# **5G-TOURS NEWSLETTER**

The official 5G-TOURS project newsletter

## **5G-TOURS**

5G-TOURS is 5G-PPP Project European Commission Call H2020-ICT-2018-2020 Grant number 856950

### A welcome from the 5G-TOURS coordinator

### Silvia Provvedi

5G-TOURS is approaching the conclusion of the project after 3 years of fruitful collaboration, which resulted in the achievement of the objectives set and overcoming challenges, primarily its development almost always during the pandemic.

The project is an exemplary demonstration of the power of 5G technology in a variety of vertical applications and delivers results through KPI measurement and direct feedback from end users and verticals collected during real-world trials. Indeed, trials on media, AR/VR and robotic use cases have been executed in presence of public and involving schools, 5G opportunities in the health sector have been evaluated by involving hospital doctors, use cases in the airport sector also testing emergency situation like evacuation of people.

This fourth newsletter encompasses an overview of the project's goal, main technical achievements, innovators and results, key dissemination events and finally a last snapshot of the project outcomes.

Enjoy the reading!

And visit our website and our YouTube channel for the latest videos!



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### **5G-TOURS Roadmap**

5G-TOURS has already deployed full end-to-end trials to bring 5G to real users for thirteen representative use cases. The project already provided efficient and reliable close-tocommercial services for tourists, citizens and patients in three different types of cities:

- Rennes, the safe city where e-health use cases will be demonstrated;
- Turin, the touristic city focused on media and broadcast use cases;
- Athens, the mobility-efficient city that brings 5G to users in motion as well as to transport-related service providers.

These services not only improve the quality of life for citizens and tourists, but also represent an important business opportunity as they address industry segments accounting for more than 50% of the estimated revenues generated by verticals.

The ultimate goal of 5G-TOURS was to bring 5G deployments to a real use. To this end, a set of use cases have been defined to provide services to the vertical customers involved in the consortium, which include a school, a museum, a hospital, a municipality and an airport. The different use cases have been grouped around three themes, the touristic city, the safe city and the mobility-efficient city, which were successfully deployed in three of the nodes provided by the 5G-EVE platform.

The main steps followed by 5G-TOURS were (i) the design and deployment of an architecture composed of the precommercial components brought by the 5G-EVE platform along with the innovations coming from Phase 2 projects and 5G-TOURS itself, (ii) the implementation of the 5G-TOURS solutions that combine the use of the appropriate network slicing instances of the architecture and the vertical solutions relying on 5G communication are needed for the use cases, and (iii) the deployment of trials to evaluate the 5G-TOURS vertical solutions on top of the 5G-EVE nodes. successfully achieved, was to get the European 5G Vision of "5G empowering vertical industries" closer to commercial deployment with highly innovative use cases involving cross-industry partnerships

The goal of 5G-

**TOURS**, which was

The full roadmap of the project is represented on the next page.





#### Network technology development

The architecture developed by the project was deployed in three fully operational sites in Europe demonstrating the capabilities of

#### Service layer design

The service layer was sucessfully deployed in the three 5G-TOURS trials and evaluated by the layer was also developed and provided as open source to external stakeholders for its evaluation. Piazza Castello





#### Vertical solutions development

use cases and demonstrated in the corresponding trials.

#### **Trials deployment**

The deployments were based on the existing infrastructure offered by the by the project itself, such as indoor coverage of two museums, of a wireless operating room and of an airport.

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#### Use cases deployment

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#### Network and vertical services' KPIs

The customer satisfaction of the use cases addressed by 5G-TOURS was evaluate the performance of the service; and (ii) performing a subjective and customers involved in 5GTOURS as well as by external stakeholders.



