PROJECT "LOCUS": LOCalization and analytics on-demand embedded in the 5G ecosystem, for Ubiquitous vertical applicationS

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DELIVERABLE D7.4

Report on Communication, Dissemination Actions, Standardization and Open-Source Contributions, v3

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Short Abstract:	Report on communication and dissemination actions, on the progress

	against initial plans, as well as on awareness and advice inferred from these activities. Standardization and open-source contributions until the release date of each version, the impact that these have been perceived to have, and the plans for further standardization and open-source contributions
Keyword List:	Communication, Dissemination, Standardization, Open-Source Contributions

Executive Summary

This deliverable has the objective to report the LOCUS activities in three main areas: (1) Communication and dissemination; (2) Standardization; (3) Data management.

VERSION CONTROL TABLE			
VERSION N.	**PURPOSE/CHANGES**	**AUTHOR (S)**	**DATE**
1.0	First draft with ToC and Standardization Report	CNIT, Stefania Bartoletti, Natascia De Fenzo SAMS, Mythri Hunukumbure;	25 September 2022
1.2	Revised Draft	CNIT, Natascia De Fenzo	15 October 2022
2.0	General Revision from the Project Consortium	All Partners	20 October 2022
2.1	Revised Standardization Activities	SAMS, Mythri Hunukumbure; David G. Estevez	27 October 2022
2.2	Updates on the Data Management Plan from PDOs	CNIT, Stefania Bartoletti	3 November 2022
2.3	External Independent Ethics Advisor and PDO	CNIT, Raffaele Bolla, Azelio Fulmini, Stefania Bartoletti	11 November 2022
2.4	Final revision from Coordinator	CNIT	11 November 2022
2.5	Additional Request from the EIEA	CNIT	16 November 2022

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1. Introduction

This report presents the communication, dissemination, and standardization activities of the LOCUS project, which are part of WP7. More specifically, WP7 is structured in three main tasks related to (i) communication and dissemination, (ii) standardization and open-source contributions, and (iii) innovation and commercial exploitation.

In this deliverable, we focus on how LOCUS research outcomes, after a proper IPR analysis described in D7.7 [1], are disseminated and communicated to the external world, and how data is managed within the project. The process is shown in Figure 1.

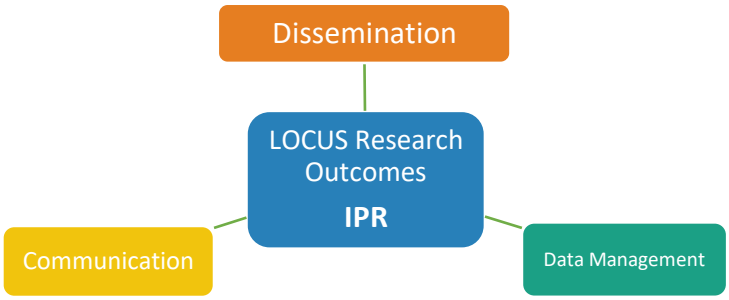

Figure 1: Dissemination, Communication and Data Management

Figure 2 presents the general roadmap for the monitoring and reporting of WP7 activities, including the Four-monthly reports and the previous versions of D7.x.

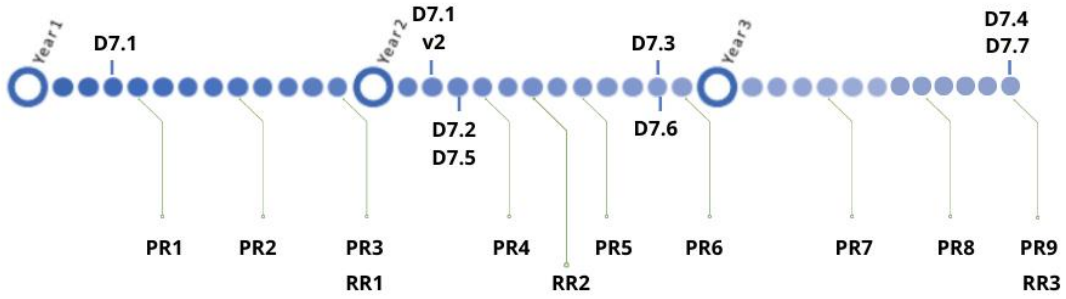

Figure 2: Roadmap of Communication and Dissemination Monitoring

In this report, we provide an overall presentation of the activities and main outcomes in terms of communication and dissemination strategy. Then, we provide an update and overview of the standardization activities. We provide an evaluation of the measurable KPIs compared to the target values proposed in D7.1. Finally, some updates on the activities related to data management, with particular focus to data protection, are presented.

List of Abbreviations

ABBREVIATION	FULL NAME
5G-PPP	5G Infrastructure Public Private Partnership
3GPP	3rd Generation Partnership Project
AI	Artificial Intelligence
API	Application Programming Interfaces
AGV	Automated Guided Vehicles
BMB	Business and Marketing Board
CA	Consortium Agreement
CAM	Connected and Automated Mobility
DOA	Description of the Action
DMP	Data Management Plan
E4P	Europe For Privacy-Preserving Pandemic Protection
EB	Executive Board
EIEA	External Independent Ethics Advisor
eLCS	Enhanced Location Services
FAIR	Findable, Accessible, Interoperable and Reusable
GA	Grant Agreement
GB	General Board
gNB	G Node- B, i.e. the 5G Base Station
ICT	Information and Communication Technologies
ITS	Intelligent Transport System
IoT	Internet of Things
KPI	Key Performance Indicators
ML	Machine Learning
NSA	Non-Stand Alone
NSE	New Services
NFV	Network Functions Virtualization
PC	Project Coordinator
PO	Project Office
PR	Public Relations

OAI	Open Air Interface
O-RAN	Open Radio Access Network
QoS	Quality of Service
RAN	Radio Access Network
SRS	Sounding Reference Signals
SME	Small and medium-sized enterprises
GitLab	Subversion
VRU	Vulnerable Road User
UE	User Equipment
V2X	Vehicle-To-Everything
UWB	Ultra-wideband

Table 1: Abbreviation List

1.1 Table Index

2. Report on the LOCUS Activities

In this Section, we report the communication and dissemination activities carried out within the LOCUS project to date.

2.1 Report on Communication and Dissemination Activities

2.1.1 Communication Activities

All the communication activities have, as main focus, the promotion of the LOCUS project by sharing its objectives, achievements and publications with the public. We recall that the main tools, which are mostly managed by the LOCUS communication team, are:

- Social media: Twitter (H2020Locus) and LinkedIn (Locus Project) account
- Website: www.locus-project.eu
- Zenodo: https://zenodo.org/communities/locus-project/

In some cases, they are used directly by the individual partners for the internal and external communication of their activities, events, and/or research products.

2.1.1.1 LOCUS Website

The main Key Performance Indicators (KPIs) monitored for measuring the success of the websites are the number of visits and unique visitors per day and the top 10 pages visited. To this date, the average number of visits during the last month, is above 100 per day, whereas the number of visitors is above 30 per day. The most visited page is the homepage. As an examplary figure of merit, we show the hit statistics for the month of October 2022 in Figure 3 and Figure 4.

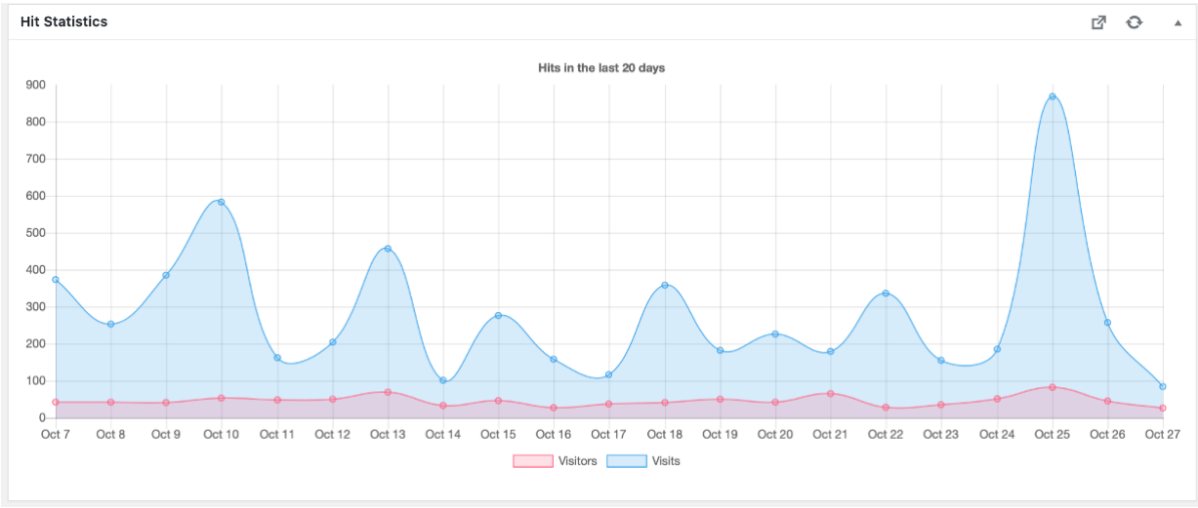

Figure 3 Hit statistics of the website.

Top 10 Pages

ID	Title	Link	Visits
1	Home Page	/	26,990
2	IEEE ICC 2022 Workshop	/ieee-icc-2022-workshop/	3,026
3	Contacts	/contacts/	1,044
4	Deliverables	/results/deliverables/	971
5	White paper on "Empowering Vertical Industries through 5G Networks – Current Status and Future Trends"	/white-paper-on-empowering-vertical-industries-through-5g-networks-current-status-and-future-trends/	922
6	Download	/download/	915
7	Communication	/results/communication/	892
8	Specific Objectives	/about/specific-objectives/	846
9	About	/about/	826
10	WPs Description	/about/wps-description/	818

Figure 4 Top 10 pages visited.

2.1.1.2 LOCUS Social Media

LinkedIn

A LOCUS LinkedIn account has been created at the beginning of the project and is available at:

https://www.linkedin.com/in/locus-project-h2020/

Here, many updates about deliverables, use cases, participations to international events and publications are being posted. The LinkedIn account currently accounts for 488 contacts and 556 followers, with an average of one post per week. A LinkedIn feature allows the user to consult the demographics and content performance statistics of a selected 365-day period. From the figures below, it emerges that, in terms of target audience, days, and views, in general, the most active contacts of LOCUS are **research and product quality engineers and academics (i.e., professors and lecturers)**. Even though in the first and second year the software developers appeared to be among the most active contacts too, the result has remained almost the same since the beginning of the project.

At the beginning of the project, the aim was to increase the number of contacts for a total of 500 by the end of the third year; from the numbers above, it emerges that this goal has been successfully reached.

