5TONIC

Exploring the future of the network

Building a new tech ecosystem

Future 5TONIC

Index

1. What is 5TONIC?

5TONIC laboratory in Madrid

The 5TONIC co-creation laboratory was launched in 2015 to provide an open environment where members from services, users and SMEs can collaborate with the telecom community on specific 5G mobile research and innovation projects. The aim is to support innovation and help organizations work together to develop and deliver market-ready 5G solutions, technology applications and business ventures. 5TONIC promotes joint project development, entrepreneurial ventures, discussion fora, events and conferences with focus on 5G mobile technology, supporting members along the technological cycle from research to practical business application.

Telefónica and IMDEA Networks founded 5TONIC in 2015 and, since then, some of the most innovative companies and technological organizations have joined 5TONIC for its collaborative work formula, where companies cooperate to achieve specific objectives jointly: Ericsson, CommScope, University Carlos III of Madrid (UC3M), InterDigital and Capgemini engineering.

Other companies within the 5TONIC ecosystem play a collaborator role, joining the laboratory to develop specific projects that may leverage early access to the technology provided by the laboratory facilities for innovating on their business solutions. In this category we can find Nokia, Intel, ASTI Mobile Robotics, Rohde & Schwarz, Celling 5G, Utek, Telcaria, Yerba Buena VR, DeepSight AI Labs, Fivecomm, GMV, NEC Laboratories Europe, OpenNebula and ATOS.
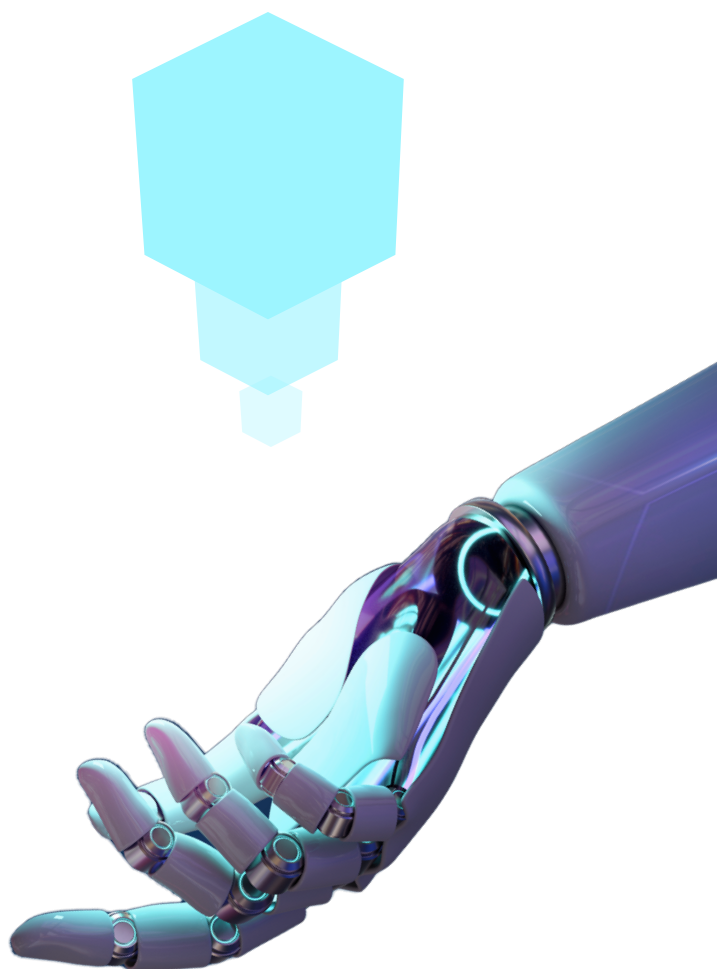
2. What has 5TONIC achieved since its launch?

Throughout these years, the laboratory has participated in more than 30 projects and collaborated with more than 50 companies, making it one of the most advanced 5G laboratories in Europe, having received the consideration of Digital Innovation Hub from the European Commission.

Since its launch in 2015, it has been working on **two fundamental lines of activities:**

INDUSTRY 4.0
HEALTH
MEDIA
GAMING
TOURISM
TRANSPORT

• **Firstly**, and with the highest priority, converting the theoretical capabilities of the 5G mobile networks into enablers of real-world use cases and applications for the different vertical industries, developing solutions for health, industry 4.0, gaming, surveillance, transportation, automotive, and tourism sectors, as well as for the efficient management of cities (smart cities), among others.