Through design and deployment of complex network setup in three trial sites was realized a set of distinct use cases which improve citizen lives

## 5G-TOURS final architecture

The fundamental feature of the 5G-TOURS concept is the dynamic use of the network to seamlessly provide different types of services adapted to the specific needs of individual use cases. 5G-TOURS enabled different capabilities such as network slicing, virtualisation, orchestration or broadcasting as well as additional features developed by the project to bring more flexibility and improved performance. The ambition was to fully demonstrate pre-commercial 5G technologies at a large scale, showing the ability of the 5G network to meet extreme and conflicting KPIs while supporting very diverse requirements on the same infrastructure.

This architecture has been designed with a set of requirements in mind, coming from the interaction with WP2 on the generation of the network slice blueprints through NEST templates, an activity that is also reflected in WP7. In the following, we first discuss the requirements coming from WP2 on the architectural design perspective, then we have an indepth analysis of our designed architecture, structured along different axes.

In order to support the 5G-TOURS envisioned use cases, the WP3 included enhanced additional functionality that was developed on top of the existing 5G-EVE platform. These development activities in some cases introduced additional side functionalities, like monitoring features, which were outside the scope of the 5G-EVE project, or included some cornerstone network function, as for the case of broadcast support, Al-enhanced MANO, a functionality that is mandatory for the correct realization of the UCs. More specifically, the 5G-TOURS additions to the baseline 5G EVE ecosystem can be summarized as:

- · More and diverse network infrastructure deployment.
- Targeted vertical to network interaction, through the usage of the 5G-TOURS Service Layer. This includes the API for the usage of Artificial Intelligence, Broadcast, and enhanced monitoring.
- The specific algorithms implementing these functionalities (e.g., the AI agents).

The workflow took place as follows: the UC owners introduced requirements (by their initial description, but also through the NEST templates definition) which were then fulfilled by WP3. The 5G-TOURS Network Architecture is depicted in the figure below.



It encompasses three different domains (Verticals, Network, and Infrastructure), in a layered fashion. The different layers are:

- The 5G-TOURS Verticals, that represent all the application ecosystem providing the UC related functionality. These VNF NetApps available in this layer, are then onboarded in the network us-ing the Service Layer, either directly leveraging the 5G EVE portal, or the direct connection to the underlying MANO service available at each site/infrastructure deployment.
- The 5G-TOURS Service Layer implements all the facilities needed by NetApps to be fully inte-grated with the underlying network architecture. In 5G-TOURS this layer is provided by means of extensions to the 5G EVE portal and specific 5G-TOURS Service Layer solutions.
- The MANO, local to each site. This layer is mostly composed by 5G EVE configured elements, with the addition of 5G-TOURS specific elements, which are usually tightly integrated with the service layer, using the connection. The MANO also includes AI specific modules.
- The VNFs (Core and Access) available at each site. Again, these assets are partly inherited by 5G EVE, but they have been integrated with specific 5G-TOURS technology, especially in the access network side, but also for the specific multicast-enabled elements in the core.
- Finally, the infrastructure, mostly related to provide access network to the final trial sites (e.g., the museums in Turin, the hospital in Rennes, and the airport in Athens), but also related to vir-tualization deployed into each site.

### 5G-TOURS deployed use cases Turin - Touristic City

The Touristic City UCs enables a new ecosystem of applications and solutions that improve the quality of the visit of citizens and tourists in the city of Turin, under many points of view. First, to allow people to access and enjoy attractions in enhanced or novel ways, and second to enable new opportunities for the vertical sectors (Tourism and Media) to exploit the available assets. The use cases tested within the project are part of a wider spectrum of innovative solutions in the cultural field, on which the city of Turin has worked and will work in the coming years. This section describes the outcome of the work performed during the course of the project in work package 4 (WP4). Also, you can read more about all the use cases in the final WP4 <u>Deliverable 4.4</u>.



#### UC 1 - Augmented tourism experience

This use case is focused on the use of Augmented and Virtual Reality technology. It provides visitors of targeted museums with an improved and more engaging experience based on the use of an augmented reality inside and outside the Palazzo Madama Museum concerning virtual reality technology.