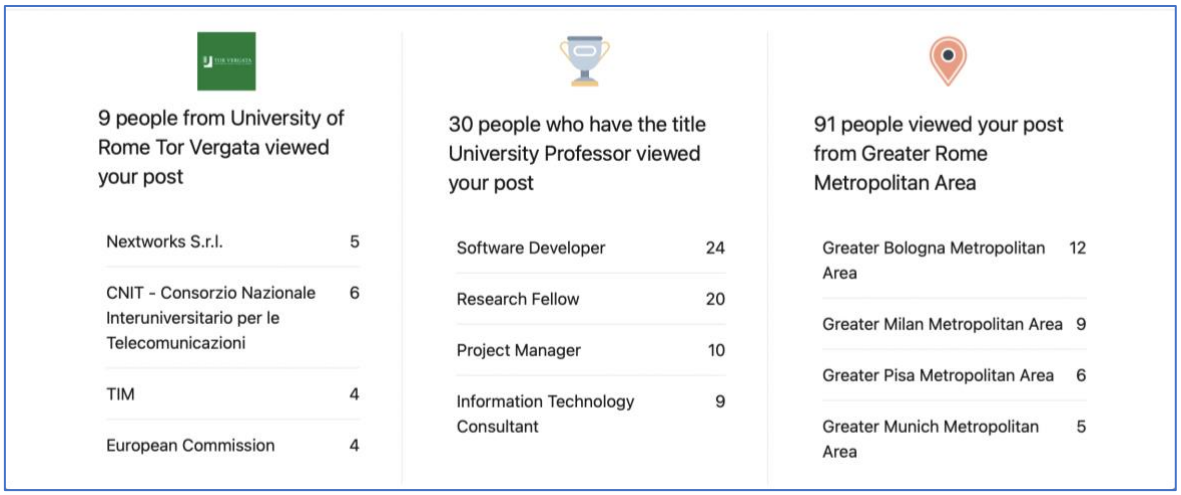

Figure 5 Single post target analysis

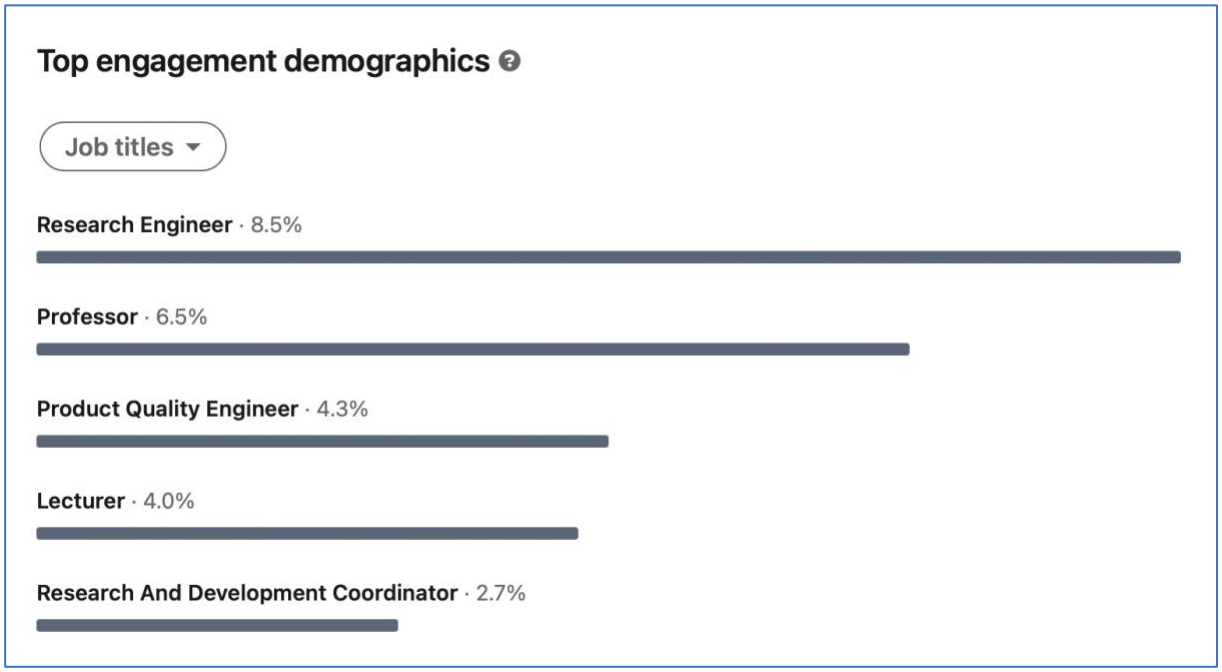

Figure 6 Top engagement demographics

In Figure 7 the content performance from October 2021 to October 2022 has been analysed. LOCUS LinkedIn profile has reached, in the period considered, a total number of 28,998 impressions and 445 engagements. The peaks of the line graph represent the days in which LOCUS followers reacted the most to LOCUS posts.

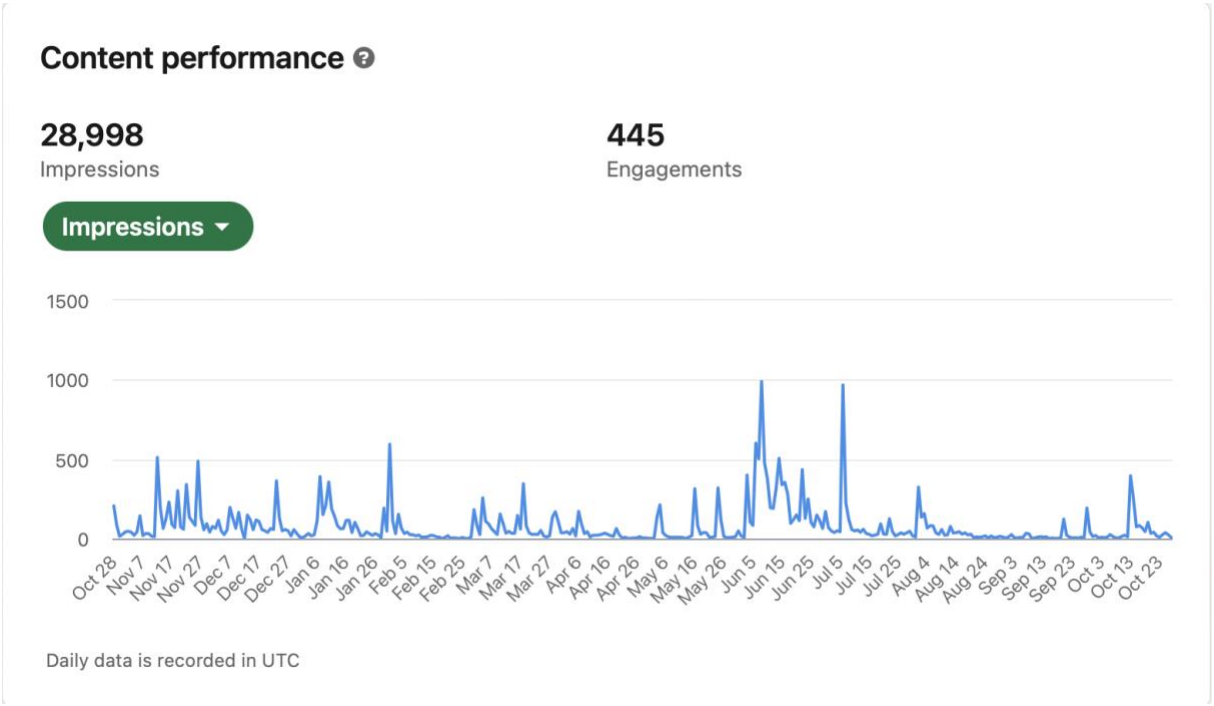

Figure 7 Content performance between October 2021 to October 2022.

Twitter

The Twitter account is available at:

https://twitter.com/H2020Locus.

It currently has 536 followers, with an average of one post per week. Twitter provides a tool called Analytics, which is used by the Communication Team to keep track of all the activity done during the project's lifetime, including the interactions and profile visits. Figure 8 shows an example of Twitter analytics summary for the 28-day period of October 2022. Figure 8 shows that during the period considered, LOCUS Tweets earned 287 impressions (impressions help measure the number of people who have seen a post, even if they didn't click, comment, or otherwise engage with that post). Comparing these numbers to the ones emerged in the previous two years, the trend appears to be considerably variable, depending on the period in which the analysis has been done and on the contents that have been shared. For example, from the 28-day period analysed in D7.3 (August 2021 – September 2021), it emerged that

LOCUS Tweets earned 1,500 impressions. For the reason mentioned above, and the limitation of the tool, these numbers cannot give an overall 3-year analysis of the social communication

Figure 8 Twitter analytics

This tool analyses also every single tweet, considering the number of impressions, media views, and total engagements. An example is shown in Figure 9.

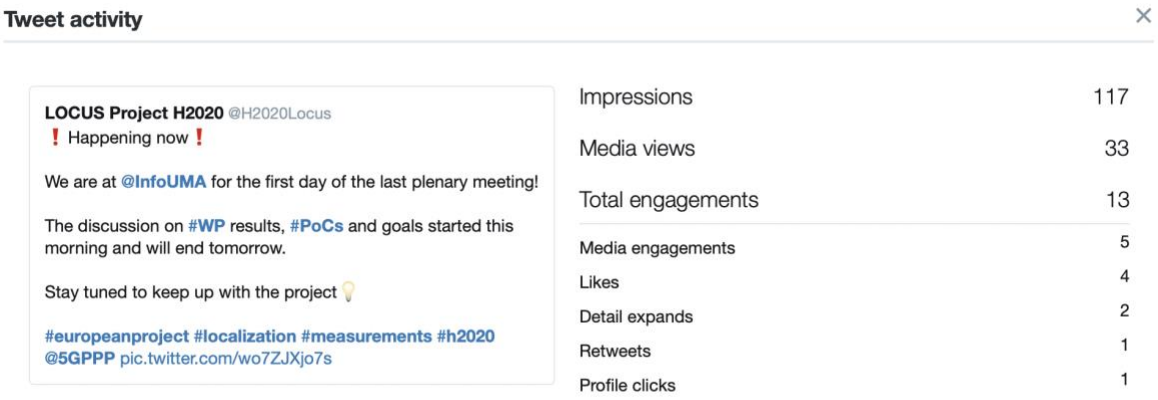

Figure 9 Tweet activity

2.1.2 Internal Communication

Internal communication has been done mainly online, on the GoToMeeting app, due to the COVID-19 outbreak. This involved biweekly general calls where all partners participated, plenary meetings at regular intervals and WP and/or FG-specific calls.

However, due to the recent lifting of EU COVID restrictions, two hybrid plenary meeting have been organised and held in Athens, from 28 to 29 June 2022, and in Malaga, from 13 to 14 October 2022, where the WP leaders provided an overview on the main results and some updates on the three PoCs considering what had been presented at EUCNC at the beginning of the month. During the last Plenary meeting in Malaga, LOCUS Partners organized the agenda for the final review and discussed the last details on PoCs and results.

Moreover, each Partner identified a PR which communicated to WP7 leader all the communication activities related to LOCUS project and other relevant results related to it, to share and promote LOCUS achievements.

A periodic e-mail has been sent to each PR to give continuity to the communication activity through LOCUS social networks. Another periodic e-mail has been sent to all LOCUS partners, asking for a continuous update on the dissemination activities reported on the Excel file and any available pre-print to publish on Zenodo:

https://zenodo.org/communities/locus-project/?page=1&size=20 .

2.1.3 Dissemination Activities

The dissemination activities reported in this Subsection are classified in (i) scientific publications already published or accepted papers in peer-reviewed international journals or conferences; (ii) events including exhibitions, workshops, congresses, or PhD schools; and (iii) collaboration with peer projects.

