IoT and URLLC as Critical IoT [5].

Although 3GPP is developing three different standards to address the IoT ecosystem (i.e. LTE-M, EC-GPRS and NB-IoT [5]), it will have to compete with diverse existing technologies developed under the aegis of International Alliances, IEEE, private companies, etc. A good example of the aforementioned diversity can be found in [6], where an outstanding classification of IoT technologies is surveyed. Table 1 shows the most prominent standards classified based on the coverage area and identified by Keysight Technologies in [6]:

Table 1. Summary of IoT technologies [6].

Coverage Area	Technology
Cellular Wireless Wide Area Networks	LTE MTC Cat 0; LTE eMTC Cat M; EC-GPRS
Low Power Wide Area Networks	NB-IoT ; LoRaWAN; SigFox; Telensa; Ingenu; PTC; Weightless-W/N/P
Wireless Neighbourhood Area Network	ZigBee NAN, Wi-SUN; Wireless M-Bus
Wireless Local Area Network	WiFi; WiGig; WiFi HaLow; WiFi WAVE; TV White Space
Wireless Field Area Network	Wireless HART; ISA 100.11a
Wireless Home Area Network	ZigBee; Thread; Z-Wave; EnOcean
Wireless Personal Area Network	Bluetooth; ANR+; MiWi
Proximity	NFC

The convergence of such a wide range of technologies will definitely require efforts to harmonize the diverse standards (when possible) and exploit their potentials and complementarities to tailor the future ubiquitous 5G connectivity. As the SINERGIA project is mainly focused on attaining the convergence of M2M technologies in the framework of 5G networks, in the following sections a summary of requirements for 5G M2M use cases.

2. 3GPP Use cases and Potential Requirements

Organizations like 3GPP, NGMN, 5GPPP, etc have proposed an extensive set of envisaged use cases and the corresponding potential requirements for M2M in the framework 5G networks. These use cases have been detailed in [7] as a compilation of existing works. In the following, Table 2 shows a summary of the subset of use cases and requirements in which M2M communications are significantly involved. Table 2 has been extracted from [7].

Table 2. Subset of use cases and requirements extracted from table 6.3.2 of [7] in which M2M communications ply a significant role.

Group of Use cases	Data Rate	Latency	Reliability	Comm. efficiency	Traffic density	Conn. density	Mobility	Position accuracy	Remarks
Critical communications		Realtime low latency (e.g. as low as 1 ms end-to-end; the case “Smart grid system”: less than 8 ms, Round trip latency less than [150 ms], low latency (~1 ms), UE-UE latency: low latency [1-10 ms], 0.5ms one-way delay, Round trip latency less than [150 ms])	Ultra high Reliability, high availability (e.g. limit the duration of service interruption for mission critical traffic, Packet loss rate: as low as 1e-04; delivered in 8 ms, Reliability with Priority, Precedence, Preemption (PPP) mechanisms)		high density distribution (e.g. 10k sensor /10sqkm)			Precise position within [10 cm] in densely populated areas.	Characterised by low latency, ultra high reliability
Massive IoT				Coverage enhancement, Efficient resource and signalling to support low power,	High density massive connections (e.g.1 million connectio	Low mobility (for majority of MTC cases except for		High positioning accuracy in both outdoor and indoor scenarios (e.g., 0.5m)	Difference with CC is: No low Latency

				support devices (e.g., smart meter) with limited communication requirements and capabilities	ns per square kilometre), to accept information from large numbers of locally dense devices, possibly simultaneously	inventory)			
Enhance V2X	Medium Rate (10 of Mbps per device)	Low latency (e.g. 1 millisecond end-to-end latency)	High Reliability (nearly 100%)		Medium traffic density	Medium connection Density (e.g. the number of vehicles can exceed 10000 in scenarios with multiple lanes and multiple levels and types of roads)	High mobility(e.g. up to 500 KM/h, absolute speed more than 200 km/h while relative speed more than 400 km/h).	High positioning accuracy (e.g. 0.1 meters)	V2X differs from eMBB due to its high reliability , lower rate , high speed and high positioning accuracy

3. List of Acronyms

3GPP	*3rd Generation Partnership Project*
5G	*fifth Generation*
CAGR	*Compound Annual Growth Rate*
EC-GPRS	*Extended Coverage GPRS*
eMBB	*enhanced Mobile BroadBand*
eMTC	*Enhanced Machine-Type Communications*
IMT 2020	*International Mobile Telecommunications for 2020*
IoT	*Internet of Things*
ITU-R	*International Telecommunication Union - Radiocommunication Sector*
LoRaWAN	*Long Range Wide Area Network*
LTE-M	*Long-Term Evolution for Machines*
M2M	*Machine-to-Machine*
mMTC	*massive Machine Type Communications*
MTC	*Machine-Type Communications*
NB-IoT	*Narrow Band-IoT*
PTC	*Positive Train Control*
RAN	*Radio Access Network*
URLLC	*Ultra-Reliable and Low Latency Communications*

4. References

[1] Cisco Systems Inc, “Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2014-2019,” 2015.

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[6] Keysight Technologies, “The Internet of Things: Enabling Technologies and Solutions

for Design and Test," 2015.
[7] 3GPP, "Feasibility Study on New Services and Markets Technology Enablers V14.2.0," 2016.