5G CITY

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D6.5 – Final Report on Dissemination, Exploitation and Standardization activities

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D6.5 – Final Report on Dissemination, Exploitation and Standardization activities

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Change History

Version	Date	Partners	Description/Comments
0.0	01/03/2020	I2CAT	Initial ToC
0.1	25/03/2020	I2CAT, All	First consolidated version with inputs from all partners
0.17	10/03/2020	I2CAT	Multiple improvements and refining of text after initial review. Ready for ext. Review
0.18	15/03/2020	NxW	Revised with suggestions.
1.0	17/04/2020	I2CAT	Complete report for submission

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Executive Summary

This deliverable contains the final report on dissemination, standardization and exploitation activities carried out in the 5GCity project. For completeness and to ease a better evaluation of the KPI achievements, the report is structured to list all the impact achievement activities executed during the entire project (M1-M34).

The 5GCity project has gained a relevant position in the communities working on 5G, Media Verticals and Smart Cities, due to the maturity of research results produced by the project and the impact generated by the dissemination and communication activities. Key impact elements have been the Neutral Hosting platform developed within the project, and the many related technology enablers such as edge/core virtualization, network slicing, service orchestration, service design, RAN virtualization. All these aspects have been validated in three live city pilots (Barcelona – ES, Bristol – UK and Lucca - IT), which further increased the impact results and attention of the community to project's actions. Having in mind the achievements developed by the project, the dissemination, standardization and (individual/joint) exploitation activities have been structured to maximise impact and largely expose the project results.

For dissemination and communication, the strategy the Consortium has applied consisted of presentations of scientific results and showcasing at various highly relevant events and conferences (among the others, Mobile World Congress Barcelona, Smart City Expo World Congress, SDN/NFV World Congress, and many others), in addition to a continuous promotion of project concepts and objectives via communication channels (e.g. Twitter). The project team has also worked with standard organization and NFV/MEC open source communities, in continuation of collaborations just started in the first period of the project. The multiple project results and outcomes have also stimulated concrete exploitation actions, both individually by partners and jointly, some of which also occurred during the execution of the project.

Key results achieved by the project during its activity timeframe can be summed up as in the following:
- **26 scientific papers** have been published or accepted, among journal (2 published) and conferences (24), out of 32 publications. Two papers are pending evaluation (1 journal and 1 conference paper), only 2 papers were rejected, and 2 are in elaboration which cover the latest results from use case validation and business models.
- 5GCity presentations, keynotes and panels have been given in **47 important and well-known international events**; only 2 programmed events were cancelled in 2020 due to COVID-19 outbreak;
- **19 demos** have been executed in various events (IBC 2018, Lucca Comics and Games 2018, SCWEC 2018, ICT 2018, MWC2019, European Digital Forum 2019 – Lucca, EUCNC2019,) and other 3 demos were ready to be shown at MWC2020 before cancellation due to COVID-19
- **5GCity website** launched at M1 and continuously updated with new contents achieved incredible numbers of in terms of impressions (>1 million) and direct links (>15k direct clicks to 5GCity.eu).
- **6 Newsletters and 15 Tech Blog posts** were produced and highly advertised in the large 5GCity network of contacts
- Very bold presence of 5GCity on social channels: on Twitter the project reached **2,188 followers**, with an intense activity (**3,479 Tweets, 25 mentions, 240 Profile visits,** and **71,7K impressions)**.
- Actively **contributed to 11 between 5G IA and 5G PPP Working Groups**, with continuous involvement in the production of programme level technical and strategic results (positioning papers, joint events, joint papers and task forces, etc.).
- Established **Unikraft** first as Xen Project under the Linux Foundation (https://www.xenproject.org/developers/teams/unikraft.html), then as solid independent community (http://unikraft.org/)
- Contributed to **Eclipse IoT Consortium** and formed the **Eclipse fogØ5 Project** (http://projects.eclipse.org/proposals/eclipse-fog05) and then evolved into an independent community (https://fog05.io/)

- Contributed to **Open Fog Consortium Reference Architecture**, **ETSI MEC (19)000120 - MEC011-MEC010-2 ME App Start-up and Termination procedures, SMPTE TC-32NF-60 DG Studio Video over IP (SVIP), AMWA NMOS Networked Media Incubator**, and started interactions with **EBU 5G Deployment Group**
- Matured know how to contributed to **ETSI MEC whitepaper on Edge Computing and to various Specialist Task Forces at ETSI NFV and ETSI MEC on testing and OpenAPI**
- Contributed to **Open Source community with KVM hypervisor patches, ETSI OSM VIM   connector for Eclipse fog05, ETSI OSM Support of multiple VIM accounts**
- Defined individual and joint exploitation plans related to the final project results and executed **4 joint exploitation activities** (*Smart Lamppost, 2 new H2020 projects following up on specific 5GCity research, Wi-Fi and small cell radio NETCONF management and control interface, Barcelona TV video acquisition via Neutral Host*).

1. Introduction

This document reports on the achievements and activities related to communication, dissemination, standardization and exploitation of the 5GCity project.

The document is organized in three core chapters corresponding to different types of activities as follows:

- Section 2 reports on the dissemination and communication and public activities undertaken jointly by the consortium and individually by the partners during the whole duration of the project.
- Section 3 summarizes standardization activities, partners' strategies and updates towards SDO working on 5GCity related topics, and 5GCity contribution to different open source communities.
- Section 4 details the individual exploitation activities executed by the partners, in relation to the knowledge and results generated within 5GCity. Furthermore, it also details the joint exploitation plans of different partners in the consortium according to their interest, activities, and role in the three cities.

In last place, section 5 summarizes the key relevant aspects and strategic achievements in this area, and also provides an overview on the level of fulfilment of 5GCity KPIs which have been set in the Description of the Action.

2. Dissemination and Communication Activities

The Dissemination and Communication activities during the life-time of the 5GCity project have been actively carried out by consortium partners with the aim to establish a bold project visibility in the scientific, industrial and vertical community working on 5G.

The entire consortium and partners individually have been involved in many activities, ranging from event and standards participation, to keynote presentations and roundtables, have produced a significant number of scientific papers and prepared material for key exhibition events of the 5G community. The project communication has been focused to stress the unique selling points of the project across various channels (website, socials, local communities, large worldwide conferences and exhibitions), to reach the target stakeholders in Media and Smart City market areas with highlights and public presentations of the project use cases and the initial technical results in terms of architecture and city infrastructure design. The active involvement in the 5GPPP and its various Working Groups (WG), in the 5G Infrastructure Association, and in the 5G community at large has granted further opportunities for the project team to discuss approaches and R&D directions, together with presentations of plans and results.

From day one, the activities in dissemination and communication have been given top priority in the project, allowing to properly propagate the inner value behind all the efforts and research carried out in 5GCity.

The summary of top remarkable results achieved is presented below, reporting on project activities in different dissemination areas:

- Scientific publications
- Participation to talks/Panels/Webinars
- Demonstrations
- 5G PPP collaborations
- Liaison with other Projects
- Communication via Project Web Site
- Communication via Social Networks (twitter, LinkedIn)
- Newsletter and technical blogs

2.1. Papers and Scientific Publications

During the project activity lifecycle, a total of **32 publications have been elaborated, 26** of which have been **published / accepted** to relevant conferences and important events, **2 are pending evaluation**, **2 were rejected** and **2 are in elaboration.** The complete list of papers and scientific publications have been reported in Table 1.

# (Scientific, Industry)	Type	Title	Authors	Conference	Status
1 (S)	Poster	Techno Economic Assessment of Immersive Video Services in 5G Converged Optical/Wireless Networks	I. Neokosmidis (INC), T. Rokkas (INC), P. Paglierani (ITL), Claudio Meani (ITL), K M. Nasr (UoS), Klaus Moessner UoS, M Shuaib Siddiqui (i2CAT), P. Sayyad Khodashenas (i2CAT)	Optical Fiber Communications (OFC) 2018 San Diego, California, USA, March 3-7, 2018	Published

# (Scientific, Industry)	Type	Title	Authors	Conference	Status
2 (I)	Conference Paper	A novel pflua-based OpenFlow implementation for VOSYSwitch	Jérémy Fanguède, Michele Paolino, Dimitar Dimitrov and Daniel Raho	The Third IEEE International Conference on Fog and Mobile Edge Computing (FMEC 2018) Barcelona, Spain, April 23-26, 2018	Published
3 (S)	Conference Paper	Are 5G Networks, and the Neutral Host Model, the Solution to the Shrinking Telecom Market?	Ioannis Neokosmidis, Theodoros Rokkas, Dimitris Xydias, Antonino Albanese, Muhammad Shuaib Siddiqui, Carlos Colman-Meixner, Dimitra Simeonidou	3RD WORKSHOP ON "5G – PUTTING INTELLIGENCE TO THE NETWORK EDGE" (5G-PINE 2018 within AIAI 2018 conference) Rhodes, Greece, May 25-27, 2018	Published
4 (I)	Conference Paper	5G city: A novel 5G-enabled architecture for ultra-high definition and immersive media on city infrastructure	Carlos Colman Meixner, Pedro Diogo, Shuaib Siddiqui, Antonino Albanese, Hamzeh Khalili, Alex Mavromatis, Luca Vignaroli, Alexandre Ullisses, Jordi Colom, Reza Nejabati and Dimitra Simeonidou	IEEE International Symposium on Broadband Multimedia Systems and Broadcasting 2018 (BMSB2018) Valencia, Spain June 6-8, 2018	Published
5 (I)	Conference Paper	Virtualized Infrastructure Managers for edge computing: OpenVIM and OpenStack comparison	Teodora Sechkova, Michele Paolino and Daniel Raho	IEEE International Symposium on Broadband Multimedia Systems and Broadcasting 2018 (BMSB2018) Valencia, Spain June 6-8, 2018	Published
6 (S)	Conference Paper	Enabling Vertical Industries Adoption of 5G Technologies: a Cartography of evolving solutions	Anastasios Zafeiropoulos, Panagiotis Gouvas, Eleni Fotopoulou, George Tsiolis, Thanos Xirofotos, Jose Bonnet, Gino Carrozzo, Stamatia Rizou, Anastasius Gavras, Maria Barros, Xavier Costa- Perez, Athul Prasad, Marco Gramaglia, Anna Tzanakaki, Dimitra Simeonidou, John	The European Conference on Network Communications (EUCNC2018) Ljubljana, Slovenia June 18-21, 2018	Published

# (Scientific, Industry)	Type	Title	Authors	Conference	Status
			Cosmas, Mikael Fallgren, Raul Muñoz, Ricard Vilalta		
7 (S)	Conference Paper	fog05: Unifying the computing, networking and storage fabrics end-to-end	Angelo Corsaro, Gabriele Baldoni	3rd Cloudification of the Internet of Things Conference (CIoT2018) Paris, France, July 2-4 2018	Published
8 (S)	Conference Paper	Design considerations for an energy-aware SDN-based architecture in 5G EPON nodes (Invited) Web: https://www.5gcity.eu/wp-content/uploads/2018/12/Design-Considerations-for-an-Energy-Aware-SDN-based-Architecture-in-5G-EPON-Nodes.pdf	Hamzeh Khalili, Pouria Sayyad Khodashenas, David Rincon, Shuaib Siddiqui, Jose Ramon Piney and Sebastia Sallent	20th Anniversary International Conference on Transparent Optical Networks (ICTON 2018) Bucharest, Romania 1-5July 2018	Published
9 (S)	Conference Paper	Enabling Vertical Industries Adoption of 5G Technologies: a Cartography of evolving solutions	Anastasios Zafeiropoulos, Panagiotis Gouvas, Eleni Fotopoulou, George Tsiolis, Thanos Xirofotos, Stamatia Rizou, Jose Bonnet, Anastasius Gavras, Maria Joao Barros, Gino Carrozzo, Xavier Costa-Perez, Athul Prasad, Marco Gramaglia, Anna Tzanakaki, Dimitra Simeonidou, John Cosmas, Mikael Fallgren, Raul Muñoz, Ricard Vilalta,	EUCNC 2018, Ljubljana, Slovenia, 18-21 June 2018	Published
10 (S)	Conference Paper	5G City: A Novel Distributed Cloud and Edge Platform for 5G Neutral Host	Carlos Colman-Meixner, Shuaib Siddiqui, Paolo Cruschelli, Antonino Albanese, Maria Rita Spada, Teodora Sechkova, Hamzeh Khalili, Luca Vignaroli, David Pujals,Alberto Hernando, Nicola Ciulli, Simon Prior, Alex Mavromatis, and Dimitra Simeonidou	EUCNC 2018, Ljubljana, June 18-21, 2018	Rejected

# (Scientific, Industry)	Type	Title	Authors	Conference	Status
11 (I)	Conference Paper	Edge Computing Enhancements in an NFV-based Ecosystem for 5G Neutral Hosts	Gabriele Baldoni; Paolo Cruschelli; Michele Paolino; Carlos Colman Meixner; Antonino Albanese; Apostolos Papageorgiou; Hamzeh Khalili; Muhammad Shuaib Siddiqui; Dimitra Simeonidou	IEEE Conference on Network Function Virtualization and Software Defined Networks, 27-29 Nov 2018 – Verona, Italy	Published
12 (I)	Journal paper	Deploying a Novel 5G-Enabled Architecture on City Infrastructure for Ultra-High Definition and Immersive Media Production and Broadcasting,	Carlos Colman-Meixner, Hamzeh Khalili, Konstantinos Antoniou, Muhammad Shuaib Siddiqui, Apostolos Papageorgiou, Antonino Albanese, Paolo Cruschelli, Gino Carrozzo, Luca Vignaroli, Alexandre Ulisses, Pedro Santos, Jordi Colom, Ioannis Neokosmidis, David Pujals, Rita Spada, Antonio Garcia, Sergi Figerola, Reza Nejabati, and Dimitra Simeonidou.	IEEE Transaction on Broadcasting.	Published
13 (I)	Conference Paper	Cloud & Edge Trusted Virtualized Infrastructure Manager (VIM) - Security and Trust in OpenStack	Teodora Sechkova, Enrico Barberis, Michele Paolino	IEEE WCNC19 15-19 April 2019, Marrakech, Morocco	Published
14 (S)	Conference Paper	A practical approach to slicing Wi-Fi RANs in future 5G networks	Joan Josep Aleixendri, August Betzler, Daniel Camps-Mur	IEEE WCNC19 15-19 April 2019, Marrakech, Morocco	Published
15 (S)	Poster	Unleashing the Power of Unikernels with Unikraft	Simon Kuenzer, Felipe Huici (NEC)	SYSTOR 2019 June 3-5 2019 Haifa, Israel	Published
16 (S)	Conference Paper	Regulatory Considerations in the 5G Era: The 5GCity Neutral Host Case	Ioannis Neokosmidis, Theodoros Rokkas, Dimitris Xydias and Maria Rita Spada	4TH WORKSHOP ON "5G – PUTTING INTELLIGENCE TO THE NETWORK EDGE" (5G-PINE 2019 within AIAI 2019 conference)	Published
17 (S)	Conference Paper	"Computing and Network Virtualization at the Edge for 5G Smart Cities Neutral Host Infrastructures", 28th European Conference on Networks and Communications (EUCNC 2019), June 18-21, 2019, Valencia, Spain	Michele Paolino, Carlos Colman Meixner, Teodora Sechkova, Gino Carrozzo, August Betzler, Hamzeh Khalili, Muhammad Shuaib Siddiqui, Dimitra Simeonidou,	EUCNC 2019, June 18-21, 2019, Valencia, Spain	Rejected