2.1.3.1 Scientific Publications

Since the beginning of the project, a total number of **76 scientific publications** have been already accepted or published, and specifically **37 journal papers** listed in Table 2 **and 39 publications in peer-reviewed conference proceedings** and listed in Table 3. Many others are under submission or in preparation for submission in the next months. In addition to the publication listed below, **the LOCUS project will publish a Wiley-IEEE book together with other experts on localization and positioning. The book is expected to be published in 2023.**

Table 2 Overall List of Journal Publications

Title	Authors	Journal
5G and beyond for contact tracing	Domenico Giustiniano, Giuseppe Bianchi, Andrea Conti, Stefania Bartoletti, and Nicola Blefari Melazzi	IEEE Communication Magazine - Special issue on Networking Technologies to Combat the COVID-19 Pandemic
A Context-Aware Data-Driven Algorithm for Small Cell Site Selection in Cellular Networks	Juan Luis Bejarano Luque, Matías Toril, Mariano Fernández Navarro, Antonio Jesús García, Salvador Luna Ramírez	IEEE Access
A Sparse Learning Approach to the Detection of Multiple Noise-Like Jammers	Linjie Yan, Pia Addabbo, Yuxuan Zhang, Chengpeng	IEEE Transactions on Aerospace and Electronic Systems

	Hao, Jun Liu, Jian Li, Danilo Orlando	
Beam Searching for mmWave Networks with sub-6 GHz WiFi and Inertial Sensors Inputs: an experimental study	Maurizio Rea, Domenico Giustiniano, Pablo Jiménez Mateo, Yago Lizarribar, Joerg Widmer	Elsevier Computer Networks
Bluetooth Low Energy for Close Detection in Search and Rescue Missions with Robotic Platforms: an experimental evaluation	Cantizani-Estepa, Juan and Bravo-Arrabal, Juan and Fernández-Lozano, J.J. and Fortes, Sergio and Barco, Raquel and García-Cerezo, Alfonso and Mandow, Anthony	IEEE Access
Cellular Network Radio Monitoring and Management through Virtual UE Probes: A Study Case Based on Crowded Events	Eduardo Baena, Sergio Fortes, Özgü Alay, Min Xie, Håkon Lønsethagen, Raquel Barco	MDPI Sensors
Channel Classification Scheme Accounting for Nakagami-m Shadowing and FTR Model	Chaoran Yin, Gaetano Giunta, Danilo Orlando, Chengpeng Hao, and Chaohuan Hou	IEEE Wireless Communication Letters
Design and Experimental Assessment of Detection Schemes for Air Interface Attacks in Adverse Scenarios	Danilo Orlando, Ivan Palama, Stefania Bartoletti, Giuseppe	IEEE Wireless Communication Letters
Device-free Localization of Multiple Targets in Cluttered Environments	Stefania Bartoletti, Zhenyu Liu, Moe Z Win, Andrea Conti	IEEE Transactions on Aerospace and Electronic Systems
High-Speed Millimeter-Wave Mobile Experimentation on Software-Defined Radios	Jesus O. Lacruz, Dolores Garcia, Pablo Jimenez, Joan Palacios and Joerg Widmer	ACM GetMobile: Mobile Computing and Communications

Hybrid Network-Spatial Clustering for Optimizing 5G Mobile Networks	Aristotelis Margaris, Ioannis Filippas, Kostas Tsagkaris	Applied Sciences – Special issue “5G Network Planning and Design”
Innovative Attack Detection Solutions for Wireless Networks with Application to Location Security	Danilo Orlando, Stefania Bartoletti, Ivan Palamà, Giuseppe Bianchi, and Nicola Blefari Melazzi	IEEE Transactions on Wireless Communications
Joint Communication and Localization in Millimeter Wave Networks	Girim Kwon, Andrea Conti, Hyuncheol Park, Moe Z.Win	IEEE Journal of Selected Topics in Signal Processing
Location Awareness in Beyond 5G Networks	Andrea Conti, Flavio Morselli, Zhenyu Liu, Stefania Bartoletti, Santiago Mazuelas, William C Lindsey, Moe Z Win	IEEE Communications Magazine
Location awareness in beyond 5G networks via reconfigurable intelligent surfaces	Ziyi Wang, Zhenyu Liu, Yuan Shen, Andrea Conti, Moe Z Win	IEEE J. Sel. Areas Commun., special issue on Integrated Sensing and Communication
Location Awareness Via Intelligent Surfaces: A Path Toward Holographic NLN	Moe Z Win, Ziyi Wang, Zhenyu Liu, Yuan Shen, Andrea Conti	IEEE Vehicular Technology Magazine
Location Secrecy Enhancement in Adversarial Networks via Trajectory Control	Mohammad Javad Khojasteh, Augustin A Saucan, Zhenyu Liu, Andrea Conti, Moe Z Win	IEEE Control Systems Letters
Location-Aware Node Management Solution for Multi-Radio Dual Connectivity Scenarios	Jesus Burgueño, Isabel de-la-Bandera and Raquel Barco	Sensors. Special Issue: "5G and Beyond Wireless Communication Networks: Radio Technologies and Deployment Scenarios"
Location-aware Wireless Resource Allocation in Industrial-like Environment	Maurizio Rea, Domenico Giustiniano	IEEE Transaction on Mobile Computing

Location-Awareness for Failure Management in Cellular Networks: An Integrated Approach	S. Fortes, C. Baena, J. Villegas, E. Baena, M. Asghar, R. Barco	MDPI Sensors
Location-based Analytics in 5G and Beyond	Stefania Bartoletti, Luca Chiaraviglio, Sergio Fortes, Takai Eddine Kennouche, Gurkan Solmaz, Giacomo Bernini, Domenico Giustiniano, Joerg Widmer, Raquel Barco, Giuseppe Siracusano, Andrea Conti, and Nicola Blefari Melazzi	IEEE Communications Magazine
Mass tracking in cellular networks for the Covid-19 pandemic monitoring	Emil J. Khatib, María Jesús Perles Roselló, Jesús Miranda-Páez, Victoriano Giralt, Raquel Barco	MDPI Sensors
MIMORPH: A General-Purpose Experimentation Platform for sub-6 GHz and mmWave Frequency Bands	Jesus Omar Lacruz, Rafael Ruiz, Joerg Widmer	ACM GetMobile: Mobile Computing and Communications
Noncentral complex Wishart matrices: Moments and correlation of minors	Velio Tralli, Andrea Conti	Random Matrices: Theory and Applications
Opportunistic fusion of ranges from different sources for indoor positioning	Carlos Álvarez Merino, Hao Qiang Luo Chen, Emil J. Khatib, Raquel Barco	IEEE Communications Letters
Pencil Beamforming Increases Human Exposure to ElectroMagnetic Fields'': True or False?	Luca Chiaraviglio, Simone Rossetti, Sara Saida, Stefania Bartoletti, Nicola Blefari-Melazzi	IEEE Access
Positioning and Sensing for Vehicular Safety Applications in 5G and Beyond	Stefania Bartoletti, Henk Wymeersch, Tomasz Mach, Oliver Brunnegard, Domenico Giustiniano, Peter	IEEE Communications Magazine

	Hammarberg, Musa Furkan Keskin, Jesus O. Lacruz, Sara Modarres Razavi, Joakim Ronnblom, Fredrik Tufvesson, Joerg Widmer, and Nicola Blefari Melazzi	
Radio Positioning with EM Processing of the Spherical Wavefront	Francesco Guidi, Davide Dardari	IEEE Transactions on Wireless Communications
Scalable Phase-Coherent Beam-Training for Dense Millimeter-wave Networks	Dolores Garcia, Jesus O. Lacruz, Pablo Jimenez, Joan	IEEE Transaction on Mobile Computing
A conversation with Gürkan Solmaz: situation classification in the internet of things (IoT).	B. Anjum	ACM Ubiquity Magazine, August 2020.
SHARP: Environment and Person Independent Activity Recognition with Commodity IEEE 802.11 Access Points	Francesca Meneghello, Domenico Garlisi, Nicolò Dal Fabbro, Ilenia Tinnirello, Michele Rossi	IEEE Transactions on Mobile Computing
Similarity Building a Smart Campus Digital Twin: Lessons Learned From a Real-World Project	Luis Roda Sánchez, Flavio Cirillo, Gurkan Solmaz, Tobias Jacobs, Celia Garrido-Hidalgo	IEEE Internet of Things Journal, Special Issue on Smart Cities and Systems: Theories, Tools, Trends, Applications, Challenges, and Opportunities
SINR prediction in presence of correlated shadowing in cellular networks	Imed Hadj-Kacem, Sana Ben Jemaa, Hajer Braham and Ahmad Mahbubul Alam	IEEE Transactions on Wireless Communications
Social-Aware Forecasting for Cellular Networks Metrics	J. Villegas, E. Baena, S. Fortes, R. Barco	IEEE Communications Letters
Social-Aware Load balancing System for Crowds in Cellular Networks	Renato Torres, Sergio Fortes, Eduardo Baena, Raquel Barco	IEEE Access

Spectrum Occupancy and Interference Model based on Network Experimentations in Hospital	Lorenzo Mucchi, Risto Vuohtoniemi, Hasnain Virk, Andrea Conti, Matti Hamalainen, Jari Iinatti, Moe Z. Win	IEEE Transactions on Wireless Communications
WiFi FTM and UWB characterization for localization in construction sites	Carlos S. Álvarez-Merino , Emil Jatib Khatib, Hao Qiang Luo-Chen, Joel Llanes Michel, Sebastián Casalderrey-Díaz, Jesús Alonso and Raquel Barco	MDPI Sensors, Special Issue "Indoor Wi-Fi Positioning: Techniques and Systems"
Radio Environment Map Based Coordinated Multi-User Scheduling in Massive-MIMO System	Wassim Ben Chikha, Marie Masson Sana Ben Jemaa and Zwi Altman	IEEE Transactions on Vehicular Technology

Table 3 Overall List of Publications in Peer-Reviewed Conference Proceedings

Title	Authors	Conference
Indoor Clutter Characterization for UWB Sensor Radar Networks	Flavio Morselli, Stefania Bartoletti, Andrea Conti	IEEE Workshop on Advances in Network Localization and Navigation (ANLN)
LSTM-based GNSS Spoofing Detection Using Low-cost Spectrum Sensors	Roberto Calvo Palomino, Arani Bhattacharya, Gerome Bovet, Domenico Giustiniano	IEEE WoWMoM
Group-In: Group Inference from Wireless Traces of Mobile Devices	Gurkan Solmaz, Jonathan Fuerst, Samet Aytac, Fang-Jing Wu	19th ACM/IEEE Conference on Information Processing in Sensor Networks (IPSN'20)
Location Inference Based on Channel Impulse Response	Zehao Yu, Zhenyu Liu, Florian Meyer, Andrea Conti, Moe Z. Win	2020 IEEE/ION Position, Location and Navigation Symposium (PLANS)