#### UC 2 - Telepresence

This use case provide the possibility for a robot located inside the museum to be controlled by a remote user by exploiting an underlying 5G network capable of meeting the stringent KPIs necessary for effective robot control and low latency high quality video stream.



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#### UC 3 - Robot-assisted museum guide and monitoring

This use case leverages the use of robotic technology to provide an enhanced museum visit experience. This guided tour is performed autonomously by the robot following a predefined path. In this use case the humanoid robot R1 is used to carry out a guided tour.



Read More >>

#### UC 4 - High quality video services distribution

This use case enables the distribution of enhanced high-quality video services for tourists to improve the user experience when visiting a city. The use case is based on the use of 5G broadcast delivery services using the broadcasting network and the development of a 5G core multicast component.





#### UC 5 - Distributed video production

This use case explores the 5G-TOURS network features for remote television production, in a distributed TV video production context; the content has been produced by mixing local and remote audio and video contributions in the TV studio.





### 5G-TOURS deployed use cases Rennes - Safe City

5G technology has the potential to help save lives, as an underlying component of a modern healthcare service. That's why, one of the three main themes addressed by the 5G-TOURS project is the safe-city, focusing on connected and remote healthcare use cases enhanced by 5G technology. This section describes the outcome of the work performed during the course of the project in work package 5 (WP5).

Also, you can read more about all the use cases in the final WP5 Deliverable 5.4.



### UC6 - Health monitoring and incident driven communications prioritization

This use case addresses solutions for remote health monitoring of people, especially patients with a critical and/or chronic disease. This involves remote health monitoring technology /services and reliable / timely technology /services to notify relevant care professionals and family members in case of detected health deterioration and/or acute care needs



#### UC7 - Teleguidance for diagnostics and intervention support

This use case shows the importance of providing care as early as possible, before the arrival at the hospital, to prevent irreversible deterioration and save the life of critical patients. Ultrasound diagnostics at the incident site are needed to decide what to do and start the right treatment directly. Teleguidance by a remote expert proved to be of vital importance in this case, requiring reliable low latency communication of audio, high resolution video and ultrasound images.









#### **UC8 - Wireless Operating Room**

The goal of the use case is to demonstrate the impact of 5G inside the operating room. Among other things, advantages are that wireless imaging devices are easier to install, connect and synchronize with other imaging equipment and easier to keep sterile. This use case will face low latency and high reliability requirements in addition to a significant amount of video data to be transferred in real-time.



#### UC9 - Optimal ambulance routing

This use case addresses real time navigation of an ambulance, both to the site of the emergency, to ensure that medical help will be provided as quickly as possible, as well as from the incident site to the hospital. This will prevent loss of time due to e.g., traffic, road works/blocks as much as possible. The goal is to improve the overall health outcome for the patient by minimizing the time-tocare.







### 5G-TOURS deployed use cases Athens - Mobility-Efficient City

The 5G-TOURS project work within the mobility-efficient city aims at implementing a set of use cases that improve mobility-related experiences from various perspectives. These use cases revolve around the 5G EVE Athens site, including an extension to the Athens International Airport (AIA). This section describes the mobility efficient city use cases final implementation evaluated on final network infrastructure that is deployed at AIA as an extension of the 5G EVE Athens site, EVE Athens site, as well as the final results that have been achieved.

Also, you can read more about all the use cases in the final WP6 Deliverable 6.4.



#### Use case 10 - Smart airport parking management

In this use case, parking users at the airport obtain real time information on available and occupied spaces through 5G-enabled parking sensors. They are able to locate available parking spaces directly through a mobile application and are guided there via the optimal route. This use case involves large throughputs, low latencies, and high capacity, which represents an essential functionality of the 5G family technology.