# (Scientific, Industry)	Type	Title	Authors	Conference	Status
18 (S)	Conference Paper	Secure Location-Aware VM Deployment on the Edge Through OpenStack and ARM TrustZone	Teodora Sechkova, Enrico Barberis, Michele Paolino	EUCNC 2019, June 18-21, 2019, Valencia, Spain	Accepted
19 (S)	Conference Paper	Network Slicing-Aware NFV Orchestration for 5G Service Platforms	Hamzeh Khalili, Apostolos Papageorgiou, Shuaib Siddiqui, Carlos Colman-Meixnerx, Gino Carrozzo,Reza Nejabati, and Dimitra Simeonidou.	EUCNC 2019, June 18-21, 2019, Valencia, Spain	Published
20 (S)	Extended abstract	Definition and Evaluation of Latency in 5G with Heterogeneous Use Cases and Architectures	Gino Carrozzo, M. Shuaib Siddiqui, Kevin Du, Bessem Sayadi, Oscar Carrasco, Fotis Lazarakis, Janez Sterle, Roberto Bruschi	EUCNC 2019, June 18-21,2019, Valencia, Spain	Published
21 (S)	Extended abstract	Path to 5G Smart Cities: Experiences from Media and Public Safety Pilots in 5GCity	Gino Carrozzo, M. Shuaib Siddiqui	EUCNC 2019, June 18-21, 2019, Valencia, Spain	Published
22 (S)	Conference Paper	Assessment of CAPEX and OPEX for Media Services in Cloud Enabled 5G Networks	Ioannis Neokosmidis, Theodoros Rokkas, Pietro Paglierani, Claudio Meani, Karim M Nasr, Klaus Moessner and Pouria S Khodashenas	2019 CTTE-FITCE: Smart Cities & Information and Communication Technology (CTTE-FITCE), Ghent 25-27 Sept. 2019	Published
23 (I)	Conference Paper	Computing and network virtualization at the edge for 5G smart cities neutral host infrastructures	Michele Paolino, Gino Carrozzo, August Betzler, Carlos Colman-Meixner, Hamzeh Khalili,Shuaib Siddiquix, Teodora Sechkova, and Dimitra Simeonidou.+	2019 IEEE 5G World Forum (5GWF), Sept 30 - Oct 2 2019, Dresden, Germany	Published
24 (I)	Conference Paper	Definition and Evaluation of Latency in 5G: A Framework Approach	Xuan Du, Gino Carrozzo, Bessem Sayadi, Fotis Lazarakis, M.S. Siddiqui, Oscar Carrasco, Michail Alexandros Kourtis, Janez Sterle, Roberto Bruschi,	2019 IEEE 5G World Forum (5GWF), Sept 30 - Oct 2 2019, Dresden, Germany	Published
25 (S)	Journal paper	On 5G network slice modelling: Service-, resource-, or deployment-driven?	Apostolos Papageorgiou Adriana Fernández-Fernández Shuaib Siddiqui Gino Carrozzo	Elsevier Computer Communications Journal	Published
26 (S)	Conference Paper	Enhancing the performance of 5G slicing operations via multi-tier orchestration	Miquel Puig Mena, Apostolos Papageorgiou, Leonardo Ochoa-Aday,	23rd Conference on Innovation in Clouds, Internet and Networks (ICIN 2020)	Published

# (Scientific, Industry)	Type	Title	Authors	Conference	Status
			Shuaib Siddiqui, Gabriele Baldoni		
27 (S)	Conference Paper	SLA Management Procedures in 5G Slicing-based Systems.	Apostolos Papageorgiou, Adriana Fernández-Fernández, Leonardo Ochoa-Aday, Miguel Silva Peláez, Shuaib Siddiqui	European Conference on Networks and Communications 2020 (EuCNC '20)	Submitted
28 (S)	Journal paper	REPEL: A Strategic Approach for Defending 5G Control Plane from DDoS Signalling Attacks	Renato Souza Silva Carlos Colman Meixner Rafael Guimaraes Borja Otura Garcia Thierno Diallo Magnos Martinello Luis Felipe Magalhães de Moraes Reza Nejabati Dimitra Simeonidou	IEEE Transactions on Network and Service Management (IEEE TNSM)	Submitted
29 (I)	White Paper	Enabling a new business with 5G Neutral Hosting: the 5GCity Architecture	Antonino Albanese Maria Rita Spada Michele Paolino Gino Carrozzo Apostolos Papageorgiou Ioannis Neokosmidis Carlos Colman Meixner	5GCity Online April 2020	Published
30 (S)	Conference paper	Business Aspects of the Neutral Host Model: The Immersive Video Services Case	Ioannis NEOKOSMIDIS, Vangelis LOGOTHETIS, Theodoros ROKKAS, Luca VIGNAROLI, Davide DESIRELLO, Antonino ALBANESE, Viscardo COSTA, Mariano LAMARCA, Maria Rita SPADA, Muhammad Shuaib SIDDQUI and Carlos COLMAN-MEIXNER	5TH WORKSHOP ON "5G – PUTTING INTELLIGENCE TO THE NETWORK EDGE" (5G-PINE 2020 within the 16th International Conference on Artificial Intelligence Applications and Innovations (AIAI 2020) conference) Halkidiki, Greece, June 5-7, 2020	Accepted
31 (S)	Journal paper	Neutral Host Business Model and Techno Economics Analysis	Ioannis Neokosmidis Carlos Colman Meixner Theodoros Rokkas David Pujals, Rita Spada, Aitor Rubio Elguea Viscardo Costa Antonino Albanese Luca Vignarorli Davide Desiderio Dimitra Simeonidou	Elsevier Journal Journal of Network and Computer Applications	To be Submitted

# (Scientific, Industry)	Type	Title	Authors	Conference	Status
32 (S)	Journal paper	Validating a 5G-Enabled Neutral Host Framework in City-Wide Deployments.	Carlos Colman Meixner Adriana Fernandez, Leonardo Ochoa, August Betzler, Shuaib Siddiqui, Gino Garrozo, Sergi Figuerola, Reza Nejabati, Dimitra Simeonidou	Elsevier Journal Journal of Network and Computer Applications	To be Submitted

Table 1 – Scientific publication during project M01-M34

2.2. Participation to Talks/Panels/Webinars/Workshops

Regarding event participation during the whole project duration, the Consortium has been actively involved and represented 5GCity in many highly relevant events for the scientific and industry sector. Between 2017, 2018 and 2019, the Consortium has presented the project in **47 important and well-known events.** In 2020, **2 programmed events were cancelled, forced by COVID-19 outbreak.** Partners had the possibility to participate with 5GCity presentations, keynotes, panel discussions on UCs deployments, videos, booths and showcases (both outdoor and indoor).

The complete list of events that had seen 5GCity participation, it is been reported in Table 3 which is summarized by year as follows:
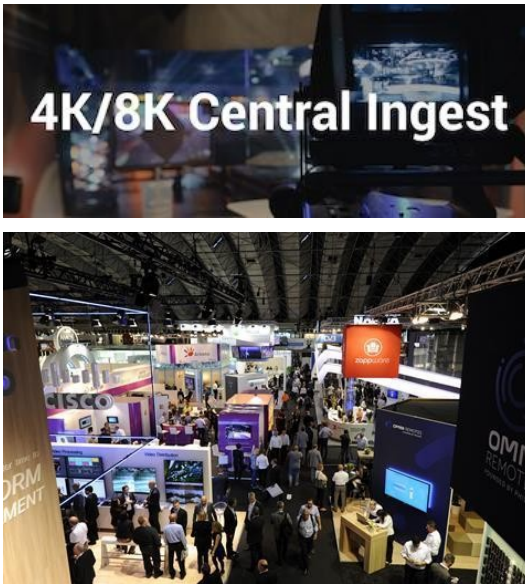
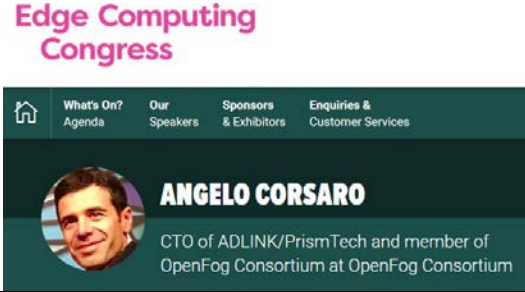| Event Type	Events # 2017	Events # 2018	Events # 2019	Events # 2020
(I)Industry	5	11	7	1
(S) Scientific	3	11	5	1
(EU)EU Event	1	2	2	

Table 2 – Summary of Events with 5GCity participation

2017			
	Title	**"A distributed cloud & radio platform for 5G neutral hosts"**	
1	Type	Invited talk	
	Speaker/ Attendees	Sergi Figuerola - i2Cat	
	Event (EU)	EUCNC-17	
	Date	12-15 June 2017	
	Place	Oulu, Finland	
	Link	https://www.eucnc.eu/2017/www.eucnc.eu	
	Documents	https://5g-ppp.eu/eucnc-2017-oulu-presentations/ https://5g-ppp.eu/wp-content/uploads/2017/06/5GCity_5G PPP_P2_EuCNC.pdf	
	Title	**'5G CITY & A NEW GREEN BROADCASTING'**	

2	Type	5G Dedicated Session and speaking slot during the event, media promotion, 5GCity logo/brand visibility, social promotion, dissemination	
	Speaker/ Attendees	Antonio Morello – RAI, Gino Alberico – RAI, Andrea Michelozzi – CoDi	
	Event (I)	14th European Digital Forum	
	Date	15-16 June 2017	
	Place	Lucca, Italy	
	Link	www.comunicaredigitale.it/en	
	Documents	www.comunicaredigitale.it/en/agenda-lucca-2017/ https://www.panoramaaudiovisual.com/2017/06/16/el-forum-digital-europeo-analiza-los-desafios-del-contenido-y-su-distribucion-en-un-nuevo-entorno/	
3	**Title**	**5GCity Project presentation**	
	Type	MOG Exhibition booth 5GCity project presentation	
	Speaker/ Attendees	MOG´s team	
	Event (I)	IBC 2017	
	Date	15-19 Sept. 2017	
	Place	Amsterdam, UK	
	Link	https://show.ibc.org	
	Documents	https://ibc17.mapyourshow.com/7_0/exhibitor/exhibitor-details.cfm?ExhID=3827	
4	**Title**	**"Open FogUpdate–Fog computing to solve advanced IoT deployment challenges"**	
	Type	Invited Talk	
	Speaker/ Attendees	Angelo Corsaro - ADLINK Tech.	
	Event (S)	Edge Computing Congress	
	Date	26 Sept 2017	
	Place	Berlin, Germany	
	Link	https://tmt.knect365.com/edge-computing-congress/	
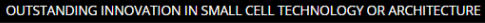
	Documents	https://tmt.knect365.com/meccongress/speakers/angelo-corsaro	
5	**Title**	**"5G Y LA NUEVA FRONTERA AUDIOVISUAL Y MULTIMEDIA. 5GMEDIA Y 5GCITY, ADELANTÁNDOSE AL FUTURO"**	
	Type	Keynote project presentation and Panel discussion	
	Speaker/ Attendees	Shuaib Siddiqui – i2CAT, Andrea Michelozzi – CoDi, Javier Marcos – Retevision (Cellnex)	
	Event (I)	BIT Experience 2017	
	Date	04-05 Oct 2017	
	Place	Madrid, Spain	
	Link	http://www.ifema.es/bitexperience_01/	
	Documents	http://www.ifema.es/bitexperience_06/Prensa/NotasdePrensa/INS_094523_0 https://youtu.be/ERMaSFdrhjs	
6	**Title**	**"The Global Internet of the Future"**	
	Type	Invited speech Ubiwhere's current and future R&I during conference	
	Speaker/ Attendees	Pedro Diogo – Ubiwhere	
	Event (S)	Visions for Future Communications Summit	
	Date	23-24 Oct 2017	
	Place	Lisbon, Portugal	
	Link	https://futurecomresearch.eu	
	Documents	n/a	
7	**Title**	**"The Making of Fog Computing"**	
	Type	Keynote	
	Speaker/ Attendees	Angelo Corsaro - Adlink Tech.	
	Event (I)	Industrial IoT Forum 2017	
	Date	8 Nov 2017	
	Place	Berlin, Germany	
	Link	https://www.fokus.fraunhofer.de/en/fokus/events/iiot-forum	

	Documents	https://www.fokus.fraunhofer.de/iiot-forum/speaker/corsaro	
8	**Title**	**5GCity Presentation**	
	Type	5GCity presentation at IMI booth	Sergi Figuerola (I2CAT) about 5GCITY
	Speaker/ Attendees	Sergi Figuerola – i2Cat, Laura Vidal – IMI, Antonio Garcia – Accelleran, Gabriele Piscitelly - Accelleran	
	Event (I)	SMARTCITY Expo World Congress	
	Date	14-16 Nov 2017	
	Place	Barcelona, Spain	
	Link	http://www.smartcityexpo.com/en/	
	Documents	Figuerola interview: https://youtu.be/UlYT-OHsMOk	
9	**Title**	**5GCity partner Adlink: speech**	
	Type	Invited speech	
	Speaker/ Attendees	Gabriele Baldoni - Adlink	
	Event (I)	Huawei Global Mobile Broadband Forum 2017	
	Date	15-16 Nov 2017	
	Place	London, UK	
	Link	https://www.huawei.com/minisite/hwmbbf17/en/	
	Documents	http://www.huawei.com/minisite/hwmbbf17/assert_4/files/MBB_Invitation_letter_en.p df	
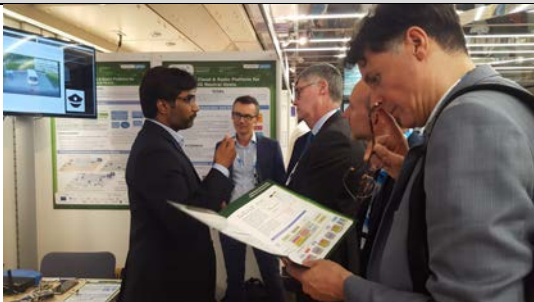
<table>
<tr><td colspan="3" align="center">**2018**</td></tr>
<tr><td rowspan="9">**10**</td><td>**Title**</td><td>**5GCity partners Accelleran, Cellnex, Italtel, i2Cat: promotion, flyers & roll-up at MWC'18**</td></tr>
<tr><td>Type</td><td>Accelleran booth at Belgium Pavilion 7G71, 5GCity demos on neutral host, virtualization, MEC on live 3.5GHz commercial spectrum and cabled 2.6GHz with Small Cells and smartphones Accelleran showed operating 3.5GHz Small Cell in IMI lampost with MEC video server and 3.5GHz smartphone (Belgium Pavilion) At Cellnext booth showcase project slides, dissemination material.</td></tr>
<tr><td>Speaker/ Attendees</td><td>Antonio Garcia – Accelleran, Trevor Moore – Accelleran, David Pujals - Cellnex Telecom, Javier Marcos -Cellnex Telecom Interview Domenico Favuzzi - Italtel</td></tr>
<tr><td>Event (I)</td><td>MWC'18</td></tr>
<tr><td>Date</td><td>27 Feb. - 1 Mar. 2018</td></tr>
<tr><td>Place</td><td>Barcelona, Spain</td></tr>
<tr><td>Link</td><td>www.mobileworldcongress.com</td></tr>
<tr><td>Documents</td><td>Footage of Barcelona TV (betevé) coverage in the evening news Friday 02/03/2018: http://beteve.cat/5GCity-fanals-antenes- telefonia-prova-pilot/ Italtel - https://youtu.be/IH021SEpjHw</td></tr>
<tr><td rowspan="8">**11**</td><td>**Title**</td><td>**"Use Cases for Smart Cities to improve the 5G ecosystem using a strong partnership between industrial and research area"**</td></tr>
<tr><td>Type</td><td>Keynote</td></tr>
<tr><td>Speaker/ Attendees</td><td>Maria Rita Spada – Wind Tre</td></tr>
<tr><td>Event (S)</td><td>IEEE 5G SUMMIT, Trento Italy</td></tr>
<tr><td>Date</td><td>6 Mar. 2018</td></tr>
<tr><td>Place</td><td>Trento, Italy</td></tr>
<tr><td>Link</td><td>http://www.5gsummit.org/trento/</td></tr>
<tr><td>Documents</td><td>https://www.5GCity.eu/wp-content/uploads/2018/04/Trento-IEEE-2018.pdf</td></tr>
<tr><td></td><td>**Title**</td><td>**"Toward 5G from research and market opportunities"**</td></tr>
<tr><td></td><td>Type</td><td>Keynote</td></tr>
</table>