Beam Search Strategy for Millimeter Wave Networks with Out-of- Band Input Data	Maurizio Rea, Domenico Giustiniano, Guillermo Bielsa, Danilo De Donno, Joerg Widmer	IEEE MedComNet 2020
LOCUS: Localization and analytics on demand embedded in the 5G ecosystem	Nicola Blefari Melazzi et Al.	IEEE EUCNC 2020
Virtual Inertial Sensors with Fine Time Measurements	M. Rea, D. Giustiniano, J. Widmer	IEEE Mass
The diverse and variegated reactions of different cellular devices to IMSI catching attacks	I. Palamà, F. Gringoli, G. Bianchi, N. Blefari-Melazzi	Proceedings of the 14th International Workshop on Wireless Network Testbeds, Experimental evaluation & Characterization
Indoor 3D localization in emergency scenarios through drone based rapid 5G deployment	Mythri Hunukumbure, Oluwatayo Kolawole, Shangbin Wu, Yinan Qi	IEEE Globecom 2020 workshops, Taiwan, 7-11 Dec. 2020
Cellular KPI Estimation with Social Information	Javier Villegas, Sergio Fortes, Eduardo Baena, Raquel Barco	2nd Post-IRACON Meeting
Accurate Ubiquitous Localization with Off-the-Shelf IEEE 802.11ac Devices	Alejandro Blanco, Joan Palacios, Marco Cominelli, Francesco Gringoli, Joerg Widmer	ACM MobiSys 2021
A Real-Time Experimentation Platform for sub-6 GHz and Millimeter-Wave MIMO Systems	Jesus O. Lacruz, Rafael Ruiz, Joerg Widmer	ACM MobiSys 2021
D2D-based QoS prediction analysis in beyond 5G V2X	Tomasz Mach, Galini Tsoukaneri, Daniel Warren	IEEE ICC 2021
Location Security under Reference Signals' Spoofing	Stefania Bartoletti, Giuseppe Bianchi, Danilo	ARES 2021 - ACM Conference

Attacks: Threat Model and Bounds	Orlando, Ivan Palamà and Nicola Blefari-Melazzi	
Proactive RAN Resource Reservation for URLLC Vehicular Slice	Nathalie Naddeh, Sana Ben Jemaa, Salah Eddine El Ayoubi and Tijan Chahed	IEEE VTC Spring 2021
Network Localization with Assisting Nodes	C. A. Gomez-Vega, Z. Liu, C. A. Gutierrez, A. Conti, and M. Z. Win	KICS Winter 2021
Localization in 5G Ecosystem with Wi-Fi	Flavio Morselli, Stefania Bartoletti, Moe Z. Win, Andrea Conti	IEEE International Workshop on Signal Processing Advances in Wireless Communications (SPAWC 2021)
mmWave Communications for High Mobility Devices: The Case of Road Side Links	Mohaned Chraiti, Andrea Conti, Moe Z. Win	IEEE International Workshop on Signal Processing Advances in Wireless Communications (SPAWC 2021)
A Statistical Range Information Model with Application to UWB Localization	Carlos A Gómez-Vega, Flavio Morselli, Moe Z Win, Andrea Conti	2021 IEEE Military Communications Conference (MILCOM)
mmWave Communications for High Mobility Devices: The Case of Road Side Links	Mohaned Chraiti, Andrea Conti, Moe Z. Win	IEEE International Workshop on Signal Processing Advances in Wireless Communications (SPAWC 2021)
CountMeIn: Adaptive Crowd Estimation with Wi-Fi in Smart Cities	Gurkan Solmaz, Pankaj Baranwal, Flavio Cirillo (NEC Laboratories Europe)	The 20th International Conference on Pervasive Computing and Communications (PerCom 2022)
A Drone-based 3D Localization Solution for Emergency Services	Oluwatayo Kolawole, Mythri Hunukumbure	ICC 2022

Source Localization with Intelligent Surfaces	Ziyi Wang, Zhenyu Liu, Yuan Shen, Andrea Conti, Moe Z Win	ICC 2022-IEEE International Conference on Communications
Wideband Localization with Reconfigurable Intelligent Surfaces	Ziyi Wang, Zhenyu Liu, Yuan Shen, Andrea Conti, Moe Z Win	2022 IEEE 95th Vehicular Technology Conference:(VTC2022-Spring)
Optimising UWB based Location Tracking in SmartPhones through the Support of 5G	Mythri Hunukumbure, Oluwatayo Kolawole, David M Gutierrez-Estevez	ICCE 2022
Characterizing Location Management Function performances in 5G Core Networks	Andrea Pinto, Giuseppe Santaromita, Claudio Fiandrino, Domenico Giustiniano, Flavio Esposito	IEEE NFV-SDN'22
Sidelink 5G-V2X for Integrated Sensing and Communication: the Impact of Resource Allocation	Stefania Bartoletti, Nicolò Decarli, and Barbara Masini	IEEE ICC 2022 - Workshop on Synergies of Communication, Localization, and Sensing towards 6G
RANSAC Methods for Robust Positioning with 5G Networks in Industrial IoT Scenarios	Lindmark, Gustav; Nygren, Johannes; Dwivedi, Satyam	ICL-GNSS 2022
Uncertainty Quantification of 5G Positioning as a Location Data Analytics Function	Stefania Bartoletti, Giacomo Bernini, Ivan Palamà, Michael De Angelis, Lorenzo Maria Monteforte, Takai Eddine Kennouche, Kostas Tsagkaris, Giuseppe Bianchi, and Nicola Blefari Melazzi	EUCNC 2022
A 5G Based Architecture for Localization Accuracy	Maria Belesioti, Kostas Tsagkaris, Aristotelis Margaris, Ioannis Chochliouros	AIAI 2022

5G Positioning with SDR-based Open-source Platforms: Where Do We Stand?	Ivan Palamà, Stefania Bartoletti, Giuseppe Bianchi, and Nicola Blefari Melazzi	IFIP/IEEE International Conference on Performance Evaluation and Modeling in Wired and Wireless Networks (IEEE PEMWN 2022)
Selection of Reference Base Station for TDOA-based Localization in 5G and Beyond IIoT	Gianluca Torsoli, Moe Z. Win, Andrea Conti	2022 IEEE Globecom Workshops (GC Workshop): Future of Wireless Access and Sensing for Industrial IoT
A 5G-Based Architecture for Localization Accuracy	M. Belesioti, K. Tsagkaris, A. Margaris and I.P. Chochliouros	Proceedings of the 7th Workshop on 5G-Putting Intelligence to the Network Edge (5G-PINE 2022) / AIAI-2022 International Conference, June 17-20, 2022, Hersonissos, Crete, Greece (Hybrid Conference).
Augmenting mmWave Localization Accuracy Through Sub-6 GHz on Off-the-Shelf Devices	A. Blanco, P. Jiménez Mateo, F. Gringoli, J. Widmer	ACM MobiSys 2022
UAV based 5G Indoor Localization for Emergency Services	Oluwatayo Kolawole, Mythri Hunukumbure	Mobicom2022 - International Conference On Mobile Computing and Networking
Deep Learning Approaches for Mobile Trajectory Prediction	Ioannis Filippas, Aristotelis Margaris, Konstantinos Tsagkaris	IEEE Globecom 2021, IEEE 9th Workshop on Advances in Network Localization and Navigation (ANLN) (Y. Filippas, A. Margaris and K. Tsagkaris, "Deep Learning Approaches for Mobile Trajectory Prediction," 2021

		IEEE Globecom Workshops (GC Wkshps), 2021, pp. 1-6, doi: 10.1109/GCWkshps52748.2021.9682164.)
Selection of Reference Base Station for TDOA-based Localization in 5G and Beyond IIoT	Gianluca Torsoli, Moe Z. Win, Andrea Conti	2022 IEEE Globecom Workshops (GC Workshop): Future of Wireless Access and Sensing for Industrial IoT
SPARCS: A Sparse Recovery Approach for Integrated Communication and Human Sensing in mmWave Systems	Jacopo Pegoraro, Jesus Omar Lacruz, Michele Rossi, Joerg Widmer	ACM Information Processing in Sensor Networks
Anticipatory Slice Resource Reservation for 5G Vehicular URLLC Based on Radio Statistics	Nathalie Naddeh, Sana Ben Jemaa, Salah Eddine El Ayoubi and Tijan Chahed	IEEE PIMRC 2022

2.1.3.2 Exhibitions, workshops, congresses

Table 4 reports the **89 events** among main exhibitions, congresses and workshops attended by the LOCUS participants and where the LOCUS research outcomes have been presented in terms of tutorial, invited talk, or other types of dissemination activities.

Exhibition, Congress, Workshop	Partner Involved/ Proposer	Name of the activity	Type f activity	Locatio n	Date
Infocom World 2019 - «Economy 4.0: Connected Future»	OTE	LOCalization and analytics on-demand embedded in the 5G ecosystem, for Ubiquitous vertical applicationS: The Case of LOCUS Project	Dissemina tion	Athens	Nov-19
3rd High Frequency Technologies for 5G Workshop	CNIT	Localization of Things	Invited Talk	Milan, Italy	Nov-19
IEEE Milcom 2019	CNIT	Positioning, Navigation, and Timing for Information Superiority: From Foundation to Operation	Tutorial	Norfolk, VA, USA	Nov-19
5G Italy	CNIT	5G Communication	Organizati on	Rome	Dec-19
5G Italy	SAMS	Smart transport: smart mobility and autonomous driving	Dissemina tion	Rome	Dec-19

5G Italy	TEI	Synchronization and Positioning: Critical functions for 5G; Empowering OTT technologies	Dissemination and Technical Sponsor	Rome	Dec-19
IEEE ICCE 2022	SAMS	Optimising UWB based Location Tracking in SmartPhones through the Support of 5G	Dissemination	Online	Jan-20
Ph.D. Course at the University of Florence	CNIT	Localization of Things	Ph.D. Course	Florence	Jan-20
ACM/IEEE IPSN 2020	NEC	Group-In: Group Inference from Wireless Traces of Mobile Devices	Dissemination	Virtual	Apr-20
5GFORUM	UMA	H2020 LOCUS Project: Localization and Data Analytics in 5G Systems	Dissemination	Málaga, Spain	May-20
IEEE – MEDCOMNET 2020	IMDEA	Beam search strategy for millimeter wave networks with out-of-band input data	Dissemination	Arona, Italy	Jun-20

IEEE EUCNC 2020	CNIT, IMDEA, UMA, INCE, NEC, SAMS, NXW	LOCUS: Localization and analytics on-demand embedded in the 5G ecosystem	Dissemination	Dubrovni k, Croatia	Jun-20
IEEE ICC 2020	CNIT	Indoor Clutter Characterization for UWB Sensor Radar Networks	Dissemination	Dublin, Ireland	Jun-20
IEEE ICC 2020	CNIT	Localization-of-Things: from Foundation to Operation	Tutorial	Dublin, Ireland	Jun-20
IEEE ICC 2020	CNIT	Advances on Network Localization and Navigation	Organizer	Dublin	Jun-20
IEEE ICC 2020 - Workshop on Advances in Network Localization and Navigation (ANLN)	CNIT	Indoor Clutter Characterization for UWB Sensor Radar Networks	Dissemination	Virtual	Jun-20
ISIF International Conference on Information Fusion	CNIT	Localization-of-Things: Foundations and Data Fusion	Tutorial	Sun City, South Africa	Jul-20

IEEE WOWMOM 2020	IMDEA	LSTM-based GNSS spoofing detection using low-cost spectrum sensors	Dissemination	Online	Aug-20
Post-IRACON Meeting	UMA	Location-Aware Compensation System for Load Balancing in Cellular Networks	Dissemination	Online	Sep-20
ECAI 2020	NEC	Spotlight Tutorial: Combining IoT and ML for Situation Classification	Tutorial	Virtual	Sep-20
XXXV Simposium Nacional de la Unión Científica Internacional de Radio (URSI 2020)	UMA	Fusion of LTE and UWB ranges for trilateration	Dissemination	Online	Sep-20
XXXV Simposium Nacional de la Unión Científica Internacional de Radio (URSI 2020)	UMA	Análisis del efecto del número de beams sobre un escenario 5G	Dissemination	Online	Sep-20
XXXV Simposium Nacional de la Unión Científica Internacional de Radio (URSI 2020)	UMA	Predicción de métricas de red celular basada en información social	Dissemination	Online	Sep-20