• **Secondly**, to carry out tests of the new technologies that are being incorporated into the 5G ecosystem and that facilitate many of these use cases, such as network function virtualization orchestration systems (NFV) and the softwarization of networks (SDN), the processing capacity of edge computing, network slicing or quantum networking.

5G as enabler for real-world use cases and applications for the different vertical industries
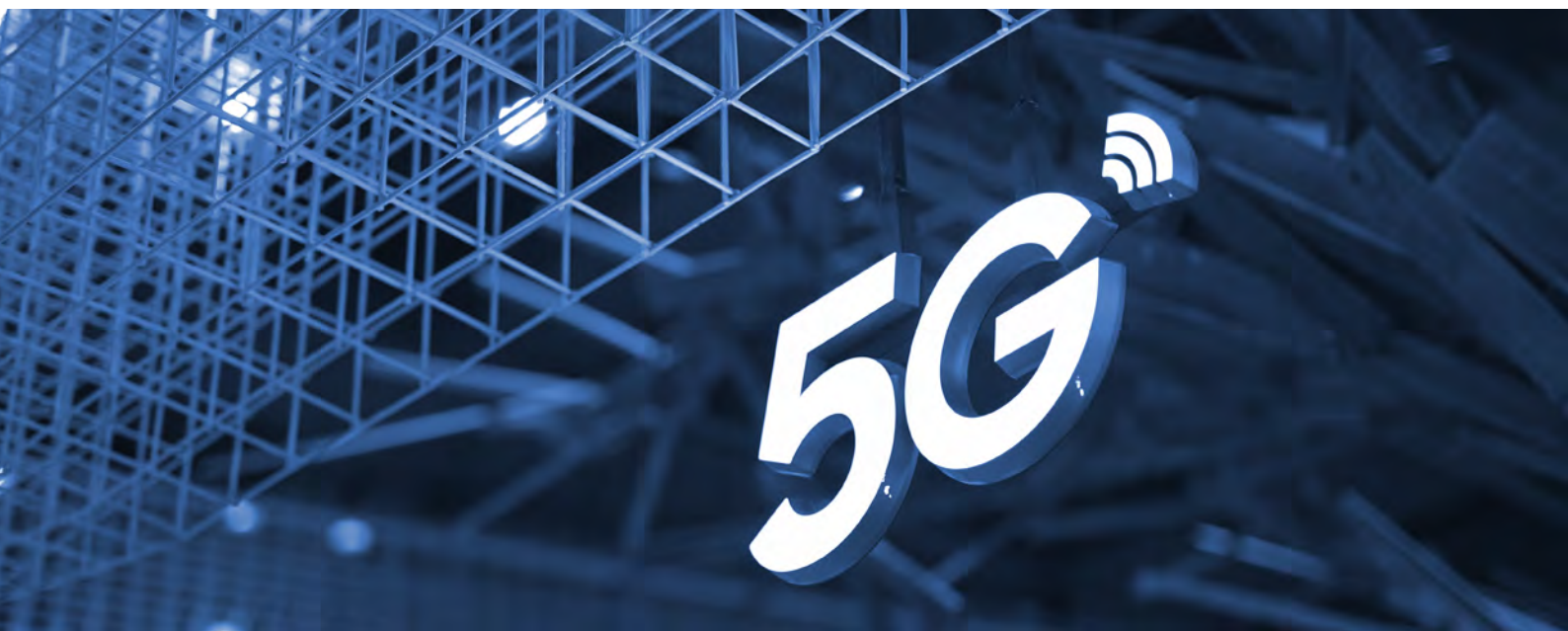
UC3M, **Ericsson and Telefonica** develop, together with **SAMUR-PC**, trials of a 5G-based emergency service that dramatically reduces the time for assisting victims of cardiovascular accidents.

Health

ASTI/ABB develops, together with **Ericsson, Intel, Telefónica, IMDEA and FiveComm**, trials of 5G-connected Autonomous Guided Vehicles (AGV) that also support real-time video gesture recognition.