12	Speaker/ Attendees	Paolo Comi - Italtel	
	Event (S)	IEEE 5G SUMMIT, Trento Italy	
	Date	6 Mar. 2018	
	Place	Trento, Italy	
	Link	http://www.5gsummit.org/trento/	
	Documents	http://www.italtel.com/towards-5g-from-research-and-market-opportunities/ https://www.5GCity.eu/2018/03/21/towards-5g-from-research-and-market-opportunities/	
13	**Title**	**"Italia 5G: 5G opportunità di sviluppo cooperativo"**	
	Type	Moderation, Keynote Sessions and Roundtable	
	Speaker/ Attendees	Andrea Michelozzi – CODI - Session organization & moderation Presentations: Rita Spada - Wind Tre: La fine del Digital divide. I piani dell'industria Gino Alberico - RAI: 5G, Città e Nuovi servizi Media Mauro di Bugno - Comune di Lucca: Il 5G come Sviluppo delle Città del 2020 Gino Carrozzo – Nextworks: 5G: L'Industria e la Città	
	Event (I)	IOTHINGS MILAN	
	Date	10-11 April 2018	
	Place	Milan, Italy	
	Link	http://www.iothingsmilan.com	
	Documents	http://www.iothingsmilan.com/programma-2018/#italia5g Alberico- Rai: https://www.5GCity.eu/project-material/ Spada – Wind Tre: https://www.5GCity.eu/wp-content/uploads/2018/04/Mise-5g-Eng_Draft_5G_CITY_Milano_20180410_Final.pdf Carrozzo- Nextworks/Gino Alberico-RAI: https://www.5GCity.eu/project-material/	
	Title	**"Neutral Host/Edge Small Cell live demos using US CBRS regulatory shared spectrum access system"**	
	Type	Live demos and discussions on neutral host use case	
	Speaker/ Attendees	Antonio Garcia – XLRN , Frederic van Durme - XLRN	

14	Event (S)	CBRS Alliance Annual Member´s meeting	
	Date	8-10 May 2018	
	Place	Washington, USA	
	Link	https://www.cbrsalliance.org	
	Documents	http://www.accelleran.com/accelleran- federatedwireless-athonet-end-to-end/	
15	**Title**	**"Neutral Host/Edge Small Cell live demos with real-time L3 switching between server and small cell"**	
	Type	Live demos and discussions on neutral host use case. Accelleran awarded SCF "Outstanding Innovation in Small Cell Technology Architecture or Technology" in SCF Awards 2018	
	Speaker/ Attendees	Antonio Garcia – XLRN, Frederic van Durme – XLRN, Trevor Moore – XLRN, Jeff Land – XLRN	
	Event (S)	Small Cell World Summit 2018 / Small Cell Forum Plenary	
	Date	22-24 May 2018	
	Place	London, UK	
	Link	http://www.scwsworld.com https://www.smallcellforum.org/events/ awards-2018/winners-2018/	
	Documents	Accelleran won Small Cell Forum Award in the category "Outstanding innovation in small cell technology or architecture" for their "Accelleran Carrier and mission-critical grade architecture-agnostic small cell RAN- vRAN software solutions" See http://www.accelleran.com/accelleran-scf-award-winner/	
	Title	**"5G –Putting Intelligence to the Network Edge"**	
	Type	Workshop	
	Speaker/ Attendees	inCITES	
	Event (S)	AIAI 2018	
	Date	25-27 May 2018	
	Place	Rhodes, Greece	
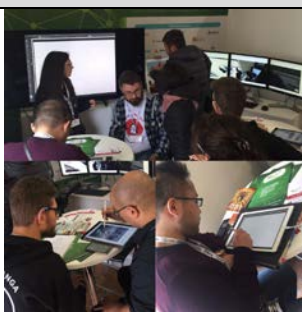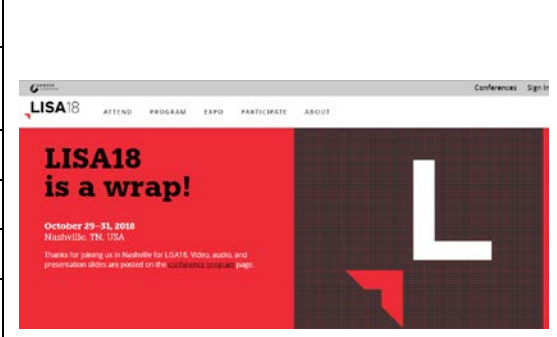
16	Link	http://easyconferences.eu/aiai2018/	
	Documents	n/a	
17	**Title**	**"5G – Enabled Architecture on City Infrastructure for UHD and Immersive Media Production and Broadcasting"** **"Virtualized Infrastructure Managers for edge computing: OpenVIM and OpenStack comparison"**	
	Type	5GCity paper presentation	
	Speaker/ Attendees	Partners	
	Event (S)	IEEE Broadband Multimedia Systems and Broadcasting (BMSB)	
	Date	06-08 June 2018	
	Place	Valencia, Spain	
	Link	https://www.mcg.upv.es/en/bmsb2018/	
	Documents	https://ieeexplore.ieee.org/abstract/document/8671464/authors#authors	
18	**Title**	**Interop-18**	
	Type	, 5GCity demos and dissemination material	
	Speaker/ Attendees	VOSYS	
	Event (I)	Interop 2018	
	Date	13-15 June 2018	
	Place	Tokyo, Japan	
	Link	https://archive.interop.jp/2018/en/	
	Documents	n/a	
	Title	**"5GMedia and Industry"**	
	Type	Booth, panel, dissemination material	

19	Speaker/ Attendees	RAI in 5G panel for Media; Booth: Comune di Lucca, Comunicare Digitale, RAI, Nextworks	
	Event (I)	15th European Digital Forum	
	Date	14-15 June 2018	
	Place	Lucca – Italy	
	Link	https://www.forumeuropeo.tv/agenda-lucca-2018/	
	Documents	n/a	
20	**Title**	**EUCNC 2018**	
	Type	5GCity 3 demos at booth: •Neutral Hosting; •Guest Optimization in 5GCity (Unikraft); •5GCity far-Edge Orchestrator & VIM (fog05) 5GCity in workshops within EUCNC: •WS1: Vertical Industries & Services for 5G (VIS5G); •WS3 Multi-provider, multi-vendor, multi- player orchestration: from distributed cloud to edge and fog environments in 5G; •WS4 2nd Workshop on business models and techno-economic analysis for 5G networks; •WS6 5th International Workshop on programmable networks: Demystifying software networks for Vertical Industries; •WS8: Next generation network systems security	
	Speaker/ Attendees	All Partners	
	Event (EU)	EUCNC 2018	
	Date	18-21 June 2018	
	Place	Ljubljana Slovenia	
	Link	https://www.eucnc.eu/2018/www.eucnc.eu/general-programme/index.html	
	Documents	G.Carrozzo: https://www.5gcity.eu/wp-content/uploads/2018/09/EUCNC2018-WS1-5GCity-v1.0.pdf S.Siddiqui: https://www.5gcity.eu/wp-content/uploads/2018/09/5GCity_EdgeComputingWS_EuCNC-2018.pdf	

		Title	"3rd Cloudification of the Internet of Things Conference"	
21		Type	Presentation of Accepted Paper, title: fog05: Unifying the computing, networking and storage fabrics end-to-end.	
		Speaker/ Attendees	Angelo Corsaro, Gabriele Baldoni. ADLINK Technologies, France	
		Event (S)	IEEE ComSoc Conference	
		Date	2-4 July 2018	
		Place	Paris, France	
		Link	www.ciot-conference.org/	
		Documents	n/a	
22		Title	IBC 2018	
		Type	Presentation, Demo, Dissemination material	
		Speaker/ Attendees	MOG, Cellnex	
		Event (I)	IBC 2018	
		Date	13 - 17 Sept 2018	
		Place	Amsterdam, Holand	
		Link	www.ibc.org	
		Documents	n/a	
23		Title	"Il 5G come sviluppo delle città del2020"	
		Type	5GCity Presentation	
		Speaker/ Attendees	Mauro Di Bugno (Comune di Lucca)	
		Event (I)	LuBec 2018	
		Date	4 Oct. 2018	
		Place	Lucca	
		Link	https://www.lubec.it/eventi/3150-2	
		Documents	https://www.5gcity.eu/wp-content/uploads/2018/10/LuBec-4ott2018_5GCity.pdf https://www.5gcity.eu/2018/10/06/5gcity-takes-part-in-the-lubec-2018/	
24		Title	SDN NFV World Congress 2018	
		Type	5GCity Presentation: Neutral Hosting for 5G Infrastructures: Concept & Challenges	
		Speaker/ Attendees	Muhammad Shuaib Siddiqui	
		Event (I)	SDN NFV World Congress 2018	

		Date	10 Oct. 2018	
		Place	The Hague	
		Link	https://events.layer123.com/	
		Documents	https://www.layer123.com/sdn-webcast-mle123	
25	Title		**"Towards 5G Enabled Gigabit Society"**	
	Type		Presentation	
	Speaker/ Attendees		Mariano Lamarca Barcelona City Council	
	Event (S)		ITU Events	
	Date		11-12 Oct. 2018	
	Place		Athens, Greece	
	Link		https://www.itu.int/en/ITU-D/Regional-Presence/Europe/Pages/Events/2018/5G Forum/Towards_5G_Enabled_Gigabit_Society.aspx	
	Documents		n/a	
26	Title		**IoT Solutions World Congress 2018**	
	Type		Demo/Dissemination material	
	Speaker/ Attendees		VOSYS	
	Event (I)		IoT Solutions World Congress	
	Date		16-18 Oct 2018	
	Place		Barcelona, Spain	
	Link		www.iotsworldcongress.com	
	Documents		vosysiot_IOTWC2018.pdf	
27	Title		**"From Handcraft to Unikraft: Simpler Unikernelization of Your Application"**	
	Type		Talk	
	Speaker/ Attendees		Florian Schmidt- NEC	
	Event (S)		Open Source Summit Europe 2018	
	Date		21 Oct. 2018	
	Place		Edinburg	
	Link		https://osseu18.sched.com/event/FxXZ/from-handcraft-to-unikraft-simpler-unikernelization-of-your-application-florian-schmidt-nec-labs-europe	
	Documents		https://www.slideshare.net/xen_com_mgr/osseu18-from-handcraft-to-unikraft-simpler-unikernelization-of-your-	

		application-florian-schmidt-nec-labs-europe	
28	Title	**Lucca Comics and Games 2018**	
	Type	Booth, Demos, Dissemination material, Presentation	
	Speaker/ Attendees	Comune di Lucca, Rai, Nextworks, Italtel, Wind Tre, Comunicare Digitale	
	Event (I)	Lucca Comics & Games 2018	
	Date	29 Oct. - 4 Nov. 2018	
	Place	Lucca, Italy	
	Link	https://www.luccacomicsandgames.com /it/2018/home/	
	Documents	https://www.youtube.com/watch?v=Q6 APMin2lC0 https://www.5gcity.eu/2018/10/31/rai-a-lucca-comics-games-2018-il-progetto-5gcity/	
29	Title	**"Unikraft: Unikernels Made Easy"**	
	Type	Talk	
	Speaker/ Attendees	Simon Kuenzer	
	Event (S)	LISA 2018	
	Date	30 Oct. 2018	
	Place	Nashville	
	Link	https://www.usenix.org/conference/lisa 18/presentation/kuenzer	
	Documents	https://www.usenix.org/conference/lisa 18/presentation/kuenzer	
30	Title	**SCWEC**	
	Type	5GCity Side Event - Presentations/Demo/Dissemination material	
	Speaker/ Attendees	5GCity partner moderation in a dedicated session The Next Level of Connectivity for Industries and Society; in the Digital Transformation. 5GCity consortium was also involved in the organization and implementation of the 5GCity Side Event, with the 5G Smart City Vertical Use Case Awards. IMI/i2Cat/Accelleran showed Barcelona radome operating live with i2cat WiFi APs and Accelleran 3.5GHz LTE Small Cells in Orange spectrum at City of Barcelona Booth	
	Event (I)	SmartCity Expo World Congress 2018	
	Date	13 Nov 2018	

	Place	Barcelona, Spain	
	Link	http://www.smartcityexpo.com/en/home	
	Documents	https://www.5gcity.eu/2018/12/11/2069/	
31	**Title**	**20th Infocom World 2018**	
	Type	Presentation of 5GCity Neutral Host business model and the related regulatory considerations. Workshop on H2020	
	Speaker/ Attendees	inCITES	
	Event (I)	Infocom World Media	
	Date	21 Nov 2018	
	Place	Athens, Greece	
	Link	https://infocomworld.gr	
	Documents	n/a	
32	**Title**	**ICT 2018: Imagine Digital - Connect Europe**	
	Type	5GCity Booth Presentations/Demo/ Dissemination material. 5GCity showed-case its Neutral Hosting platform targeting city edge infrastructures. Demos were performed: • 5GCity Neutral Hosting (Multi-tenancy) • 5GCity Guest Optimization • 5GCity Edge Orchestrator and IoT VIM.	
	Speaker/ Attendees	All Partners	
	Event (EU)	ICT 2018	
	Date	4-6 Dic. 2018	
	Place	Vienna, Austria	
	Link	https://ec.europa.eu/digital-single-market/en/events/ict-2018-imagine-digital-connect-europe	
	Documents	https://www.5gcity.eu/2018/12/11/ict-vienna-2018/ https://ec.europa.eu/digital-single-market/en/events/ict-2018-im	
33	**Title**	**"Unikraft: Unikernels for Dummies" "Unikraft: Unikernels Made Easy"**	
	Type	Keynote	
	Speaker/ Attendees	Felipe Huici, Simon Kuenzer	
	Event (S)	IEEE UCC 2018	
	Date	18 Dic. 2018	

		Place	Zurich	
		Link	http://www.wikicfp.com/cfp/servlet/event.showcfp?eventid=73148copyownerid=63751	
		Documents	http://sysml.neclab.eu/projects/unikraft/papers/	