#### Use case 11 - Video-Enhanced ground-based moving vehicles

This use case provides high-definition cameras to the follow-me vehicles which lead aircrafts to parking positions, monitor and oversee the activity at the Airport Airside area, and attend incidents, emergencies and critical events, thusimproving day-to-day airport operations as well as response activities to emergencies. This use case involves very large throughputs as well as highly critical communications.







#### Use case 12 – Emergency airport evacuation

This use case focuses on the evacuation of the airport in a quick and organized fashion in case of an emergency, providing automated guidance of emergency routes from the affected area up to the muster areas. This use case focuses on the location accuracy part of 5G technology. The application relies on AR technology suitable for training exercises and simulations at the airport.



### Use case 13 – Excursion on an Augmented Reality (AR)/Virtual Reality (VR)-enhanced bus

This use case focuses on school students travelling to a destination of educational interest, generating good quality digital learning experiences both during the transportation to the destination and the visit of the exhibition, involving large throughputs and low latencies in highly mobile environments.





With 5G technologies, mobile operators will offer new services allowing verticals to use innovative applications for their needs

### 5G-TOURS evaluation results

The 5G-TOURS project goal was to demonstrate the benefits of 5G technology in the pre-commercial environment for real users, tourists, citizens and patients by implementing 13 representative use cases in 3 different types of cities: (i) Turin, the touristic city (5 use cases) ii) Rennes, the safe city (4 use cases) iii) Athens, the mobility-efficient city (4 use cases).

In this direction, WP7 was responsible to provide the overall 5G-TOURS integrated ecosystem (the 3 cities together) for the smooth deployment and trials of the aforementioned use cases, as well as a detailed KPI collection, analysis and validation. In <u>Deliverable 7.4</u> the final validation results from the execution of the trials are presented, summarised and explained. In each use case trial, all the details are presented including: a) the trial scenario deployment details; b) the details regarding the metrics collected e.g. the probe positions in the network, the probe positions in the protocol layers, duration, sampling period, collection method; c) the methodology and tools used for the analysis and the calculation of KPI values; d) the validation process including the comparison against the latest use case requirements presented in <u>Deliverable 2.3</u>.

Finally, in <u>Deliverable 7.4</u>, the level of satisfaction of end-users and verticals' players in the use cases were measured and evaluated. In this direction, for each use case a set of questionnaires are delivered to the users, filled, collected and then analysed, while the final results of the level of satisfaction of end-users were validated. In addition, in selected use cases (UC1 and UC4), models for QoS/QoE correlation were created by using correlation-regression analysis.

In order to be more comfortable for the reader to explore the validation results of all the 13 Use Cases, in the Table on the next page the summary of the validation results of the trials executed in 5G-TOURS nodes is presented. The table initially reports for each Use Case, the trial scenario or trial scenarios executed. Then it discriminates between QoS and QoE. QoS values illustrates the performance of the network and applications as validated using the metrics/KPIs collected during the trial execution. These metrics includes both network metrics (measured using network probes and tools) as well as applications metrics (measured using app layer probes). In the QoS case, the table presents for each trial scenario, the metrics/KPIs that were collected during the trials, analysed and finally validated. Then the outcome of the validation process is presented. The validation process includes the calculation of KPIs from collected metrics and the comparison of KPI values against the vertical requirements and targets reported in Deliverable 2.3.