Industry 4.0

Tourism

At FITUR 2020 it showcased a virtual tourism application enabling users to attend and experience an exhibition remotely over 5G as a result of the collaboration with **Ericsson, IMDEA Networks, SEGITTUR and YBVR.**

5G
as enabler for real-world use cases and applications for the different vertical industries
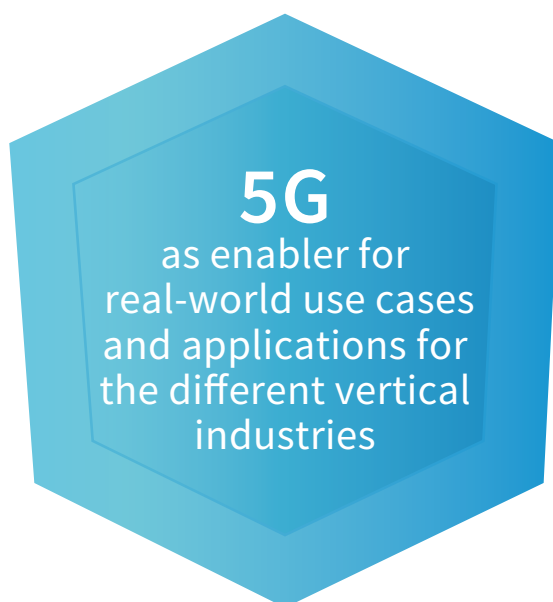
Media

360-video production in motion in collaboration with technology start-up **YBVR**, together with **Telefónica and UC3M.**

Transport

5TONIC supported the world's first remotely controlled unmanned vessel using the commercial mobile network, in collaboration with **Telefónica and Ericsson** together with **UTEK Technologies**.

Gaming

Testing the 5G access suitability for supporting online gaming, both for games played on mobile devices as well as games with high performance requirements, carried out by **Telefónica and Ericsson** in cooperation with several gaming platform providers.

Test of new technologies that may be part of the 5G ecosystem

• 5TONIC deployed member company CommScope's OneCell® technology within the laboratory to mimic 5G networks.

• Automated deployment of an internet protocol telephony service on unmanned aerial vehicles using NFV.

• One of the first deployments of the new 5G Core solution, enabling "stand-alone" access from the 5G New Radio node. It facilitates support for new use cases, as well as the use of "network slicing" that allows customisation of 5G network capabilities to the needs of users. The onboarding of a network slice, from core to radio, was configured and deployed in a few minutes using advanced automation mechanisms.

• Recently, Telefónica and Ericsson have demonstrated pioneering end-to-end, automated network slicing in 5G standalone (SA) mode, including Dynamic Radio Resource Partitioning, achieving, in a first phase, fully automated end-to-end network slicing based on 5G SA. It showed the end-to-end orchestration for full slicing life cycle support and radio resources partitioning, offering a key differential user experience to customers, based on network slice selection mechanisms from the handset.

• 5TONIC created, together with UC3M, the world's first master's degree in NFV/SDN for 5G networks, sponsored by Ericsson.

Participation in main 5G research projects

5TONIC also collaborates with other national and international research and innovation projects and has been chosen by the three major pan-European projects funded by the European Union in the Call ICT-17 "5G End to End Facility," in charge of developing 5G technology testing infrastructures for European companies and verticals: 5G EVE, 5G-VINNI and 5Genesis.

Multiple projects from other EV calls (e.g., ICT-19 Advanced 5G validation trials across multiple vertical industries) are, as a result, extensively using these 5TONIC infrastructures.

This is the case, for example, of 5Growth, whose objective was to empower vertical industries with an AI-driven automated and sharable 5G end-to-end solution that will allow these industries to achieve their respective key performance targets. 5TONIC also supports the activities of other European projects, as well as collaborative projects with Taiwan, Brazil and the United States. 5TONIC is also involved in several projects of the SNS (Smart Networks and Services) Horizon Europe, which makes it well positioned to explore the use of beyond-5G capabilities,

bringing unique new service capabilities with wider economic implications.

The laboratory was recognized as a centre for excellence in 5G technology and was awarded the status of Digital Innovation Hub by the European Commission in 2018.

All these have been great achievements but, as an innovation lab, 5TONIC needs to renew itself periodically to keep the spirit of progress and collaboration alive.

3. What is next?

New use cases for the beyond 5G era

With the consolidation of the 5G technology in the networks worldwide and the evolution to 5G-Advanced (releases 17 to 20 of 3GPP), there are opportunities open for new breakthrough applications in different sectors.

Some examples are:

• Solutions for the industrial sector, developing new use cases supported by additional capabilities like TSN, DetNet, RedCap and advanced IoT devices (cameras, microphones and new sophisticated sensors).