		2019		
34	Title		**The European 5G Conference**	
	Type	Dissemination and networking activities		
	Speaker/ Attendees	Comunicare Digitale		
	Event (EU)	The European 5G Conference		
	Date	22-23 Jan 2019		
	Place	Brussels, Belgium		
	Link	https://eu-ems.com/summary.asp?event_id=4388&page_id=9862		
	Documents	n/a		
35	Title		**"Unikraft: Unikernels Made Easy"**	
	Type	Talk		
	Speaker/ Attendees	Simon Kuenzer		
	Event (S)	FOSDEM 2019		
	Date	2 Feb 2019		
	Place	Brussels		
	Link	https://fosdem.org/2019/schedule/speaker/simon_kuenzer/		
	Documents	https://archive.fosdem.org/2019/schedule/event/unikraft_made_easy/		
36	Title		**MWC 2019**	
	Type	Presentation, Dissemination material, Business Questionnaire Demos: -Neutral host for 5G infrastructure concept along with the current status of the project. - Neutral Hosting solution with media related use cases: Video Acquisition & Production. – 5GCity showroom radome with Accelleran Small Cell operating in live 3.5GHz spectrum and i2cat APs with extreme edge video streaming		
	Speaker/ Attendees	ALL partners		
	Event (I)	MWC 2019		

	Date	25-28 Feb 2019	
	Place	Barcelona, Spain	
	Link	www.mwcbarcelona.com/	
	Documents	www.5gcity.eu/wp-content/uploads/2019/02/MWC2019-5GCity-final-version_SSv3.pdf https://www.5gcity.eu/wp-content/uploads/2019/03/Neutral-Host-Survey.pdf	
37	**Title**	NAB Show	
	Type	Demonstration of new solutions based on the video decentralized production UC	
	Speaker/ Attendees	MOG	
	Event (I)	NAB Show	
	Date	6-11 April 2019	
	Place	Las Vegas, US	
	Link	www.nabshow.com	
	Documents	n/a	
38	**Title**	**PANEL UNIVERSIDADES Y PROYECTOS 5G**	
	Type	Presentation	
	Speaker/ Attendees	Shuaib Siddiqui	
	Event (I)	5GForum	
	Date	24-25 April 2019	
	Place	Malaga, Spain	
	Link	https://www.5gforum.es/en/ https://www.5gforum.es/web/wp-content/uploads/2019/04/5G_AGENDA-2019_006_web.pdf	
	Documents	n/a	
	Title	**"CNERT: Computer and Networking Experimental Research using Testbeds"**	
	Type	Workshop about testbeds	
	Speaker/ Attendees	Bristol University	
	Event (S)	IEEE Internal Conference on Computer Communication	

39	Date	29 April- 2 May 2019	
	Place	Paris, France	
	Link	http://infocom2019.ieee-infocom.org/cnert-computer-and-networking-experimental-research-using-testbeds	
	Documents	https://infocom2019.ieee-infocom.org/cnert-computer-and-networking-experimental-research-using-testbeds-program	
40	**Title**	**Panel "5G & PRODUCTION"**	
	Type	5GCITY Booth, video & outdoor Life demo, panel participation, dissemination material, meetings	
	Speaker/ Attendees	Italian Partners	
	Event (I)	16th European Digital Forum	
	Date	6-7 June 2019	
	Place	Lucca, Italy	
	Link	https://www.forumeuropeo.tv/wp-content/uploads/2019/05/Lucca-2019-Programma.pdf	
	Documents	https://www.5gcity.eu/2019/07/30/5gcity-transforming-cities-into-5g-neutral-hosts-5g-live-broadcasting-a-reality/	
41	**Title**	**EUCNC 2019**	
	Type	2 papers accepted; Presentations in a special session; Business Model Workshop presentation; Presentation in Software Networks WG workshop: "Path to 5G smart cities: experiences from media and public safety pilots in 5GCity", Gino Carrozzo (Nextworks) Shuaib Siddiqui (I2CAT); Dissemination material; Indoor booth. Demos: 5GCity SDK + Platform Mobile backpack video transmission (beteve); Video Acquisition and Production (MOG); 5 mobile handsets number of cores at the edge; Augmented Reality service (Rai)	
	Speaker/ Attendees	ALL Partners	
	Event (EU)	EUCNC 2019	
	Date	18-21 June 2019	
	Place	Valencia, Spain	
	Link	https://www.eucnc.eu/	

	Documents	https://www.5gcity.eu/2019/07/10/transforming-cities-into-5g-neutral-hosts/ 5GPPP video: https://youtu.be/Z1OgPH0vOEo Live streaming: https://youtu.be/HnR5CLgH0_o	
42	**Title**	**I 5GCity Hackathon**	
	Type	Use and hack 5GCity slices Structure: 5GCity tutorial (platform+dashboard+sdk) Demonstrate 1 5GCity use case on SDK launch your service design session /module implementation (e.g. monitoring exporters) Participants: students	
	Speaker/ Attendees	All Partners	
	Event (S)	1st 5GCity Hackathon	
	Date	9-12 July 2019	
	Place	Bristol, UK	
	Link	https://osm.etsi.org/wikipub/index.php/5th_OSM_Hackfest#OSM_Hackfest_Sessions	
	Documents	https://www.5gcity.eu/2019/07/30/1st-5gcity-hackathon-in-bristol-hack-the-5g-city-new-smart-apps-in-5gcity-slices/	
43	**Title**	**IBC2019**	
	Type	Presentation, Demo, Dissemination material	
	Speaker/ Attendees	Partners	
	Event (I)	IBC 2019	
	Date	12-17 Sept 2019	
	Place	Amsterdam, Holland	
	Link	https://show.ibc.org/	
	Documents	n/a	
44	**Title**	**"Assessment of CAPEX and OPEX for Media Services in Cloud Enabled 5G Networks"**	
	Type	Session 6: Techno-economics for smart cities presentation	

	Speaker/Attendees	Ioannis Neokosmidis – InCites	
	Event (I)	**10th CTTE- 58th FITCE Congress- Smart Cities & ICT**	
	Date	26-27 Sept. 2019	
	Place	Ghent, Belgium	
	Link	https://cttefitce2019.eu/programme/day3/congress	
	Documents	n/a	
45	Title	**"La implantación de las redes 5G en el territorio"**	
	Type	Event about 5G net deployment in Spain. Presentation of Spanish 5G net deployment; results and outcomes elaborated from the study by Instituto Cerdà in collaboration with 5GCity.	
	Speaker/Attendees	Cellnex	
	Event (S)	COIT-Colegio de Ingenieros de Telecomunicaciones	
	Date	10 Oct. 2019	
	Place	Madrid	
	Link	https://www.coit.es/eventos/save-day-la-implantacion-de-las-redes-5g-en-el-territorio	
	Documents	n/a	
46	Title	**IoT Solution World Congress 2019**	
	Type	Demo/Dissemination material	
	Speaker/Attendees	Partners	
	Event (I)	IoT Industry, Policy Makers, Regulators, Regional and International Organizations, Private Sector, Press	
	Date	29-31 Oct 2019	
	Place	Barcelona, Spain	
	Link	https://www.iotsworldcongress.com/	
	Documents	n/a	
47	Title	**OSM Hackfest-II 5GCity Hackathon Parallel hackathons from OSM and 5GCity**	
	Type	OSM Hackfests co-located with OSM Plenary and mid-release meetings. OSM traditional scope 5GCity scope: tutorial (platform+dashboard+sdk); Demonstration of 1 5GCity use case on SDK;	

		Launch your service design session /module implementation (e.g. monitoring exporters)	
	Speaker/ Attendees	Partners	
	Event (S)	industrial community around 5G students	
	Date	18-22 Nov. 2019	
	Place	Lucca, Italy	
	Link	https://osm.etsi.org/wikipub/index.php/5th_OSM_Hackfest#OSM_Hackfest_Sessions	
	Documents	https://www.5gcity.eu/2019/11/27/2nd-5gcity-hackathon-in-lucca/ https://www.5gcity.eu/wp-content/uploads/2019/11/5GCity-Webinar.pdf	

2020			
48	Title	**MWC2020**	
	Type	Video with project's technical developments under the 5GCity hood to achieve Neutral Hosting, infra deployments in three cities, and an example of a UC validation and KPI measurements to be played in the loop at multiple booths at MobileWorldCapital, i2CAT booths Flyer at MobileWorldCapital, i2CAT, 5GPPP booths, Roll-up	
	Speaker/ Attendees	All partners	
	Event (I)	Telco industry, Policy Makers, Regulators, Regional and International Organizations, Private Sector, Non-Governmental Organizations and Academia, Press.	
	Date	24-27 Feb 2020	EVENT CANCELED because COVID-19 outbreak
	Place	Barcelona	
	Link	www.mwcbarcelona.com/	
	Documents	https://www.5gcity.eu/ https://youtu.be/Ow2abOajD-4	
49	Title	**Cellnex Connectivity Days**	
	Type	5GCity Workshop	
	Speaker/ Attendees	Dimitra Simeonidou (UniBristol) Sergi Figuerola (i2CAT- 5G Barcelona) Gino Carrozzo (Nextworks) Shuaib Siddiqui (i2CAT)	

	Oscar Pallarols (Cellnex Telecom) Francesco Raspini (Lucca City Hall)	
Event (I)	Cellnex Connectivity Days 5GCity	
Date	26 March 2020	
Place	Bristol	
Link		
Documents		EVENT CANCELED because COVID-19 outbreak

Table 3 – Participation to events during M1-M34 and Outcomes

Despites all the preparations, the cancelation of the MWC20 and Cellnex Connectivity Day Workshop due to COVID-19 outbreak were a missing opportunity for 5GCity project to show its final results, dissemination material, live Barcelona and Bristol street demos during these planned events.

For the MWC2020, 5GCity partners produced a brand new video "5GCity ICT- Infrastructure Business Model for 5G Networks", that has been published and disseminated in 5GCity website and social channels.

In each event, 5GCity updated and improved dissemination material such as: rollups, flyers, brochures, posters and videos.

Figure 1 – 5GCity Video
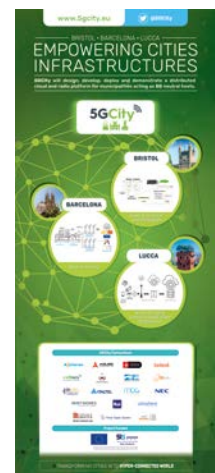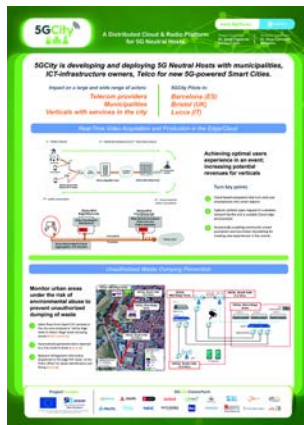
Figure 2 - 5GCity Dissemination Material

2.3. Demonstrations

As reported in previous deliverables, the Consortium has leveraged on the interim releases of the platform software and carried out demonstrations related with the 5GCity enabling technologies in different events throughout the project. Again the "force majeure" cancelation of MWC20, has deprived the project with the opportunity to show case its last results.

These showcases have been held primarily by collaborations of partners, leveraging on relevant background evolved in 5GCity. Following a list of all technical demo activities showcase in various event during the project. Demos are divided by PoCs and descriptions:

Pilots and proof of concepts (PoCs)	Event
(i) Neutral host pilot (telecom pilot)	• ICT 2018 • MWC2019 • European Digital Forum 2019 • EUCNC2019
(ii) Mobile backpack media unit (media pilot)	• EUCNC2019 • ~~MWC2020~~
(iii) UHD video distribution (media pilot)	• Lucca Comics and Games 2018 • ICT 2018 • European Digital Forum 2019 • EUCNC2019
(iv) Video acquisition and edge/cloud production (media pilot)	• IBC 2018 • SCWEC 2018 • ICT 2018 • MWC2019 • European Digital Forum 2019 • EUCNC2019 • ~~MWC2020~~
(v) Unauthorized waste dumping prevention (smart city pilot)	• ICT 2018
(vi) MEC Orchestrator & VIM IoT	• ICT 2018
(vii) Mock-up Lamp post	• ICT 2018 • MWC2019 • ~~MWC2020~~
Demo description	**Event**
o Demonstration of 5GCity UC3 (Video acquisition and production)	**IBC 2018**
o Demonstration of 5GCity UC4 (UHD Video Distribution - immersive services) o Demonstration of Edge video services at Barcelona city deployment using a random operating live with WiFi and 3.5GHz LTE Small Cell.	**Lucca Comics and Games 2018** **SCWEC 2018**
o **5GCity Neutral Hosting**: neutral host platform that enables an ICT infrastructure owner to slice and lease its infrastructure to 3rd party, such as virtual operators, which can rapidly deploy NFV-based services on the assigned slice. o **5GCity Illegal waste dumping detection**: to shows how 5G will help keeping a city clean and pleasant. It is focused on video surveillance of urban areas to prevent unauthorized dumping of waste materials by running video analytics at the edge for incident detection and alarm trigger. o **360° Video & Immersive Video Services Distribution**: to unleash immersive experiences with distribution of UHD contents for city services. It leverages on the low latency and ultra-high bandwidth promises of 5G, to offer immersive experience to end-user (e.g., tourists) to see in real-time a reconstruction of antique city buildings and towers enriching the real vision with holographic models.	**ICT 2018**

o 5G**City MEC Orchestrator & VIM IoT**: it shows the integration between NFV and MEC allowing the cities to exploit the computational power of small devices and enabling new kind of services. It uses 5GCity Multi-Tier Orchestrator to deploy a couple of ME Apps, the first one to provide a RNIS (Radio Network Information Service) that can be used by other ME Apps in the same ME Platform, the second to leverage this RNIS service to provide a dashboard that show RNIS data. o **Video Acquisition & Production**: it aims to engage the public in the media production for an event. The demo shows a mobile application capable of acquiring high-quality video in an event and stream it through 5GCity platform, using Wi-Fi connection, to a designated cloud-based application. o **Mock-up Lamp post**: its designed for use in Barcelona. This lamp post is designed to host Small Cells and Wi-Fi equipment on the lamp post in the street.	
o **5GCity Neutral Hosting solution** o **5GCity Video Acquisition & Production**: Video acquisition and production Demo to show how 5GCity neutral host platform can enable an ICT infrastructure owner to slice and lease its infrastructure to a 3rd party, who can rapidly deploy NFV-based services on the assigned slice. Specific services demonstrated include acquisition of live high-quality video from the event and streaming through 5GCity platform, via Wi-Fi connection, to a designated cloud-based application. o **5GCity City of Barcelona lamppost**: its configuration of WiFi and RAN APs. Live demo will show video streaming from local video server (local cabinet) to Smartphone via Small Cell in lamppost.	**MWC2019**
o **5GCity Neutral Host Platform**: This demo shows how the 5GCity neutral host platform enables an ICT infrastructure owner to slice and lease its infrastructure to 3rd parties (e.g. MVNO). o **5GCity Video Acquisition & Production**: This demo includes acquisition of live high-quality multiple videos from the event and streaming through 5GCity platform. o 5**GCity Augmented Reality service**: immersive experiences with distribution of UHD contents for city services. The demo leverages on 5G orchestration to offer immersive experience to end-user (e.g., tourists) who can see a reconstruction of antique city buildings and monuments in real-time with enriched context via holographic models. o **5GCity connection life from Torre Guinigi**, the tallest tower in town: Comune di Lucca, Nextworks, Cellnex, Comunicare Digitale used 5GCity platform deployed in Lucca and small cells to connect the tower with a LIVE BROADCASTING TRANSMISSION to Forum stage. LIVE CONNECTION with interviews, comments to show opportunities for broadcasters, media company, producers, digital and creative industry. o **5GCity at Puccini's Birth Home and Museum**: Italtel and RAI have design and implemented the applications used in Immersive Video Services, including real time 360° video distribution, Augmented and Virtual Reality and 4K video distribution in crowded events.	**European Digital Forum 2019**
o **5GCity SDK + Neutral Host Platform**: demo in two parts: 1) demonstrates how 5GCity SDK facilitates creation, packaging & on-boarding of network services; 2) it shows how the 5GCity neutral host platform enables an ICT infrastructure owner to slice and lease its infrastructure to 3rd parties (MVNO).	**EUCNC2019**

o **Video Acquisition & Production**: includes acquisition of live high-quality multiple videos from the event and streaming through 5GCity platform; it can support the engagement of public in the media production for big events. o **Augmented Reality service**: offers immersive experiences with distribution of UHD contents for city services, immersive experience to end-user (e.g., tourists) via holographic models. o **Mobile Backpack Transmission**: to highlights how high bandwidth connection over a dedicated network slice can enhance live TV transmissions from a mobile backpack. Acquisition, processing, and streaming/broadcasting of multiple live HD videos from a professional mobile TV camera which moves in the outdoor demo area of conference site for typical journalist activities. The camera is connected to a TV production and streaming service station installed in the 5GCity booth.	
Cancelled event: o 5GCity Video Acquisition & Production: at Pere IV district in Barcelona to deploy and evaluate 5G opportunities on mobile real-time transmission, UHD video distribution, and real-time video acquisition and production in the Edge & Cloud. The demo will show case Mobile Backpack demo for live event video broadcasting from the street using a slice of 5GCity infrastructure in the city. o 5GCity Mock-up Lamp post: designed within to host Small Cells and Wi-Fi equipment on the lamp post in Barcelona street.	~~MWC2020~~