XXXV Simposium Nacional de la Unión Científica Internacional de Radio (URSI 2020)	UMA	Sistema de Compensación de Eventos Sociales en Redes Celulares Basado en Balanceo de Carga	Dissemination	Online	Sep-20
XXXV Simposium Nacional de la Unión Científica Internacional de Radio (URSI 2020)	UMA	Sonda experimental de monitorización de redes móviles para eventos.	Dissemination	Online	Sep-20
Ericsson Research Open House Day	EAB	Deployment considerations for 5G positioning	Demo	Virtual	Nov-20
ITSF 2020	CNIT/ERI	Synchronization and Positioning: 5G Critical Functions Supporting Various Applications	Dissemination	Virtual	Nov-20
Workshop of the Technical Board of 5G- PPP	NXW, CNIT	Network Management aspects in LOCUS	Organization and Participation to workshop	Virtual	Nov-20

5G International PhD School	IMDEA	Millimeter-Wave Localization and Location-Based Network Management	Keynote	Virtual	Dec-20
5G-PPP Technical Board Workshop	CNIT	Organization of a Workshop on Localization within the 5G-PPP Technical Board Meeting	Organization of a Workshop	Virtual	Dec-20
5G-PPP Technical Board Workshop	NXW	Localization analytics as a service platform for Smart 5G Network Management	Presentation	Virtual	Dec-20
IEEE MASS	IMDEA	Virtual Inertial Sensors with Fine Time Measurements	Dissemination	Virtual	Dec-20
IBM Telco Conference	IBM	Technical session	Presentation	Virtual	Jan-21
IEEE Radio Communications Committee	CNIT	Localization-of-Things in 5G Ecosystem	Invited Talk	Virtual	Jan-21

WiLab - Huawei JIC Workshop on "Intelligent IoT for 6G"	CNIT	“Security and Privacy in 5G and Beyond: False Myths and Emerging Challenges" - Giuseppe Bianchi, CNIT/University Rome Tor Vergata, IT	Invited Talk	Virtual	Jan-21
POST-IRACON COST	CNIT	Localization-of-Things in the 5G Ecosystem	Keynote	Virtual	Feb-21
Post-IRACON Meeting 2021	UMA	Cellular KPI Estimation with Social Information	Dissemination	Virtual	Feb-21
IEEE WCNC 2021	CNIT	Integration of Radar Sensing and Communications	Panel	Virtual	Mar-21
Workshop on Synchronizatio n and Timing Systems 2021	CNIT, TEI	Synchronization and Positioning: Key Functions in 5G	Presentation	Virtual	Mar-21
IEEE EUCNC 2021	CNIT, NXW	Autonomous Network Management towards 6G	Workshop	Virtual	Jun-21

IEEE MobiSys	IMDEA	A real-time experimentation platform for sub-6 GHz and millimeter-wave MIMO systems	Dissemination	Virtual	Jun-21
IEEE MobiSys	IMDEA	Accurate ubiquitous localization with off-the-shelf IEEE 802.11ac devices	Dissemination	Virtual	Jun-21
Spectrum Sensing and IoT workshop - Armasuisse	IMDEA	5G localization - Challenges and Opportunities	Invited Talk	Virtual	Jun-21
IEEE SECON 2021	EAB	5G positioning for applications – opportunities and challenges	Keynote	Virtual	Jul-21
IEEE SECON 2021	CNIT	5G positioning for applications - opportunities and challenges	Organization and Keynote Speech	Virtual	Jul-21
IEEE WF-IoT 2021	NEC	Topical track on computing	Topical track	Hybrid (New Orleans)	Jul-21

ACM ARES 2021	CNIT	Location Security under Reference Signals' Spoofing Attacks: Threat Model and Bounds	Dissemination	Virtual	Aug-21
GTTI 2021	CNIT	Location Security	Keynote	Lecce, Italy	Sep-21
XXXV Simposium Nacional de la Unión Científica Internacional de Radio (URSI 2021)	UMA	Modelos de movilidad para simulación de multitudes sociales en entornos celulares	Participation to a national conference	Virtual	Sep-21
XXXV Simposium Nacional de la Unión Científica Internacional de Radio (URSI 2021)	UMA	Análisis de Interferencia Cross-Link sobre un escenario 5G mmWave	Participation to a national conference	Virtual	Sep-21
XXXV Simposium Nacional de la Unión Científica Internacional de Radio (URSI 2021)	UMA	Aplicación móvil para localización de interior mediante fusión de tecnologías	Participation to a national conference	Virtual	Sep-21
XXXV Simposium Nacional de la Unión Científica Internacional de Radio (URSI 2021)	UMA	Sistema de detección cercana para misiones SAR basado en BLE y sistemas robóticos	Participation to a national conference	Virtual	Sep-21

Open RAN for Beyond 5G Wireless Networks: Challenges and Visions conference 2021	SAMS	The main challenges of ML/AI in the Beyond 5G open-RAN networks	Panel	Online	Oct-21
Infocom World 2021	INCE	“Deployment Scenarios and and Business Exploitation of LOCUS Platform”	Invited Talk	Athens, Greece (virtual)	Nov-21
Infocom World 2021	SAMS	“Industry View and Samsung Role in LOCUS Project”	Invited Talk	Athens, Greece (virtual)	Nov-21
Infocom World 2021	NXW	“Localization Analytics as Service Platform”	Invited Talk	Athens, Greece (virtual)	Nov-21
Infocom World 2021	CNIT	“LOCUS: Overview of the Main Results”	Invited Talk	Athens, Greece (virtual)	Nov-21
Infocom World 2021	VIA	“ML for Positioning and Geo-Analytics in LOCUS”	Invited Talk	Athens, Greece (virtual)	Nov-21
Infocom World 2021	OTE	“Operator’s View on Location-based Services”	Organizer and Presenter	Athens, Greece (virtual)	Nov-21

Infocom World 2021	NEC	"People-Centric Location and Context-based Analytics"	Invited Talk	Athens, Greece (virtual)	Nov-21
Visions for Future Communication Summit (VFCS)	SAMS	Multi-dimensional Optimization of Localization and Tracking in 6G	Dissemination	Lisbon	Nov-21
MILCOM 2021	CNIT	Next generation PNT systems in 5G ecosystem and beyond	Tutorial	San Diego, CA	Dec-21
INTERACT	UMA	Close detection robotic platform for Search and Rescue missions based on Bluetooth Low Energy	Dissemination	Bologna, Italy	Feb-22
INTERACT	UMA	Failure management insights in 5G using ns-3 network simulation	Presentation	Bologna, Italy	Feb-22
INTERACT	UMA	UWB and WiFi characterization for localization in construction sites	Dissemination	Bologna, Italy	Feb-22

Cyber-Physical Systems and the Internet-of-Things (CPS-IoT) Week	CNIT	Localization-of-things for cyber-physical systems	Tutorial	Milan, Italy	May-22
IEEE ICC 2022	CNIT	Localization-of-things: from foundation to B5G ecosystem	Tutorial	Seoul, South Korea	May-22
IEEE ICC 2022 - Workshop on Synergies of Communication, Localization, and Sensing towards 6G	EAB	“Recent advanced in 3GPP 5G positioning and sensing”	Keynote	Virtual	May-22
IEEE ICC 2022 - Workshop on Synergies of Communication, Localization, and Sensing towards 6G	CNIT	Panel on Synergies of Communication, Localization, and Sensing towards 6G	Panel	Virtual	May-22
IEEE ICC 2022 - Workshop on Synergies of Communication, Localization, and Sensing towards 6G	CNIT	"Synergies of Communication, Localization, and Sensing towards 6G"	Organization of a Workshop	online	May-22
IEEE ICC 2022 - Workshop on Synergies of Communication, Localization, and Sensing towards 6G	CNIT	“Sidelink 5G-V2X for Integrated Sensing and Communication: the Impact of Resource Allocation”	Dissemination	Virtual	May-22

18th International Conference on Artificial Intelligence Applications and Innovations	OTE	A 5G-Based Architecture for Localization Accuracy	Dissemination	Hybrid/ Crete, Greece	Jun-22
IEEE EUCNC 2022	CNIT, VIA, INCE, NXW	Uncertainty Quantification of 5G Positioning as a Location Data Analytics Function	Dissemination	Grenoble, France	Jun-22
IEEE EUCNC 2022	CNIT, IMDEA, UMA, INCE, NEC, SAMS, NXW	Participation to LOCUS Booth at EuCNC | 6G Summit	Exhibition	Grenoble, France	Jun-22
IEEE MELECON 2022	IMDEA/SAMS	5G localization: from research to standardization'	Tutorial	Palermo, Italy	Jun-22
IEEE SMARTCOMP 2022	SAMS	Industry View and Samsung Role in LOCUS project	Dissemination	online	Jun-22
IEEE SMARTCOMP 2022	EAB	Past, present and future positioning standardization in 3GPP	Keynote	online	Jun-22
IWFC 2022	CNIT	Localization-of-Things in the beyond 5G ecosystem	Keynote	Singapore	Jun-22

STAR Days	Ericsson AB	Ericsson positioning and sensing workshop	Presentation, discussion	Stockholm, Sweden	Sep-22
XXXV Simposium Nacional de la Unión Científica Internacional de Radio (URSI 2022)	UMA	Caracterización de UWB y WiFi FTM en obras	Dissemination	online	Sep-22
ACM International Conference on Mobile Computing and Networking 2022	IMDEA	Experimenting with Localization Management Functions in 5G Core Networks	Demo	Sydney, Australia	Oct-22
ACM Mobicom 2022	SAMS	UAV based 5G Indoor Localization for Emergency Services	Dissemination	Sydney, Australia	Oct-22
Univerity of Technology Sydney	SAMS	'5G Localization – Standards review and application to use cases'	Guest Lecture	Sydney, Australia	Oct-22
Rohde and Schwarz 6G Experts' Day	SAMS/UMA	'Can 5G-NR and UWB positioning work together?'	Invited Talk	Munich, Germany	Nov-22

IFIP/IEEE International Conference on Performance Evaluation and Modeling in Wired and Wireless Networks (IEEE PEMWN 2022)	CNIT	5G Positioning with SDR-based Open-source Platforms: Where Do We Stand?	Dissemination	Rome, Italy	Nov-22
ACM CoNEXT Student Workshop 22	IMDEA	Covid-19 Contact Tracing through Multipath Profile Similarity	Dissemination	Rome, Italy	Dec-22
IEEE Globecom 2022	SAMS/EAB/CNIT/IMDEA	Localization and Sensing in 5G-Advanced and Beyond - Research and Standardisation Outlook	Panel	Online	Dec-22
IEEE Globecom 2022 - Workshop on Advances in Network Localization and Navigation	NEC	Keynote Speech	Keynote	Virtual	Dec-22

IEEE ICC 2023 - Workshop on Synergies of Communication, Localization, and Sensing towards 6G	CNIT, IMDEA, UMA, INCE, NEC, SAMS, NXW	Organization of the 2nd Workshop on Synergies of Communication, Localization, and Sensing towards 6G	Organization of a Workshop	Rome, Italy	May-23

Table 4 Participation and Organization of Exhibitions, Fairs, Congresses, and Workshops.