• Multiple applications based on video analytics: zero-default manufacturing, video surveillance, remote drone-based inspection of critical infrastructures.

• Infrastructure and solutions to support Metaverse-like scenarios in a sustainable way for massive applications exploiting capabilities like high-capacity 5G Radio, WiFi 6/7, edge computing and NaaS-based Quality of Delivery. Metaverse applications will apply in different segments: consumer (for entertainment, video, gaming), enterprise (IT processes like in retail) and industrial (with Mobile Augmented Reality for in-factory or field technicians).

• Autonomous networks, transforming network operations towards zero touch, by applying extensively technologies like Big Data, Artificial Intelligence/Machine Learning and digital twins to the network processes, moving from reaction to prediction, from repair to prevention.

They will prepare 5TONIC for a 6G future of pervasive sensing (Internet of Senses), with machines that can see (computer vision) and augmented humans with ergonomic untethered XR glasses and connected bio-sensors and exoskeletons, industry processes supported on a fusion of digital and physical worlds using extensively interactive 3D digital twins.

Extending lab capabilities to support the new wave of technologies and applications

The next years up to the introduction of 6G, around 2030, will see a great progress in the introduction of new technologies, with some coming in the short-medium term (up to 2025) and others requiring a longer time to maturity (up to 2030).

A great deal of new technologies will be introduced during the evolution towards 6G.

In the short-medium term we will see:

Widely available **edge computing service**, with low-latency coverage and capacity extending over time, forming an edge-to-cloud continuum built by aggregation and federation of multiple distributed edge and cloud providers, that will support both dynamic cloud-based networks as well as business applications.

The extension of **high-capacity 5G Radio worldwide,** with massive deployments of 5G-NR and selective coverage of mmWave and WiFi 6/7, **new antennas** like 8T8R FDD in mid bands and FDD massiveMIMO, **non-3GPP access** (WiFi 6/7) and other **new features** like precise location, Dual Connectivity/Carrier Aggregation or 5G-Advanced uplink improvement.

The consolidation of a **network programming environment**, delivered by an NaaS platform (API gateway) that offers Open NaaS Service APIs to customers (application developers, enterprises) supported by new network capability exposure functionality (like NEF/SCEF, NWDAF, PCF, RAN-RIC, SDN-C, Edge/Cloud orchestration) and open standards (like CAMARA). **Network slicing** will emerge in this period, in a first step static and based on 5G SA features and consolidate as a major asset to be exposed and monetized by 5G service providers.

Network and computing resources will not be enough. They will have to be complemented by advanced **data processing capabilities.** We will see a pervasive use and application of **Big Data** and **AI/ML** along all verticals and business processes, supported at different locations on and off-net, with extensive application in the analysis of video data **(video analytics)** and in the recreation of **digital twins** of people, objects, assets or even processes. **Dataspaces** will also be a fundamental tool for a secure and controlled data sharing for the improvement of processes across value chains in different sectors.

New capabilities that provide **time synchronization** and **real-time** support, like TSN or DetNets, relevant for multimedia content production and industrial environments.

A **cloudified network** whose main components will be virtual RAN and virtual OLT, open IP/Optical and SDN-Controllers and the 5G SA Core, shaping a new open digital architecture for the network, with open standard APIs to facilitate the integration of network components and horizontal tools for operation and maintenance.

Advanced capabilities for **massive IoT** like RedCap, facilitating the massive penetration of IoT sensors and actuators.

These capabilities will be progressively incorporated to the 5TONIC lab environment as use cases and research projects demand them. The 5G lab setup will become more flexible with a portable 5G SA Core (both backpack and cloud-based setups), distributed UPFs (beyond Release 17), and managed facilities for temporarily attaching external nodes facilitating the incorporation of new partners and the launch of new projects.

In the longer term, we expect other breakthrough innovations to come into our lab:

New bands like FR3 (7.125 GHz to 24.25 GHz) and THz for 6G (~300 GHz)

Federation and roaming services that will facilitate our interconnection with other labs.

New radio innovations for 6G like giga-MIMO, Reconfigurable Intelligent Surfaces (RIS), Integrated Sensing and Communication (ISAC).

Decentralized Internet, Web 3.0, blockchain/DLT technology.

Multicloud orchestration solutions will facilitate the use and management of the complex hybrid multiprovider edge-to-cloud continuum.

Highly specialized networks: in-vehicle, in-body, in-factory… with specific frequencies, antennas, devices, computing and security requirements and space and power limitations, and connected between them and with the public network.