Table 3 - 5GCity Event Demonstrations

2.4. **5G PPP Collaborations and 5G IA activities**

Regarding the liaison with 5G PPP projects and the participation to 5G PPP activities, the consortium has actively contributed since the project's kick-off in June 2017, to various Working Groups and events.
In particular, 5GCity has participated to various key Working Groups of the 5G PPP through designated representative partners as briefly reported in the following table:

Area	Working Group	5GCity representative	Main activities
5G PPP	Steering Board	i2CAT (S. Figuerola and S. Siddiqui) - PC	• Coordination with other projects • Annual Program report • MWC2019, EUCNC 2019 & MWC2020 coordination • Face to face meetings • Periodic conference calls

5G PPP	Technical Board	NXW (G. Carrozzo) TM	• Cross-project technical coordination
			• Continued joint work on cartography for projects and trials
			• Continued joint work on 5G PPP KPIs
			  o Coordination of work on Service Creation KPI with other Phase 2 Projects
			  o 2 papers on Latency KPI
			• EUCNC 2019 technical contributions

			• Face to face meetings & Technical workshops (Brussels on May 2019 and Malaga on Oct 2019) • Periodic conference calls
5G PPP	5G PPP COMMS	CODI (C. Bressan)	• Coordination of participation and promotion of activities at ICT 2018, MWC2019, EUCNC 2019, MWC2020 • Periodic conference calls • Update of project news and activities into 5G PPP web portal • Periodic conference calls
5G PPP	Architecture	Italtel (A. Albanese)	• Discussion and contribution to the new 5G PPP Architecture whitepaper • Contribution to EUCNC 2019 workshop • Contribution to the new 5G PPP Architecture whitepaper v2.0 • Periodic conference calls • Face to face meeting
5G PPP	Network Management and QoS	UW (Luis)	• Discussion of a new Network Management whitepaper • Periodic conference calls • Contribution to Network Management whitepaper as closure of the WG activities
5G PPP	Software Networks (SDN/NFV)	UW (R. Preto) i2CAT (S. Siddiqui)	• Contribution to SwNet WG whitepapers on Cloud-Native • Collection of Open Source contributions by the 5G PPP projects • Periodic conference calls
5G IA	Pre-standards	BCN IMI (M. Lamarca)	• Fog05 presentation • Periodic conference calls
5G IA	Trials WG	NXW (N. Ciulli)	• Trials pre-structuring model and follow ups • Contribution to Trial roadmap 4.0 • Periodic conference calls
5G IA	Security	VYOSYS (M. Paolino) i2CAT (S. Siddiqui)	• Discussion on new Security whitepaper • Periodic conference calls
5G IA	Vision and Societal Challenges	INCITES (T. Rokkas)	• Periodic conference calls
Networld 2020	SME WG	NXW (N. Ciulli, G. Carrozzo)	• Preparation of SME brochure for EUCNC'19, MWC20 • SME coordinated presence and dissemination at EUCNC'19 • Preparation of SME success stories for 5G PPP web portal • Periodic conference calls

Table 4 – 5GCity collaborations within 5G PPP area

In addition to the aforementioned WG activities and contributions to joint 5G PPP results (i.e. whitepapers, disseminations, presentations, etc.), 5GCity has frequently promoted its research through and within 5G PPP with the additional contributions reported in Table .

Title	5GCity Project Overview

Type	Keynote
Speaker/ Attendees	Shuaib Siddiqui – i2CAT
Event	5G PPP Phase 2 Kick-off and Collaboration Meeting
Date	1 June 2017
Place	Brussels, Belgium
Link	https://5g-ppp.eu/5g-ppp-phase-2-projects/
Documents	https://www.5GCity.eu/2017/07/10/5gppp-phase-2-kick-off-collaboration-meeting/ https://www.5GCity.eu/wp-content/uploads/2017/08/5G PPP_P2_Collaboration_KO_01062017B.pdf
Title	**Interview Partner 5GCity**
Type	Video shot by the Euro-5G & To-Euro-5G projects.
Speaker/ Attendees	Nicola Ciulli – Nextworks
Event	EUCNC2017
Date	7 Oct. 2017
Place	Oulu, Finland
Documents	https://youtu.be/tx_5iyDZPM4
Title	**EUCNC 2018 Workshops**
Type	WS1: Vertical Industries & Services for 5G (VIS5G) - WS3 Multi-provider, multi-vendor, multi-player orchestration: from distributed cloud to edge and fog environments in 5G - WS4 2nd Workshop on business models and techno-economic analysis for 5G networks -WS6 5th International Workshop on programmable networks: Demystifying software networks for Vertical Industries - WS8: Next generation network systems security
Speaker/ Attendees	Partners
Event	EUCNC2018
Date	18-21 June 2018
Place	Ljubljana Slovenia
Documents	https://5g-ppp.eu/5g-ppp-at-eucnc-2018/
Title	**5G PPP 5GCity EUCNC 2019 Project Demo**
Type	Video production by 5GPPP
Speaker/ Attendees	Partners
Event	EUCNC 2019
Date	18-21 June 2019
Place	Valencia
Documents	https://youtu.be/Z1OgPH0vOEo
Title	**KPIs from 5GCity pilots & use cases**

Type	Presentation
Speaker/ Attendees	G. Carrozzo
Event	5G PPP KPI Workshop
Date	20-22 November 2018
Place	Kista (Sweden)
Documents	On 5G PPP BSCW document repository
Title	**Path to 5G Smart Cities: Experiences from Media and Public Safety Pilots in 5GCity**
Type	Presentation
Speaker/ Attendees	Gino Carrozzo, Nextworks (IT), Muhammad Shuaib Siddiqui, Fundaciò i2CAT (ES)
Event	EUCNC 2019 Special Session 3: 5G trials for vertical industries
Date	18-21 June 2019
Place	Valencia (Spain)
Documents	On 5G PPP BSCW document repository
Title	**5GCity approach to Edge Computing**
Type	Presentation
Speaker/ Attendees	G. Carrozzo
Event	5G PPP Technical Workshop
Date	8-10 October 2019
Place	Malaga (Spain)
Documents	On 5G PPP BSCW document repository

Table 5 – 5GCity presentations and mentions within 5G PPP

The relation with 5G PPP coordination teams has been productive and regular. Special focus has been put on the collaboration via social channels. Several news regarding the 5GCity project have been published and shared among the 5G PPP web and social networks, and – reciprocally – 5GCity has reflected many program level news posts and twits in collaboration with 5G PPP communication office. The significant number of interactions between 5GCity and the 5GPPP on social network platforms (LinkedIn, Twitter), with a consistent number of 5G PPP re-tweets and posts related to 5GCity relevant topics, clearly demonstrate the interest of 5GPPP community in 5GCity activities and research plan.

2.5. **Liaison Activities with Projects**

In addition to the initial contacts with other 5G PPP projects from Phase 1 and Phase 2 and the joint organization of workshops at BMSB2018 and EUCNC2018, the consortium has established through individual partners' actions, additional liaison activities with different institution and organizations, aiming at promoting particularly the initial software results and assets to be used for 5GCity NFVI.

The major achievements are summarized below:

- Towards **5G-TANGO** (Involved partners: i2CAT, NXW, UW):

- o   Collaboration on Service creation Time KPI definition framework within 5G PPP TB

- o   Discussion of 5G Catalogue and SDK models in use

- Towards **NG-PaaS, 5G ESSENCE and MATILDA** (Involved partner: NXW via 5G PPP TB):

  - o   Joint work on Latency KPI evaluation framework

  - o   1 extended abstract paper and related presentation in EUCNC19 Special Session 3

  - o   1 conference paper at 5GWorldForum 2019, Dresden (Germany)

- Towards **5G-XCAST** (Involved partner: NXW, i2CAT)

  - o   Support from UPV (5GXCast Project Coordinator) in outdoor activities at EUCNC19/Valencia (3x interview sessions in live TV broadcasting streamed live on 5GCity YouTube channel, UC3+UC5)

  - o   Organization of the Special Session 3 5G trials for vertical industries at EUCNC' 19

- [Extra 5G PPP] Towards **5G UK Hub and 5G Barcelona** (Involved partner: i2CAT, Univ. Bristol)

  - o   Joint visibility with 5G Barcelona @ MWC19

  - o   1st 5GCity Hackathon in Bristol with visibility within 5GUK Trial project participants

  - o   Synergies for the development of the 5G infrastructures in Bristol and Barcelona, link to 5GCity use cases and territory

2.6. **Communications via public Web Site**

5GCity's website (http://www.5GCity.eu) played a major role in the communication & dissemination activities within the project. It is an eye-catching website that was launched in June 2017, when the project started. It contains all the information about the 5GCity activities, developments, and results.

 With satisfaction, it could be said that all main objectives of 5GCity website were achieved:

- To build & deploy constant and permanent information and data to help 5GCity dissemination and promotion.

- To distribute information, data, presentations, news, ideas periodically to keep high the attention upon the project. (PPT, papers, deliverables, videos interviews, etc)

- To upload and making available through the project's website all dissemination material (flyers, rollups, press releases, etc.).

- To circulate the information from all partners to amplify the power of the various activities.

- To strengthen an enlarge the networking, media & press contacts, creating a "5G universe".

- To be visible and active online and offline, in the public sphere of relations of the "5G universe".

Figure 3 - 5GCity Dissemination Material

The catchy website designed was intuitive, clear, and effective to convey the project contents; formed by 8 sections and 6 sub-sections: Home; About 5GCity [Objectives, Partners]; Project Outcomes [Use Cases, Architecture, Deliverables, Papers, Software]; Project material; Blog; New & Events; Gallery; Contact.

Data from Analytics is very positive; from 12 Feb to 12 March 2020 there has been 1.2 million impressions and 15,137 direct clicks to 5GCity.eu.

As expressed in prior deliverables, the consortium plans to maintain the website active for a minimum of two years after project's end in order to ensure the sustainability of the project results.

Figure 4 - Website Analytics

All information released from the website is licensed via a Creative Commons license (likely the "CC BY" license) for maximum dissemination and use of licensed presentations.

2.7. **Communications via Social Networks**

Twitter: **Analytics from 5GCity Social Media: 5G Twitter (@5gcity)** At the present time (March 2020- 28-day summary) the account has reached **2,188 followers,** after an intense activity with **3,479 Tweets, 25 mentions, 240 Profile visits,** and **71,7K impressions.** An overview of the situation is given below:
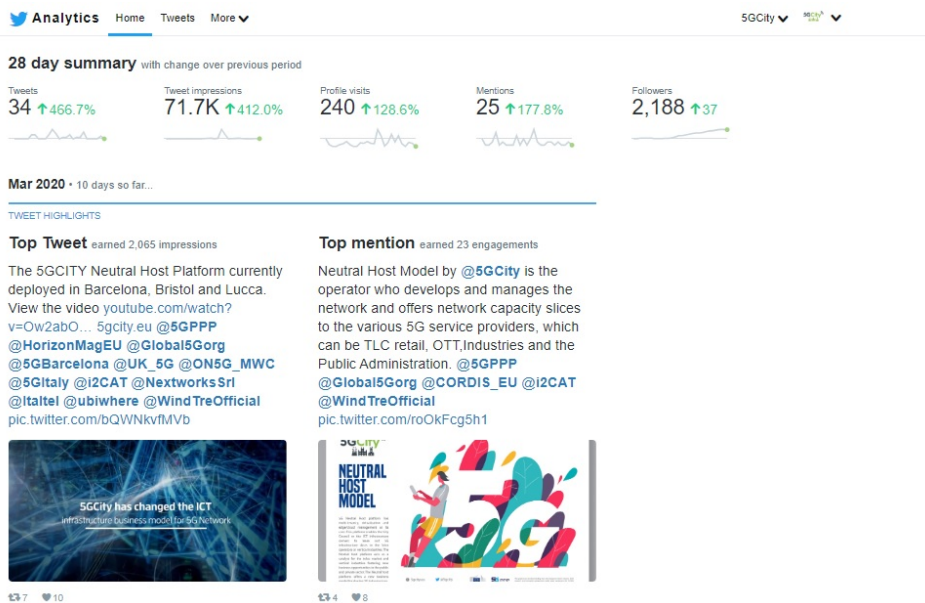
Figure 5 - Twitter Analytics

Right after MWC2019, in April 2019 a 5GCITY communication campaign was launched trough the socials and website to maintain high the interest among 5G community and attract new peers over 5G and 5GCity activities before the European Digital Forum 2019 and the EUCNC 2019. Another media and social campaign to attract millennials was launched before the 2nd 5GCity Hackathon in Lucca on Nov. 2019.

5GCity LinkedIn Group:

In the 5GCity LinkedIn Group, the number of participants has increased slowly but constantly throughout the years, moving from 106 in February 2018 to **158 members** at present March 2020. The LinkedIn Group was useful for shaking group activities, stimulating discussion and networking, in an effort to reach out and create a community with a consistent number of members.