## Summary of 5G-TOURS validation results

USE CASE	SCENARIO	QOS RESULTS (NETWORK AND APPLICATION PERFORMANCE)		
		KPIS COLLECTED, ANALYSED AND VALIDATED	VALIDATION RESULTS	
Use case 1	Augmented tourism experience	RTT latency, RAN latency, Throughput, Reliability, Availability	PASSED	
Use case 2	Telepresence	RTT latency, RAN latency, Throughput, Reliability, Availability	PASSED	
Use case 3	Robot-assisted Museum guide	RTT latency, RAN latency, Throughput, Reliability, Availability	PASSED	
Use case 4	High-quality video services distribution	RTT latency, RAN latency, Throughput, Reliability, Availability	PASSED	
Use case 5	Remote and distributed video production	RTT latency, RAN latency, Throughput, Reliability, Availability	PASSED	
Use case 6	Health monitoring and incident- driven communications prioritization	RTT latency, Throughput DL/UL, Service Availability, Service Reliability, App layer RTT latency	PASSED: mMTC, eMBB, URLLC FAILED: Only RTT latency (URLLC case)	
	Smart glasses and ultrasound Android application with XpertEye webrtc screen sharing	Latency, Data rate, Frame drops	PASSED	
Use case 7	Multi-stream digital ultrasound data transfer	Latency, Data rate, Frame drops	PASSED (Edge) FAILED (Core)	
	3D telepresence	Data rate	PASSED	
Use case 8	Wireless operating room	Latency, Throughput DL/UL	PASSED	
Use case 9	Optimal ambulance routing	RTT latency, Throughput DL/UL, Service Availability, Service Reliability, App layer RTT latency	PASSED: eMBB, URLLC FAILED: Only RTT latency (URLLC case)	
Use case 10	Smart airport parking management	RTT latency, Throughput DL/UL, Network and Service Availability and Reliability, App layer RTT latency	PASSED	
Use case 11	Video-enhanced follow- me moving vehicles	RTT latency, Throughput DL/UL, Network Availability, Network Reliability	PASSED	
Use case 12	Emergency airport evacuation	RTT latency, Throughput DL/UL, Network Availability, Network Reliability, Service Availability, Service Reliability, App layer RTT latency, Location accuracy	PASSED: Network Availability, Networ Reliability, Service Availability, Throughput UL FAILED: RTT latency, Throughput DL Service Reliability, Location accuracy	
Use case 13	Excursion on AR/VR- enhanced bus	RTT latency, Throughput DL/UL, Network Availability, Network Reliability	PASSED FAILED: Only VR case (Throughput DL, Network Reliability)	

### **5G-TOURS industrial workshops**

5G-TOURS organised three industrial workshops, one at each of the trial sites, specifically targeted at industrial actors. The aim of these workshops was to gather technology stakeholders and vertical industries beyond those in the 5G-TOURS consortium and communicate to them the project concept and results in a direct and effective way. A strong emphasis was given to the use cases demonstrations, to show the advantages and benefits of 5G to address real problems and provide practical solutions.

Industrial workshop hosted in Torino: the touristic city On 30 September 2021, the House of Emerging Technologies in Torino hosted the 5GTOURS Industrial Workshop "Torino – The touristic city" in a hybrid format, gathering more than 50 participants including attendees in presence and online.

The aim of the workshop was to inform the local verticals (museums, cultural organizations, innovation centres, ...) about the opportunities offered by the use cases developed by 5GTOURS in the fields of augmented reality/virtual reality, robotics, broadcasting and remote video production and distribution applied to the cultural and tourist sectors. The ultimate goal was to stimulate a conversation on the benefits, usability and long-term sustainability of such solutions.

The Industrial workshop was just one of the opportunities to dialogue with the end-users of the 5GTOURS solutions, many more will come in 2022 with the actual on-site trials in Torino. Read more on our <u>blog.</u>

And in May 2022 5G-TOURS organized a <u>second event</u> aimed at museum and tourism sector experts in which all the demos of the various use cases were presented.



#### Workshop Healthcare Solutions Powered by 5G

On 2022 June 2nd we organised an industrial workshop to reach healthcare professionals who were not directly involved in the project consortium and make them aware of the advantages that 5G can potentially bring to their businesses.

A strong emphasis was given to the use cases demonstrations, to show the advantages and benefits of 5G technology to address real problems and provide practical solutions.

Due to the health crisis and the triggering of the white plan at the Rennes University Hospital, the workshop has been postponed twice. To meet the deadline of the 5G projects, early June was the very last opportunity. Therefore, it was planned on June 2nd.