2.1.3.3 Related Projects

We highlight two types of collaborations between LOCUS and other research projects: (a) individual collaborations from partners within specific projects for research and common development, or (b) the collaboration of LOCUS as a whole in the area of 5G-PPP. The second type of activity is coordinated by CNIT and involves also other partners from the consortium based on the specific activities and competences needed.

2.1.3.3.1 Collaborations for research and development activities

LOCUS is collaborating with other national and international projects, including EU projects in the framework of the 5G-PPP program and with projects of the ICT calls. Table 5 shows the **collaborations carried out during the whole year.**

Joint Collaboration with LOCUS	Partner Involved /Proposer	Type of activity	Target (e.g., R&D collaboration)	Location	Date
5G-SMART	EAB	Getting positioning advices from LOCUS team on IIoT scenario	Integrate communication with big data analytics for applications such as localization, with privacy-preserving solutions by design	Sweden	2020

CEF ODALA	NEC	Using location-based services for assessing the mobility patterns	Close relation with Heidelberg City and possible testbed in the near future	Germany	2020
CEF ODALA	NEC	EU project	Deployment in multiple smart cities in EU	Europe	2021-2022
5G-POS	EAB	Aligning 5G positioning views for both projects	R&D collaboration	Sweden	2020
5G-POS	CNIT, IMDEA, SAMS, EAB	Joint project collaboration	Joint magazine on positioning and sensing for the V2X safety scenario	Europe	2021
PinPoint5G+	IMDEA	Positioning and network management	R&D collaboration	Spain	2021
PinPoint5G+	IMDEA	Research project	Positioning and network management	Spain	2019-2021
HumAid	NEC Laboratories Europe, NEC Japan, ICRC	Joint project collaboration	Development of Humanitarian AI and IoT platform	Japan & EU	2020-2022
5G-Solutions	IBM	Joint project collaboration	Deployment of localization service on 5G solutions test bed	Ireland	2021-2022
5G-Solutions	IBM	R&D collaboration	Discussion about potential sharing of experimental platforms for PoC1. Unfortunately, the timing and type of hardware was not feasible for a full collaboration within the end of the project.	Remote	2022

HOP5G	EAB	GNSS measurement modelling; R&D, benchmarking hybrid GNSS+5G positioning	Realistic yet simple modelling of GNSS pseudo range measurements for evaluation of hybrid GNSS+5G positioning performance.	Remote	2021
5G-VINNI	SAMS	Use of BT Labs 5G test facility for a measurement campaign	Collection of measurements for DFL with FWA	BT Labs, UK	2021
MAP-6G	IMDEA	R&D, subcontracts	Integrate communication with big data analytics for applications such as localization, with privacy-preserving solutions by design	Remote	2022
RISC-6G	IMDEA	R&D, subcontracts	Practical techniques and algorithms to enable innovative solutions in the project and investigate the integration of communication with localization and sensing functions in future 6G deployments	Remote	2022

Table 5 Collaborations with peer projects

Additional activities within the 5G-PPP context are presented in Sec. 2.1.3.3.2.

2.1.3.3.2 Collaboration with 5G-PPP

The 5G Infrastructure Public Private Partnership (5G-PPP) is a joint initiative between the European Commission and European ICT industry: ICT manufacturers, telecommunications operators, service providers, small and medium-sized enterprises (SMEs) and researcher Institutions. The coordinator of the project is part of the steering board committee of 5G-PPP, attending periodical meetings with the coordinators of other ICT projects. The TM of the

project, coordinating the scientific team, is also part of the technical board committee of 5G-PPP, attending periodical meetings and phone calls to organize dissemination events together with other ICT projects and present LOCUS results.

Within the 5G-PPP, LOCUS is part of the Automotive and Architecture working group.

Several activities have been planned during the last three years as joint activities among multiple partners. A selection of **the main joint activities** follow:

- Participation to the Annual Journal in 2019
- Coordination of a joint workshop proposal at EUCNC 2020 with other ICT-20 projects of 5G-PPP
- White paper on "Empowering Vertical Industries through 5G Networks – Current Status and Future Trends", presented on 9th September at a webinar co-organized by 5GPPP and 5G IA.
- Preparation of a Brochure for the presentation of the 5G-PPP projects
- Participation to the workshop of the 5G-PPP technical board with a presentation on network management and LOCUS architecture
- Presentation of LOCUS to the Automotive Working Group
- Participation to the Annual Journal in 2020
- Coordination of a joint workshop at EUCNC 2021 with other ICT-20 projects of 5G-PPP
- Presentation of the LOCUS work in the "White Paper V4.0: A European View on 5G Architecture and Beyond"
- Organization of a Session dedicated to Localization within the workshop of the 5G-PPP technical board.
- Organization of the workshop at the IEEE ICC 2022 conference. The workshop is led by CNIT and IMDEA and in collaboration with other 5G-PPP projects. Other partners participated as keynote speakers or through the presentation of a conference paper.
- Organization of the accepted workshop at the IEEE ICC 2023 conference (May 2023). The workshop is led by CNIT and IMDEA in collaboration with other 5G-PPP projects. Other partners will participate as keynote speakers or through the presentation of a conference paper.
- Participation to the Heritage Figures and Brochures
- Whitepaper, "From 5G to 6G Vision: a Connected and Automated Mobility Perspective", with the participation of Tomasz Mach from SAMS.

- Besides the online periodical meetings, LOCUS participated to the in-person TB and SB meetings in Athens (October 2022)

3. Project Standardization Activities

There are several important standardisation activities happening around localization and LOCUS project has managed to contribute to many of them. These activities range from the planned activities in 3GPP which aim to enhance localization accuracy for enabling 5G vertical applications, to the new efforts in ETSI related to track and trace applications as a response to the COVID-19 pandemic. The open standards, particularly O-RAN and OAI, are looking at supporting localization applications in a more virtualized and open manner. The project is closely following these developments and contributing to these where possible.

Details of the activities during the full project life cycle in these fronts are provided in the sections below.

3.1 3GPP

3.1.1 Monitoring and Contribution

With localization related topics in 3GPP 5G-NR standardisation, there is a clear emphasis to improve the localisation accuracies and other KPIs from the levels required for traditional outdoor and indoor emergency use cases to more commercial applications in 5G verticals. In this regard, there is a number of related activities in the RAN and SA working groups.

In RAN (mainly in RAN1), the NR-positioning study and work items in release 16 defined the simulation parameters and the basic positioning signals of PRS (positioning reference signal for downlink) and SRS (sounding reference signal for uplink) respectively. In the subsequent NR-positioning enhancements study item in release 17 [8], the high precision localization for Industry IoT applications is studied. In RAN2 of NR Rel.17 work, it is the first time that the topic of positioning integrity is being discussed and studied. While until now, 3GPP has been mainly focusing on positioning accuracy, currently in Rel.17 both latency and integrity are being also studied, together with other KPIs. Ericsson on behalf of LOCUS has been contributing to the integrity topic in RAN2 and the following contributions are with respect to the work carried in LOCUS:

- R2-2006954, **"POSITIONING INTEGRITY KPIS", RAN2 CONTRIBUTION, ERICSSON.**
- R2-2006955, **"FACTORS IMPACTING RAT DEPENDENT POSITIONING INTEGRITY", RAN2 CONTRIBUTION, ERICSSON.**
- R2-2006957, **"LPP SIGNALING FOR INTEGRITY SUPPORT", RAN2 CONTRIBUTION, ERICSSON.**
- R1-2112341 **"Enhancements of DL-AoD positioning solutions", RAN1 CONTRIBUTION, ERICSSON.**
- R1-2112343 **"Potential enhancements of information reporting from UE and gNB for multipath NLOS mitigation", RAN1 CONTRIBUTION, ERICSSON.**

- **R1-2112339 "Techniques mitigating Rx Tx timing delays", RAN1 CONTRIBUTION, ERICSSON.**
- **R2-2108393, "Latency: Utilizing Time T and other associated parameters", RAN2 CONTRIBUTION, ERICSSON.**
- **R2-2108395, "On demand PRS", RAN2 CONTRIBUTION, ERICSSON.**

Figure 10 shows the 3GPP positioning anatomy history for RAN1 and RAN2 positioning study items and work items throughout different releases.

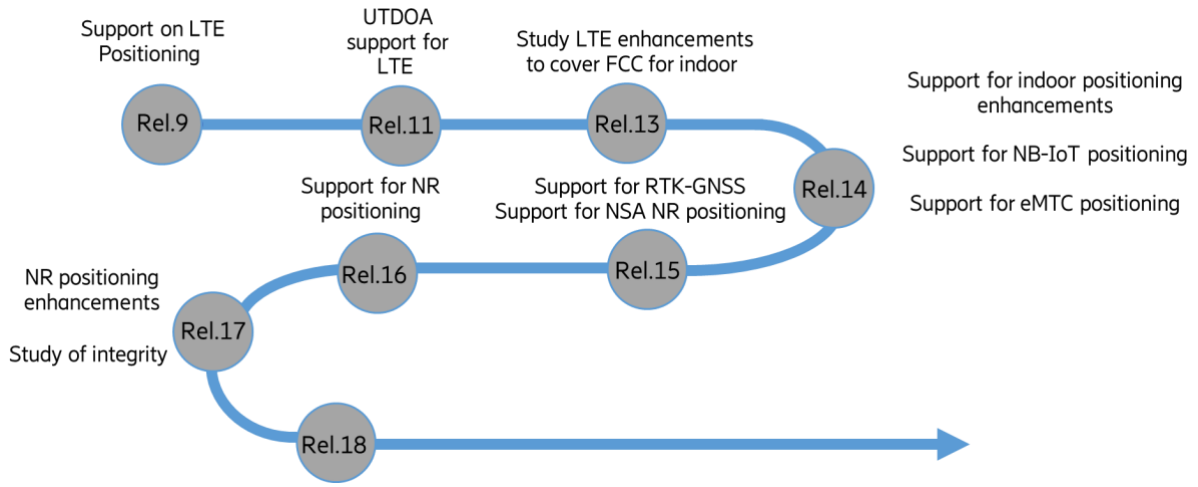

Figure 10 3 GPP positioning anatomy.

The Rel.17 SI for RAN1 has been finalized in 2020, and the Rel-17 WI was approved in 3GPP RAN plenary in March 2021. The work in RAN1, RAN2, and RAN3 has been during the third year of the project. There has been a large Rel-18 scoping workshop and process happening in 3GPP RAN, and there is a quite stable list of items for Rel-18 standardization ready to be approved in December RAN plenary.

Expanded and improved positioning is one of the RAN1-led items within Rel-18. Overall, there is a need for more discussion on how to contain the scope, particularly in terms of clear definitions. There is an expected study item with 9 months duration for side link positioning and ranging which will include study solutions including reference signals, measurements, procedures and also to include ranging (i.e. relative positioning) and absolute positioning. Coverage scenarios are to be covered focusing on out-of-coverage (with the understanding that in-coverage and partial-coverage are supported if out-of-coverage is supported). Moreover, the improved accuracy, integrity (RAT-dependent positioning techniques), and power efficiency are considered by specifying higher layer solutions for Integrity for RAT dependent positioning techniques and for accuracy improvement based on PRS/SRS bandwidth aggregation and NR carrier phase measurements

Reduced Capability (RedCap devices) positioning is also considered by evaluating performance of existing Rel-17 positioning procedures and measurements with RedCap UEs.