Figure 7 - 5GCity LinkedIn Group

2.8. Newsletters and Technical Blog

Newsletters

5GCity team has written and disseminated a total number of 6 Newsletters. Newsletters were published on the project website, and dissemination carried out on social media Twitter and LinkedIn accounts. They were was also published and shared on 5GPPP website and 5GPPP LinkedIn account. The final Newsletter#7 will be published after Review with final results and planned follow ups. The table below shows dates, number, topics covered and links:

Date	Newsletter #	Topics	Link
March 2018	NL#1	Tech. News: Unikraft: crafting Unikernels; The run of Neutral Host in the cities; Lucca 5GCity: high resolution cameras. Past Events: 5GCity KOM; EUCNC2017; Future Communication Summit 2017; BIT Experience 2017. Upcoming Events: Embedded Linux	https://www.5gcity.eu/2018/03/06/5g-city-newsletter-1/

Date	Newsletter #	Topics	Link
		Conference + OpenIoT Summit North America; European Digital Forum2018; EUCNC2018. Social News: MWC2018; 5G Summit2018 Trento; Bristol hosts UK's first public 5G trial.	
May 2018	NL#2	Tech. News: Are 5G Networks, and the Neutral Host model, the solution to the shrinking Telecom market? 5GCity to Bring the Power of Unikernels to Smart City Deployments; An innovative OpenFlow implementation for 5GCity; 5GCity - A distributed cloud and edge platform for 5G-based services deployment. Upcoming Events: INTEROP Japan; European Digital Forum 2018; EUCNC 2018; IEEE HPSR2018; Xen Summit2018. Past Events: AIAI2018; 5GForum2018; Italia 5G 2018. Blog: From Service design to network slices: Software development kits for 5GCity.	https://www.5gcity.eu/wp-content/uploads/2018/05/5GCity-2nd-Newsletter-short-version.pdf
Dec. 2018	NL#3	Tech. News: Merging NFV and MEC: the 5GCity approach;5GCity Monitoring; 5GCity Neutral Host Dashboard. Publications: Edge Computing Enhancements in an NFV-based Ecosystem for 5G Neutral Hosts (IEEE NFV-SDN conference); Design Considerations for an Energy-Aware SDN-based Architecture in 5G EPON Nodes (ICTON 2018). Past Events: ICT2018; SCEWC2018; Lucca Comics and Games 2018; IoT Solutions World Congress 2018; ITU Forum Athens2018; EUCNC2018; 15th European Digital Forum2018; 5GCity 4th F2F GA Meeting; First Year 5GCity Review. Upcoming Events: MWC2019; EUCNC2019.	https://www.5gcity.eu/2018/12/12/5gcity-3-newsletter/
April 2019	NL#4	Season Greetings Tech. News: 5GCity Crowd Streaming; 5G Impact on Media Production Workflow.	https://www.5gcity.eu/2019/04/10/5gcity-4-newsletter/

Date	Newsletter #	Topics	Link
		Publications: Deploying a Novel 5G-Enabled Architecture on City Infrastructure for Ultra-High Definition and Immersive Media Production and Broadcasting (Journal Article for IEEE Transaction on Broadcasting); Cloud & Edge Trusted Virtualized Infrastructure Manager (VIM) - Security and Trust in OpenStack (IEEE WCNC19). Past Events: MWC2019; 5GCity 5h F2F Meeting-Pisa. Upcoming Events: 5GForum; 16th European Digital Forum2019; EUCNC2019; 6th OSM Hackfest. Social Media: 5GCity new Social Campaign launch	
July 2019	NL#5	Tech News: multi-tenant and multi-technology street urban furniture, offering Neutral Hosts in Portugal; Best practices and rationalisation in the 5G mobile networks deployment; The 5GCity Neutral Host Model; The Neutral Host model: some considerations from the TELCO point of view. Publications: Secure location aware VM deployment on the edge through OpenStack and ARM TrustZone (EUCNC 2019); Network Slicing-aware NFV Orchestration for 5G Service Platforms (EUCNC 2019). Past Events: 1st 5GCity Hackathon; EUCNC 2019; 16th European Digital Forum of Lucca. Upcoming Events: 6th OSM Hackfest.	https://www.5gcity.eu/2019/07/14/5gcity-5-newsletter-2/
Dec. 2019	NL#6	Event highlight: 5GCity Hackathon in Lucca outcomes Tech news: final version of the 5GCity Orchestrator, Virtualization at the Edge. Blog: Neutral Host Modelling in Lucca Past Events: 5GCity 7h F2F Final Meeting in Lucca; OSM#8 Meeting, 5GDay and #8 OSM HackFest; Study Presentation Institut Cerdà; CTTE-FITCE Congress. Upcoming Events: MWC2020	https://www.5gcity.eu/wp-content/uploads/2020/03/5GCity-Newsletter-6.pdf

Date	Newsletter #	Topics	Link
May 2020	NL#7	5GCity Final Results outcomes	To be published

Table 8 - 5GCity Newsletter List

Technical Blog:

During the project lifecycle a series of **15 relevant Technical Blogs** were written by Consortium partners and posted regularly on 5GCity website and disseminated in social media and official 5GPPP channels. A final Blog is programmed to be posted after the Final Review with 5GCity results and conclusions. In the table below all Blogs posted:

Date	Title	Author	Link
April 2018	From service design to network slices: Software Development Kits for 5G Cities	NWX	https://www.5gcity.eu/2018/04/18/from-service-design-to-network-slices-software-development-kits-for-5g-cities/
June 2018	5GCity NFV Orchestrator Platform	i2CAT	https://www.5gcity.eu/2018/07/31/5gcity-nfv-orchestrator-platform/
July 2018	Smart cities applications' security and trust through edge computing virtualization: the 5GCity approach	VOSYS	https://www.5gcity.eu/2018/08/22/smart-cities-applications-security-and-trust-through-edge-computing-virtualization-the-5gcity-approach/
Sep 2018	Merging NFV and MEC, the 5GCity approach	ADLINK	https://www.5gcity.eu/2018/11/07/merging-nfv-and-mec-the-5gcity-approach/
Oct 2018	5GCity Monitoring System	Italtel	https://www.5gcity.eu/2018/11/21/5gcity-monitoring/
Nov 2018	5GCity Neutral Host Dashboard	Ubiwhere	https://www.5gcity.eu/2018/11/26/5gcity-neutral-host-dashboard/
Dec 2018	5G IMPACT ON MEDIA PRODUCTION WORKFLOW	RAI	https://www.5gcity.eu/2019/01/22/5g-impact-on-media-production-workflow/
Jan 2019	BEST PRACTICES AND RATIONALISATION IN THE 5G MOBILE NETWORKS DEPLOYMENT	Cellnex	https://www.5gcity.eu/2019/07/30/best-practices-and-rationalisation-in-the-5g-mobile-networks-deployment/
Feb 2019	Crowd Streaming in 5GCity	MOG	https://www.5gcity.eu/2019/03/04/crowd-streaming-in-5gcity/
June 2019	THE NEUTRAL HOST MODEL: SOME CONSIDERATIONS FROM THE TELCO POINT OF VIEW	Wind Tre	https://www.5gcity.eu/2019/07/30/the-neutral-host-model-some-considerations-from-the-telco-point-of-view/
July 2019	THE 5GCITY NEUTRAL HOST MODEL	INCITES	https://www.5gcity.eu/2019/07/30/the-5gcity-neutral-host-model/

Date	Title	Author	Link
Sep 2019	DEPLOYING A NOVEL 5G-ENABLED ARCHITECTURE ON CITY INFRASTRUCTURE FOR UHD AND IMMERSIVE MEDIA PRODUCTION AND BROADCASTING	UniBris	https://www.5gcity.eu/2019/09/16/deploying-a-novel-5g-eabled-architecture-on-city-infrastructure-for-uhd-and-immersive-media-production-and-broadcasting/
Nov 2019	NEUTRA HOST MODELING IN LUCCA	Comune Lucca	https://www.5gcity.eu/2019/11/29/neutral-host-modelling-2/
Nov 2019	VIRTUALIZATION AT THE EDGE	VOSYS	https://www.5gcity.eu/2019/11/28/virtualization-at-the-edge/
Dec 2019	NEUTRAL HOST VRAN ARCHITECTURES BASED ON ACCELLERAN DRAX™	Accelleran	https://www.5gcity.eu/2020/01/07/neutral-host-modelling-2-2/

Table 9 - 5GCity Blog Posts List

2.9. Other dissemination activities by the partners

Apart from the aforementioned events and activities, 5GCity attendance to past events are listed in Table .

Date & Location	Event	Attendees
12-14 May 2018 Portland USA	**Embedded Linux Conference + OpenIoT Summit North America** https://01.org/events/2018/embedded-linux-conference-openiot-summit-north-america	NEC
17 June 2018 Bucharest, Romania	**IEEE HPSR2018** https://hpsr2018.ieee-hpsr.org/program/hackathon/	NEC
20-22 June 2018 China	**Xen Summit2018** https://events19.lfasiallc.com/events/xensummit2018/	NEC
31 Jan 2019	**Xen Project Blog** https://xenproject.org/2019/01/31/xen-project-celebrates-unikraft-unikernel-projects-one-year-anniversary/	NEC

Table 10 –5GCity partners attendance to additional events

The participation of 5GCity project to relevant events at the end of its lifecycle and even after, it offers always a great opportunity at the consortium to keep disseminating finals result and conclusions with demos, videos, flyer, presentations, interviews. As showed in the below table, three major events were identified on 2020. Unfortunately, there are major aspects to take in consideration at the present time, the fact that these events are at risk of cancellation due to COVID-19 outbreak, as it happened for the MWC2020.

The list of events which has been considered and planned for 2020 is presented in Table .

#	Data & Location	Event	Planned attendees
1	15-18 June 2020 Dubrovnik, Croatia	EUCNC 2020 https://www.eucnc.eu/	I2CAT (virtually) Pending acceptance of submitted paper
2	18-19 June 2020 Lucca, Italy	17th European Digital Forum www.forumeuropeo.tv/en/ 5GCITY participation at 5GForum discussion inside the event to present results and conclusions, Dissemination material.	CoDi, RAI, Comune Lucca

Table 11 - 5GCity planned participation to events after project end

3. Standardization and Open Source Project Activities

Following the strategy described in deliverable D6.2 "Standardization and Exploitation Plan", the standards related activities of the project during its 34 months of execution have been mostly focused on consolidating engagement with the identified SDOs in four main areas (edge computing, 5G, cloud/orchestration and media), and setting the ground for 5GCity contributions for the successful completion of the project.

3.1. Edge Computing and Smart Cities

The number of consortium and standardisation groups that have initiatives around IoT continue to grow and mature. A clear example is that by the beginning of 2019, the Industrial Internet Consortium (IIC) and the OpenFog Consortium have finalized the details to combine efforts and become one international consortia in Industrial IoT, fog, and edge computing. The organizations will work together under the IIC umbrella. The goal of the combined consortium is to drive the momentum of the industrial internet, including the development and promotion of industry guidance and best practices for fog and edge computing [ICC-OpenFog-Merge].

3.1.1. 5GCity contribution to Eclipse IoT Consortium

In the context of the 5GCity project, we are working with the Eclipse IoT Consortium to establish an ecosystem of technologies as well as a reference platform for MEC and Fog Computing. Below the list of activities that we have performed during the project.

Eclipse Cyclone DDS Project

During the 2nd half of the project, ADLINK continued to contribute to the Eclipse Cyclone DDS, which is an implementation of the OMG Data Distribution Service (DDS) specification (see http://www.omg.org/spec/DDS/) and the related specifications for interoperability (see http://www.omg.org/spec/DDSI-RTPS/)

The contribution activity and commits on this project during the last 12 months can be seen in the official Eclipse page of the project [cyclone-dds]. Eclipse Cyclone DDS offers unique data-sharing capabilities compared to the already existing Eclipse solutions (i.e. for messaging).

Eclipse fogØ5 Project

As it was presented in previous deliverables, 5GCity contributed to accelerate the adoption of MEC and Fog Computing, for that reason ADLINK has continue to develop the Eclipse IoT project named fogØ5, that provides and infrastructure for Fog Computing and MEC.

Eclipse fog05 provides a virtualised infrastructure that allows to distribute computing, storage, control and networking functions closer to the users along a cloud-to-thing continuum. From this description it should be clear that fog05 can leverage cloud infrastructure or equally function without it.

The contribution activity and commits on this project during the last 12 months can be seen in the official Eclipse page of the project [eclipse-fog05]. The source code can be accessed in the following repository https://github.com/eclipse/fog05.

3.2. **5G/RAN**

During the entire project duration, ACCELERAN continued its participation to the Small Cell Forum. In 2018 the company was awarded the SCF Award "Outstanding Innovation in Small Cell Architecture or Technology" for their "Carrier and mission critical grade architecture agnostic RAN/vRAN solutions". This achievement is an industrial award and is related to R&D activities in scope with 5GCity, which will also stimulate subsequent contributions to SCF Release documentation packages focused on Small Cells. (http://www.accelleran.com/accelleran-scf-award-winner/).

3.3. **Cloud and Orchestration**

5GCity partners working on orchestration and NFVI functions (NXW, i2CAT, UW, VYOSYS, ADLINK) have been working with ETSI NFV and ETSI MEC Industry Study Groups, analysing the latest standard releases on NFV Network Services and VNF package descriptions and on MEC interfaces and information models (for co-existence of MEC in NFV). The aim was to align 5GCity design of SDK and edge/core virtualization infrastructure to the latest international recommendations by ETSI.

Three contributions from 5GCity have been accepted in this area:

- Mp1 interface modification for ETSU MEC(19)000120 - MEC011-MEC010-2 ME App Termination procedures

- Mp1 interface modification for ETSI MEC(19)000286r3_MEC011 Update to MEC App start-up

- Mention of 5GCity in the ETSI whitepaper "Developing Software for Multi-Access Edge Computing - 2nd edition – February 2019"

Also based on 5GCity know-how, NXW contribute to ETSI NFV and ETSI MEC discussions (mostly over mailing list) as part of activities of Specialist Task Forces set up by ETSI to work on gap analysis between OpenStack APIs, NFV interface specification via OpenAPI, Conformance Test, and MEC Testing Framework. This activity configured as a mix of standardization and exploitation tasks.

3.4. **Media and Broadcasting**

The media vertical partners of 5GCity (RAI, MOG, Barcelona TV) have continued following the activities of AMWA, EBU, Society of Motion Pictures Engineers, Digital Video Broadcasting and ITU. The EBU more specifically the 5GCP working group gathers members and the industry to identify requirements in content production that need to be met in the 5G context. In this context 5GCity vertical partners are contributing to identify such requirements with the UC5 - BTV Mobile Backpack integration tests with Accelleran 3.5GHz Small Cell. (https://tech.ebu.ch/groups/5gcp).

3.5. **Summary on 5GCity contributions to SDOs**

The summary of contribution to standards by 5GCIty is reported in Table 4.