Despite a major new crisis currently affecting all French hospitals faced with an unprecedented lack of staff, 81 people signed up for the Workshop and it was a great success. Read more on our website or in <u>Deliverable 8.5</u>.



#### Workshop of Athens, a mobility-efficiency City

On 25 February 2022, took place in Greece the 5G TOURS Workshop of Athens, a mobility-efficiency City. The event was held virtually and was broadcasted on live streaming by 5G TOURS <u>YouTube channel</u>, gathering 178 registrations, 70 attendees and more than 440 views.

The purpose of the event was to present to local business and vertical industries the solutions developed by the partners of the Greek node and inform the audience about future opportunities and potentials. The focus fields were the use cases that took place in the airport of Athens offering 5G technologies for Smart Parking Management AR/VR Busexcursions, Video-Enhanced Ground-Based Moving Vehicles, Emergency Evacuation accompanied with a thorough analysis about the Innovations and the KPIs.

Read more on our website or in Deliverable 8.5.



### **5G-TOURS on the events**

Communication of the project results to the industrial community was as one of the key activities towards fostering the adoption of the project technology by stakeholders outside the consortium. A primary target to this end was the Mobile World Congress and EuCNC.

#### **MWC 2022**

Together with other 5GPPP projects (5G-HEART and 5G-SOLUTIONS) we were represented at the 7F13 booth. A lot of attendees visited our booth to learn about Smart City deployment concepts, trials and testbeds ongoing in Rennes, Turin, and Athens.

Belkacem Mouhouche (Samsung UK) gave a presentation about the 5G-TOURS project at the MWC session "Travel Tech round grouped around Catalonia's ICT Tourism Cluster".

Also, other 5G-TOURS partners participated in the event. For example, Atos had its own stand at the event.

Atos Research & Innovation group (ARI) presented three demos on AI-based Network Management Automation based on the work resulting from their participation in two different EU-funded projects: 5G-TOURS and Affordable5G:

• Demo 1: Al-based Close loop automation for NFV MANO. Automated scaling (in/out) based on VNF CPU usage level forecasting. The video is available <u>here</u>.

• Demo 2: Al-based Close loop automation for NFV MANO. Automated scaling (in/out) based on road traffic image recognition. The video is available <u>here</u>.

Demo 3: Radio parameter optimization via ML-assisted near-real-time control loop.





#### **EuCNC 2022**

During the second week of June 2022, 5G-TOURS took part at the EuCNC2022 conference in Grenoble, France. In fact, 5G-TOURS had a stand there, where various demos for the use cases in the tourism, the health and the transportation sectors were shown to the public.

Several visitors, both within academia and industry, have stopped by our stand, watched the demos and enquired about our latest technologies.

5G-TOURS has also been honored by the visit of Mr. Pearse O'Donohue, Chair of the conference and Director Future Networks at the European Commission. We showed Mr. O'Donohue our use cases, starting from the itinerant orchestra and the R1 robot guide-assistance (tourism sector), the airport evacuation and smart parking (transport sector) and the remote assistance (health sector).

### **Project outcomes**

#### **BETTER QUALITY OF LIFE FOR EU CITIZENS** Improved the quality perceived by the customers of the networks New business models services addressed by 5G-TOURS' use cases More than 20 vertical solutions and applications **NEW NETWORK ARCHITECTURE** Novel service layer 1 mobil contributions to More than 100 NIN(O)VATEIV/F standards ound **QoE/QoE ESTIMATION METHODOLOGY** Three large-scale field-trials comprising indoor and outdoor deployments Fulfilled challenging requirements of the use cases 40 publications 3 Open source initiatives **Participation at** Industrial events 10 patents 3 Industial workshops

### Let's enjoy the benefits of 5G together!



http://5gtours.eu/

https://twitter.com/5gtours

https://www.linkedin.com/groups/8853316/

https://www.researchgate.net/project/5G-TOURS





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