Quantum safe communications, improving encryption (quantum-safe cryptography) and key management (quantum key distribution, quantum random number generation).

Composable networks: with tools to develop services based on the combination of elements from different networks (and even different providers), by enriched APIfication (NaaS), codification (Network as Code), AI/ML-based orchestration and initiatives such as Open Gateway (which aim to transform networks into interoperable, intuitive and programmable platforms) to simplify the management of network assets and operations.

Spatial computing, which will allow augmenting the physical reality with virtual objects/persons correctly positioned.

It is hard to predict what the technology will be in 5-10 years but the fact is that some of the elements of these future innovations are already present and will be the target for our work at 5TONIC in the next years.

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European projects within the SNS JU

- 5G/6G networks and vertical applications reducing their carbon footprint by a factor >10.

- End-to-end service deployment and management based on a highly-distributed grid of orchestrators.

- Orchestration platform, with native integration of AI, to support extreme URLLC application requirements.

- Second stage of the European flagship project on 6G technologies.

- Provisioning of deterministic network paths to support time-sensitive services as requested by end-customers.

- Privacy-sensitive security enablers for 6G networks.

- Full large-scale trials to implement a comprehensive set of innovative 6G applications based on various technologies.

- Enabling next-generation XR services and infrastructures.

5TONIC will host activities around a number of European B5G/6G projects that have been granted to its members.

4. Conclusions

In its first 7 years, 5TONIC has consolidated a complete 5G lab and ecosystems with all the technological components required to showcase all the opportunities 5G brings. The set of use cases and trials performed so far in many different sectors have helped to bring the technology to life, working with the customers that will consume it and validating its maturity and readiness for the different applications.

A new phase comes in which new features will be introduced to progressively transition 5G into the next generation of cellular network. 5TONIC now has the challenge to evolve its capabilities and keep on showing its value as a catalyser for the development and adoption of 5G/6G technologies in the different industry, agro and service verticals.

5. Members

Telefónica

Telefónica is one of the leading telecommunications companies in the world in terms of technology and innovation.

IMDEA institute networks

IMDEA Networks is an international research institute on network technologies whose multinational team is engaged in cutting-edge fundamental science.

uc3m

Universidad Carlos III de Madrid (UC3M) is a public research university, which has the category of Campus of International Excellence since 2009.

ERICSSON

Ericsson is a world leader that enables communication service providers and enterprises to capture the full value of connectivity by creating the technologies and services that shape our future.

interdigital

InterDigital, Inc. designs and develops advanced technologies that enable and enhance mobile communications and capabilities.

Capgemini engineering

Capgemini is the world leader in engineering and R&D services, bringing to their clients global expertise and capabilities, cutting-edge technologies in digital and software, agile engineering platforms, and an industrialized delivery model.

COMMSCOPE®

CommScope helps companies around the world design, build and manage their wired and wireless networks.

Want to be a member or collaborator? For more detailed information, access: 5tonic.org

6. Collaborators

YBVR°

ROHDE & SCHWARZ

gmv
INNOVATING SOLUTIONS

U TEK

NOKIA

Fivecomm

Telcaria

intel.

Open Nebula

NEC

Atos

ABB

celling
5G solutions

AEROTOOLS
UNMANNED AERIAL TECHNOLOGY

Want to be a member or collaborator? For more detailed information, access: 5tonic.org

7. Glossary of acronyms

AGV	Autonomous Guided Vehicles
AI	Artificial Intelligence
API	Application Programming Interface
AR	Augmented Reality
DetNet	Deterministic Networks
IoT	Internet of Things
ISAC	Integrated Sensing and Communication
MEC	Multi-access Edge Computing
MIMO	Multiple-Input Multiple-Output
ML	Machine Learning
NaaS	Network as a Service
NEF	Network Exposure Function
NFV	Network Functions Virtualization
NWDAF	Network Data Analytics Function
OLT	Optical Line Termination
PCF	Policy Control Function
QoD	Quality of Delivery
RAN	Radio Access Network
Redcap	Research Electronic Data Capture
RIC	RAN Intelligent Controller
RIS	Reconfigurable Intelligent Surfaces
SA	Stand Alone
SDN	Software-Defined Networks
SECF	Service Exposure Control Function
SNS	Smart Networks and Services
TSN	Time-Sensitive Networking
5G-NR	5G-New Radio

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