Standardization body	Partner	Contribution Details (Work item)	Contribution Type	Status (Ongoing/Accepted)
OpenFog consortium	ADLINK	OpenFog Reference Architecture for Fog Computing (2017): Messages and events. Application data management storage and persistence. More details available on https://www.openfogconsortium.org/ra/	Document inputs	**Accepted**
ETSI White Paper No. 20	5GCity project	Developing Software for Multi-Access Edge Computing - 2nd edition – February 2019: 5G City is mentioned in the Annex B - Collaborative projects related to MEC. Whitepaper available at https://www.etsi.org/images/files/ETSIWhitePapers/etsi_wp20ed2_MEC_SoftwareDevelopment.pdf	Reference to the project	**Accepted**
ETSI MEC	ITALTEL	MEC(19)000120 - MEC011-MEC010-2 ME App Termination procedures: Mp1 interface modification. Specification available at https://www.etsi.org/deliver/etsi_gs/MEC/001_099/011/02.01.01_60/gs_mec011v020101p.pdf	Sequence Diagrams	**Accepted**
ETSI MEC	ITALTEL	MEC(19)000286r3_MEC011 Update to MEC App start-up: Mp1 interface modification.	Sequence Diagrams	**Accepted**
SMPTE	MOG	TC-32NF-60 DG Studio Video over IP (SVIP): The Society of Motion Picture and Television Engineers (SMPTE, https://kws.smpte.org) is a body that joins several institutes and companies to create open standards for the video industry. SMPTE have several active workgroups to cover a wide range of the industry, from video acquisition, video processing and video storage. SMPTE also standardized a technique to transmit live video, over IP networks. The 2110 standard family cover all the technicalities of transmit and receive, video, audio, data and other auxiliary signals, like clock reference. SMPTE ST 2110 is agnostic to the physical link used to transmit the broadcast signal and can be used over 5G. MOG contribution emphases in interoperability tests and applicability of the standard in a software-based approach.	Document inputs	*Ongoing*
AMWA	MOG	NMOS Networked Media Incubator: MOG have a presence in Advanced Media Workflow Association (AMWA) bringing their expertise and experience to the consortium. AMWA have several active workgroups and MOG is present in Material Exchange Format (MXF) and Network Media Open Specifications (NMOS). The last one, have been developed for use in IP-based infrastructures to provide a control and management layer in addition to the transport layer provided by SMPTE ST2110. NMOS simply seeks to make the interconnection of products	Document inputs	*Ongoing*

Standardization body	Partner	Contribution Details (Work item)	Contribution Type	Status (Ongoing/Accepted)
		from competing suppliers as simple as possible. 5G technology can be used to enhance the IP base workflows, where the 5G equipment's coop with the IS-04 and IS-05 standards, to be visible and interoperate with other systems. MOG contribution have been focused in IP base interoperability tests and development of some IP toolkits. More details available at https://github.com/AMWA-TV/nmos/wiki/IS-04 and https://github.com/AMWA-TV/nmos/wiki/IS-05		
EBU	CLNX	EBU 5G Deployment Group: Bring the project results to SDOs and also to identify the elements that could be included in the deliverables of the EBU groups.	Document input presenting 5GCity results.	*Ongoing*

Table 4 – 5GCity Contributions to standardization bodies

3.6. Collaboration with Open Source Communities

5GCity consortium members have made a number of contributions to the open source community as reported in Table 5.

OS Community (Where)	Partner (Who)	Contribution Details	Contribution Type	Status (Ongoing/Accepted)
Eclipse IoT Foundation	ADLINK	**Fog05:** Platform for MEC and Fog Computing. Available at www.fog05.io	Code	**Accepted**
Linux Foundation	NEC	**Unikraft toolkit**: Lead community efforts for UNIKRAFT, a comprehensive toolchain and library operating system which builds highly specialized unikernels. Initially bootstrapped as Xen Project under the Linux Foundation and then matured in 2020 in an independent community project (https://unikraft.org). There is also an open-source repository (https://github.com/unikraft and a public wiki have been setup to ease engagement with the community of developers and adopters (http://docs.unikraft.org/).	Code	**Accepted**
KVM community	VOSYS	**KVM hypervisor patches merged**: Improve functionality of the Arm based guests, enabling KVM virtual machines to emulate the physical system timer.	Code	**Accepted**

OS Community (Where)	Partner (Who)	Contribution Details	Contribution Type	Status (Ongoing/Accepted)
		More details available at http://patchwork.ozlabs.org/patch/892178/		
ETSI OSM	ADLINK	**VIM connector for Eclipse fog05**: Implementation of vimconn_fos for Eclipse fog05 VIM. More details available at https://osm.etsi.org/gerrit/#/c/7368/	Code	**Accepted**
ETSI OSM	i2CAT	**Support of multiple VIM accounts for the same VIM**: Fix for better supporting the instantiation of the VNFs of a Network Service on different VIM accounts that actually belong to the same VIM, in order to generically enable more fine-granular deployment in terms of VNF placement. More details available at https://osm.etsi.org/bugzilla/show_bug.cgi?id=1051 (issue) and at https://osm.etsi.org/gerrit/#/c/osm/RO/+/8784/ (code)	Code and issue description	*Under evaluation* (Issue endorsed, code under review/integration)
ETSI NFV Plugtest	ITALTEL	**Participation in the ETSI 3th NFV Plugtests**: Test interoperability of Italtel proprietary VNFs and descriptors within the HIVE infrastructure. More details available at https://www.etsi.org/events/1278-3rd-nfv-plugtests	Testing	**Accepted**
ETSI NFV Plugtest	ITALTEL, ADLINK	**Participation in the ETSI 4th NFV Plugtests**: • Test interoperability of NFVO and VNFM interface (NFV-SOL003) • Test interoperability of fog05 vim connector and the MEC platform More details available at https://www.etsi.org/events/1550-nfv-plugtests-4	Testing	**Accepted**
ETSI OSM	NXW, UW, i2CAT	**OSM release three, four, five, six, seven**: Technical discussions, testing and supporting operations More details available in https://osm.etsi.org/wikipub/index.php/8th_OSM_Hackfest	Testing & organization	**Accepted**
AGL	VOSYS	**Automotive Grade Linux distribution**: Submitted patch to enable XEN execution in Automotive Grade Linux. This work is an enabler for the execution of connectivity functions (vehicle to city, vehicle to vehicle, vehicle to everything) and to port EdgeVIM functions (attestation, integrity check) to automotive.	code	**Accepted**

OS Community (Where)	Partner (Who)	Contribution Details	Contribution Type	Status (Ongoing/Accepted)
		More details available in https://gerrit.automotivelinux.org/gerrit/c/AGL/meta-agl/+/22202 https://gerrit.automotivelinux.org/gerrit/c/AGL/meta-agl/+/22200 https://gerrit.automotivelinux.org/gerrit/c/AGL/meta-agl/+/22201		

Table 5 – 5GCity Contributions to Open Source Community

4. Exploitation Activities

4.1. Partner's Individual Exploitation Activities

4.1.1. i2CAT

Fundació i2CAT is a non-profit technology centre that promotes R&D and Innovation activities in the field of Information and Communication Technologies and the Future Internet. Right from the beginning of the 5GCity project, i2CAT had a multi-pronged approach towards the exploitation of its results. It included i) i2CAT asset development, ii) Leverage for future projects, and iii) Knowledge and technology transfer.

i2CAT Asset Development

I2CAT invested in three different but related technical efforts, namely SDN/NFV tool enhancement, wireless network virtualization and city-wide 5G testbed. The former two technical efforts combined provide the end-to-end platform which along with infrastructure deployment constitute the latter, the city-wide 5G testbed as part of the 5GBarcelona initiative.

With regards to SDN/NFV tool enhancement, i2CAT advanced in several directions. The more important outcomes are the two modules in the 5GCity platform named Slice Manager and Multi-Tier Orchestrator (MTO). The Slice Manager is the brain of the 5GCity platform which is in charge of Slice lifecycle management, service instantiation and monitoring triggering. The MTO provides the functionality of managing multiple orchestrators, OSM and fog05, in the 5GCity platform. The MTO makes the 5GCity platform orchestrator-agnostic. Furthermore, the Slice created and managed in the 5GCity platform is end-to-end that is it includes compute and radio access network (LTE & Wi-Fi) chunks logically stitched together. This activity has increased and improved i2CAT's SDN/NFV 5G platform development expertise by many-folds along with gaining advanced expertise in related tools such as OSM, fog05, and OpenStack. In addition, i2CAT supported the efforts related to integration of NFV and MEC. This led to the contribution of fog05 VIM-connector code to the OSM community.

i2CAT also has intensely worked on the development and constant enhancement of the wireless network virtualization components, which has resulted in the generation of another asset, the i2CAT SDN-based radio access network controller (RACOON). RACOON interfaces with the Slice Manager and enables the creation of radio access network chunks that can be stitched with compute chunks to form end-to-end slices. Currently, supported radio technologies are LTE and Wi-Fi, with further technologies to be added soon (5G-NR, Li-Fi, etc.). Apart from being a tool to configure and manage radio chunks, RACOON comes with features such as a scheduling system which allows to define airtime ratios for active radio chunks, enabling QoS.

I2CAT also deployed compute and radio equipment during the course of the 5GCity project, as part of the Barcelona testbed. The deployment includes bare metal servers in i2CAT data-centre, edge compute nodes in street cabinets and Wi-Fi boxes on lampposts. The 5GCity Barcelona testbed forms part of the 5GBarcelona testbed. This exercise provided i2CAT team with expertise on design, deployment, and management of real city-wide 5G testbeds. In addition, 5GCity's association with 5GBarcelona innovation hub provided high visibility to the results of the 5GCity results as they were showcased in MWC2018 and MWC2019 as part of the 5GBarcelona booth. i2CAT identified 5GCity platform (Slice Manager, MTO, and RAN controller) as an asset for the organization as it is in line with the requirements of 5GBarcelona initiative which is led by i2CAT. These developments have resulted in an internal i2CAT project to further enhance the 5GCity platform to meet the requirements of 5GBarcelona eco-system.

Leverage for future projects

The results and healthy collaboration in 5GCity project paved the way for several new ideas and consequently, project proposals related to 5G and other topics. The successful proposals include:

- 5GCroCo (ICT-18): i2CAT participates in this project with its 5GCity platform and Barcelona testbed for validation of automotive use case.

- 5GZORRO (ICT-20): i2CAT plans to enhance the Slice Manager by adding AI-based automation in network and service management and to enable spectrum sharing via a distributed ledger-based spectrum market.

- 5G-CLARITY (ICT-20): i2CAT improves upon its RAN controller to aggregate other wireless access technologies such as LiFi and to align with the O-RAN specifications.

- PLEDGER (ICT-15): i2CAT participates with its Barcelona testbed to validate the improvements on the Edge orchestration and to aggregate the IEEE 802.11p technology to the RAN controller. Further, the testbed will be extended to provide radio coverage in new areas.

- CPSoSaware (ICT-01): i2CAT plans to extend the 5GCity platform for cyber physical systems.

- 5GaaS (EIC-FTI): i2CAT will extend the platform by integrating Block chain for a decentralized marketplace for the telecom ecosystem.

Knowledge and technology transfer

The Collider program (https://thecollider.tech/) encourages the participation of prestigious research centres and universities to build new tech transfer mechanisms and supports the creation of digital start-ups. It is a very competitive program where several entrepreneurs pitch their business idea with market analysis and technical viability for the targeted industry. The idea goes through multiple rounds of evaluation before induction in to Collider program. The knowledge and technologies generated as part of the development of Slice Manager and RAN Control put together as a 5G platform offers a solution for the Neutral Hosting in 5G private networks. Based on these technical and business ideas, i2CAT participated in the Collider program for a potential start-up, called NEUTROON (https://www.neutroon.com/). NEUTROON has cleared the evaluation rounds and is awaiting final decision

4.1.2. Nextworks

During the 5GCity project, Nextworks has continued to grow in its international recognition of NFV MANO technology experts and developers, leveraging on three major knowledge assets matured also through the design, development and trial activities of 5GCity:

- Orchestration platform, particularly for the parts related to ETSI OSM NFV MANO, the 5GCity Multi-Tier Orchestration towards MEC, and the integration with Monitoring platforms based on Prometheus;

- 5GGity Service Development Kit and NFV descriptor catalogues, which reduce significantly the complexity for Verticals who intend to edit and compose Functions into Services in NFV/MEC environments;

- 5G/NFVI infrastructure design, deployment and operation, with particular focus on aspects of multi-VIM deployment, integration of core and edge computing, use of constrained devices at edge and far-edge.

Great experience matured also on service design and testing as related to 5GCity use cases: together with use case leaders from the project, Nextworks defined all descriptors and tested in live infrastructures the City surveillance scenarios from UC1 (Unauthorized Waste Dumping Prevention), from UC3 (Video Acquisition/Production and Community media engagement in live events), from UC4 (UHD Video Distribution and Immersive Services) and form UC5 (live broadcasting). Moreover, trial and demo work for various showcase events (ICT2018, MWC2019, 14th European Digital Forum Lucca 2019, EUCNC2019) and for the

two 5GCity hackathons have further increased the team knowhow and capability to replicate 5GCity infrastructures in various working environments.

The results and successes obtained in the 5GCity project have further increases Nextworks' visibility in the 5G Community, and new business opportunities have continued to arise in 2019/2020 as continuation of existing consultancy services with:

- Standard Development Organizations (ETSI NFV with whom two additional Specialist Task Forces have been started, one hackfest organised and one NFV/MEC plugtests started)

- Operators interested in executing 5G trials (particularly in Italy, with enquires also coming from abroad Europe)

- During Q3-2019/Q1-2020, Nextworks team has secured 3 new services contracts with ETSI to cover specific topics of the NFV and MEC work programme:

- Technical support 5th ETSI NFV/MEC Plugtests running in the period Jan-2020 / Jun-2020

- ETSI STF 583 on NFV API Conformance test specification and maintenance running in the period Jan-2020 / Jan-2021

- ETSI STF 586 on OpenAPI Specifications for NFV running in the period Jan-2020 / Dec-2020

In all these consultancies, Nextworks team will worked as member of the Expert Team and covers the role of STF leader, as a consequence of the level of trustiness gained with ETSI and competence in running these types of professional activities.

In addition, during 2019 the know-how matured through 5GCity activities has stimulated training consultancies and trial Proof of Concepts for NFV and MEC components at OpEn Fiber (the largest fiber optic operator in Italy). Nextworks' expertise on virtualization, slicing and orchestration has supported design activities for the edge infrastructures and Technical Project Management of the overall trial planning with this customer.

Contacts with foreign system integrators and Telcos also continued to define potential partnerships aimed at offering 5G consultancy services in other nations.

As of today, and thanks to knowledge matured in 5GCity, Nextworks is capable to offer:

- Expert-level training on 5G, NFV, MEC, SDN architecture and tools, specifically designed for network and software development professionals

- Senior SDN/NFV Network Architect, for consultancies focused on design of SDN/NFV PoCs, virtualized infrastructures (private, public hybrid cloud) and production services

- Senior SDN/NFV Service Architect, for consultancies focused on definition of operative procedures for onboarding and acceptance of VNFs, Business Continuity, HA, Disaster Recovery, Test procedures, test plans, test reports

- Technical project management, for consultancies focused on design and roll-out of 5G/SDN/NFV projects to help you to deliver complex platforms through coordination of multi-national teams of professionals.

- Cloud-native IoT solution design and development, for consultancies focused on development of orchestration and control tools for cloud-native and virtualization environments.

Also, the work on Neutral Host generated an opportunity for continued support to the IT department of the Municipality of Lucca for defining a strategy towards the evolution of the IT infrastructure for 5G and Neutral Host in Lucca after the 5GCity project. Moreover, plans have been defined for collaboration with other 5GCity partners involved in experimentation activities in Lucca (esp. with Comune di Lucca) to study applicability of Public Safety, Smart Museum and Smart Theatre services with 5G, based on products by Nextworks like:

- automatic alerting and request for inspections in case of abuse/misuse of public spaces

- IoT devices to detect user presence and adjust lighting scenarios (part of Nextworks' IoT product offering)

- IoT devices to implement Smart Access control (also part of the Nextworks' IoT product offering)

The evaluation of the business potential of these opportunities is still under evaluation by the Nextworks' Sales Group at the time of release of this documents, but it is expected to be in line with the size of similar IoT deployment of the Nextworks' IoT products (>150kEUR per contract in custom deployments), thus configuring in an enlargement of the current customer base and market size.