Also, there is an AI/ML in PHY layer study item for the first time in Rel-18 and positioning has become one of the three focus areas to be studied. Therefore, 3GPP RAN Rel-18 would be busy with many positioning items in the list and therefore a lot of potential for LOCUS project to contribute and monitor.

In SA2, there are concurrent work items as enhanced Localisation Services (eLCS) and eLCS phase 2 for release 16 and 17 respectively. These work items define the architectural framework for 5G-NR localisation services and for high precision Industry IoT applications, respectively. Samsung is actively participating in this SA2 eLCS phase 2 topic and have provided a number of contributions in 2021. Samsung proposed the new Multiple QoS class in Release 17 eLCS-phase 2, also citing some of the work done in the LOCUS project, particularly in simulations to show the benefits in reducing latencies with this new QoS class. These latency reductions are reported in LOCUS deliverable D3.4. Samsung and Ericsson discussed this new proposal in the 3GPP focus group meetings organised by the LOCUS standardisation task lead and Ericsson agreed to co-sign these related SA2 Tdocs from Samsung. This new concept was approved in SA2, in May 2021. All these Tdocs (listed below) mention the LOCUS project, as where some of the related work was conducted.

- S2-2100393, S2-2100394, S2-21002525, "**Support for Multiple QoS Class in deferred location requests**", **Samsung and Ericsson co-signed contribution.**
- S2-2102524, **"Discussion of Multiple QoS Class for efficient, flexible location estimation"**, **Samsung and Ericsson co-signed contribution.**
- S2-2103836, "**Support for Multiple QoS Class in deferred location requests**", **Samsung and Ericsson co-signed contribution** – *addresses editor notes*
- S2-2105125, **"Support for Multiple QoS Class in deferred location requests",** , **Samsung and Ericsson co-signed contribution.** – *approved CR*

Looking ahead at 3GPP plans for Release 18 [7] in the final project year, we realized the opportunity to contribute significantly to both the RAN1, 2 and SA2 work, due to the 6 months project extension. There were a number of topics both in the RAN NR-pos-enh2 and the SA2 eLCS-phase 3 and Ranging study items that were aligned with the on-going technical work in LOCUS. Among them, the support for NR-sidelink based positioning in both RAN and SA2 was a key topic area. Also, the positioning integrity topic in RAN2 was identified as a technical area with some relevance to LOCUS work. The following technical contributions were made by Ericsson and Samsung (in RAN 1/2 and SA2 respectively), which can be related (at least in part) to the work in LOCUS in these Release 18 study items. Many of the SA2 contributions has a

mention of the LOCUS project, as where some of the related technical work has been carried out.

The following is a list of RAN contributions to NR-pos-enh2 by EAB:

- **R1-2204948, "Sidelink positioning scenarios and requirements", RAN1 contribution**
- **R1-2204952, "Improved accuracy based on NR carrier phase measurement", RAN1 contribution**
- **R1-2204955, "Considerations for PRS SRS bandwidth aggregation", RAN1 contribution**
- **R1-2204951, "Solutions for integrity of RAT dependent positioning techniques", RAN1 contribution**
- **R2-2210316, "SL positioning Terminology and Protocol Aspects", RAN2 contribution**
- **R2-2210317, "RAT-dependent integrity and TP for TR", RAN2 contribution**
- **R1-2210174, "Evaluation of NR SL positioning and ranging", RAN1 contribution**
- **R1-2210176, "Error Sources characterization for integrity of RAT dependent positioning", RAN1 contribution**
- **R1-2210178, "Evaluations for Low Power High Accuracy Positioning", RAN1 contribution**
- **R1-2210179, "Positioning for RedCap UEs", RAN1 contribution**

The following is a list of SA2 contributions to eLCS-phase3 by Samsung:

- **S2-2203817, "Terminology proposals for FS_eLCS_Ph3" –** *generated comments*
- **S2-2204902, "Terminology proposals for FS_eLCS_Ph3" –** ***approved CR***
- **S2-2202368, "23.700-86: KI#7: New Solution on Ranging Service Exposure towards AF" –** *generated comments*
- **S2-2203349, ""23.700-86: KI#7: New Solution on Ranging Service Exposure towards AF" -** ***approved CR***
- **S2-2204251, "23.700-86: KI#7: Sol#12 updates to address EN" -** *generated comments*
- **S2-2205066, "23.700-86: KI#7: Sol#12 updates to address EN" -** ***approved CR***
- ***S2-2207168, "KI#9: Sol#27 updates and ENs removal" - approved CR***
- ***S2-2207081, "KI#7: Sol#17 updates" – approved CR***
- ***S2- , KI#7, KI#5: Sol#12 updates addressing ENs -*** *generated comments*
- ***S2-2207125, "KI#7, KI#5: Sol#12 updates addressing ENs", - approved CR***

3.1.2 Work progress in LOCUS with respect to 3GPP

At the start of the LOCUS project, it was identified that WP3 work is well aligned with the NR-positioning enhancements study item in 3GPP RAN working groups and steps have been taken even from the early preparation of the 3GPP enabler technology task (T3.1) to be compatible with this. The NR-positioning work in Rel.16 was introduced to the partners and they were encouraged to follow the simulation specifications of TR 38.855. A 3GPP focus group was created with the joint leadership of Samsung and Ericsson, the two industry partners active in the 3GPP NR-positioning enhancements study and in LOCUS T3.1. There have been many discussions in the focus group targeting to identify and agree on potential areas that technical contributions to 3GPP RAN can be made. The positioning integrity topic in RAN2 and the use of multiple reference signals (to broaden the scope than the PRS and SRS reference signals defined as per 3GPP release 16 specs) are two of the areas that have emerged. Ericsson has made 3 technical contributions to the 3GPP RAN2 working group on the topic of positioning integrity.

With 3GPP Release 17 work, it was identified that some of the areas discussed in eLCS phase 2 topic can be quite relevant to the 'Integration with non-3GPP technologies' theme of LOCUS T3.2. Samsung undertook a new work area in this Task on 'Integration of 5G and UWB localization in crowded environments. The new QoS class Samsung proposed in the eLCS phase 2 was used in the research study developed in this work area, as discussed above. This study is continuing and will show the results in LOCUS Deliverable D3.4. Another particular aspect this research study is focussing on is the use of user clustering and the NR-sidelink for positioning amongst the cluster members to reduce the overheads.

The NR-sidelink usage is a main topic in 3GPP Release 18 NR-positioning, eLCS-phase 3 and Ranging study items, as noted before. Samsung was able to relate some of the work they did for LOCUS Deliverable D3.4 in terms of lead UE based positioning with the usage of NR-sidelink to the eLCS-phase 3 and Ranging study items in SA2. Also, Samsung was successful in taking the time to collision analytics concept to 'Enablers for Network Automation for 5G - phase 3' study item. This is a clear indication where a seed idea was developed in LOCUS, then taken to ETSI and finally taken to 3GPP when the idea has sufficiently matured.

The 3GPP focus group meetings on LOCUS were held once every 4 months. All partners are invited, and the meetings are chaired by Samsung, as the Standardisation task lead. These meetings are used to update the LOCUS partners on the latest developments in the Localization related topics in RAN 1, 2 and SA2 by relevant Standards delegates from Ericsson and Samsung. Also, opportunities to collaborate and push ideas relevant to the LOCUS project are also discussed, as illustrated by the case of the Multiple QoS class detailed in section 4.1.1.

The focus group meetings in the final project year discussed the localization related likely topics to emerge in Release 18 and any possibilities for the 3GPP partners (Samsung, Ericsson, Orange and NEC) to collaborate in some of these. The focus group was successful in identifying key areas to contribute, as shown in the long list of successful 3GPP contributions made to RAN1/2 and SA2 as listed above.

3.2 ETSI

The LOCUS project actively contributed to various standardization activities in ETSI. The partner Samsung was the one leading this activity, and this encompassed the following groups:

a) **ETSI Intelligent Transport Systems (ITS) Technical Committee**: From the beginning of the project both in WP4 and WP5, LOCUS championed topics related on how improved 5G localization and analytics mechanisms developed by LOCUS could contribute to novel 5G verticals applications such as Connected and Automated Mobility (CAM), including Vehicle-To-Everything (V2X) communications, taking into account their specific characteristics such as importance of road users, safety aspects etc. In WP5 this work, in collaboration with other partners resulted in developing Vulnerable Road User (VRU) use case (NSE-UC3) and other technical contributions on corresponding new functionalities and their data models such as 'Vulnerable Road Users clustering', which aim to improve V2X communication system performance by leveraging improved 5G location accuracy. In addition, the 'Time-To-Collision as a service in V2X' functionality (described in D5.1) is also applicable to Logistics in a seaport terminal using AGVs use case (NSE-UC4). These solutions may be the future enabler for new applications in CAM leveraging 5G analytics. It is worth highlighting, that proposed mechanisms were developed based on the current progress of V2X technology standardization in Europe, in ETSI ITS. This includes ongoing VRU standard development for ITS standard 2 and for V2X globally (5G Automotive Association), where Samsung is actively involved, seeking potential relevance and contribution opportunities for LOCUS research and technology. So far, this activity ensured technical insights and direct relevance of LOCUS work into recent developments in the automotive vertical ecosystem.

b) **ETSI Europe For Privacy-Preserving Pandemic Protection (E4P) Industry Specification Group**: This new group, formally created in May 2020, has been developing COVID-19 proximity tracing systems as an interoperability framework for contact tracing applications. The current standardization work is focused on smartphone-based proximity systems using Bluetooth technology for proximity detection, however later, the group will explore other systems including cellular based solutions. SAMS as rapporteur of one of the core technical specifications [6] provided periodic E4P progress and roadmap updates to LOCUS partners facilitating potential contribution of developed solutions addressing COVID-19 to E4P in Q2

2021. In addition, Samsung indicated challenges and technical areas not fully addressed by currently deployed Bluetooth based solutions, enabling better Health Authority insight into pandemic development. This has been addressed further by LOCUS research activities and platform development, leveraging improved 5G location accuracy and analytics. This activity has supported corresponding COVID-19 focused research in WP5, demonstrating consortium flexibility and proactive approach as far as timely addressing of global challenges posed by the coronavirus. It should be mentioned that this action is beyond the initial scope of the project.

3.3 FiRa consortium

Recently, Ultra-Wideband (UWB) based positioning has gained much attention due to the very high accuracy levels it can provide (up to 10 cm accuracy). The FiRa (or Fine Ranging) consortium [10] promotes the use of UWB for a number of localization applications and has seen a rapid growth of its membership over the past year. It develops specifications for the higher management and application layers but uses the specs of IEEE 802.15.4z for the PHY and MAC layers of the UWB based localization solutions. Samsung is a member of the FiRa consortium and will closely follow its developments. If there is an opportunity, Samsung will contribute, citing the LOCUS project, using the results of the T3.2 activity dedicated to data fusion between UWB and 5G.

3.4 Open-Source Contributions

This section presents a brief introduction of some existing open standards emphasizing on their compatibility to the LOCUS project. It also shows how the work carried out within the LOCUS project is contributing or has potential to contribute to these standards.

3.4.1 Open Air Interface (OAI)

OAI [3] is a flexible software platform providing 3GPP compliant reference implementations of key elements of 4G and 5G Radio Access Network (RAN). The current focus of OAI is in the development of a 5G NSA solution using the EN-DC architecture where the eNB handles all the control-plane traffic and the gNB only needs to handle the user-plane traffic.

The physical layer already implements 4G features according to 3GPP 36.211, 36.212, 36.213 specification and 5G features according to 3GPP 38.211, 38.212, 38.213 specification under development. These features support all downlink and uplink channels including sounding reference signals (SRS) which can be used to retrieve location information.

Within the LOCUS project, IMDEA Networks is deploying a testbed in the 5TONIC lab to use OAI and implement a 5G link between the UE and BS in the context of WP3 for fast and low-overhead localization for URLLC service, and had conducted the first experiments which are

reported in D3.2. The testbed has been upgraded using the latest USRP N310 as BS and a powerful server with 16 cores for data processing. This link will allow the testing of the proposed fast localization strategies.

3.4.2 Open-Source MANO (OSM)

OSM [9] is an operator-led ETSI community with the objective to deliver production-quality open-source solutions for Network Functions Virtualization (NFV) Management and Orchestration (MANO). The solutions are closely aligned with ETSI NFV Information Models and are versatile, easily applied in both laboratory and field (real-world) trials.

As regards LOCUS, the ETSI MANO architecture [9] is very relevant as it offers application programme interfaces (APIs), data models and workflow logic for building complex services.

The LOCUS platform can be implemented and deployed as a specific case of NFV. The LOCUS platform can be implemented and deployed as a specific case of NFV. In particular, Nextworks is using the ETSI OSM for the management and orchestration functionalities of the virtualization platform used in WP4 and WP5, as well as for LOCUS PoCs in WP6. Specifically, PoC#1 and PoC#3 are fully integrated with ETSI OSM in the LOCUS platform and virtualized infrastructure in OTE for managing and orchestrating the LOCUS analytics services as combination of cloud-native virtualized network functions deployed on top of the Kubernetes cluster.

3.4.3 O-RAN Alliance

The Open-Radio Access Network (O-RAN) alliance is a community of network operators, vendors, and research institutions working on the RAN industry [11]. The main focus of the O-RAN alliance is to build the virtualized RAN on open hardware and cloud, with embedded AI-powered radio control. To this aim, an O-RAN architecture is conceived, based on standards defined by the alliance itself, which are aligned and complimentary to standards promoted by 3GPP and other industry standards organizations.

ORA is a founding member of O-RAN and is actively involved in the definition and standardization of several use cases. In this context, the ORA division involved in LOCUS is focusing on data enrichment for use cases involving geolocation data. These can include geolocation, user context information for mobility management, application layer data etc. The work performed in WP4, i.e., the use of geolocation for smart network management, will be exploited for contributing to location-based use cases in O-RAN standardization. The selection of LOCUS outcomes proposed in O-RAN has been discussed within WP4 and led by Orange and VIAVI. Based on such discussion, specific contributions have been agreed with the consortium at the beginning of the second year of the project.

4. Overview of the Measurable KPIs

In D7.1, we identified measurable KPIs to monitor the communication, dissemination, and standardization activities and their effect on the target audiences. Table 6 shows the target frequency values that we forecasted by the end of the project and the actual values based on the activities carried out over the three years.

Activity	Suggested venues	Target Freq./ Number	Actual Value
Joint journal publications within the consortium	• IEEE Transactions and Magazines • ACM Computer Communications Review, Journal of the ACM	4	3 journals and 4 conference proceedings; more under revision
Joint events/conferences where more than one partner participates or is among the organizers	See Table 3 List of main international, peer-reviewed conferences of interest for LOCUS dissemination.	4	5
Journal papers on international peer-reviewed journals	• IEEE Transactions and Magazines • ACM Computer Communications Review, Journal of the ACM	8	36 published (more under revision)
Participation to international conferences	Main international, peer-reviewed conferences of interest	8	37
Organization of a workshop	Workshops within main International conferences.	2	4
Events and meetings involving policy-makers, societal, and environmental stakeholders and institutions reached.	5G-Italy, European Research Week, European commission-organized events	4	4
"Marketing-oriented" presentations at industry events. Here, PoCs in relevant environments (TRL 5) can be showcased available to third	Mobile World Congress (MWC), Open Networking Summit (ONS), ITS European Congress, etc.	3	Two PoCs shown at EUCNC and more demos in other conference or industry events.

parties for running additional experiments.			
Meeting with peer projects	5G-PPP, Other national and international projects related to 5g and telecommunication	Monthly	Monthly
Organization of joint events and publications with peer projects	Whitepapers within 5G-PPP, 5G-PPP work groups, participation to the steering committee and the technical committee of the 5G-PPP, joint brochures with peer projects, workshop organized by and with peer projects, magazine papers	4	> 4 See 5G-PPP, 6G-IA and collaborations in IEEE magazines and for the Wiley Book
Number of communications towards partner organizations at large.	Joint video conference calls or webinars with partner organizations.	4	> 4 (IBM, Ericsson, InfocomWorld, Standardization Working Group)
Number of events organized involving universities and research centers	Meetings, webinars/seminars	4	4 Guest Lecturers, PhD Schools, 5G-Italy, GTTI. Furthermore, following the publication of the Wiley-IEEE Book, more events for its presentation will be co-organized.
Number of followers, interactions and visits of the website and social media from research centers and universities	Expected numbers from the websites of the research centers and university (excluding the LOCUS project website or social media). Interactions involve feedbacks, emails, comments from outside people.	200 25 1000	Despite it was not possible to distinguish between the different categories, we estimate even higher numbers given the visits trends, participation to events, and number of followers.
Number of followers, interactions and visits from policy makers, societal, and environmental stakeholders on the	The analytics numbers for the interaction through LOCUS website or social media. This number includes general public as well as stakeholders listed on Table 2.	200 50 500	

website and social media.			
Number of participations to industry events.	Mobile World Congress (MWC), Open Networking Summit (ONS), ITS European Congress, etc.	8	
Number of policy-makers, societal, and environmental stakeholders and institutions reached	Total number of stakeholders/institutions reached through the organized events	50	
Number of people involved from general public	Participation to events involving general public	500	
Number of demonstrations through PoCs tested in relevant environments (TRL 5).	PoCs to be made available to third parties and presented to industries or public administrations.	3	Together with the three PoCs, we also prepared 3 additional demos (see D6.3)
Participation to working groups within standardization bodies.	3GPP, ETSI, IETF/IRTF, NGMN	3	>3
Number of proposals for contribution to standardization bodies.	Proposals to the standardization bodies such as 3GPP, ETSI, IETF/IRTF, NGMN	3	>3
Number of events targeting the general public.	Participation to the European research week, release of online videos and tutorials	3	Several events listed in Sec. 2.1.3.2 already targeted the general public (with limitations due to the COVID-19 related pandemic). We are preparing six videos for the PoCs and additional demos as described in detail in D6.3 [12]. Following the

			publication of the videos, we will publish a dedicated YouTube channel for the demo
Press articles	Specialized websites, Newspapers, Online news websites	4	The PoC videos, Youtube Channel, and the Wiley book publication will be advertised target national and international websites to advertise the LOCUS outcomes.

Table 6 Evaluation of the Measurable KPIs with respect to Target Values proposed in D7.1

5. Privacy, Ethics, and Data Management

LOCUS has been attentive to the matter of data management and privacy during its lifetime given the sensitive nature of the localization capabilities and analytics in the project.

5.1 Privacy and Ethics

Each partner has appointed a specific person in its organization as Personal Data Officer (PDO), as suggested by the External Independent Ethics Advisor (EIEA), to overview aspects of the project concerning privacy and personal data, as well as coordinating with the EIEA, whose role was to provide an external critical view on how sensitive information was handled by the partners. Several tasks of the PDO have been defined:

- Inform involved subject about data protection rights, obligations, and responsibilities.
- Ensure data protection compliance.
- Advice the consortium about and point out any failure to comply with the data protection rules.

Table 7 List of the PDOs of the consortium

ORGANIZATION	PERSONAL DATA OFFICER
CNIT	Raffaele Bolla
EAB	Sara Modarres Razavi
TEI	Stefano Stracca
IBM	Joseph Anthony
NEC	Gürkan Solmaz
Orange	Sana Ben Jemaa
OTE	Alexis Andreadis
SAMSUNG	Mythri Hunukumbure
VIAVI	Takai Eddine Kennouche
INC	Kostas Tsagkaris
Nextworks	Giacomo Bernini
IMDEA	PROCESIA PROYECTOS Y SERVICIOS, S.L.
UMA	Emil Jatib Khatib

Given the sensitive nature and the ethical implications of their work, the PDOs have been collaborating with the external independent ethics advisor (EIEA). In the effort of fulfilling his task to monitor the ethics issues involved in this project, the EIEA released two intermediary reports to provide the consortium with observations and recommendations. Such

recommendations have been executed by partners and periodic meetings have taken place. The EIEA participated to the meeting of October the 16th 2020 and suggested that DPOs should in future produce declarations on the possible use of personal and sensitive real data, stating that they have complied with the applicable rules on the subject, in the context of their partner's activities.

5.2 Data Management

The main steps for the Data Management Plan are summarized in the following.

The Data Management Plan has been initially presented in D7.1 in December 2020 [1]. An initial description of expected data in the project was included in [1].

A Data Catalogue has been prepared and agreed among all the partners in June 2021 and presented as an Annex of the Technical Report after the first Project Review [2]. The Data Catalogue detailed the type of data to be collected by each partner for experimentations and proof-of-concepts. The Personal Data Officers from the consortium have implemented the recommendations made by the EIEA Dr. Azelio Fulmini by monitoring compliance with the ethical requirements all issues related to the use of data presented in the Data Catalogue, in accordance with such recommendations.

As detailed in the Data Catalogue, most of the data used in the project is simulated data or measurements collected through experimentation networks within local laboratories, i.e., no personal data. The only exception is the data provided by OTE that was properly anonymized before used in the project as also declared by correspondence on June 26, 2021, by the OTE DPO, Dr. Alexis Andreadis. The complete and precise details about the collection and anonymization can be found in the Data Catalogue.

Periodically, the project PDO conducted a survey within the consortium to confirm or update the Data Catalogue presented in [2].

The outcome of all the surveys confirms that the only data used in the project are those described in the Data Catalogue and no need to collect new types of data arose at later stages.

Note that the existing shared repositories containing the documentation and non-sensitive data will be maintained active for the next 5 years by CNIT.

References

[1] Communication and Dissemination Plan v.2, D7.1, LOCUS, 2020.

[2] LOCUS Data Catalog, Annex of the 2nd Periodic Technical Report, LOCUS, 2022

[3] Innovation and Exploitation Plan, D7.7, LOCUS, 2022.

[4] Innovation and Exploitation Report, D7.3, LOCUS, 2021.

[5] ETSI TR 103 300-1 'Intelligent Transport Systems (ITS); Vulnerable Road Users (VRU) awareness; Part 1: Use Cases definition; Release 2' V2.1.1 (2019-09)

[6] ETSI GS E4P-006 'Device-based mechanisms for pandemic contact tracing systems'

[7] Kaltenberger F, Silva AP, Gosain A, Wang L, Nguyen TT. OpenAirInterface: Democratizing innovation in the 5G Era. Computer Networks. 2020 May 1:107284.

[8] 3GPP Release 17

[9] ETSI Open-Source MANO, https://osm.etsi.org/

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[11] O-RAN Alliance https://www.o-ran.org/about

[12] Assessment of applications integrated with geolocation mechanisms, D6.3, LOCUS, 2022.