Finally, the successful collaboration with 5GCity partners and in particular with i2CAT and UW has stimulated follow-up R&D activities on multi-operator orchestration and Distributed Ledger Technologies. Two newly funded H2020 project called 5GZORRO, part of the 5G PPP Phase 3, and 5GaaS, an FTI action, has recently been funded.

4.1.3. VOSYS

The VOSYS 5GCity exploitation plan is based on products, IP and services.
For what concerns products, during the project VOSYS developed TrustedVIM[1], a trusted computing enabled VIM solution derived directly from the 5GCity EdgeVIM component.
With TrustedVIM, VOSYS ambitions to secure the safety critical part of the 5G infrastructure, thus addressing the emerging market of 5G security (including verticals like Automotive, Industrial, healthcare, etc).
In addition, two patent applications have been filed: the former, "Virtual switch for multi-compartment mixed critical network communications" has been granted in US (US10127071B2) and EU (EP3264711B1). The latter, related to the initialization of computing systems, is in embargo state (targeting EU). Such applications will be used to strengthen the VOSYS products and to enrich the company IP portfolio.
Finally, VOSYS will leverage skills and expertise acquired during the project activities (trusted computing, Virtualized Infrastructure Managers, Arm architecture, virtualized systems, 5G networking, etc.) to provide related design and development services. To do this, company leverages on the visibility given by the open source contributions done during the project (Linux kernel[2] and Automotive Grade Linux[3]).

4.1.4. ADLINK

ADLINK exploitation activities in the 5GCity project were targeted at advancing the state of the art in Fog and Mobile-Access Edge Computing (MEC) platforms as well as establishing and Open Source ecosystem for edge-related technologies. At ADLINK we consider that for IIoT to happen we need open, interoperable and vendor neutral technology stacks that are designed ground up to address the needs characteristic of IIoT. The availability of this open technology ecosystem is essential to the adoption and grow of edge computing and IIoT in general. ADLINK as a global vendor of Edge Technologies will leverage these open platforms in our hardware as well as in vertical solutions. Our exploitation activities in the contexts of 5GCity are described as follows:

During the first year, ADLINK developed the Eclipse FogØ5, decentralized virtual infrastructure manager of computing, storage, communication and I/O resource availability anywhere across the network. Eclipse Fog05 addresses highly heterogeneous systems even those with extremely resource constrained nodes. In addition, it participated in the creation of an Open Source ecosystem for MEC and Fog Computing in the

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[1] http://www.virtualopensystems.com/en/products/vosystrustedvim/
[2] http://patchwork.ozlabs.org/patch/892178/
[3] https://gerrit.automotivelinux.org/gerrit/c/AGL/meta-agl/+/22200

context of the Eclipse IoT working group. As well as cross communication of 5GCity technologies as part of the OpenFog Consortium Test Beds.

During the second year it was presented the integration between MEC and NFV as part of the first 5GCity orchestration platform. The 5GCity approach to MEC-NFV integration is depicted in Figure 8, the core orchestration functionalities, namely onboarding and instantiation of 5G services is handled by the NFV Orchestrator (NFVO), but in order to allow a smooth integration of orchestrators that handle different portion of the 5G service lifecycle, using different descriptors, the 5GCity architecture has a layer of orchestration of top of the domain-specific orchestrators that enable the split of functionalities based on the descriptor of the 5G service dispatch the job to the appropriate orchestrator, the Multi-layer Orchestrator¬ exposes a simplified API that create an abstraction layer on top of the two different frameworks.

The actual integration is achieved with the partial implementation of some specific MEC components:

- The Multi-Access Edge Application Orchestrator (MEAO)
- The Multi-Access Edge Platform Manager – NFV (MEPM-V)
- The Multi-Access Edge Platform (ME-Platform)
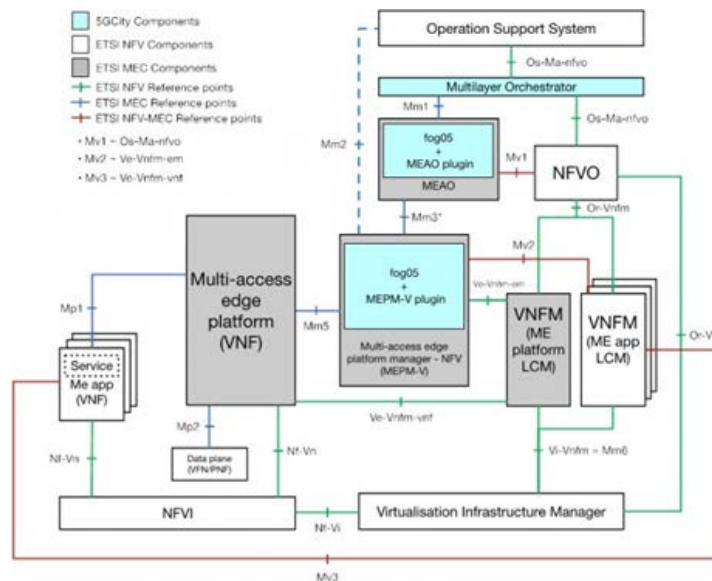
Figure 8 - Integration between MEC and NFV with FogØ5.

The MEAO and MEMP-V implementation are based on the Eclipse fog05 open source project. Eclipse fog05 aims to provide an IaaS Software for MEC and Fog Computing, is has a fully pluggable architecture that has allowed to add the functionalities that are needed for provide an MEAO and a MEMP-V, while the ME-Platform has been developed to allow communication between different Multi-Access Edge Application (ME App) that also expose services to other ME Apps. The deployment of a Network Service (NS) is depicted in Figure 9, more in detail (1) the NS deployment request is sent to the Multi-Layer Orchestrator, following that (2) the Multi-Layer Orchestrator operate a formal check on the NS descriptor, if the ME App descriptor is present within the NS descriptor then the Multi-Layer Orchestrator start two parallel work flows: (3) the first one consist in a NFV descriptor sent to the NFVO, (4) the second flow consist in the interaction between MEAO, MEMP-V and ME Platform to activate the service needed or provided by the ME App.
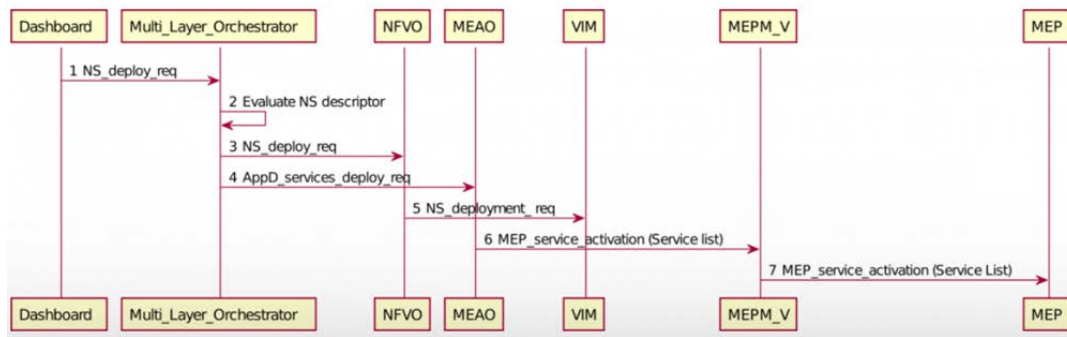
Figure 9 - Workflow of deployment of a Network Service (NS)

As described before, the role of the master orchestrator is taken by the Multi-Layer Orchestrator, while final decision about placing is taken by the 5G service placement algorithms, and the actual deployment is always performed by the NFVO, as the MEAO as no direct connection to the VIM/NFVI. The MEPM-V is responsible of the Life Cycle Management (LCM) for the ME Platform, this component has the same role of an Element Manager in a NFV ecosystem, and communicates with the NFVO through the Mm3* reference point. The are some other reference point that is worth to mention, one of this is Mm5 which is used for sending and receiving information about the ME Platform configuration so it is used for enabling services as well as requests of traffic redirection that will be activated by the NFVO.

During the final period, ADLINK participated in the ETSI 4th NFV Plugtests. In this event we tested the interoperability of Eclipse fogØ5 vim connector and the MEC platform. In connection with the 5G City ecosystem, ADLINK continue to support the use case components and tested in real life scenarios, namely in the cities in Bristol and Barcelona. The activities perform throughout the 5gCity project duration have enable the Eclipse Fog05 project dissemination, by providing an end-to-end compute, storage and networking virtualisation solution in real life scenarios. Additionally, Eclipse fogØ5 is currently used in further research activities (such as other H2020 EU initiatives i.e. 5G-CORAL, 5G-DIVE). ADLINK as a global leader of Edge Technologies will leverage these open platforms in our hardware as well as in vertical solutions in the medium term.

4.1.5. Cellnex Telecom (Retevision)

Cellnex Telecom as an infrastructure operator, during the project has participated mainly in the network infrastructure deployment in Barcelona. Specially the fibre optics connectivity.
The main aim of Cellnex Telecom in the project is getting knowledge and expertise about the neutral host concept and its rollout in dense city areas.
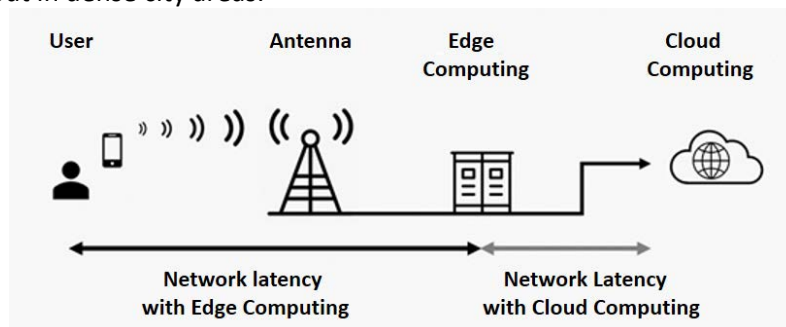
Figure 10 - Main network elements.

Improvements

It is of major importance to identify what improvements will the new 5G deployments enable. The 5G performance enhancements allow the development of a whole series of new applications. Some are

evolutions of incipient trends that are already being developed on 4G technology (or other wireless technologies), while others will be new innovative features.

Improved bandwidth

The transmission of large amounts of data facilitates a whole set of applications based on ultra-high definition (UHD) content:

- Videos in Ultra High Definition (4K 8K)
- Augmented reality.
- Virtual Reality.

The first applications are expected to be based on the improvement of bandwidth, as this is the first 5G capacity that has standardized its specifications (final specifications of Release-15 in June 2018). This improvement will result in a boom in applications based on very high-quality videos or large amounts of data.

Low Latency

The low latency of 5G technology makes communications practically in real time, which allows the appearance of a whole series of applications that are not currently possible:

- Virtual Reality
- Machinery remote control
- Autonomous capacities
- Touch Internet

Massive device connection capacity

With 5G, an increase in network capacity is achieved, which allows a greater number of devices to be interconnected with each other. This feature allows the following advances:

- Service improvement in dense environments
- Development of the internet of things

Activities

In the second period, Cellnex also tried to identify those activities that could lead to a new product or business line within the company in the field of 5G infrastructure rollout.

Antennas

While 4G network is developed on two types of antennas, the new 5G network will be developed on an infrastructure similar to the current one, although with some conceptual changes and technological advances that will improve its performance.

- Macro Cells
- Small Cells

5G is expected to prioritize the deployment of small cell antennas. Compared to macro cells, small cells can offer better benefits over the same area, at the cost of densifying the network (better service and lower emissions). The 5G network will combine both types of antennas to complement its advantages and thus offer the best service to its users:

- Current macro locations will be leveraged to offer coverage to wide areas, ensuring availability of 5G coverage at any location.

- The new small cell antennas will be deployed in those areas with the greatest demand for capacity, to complement the ubiquitous coverage offered by macro antennas with a high-performance service.

Fibre Optics

The fibre optic link is the one that allows the antennas to offer the maximum benefits of 5G technology to users with the highest reliability and least interference in the signal. The drawback of this solution is that it requires the fibre optic network to reach the antenna locations.

To minimize the impact of the new civil works, there are municipalities that take advantage of any action on public space to deploy new fibre optic pipes to urban furniture in the area, in anticipation of future 5G connection needs.

MEC infrastructure

Mobile Edge Computing (MEC) infrastructure allows to offer added functionality to the network, among which computing at the end stands out, or specific end user services.

Cellnex has positioned in this range trying to release new concepts in the 5G deployment. By trying to reach agreements with device manufacturers (antennas), by growing in the field of fibre optics deployment and implementing new product lines with MEC infrastructure.

The first Cellnex MEC product demo was going to be presented in the MWC 2020 which unfortunately was cancelled due to COVID-19 situation. However, Cellnex is planning to present the new product in a new event later on this year.

Cellnex Telecom, together with three other partners were going to present the joint initiative Edge Cloud Computing at the Barcelona MWC'20. This new architecture has been jointly developed to address the increasing challenges on telecommunication networks in bandwidth demand and latency requirements.

This innovative solution is designed to support Mobile Network Operators to improve the performance while allowing significant savings in their networks and enabling new revenues. These objectives can be simultaneously achieved driving substantial parts of the existing and future data traffic to the network edge. In that way, the existing networks can reduce the expected traffic load improving the total performance and optimizing the backhauling costs.

Cellnex is ready to act as Neutral Host with a turnkey solution based on Tower Micro Data Centres that can enable an effective and accelerated adoption of the Edge Cloud Computing with a significant saving on the total cost of ownership.

On the other hand, one of the first demonstration of a 5G and MEC infrastructure deployment product was published the second week of March together with IESE business school in Barcelona.

Figure 11 - Snapshot of the Premiere at IESE business school in Barcelona.

To demonstrate and present this product Cellnex developed an AR game (3D tick-tack-toe) which alongside with 5G technology and MEC infrastructure allowed the audience to experience the low latency and fast data

transfer network by playing in pairs by making use of AR glasses. The published news could be found at the following link: https://www.cellnextelecom.com/en/noticia-142/

As seen, that currently in 4G, operators have a lot of locations where deploying their network infrastructure in the private domain, leaving the municipalities outside of the decision making in the technology roll out plans. Conversely, in new 5G deployments, it is estimated that the need of higher concentration of antennas much closer to the end users, will lead the operator companies to make use of public domain (basically street furniture such as lampposts, bus stops, etc.) as well. So, this may strengthen the influence of administrations in the technology deployments. This influence will enhance designing more efficient schemes in order to perform a more reasonable deployment. It is also expected that the use of a neutral operator (being either a public entity or not) can speed up the availability and the deployment of any new standard, as one only entity can perform the communications and bureaucracy with the administration and all other involved actors much more efficiently than several companies altogether with different interests. Furthermore, this neutral entity will try to do its best to get benefits for the overall deployment instead of having a single business interest. In that sense, Cellnex is dealing with some entities such as mobile operators like French Bouygues Telecom which reached an agreement to operate a fibre network to connect rooftops, towers, telecommunications sites and manage and operate **edge computing centres** https://www.cellnextelecom.com/en/noticia-140/

4.1.6. University of Bristol

5GCity work at University of Bristol is hosted by the High-Performance Networks (HPN) Group. HPN group is researching about the next-generation optical transmission, new optical data centre solutions and architectures, software-defined networks (SDN), network function virtualization (NFV), cloud and edge computing, mobile edge computing (MEC), 5G technologies, Internet-of-things (IoT), and Smart City ICT solutions.

Moreover, HPN Group is part of the University of Bristol's Smart Internet Lab, a unique interdisciplinary research hub, combining more than 200 digital experts from around the world. One of the main targets of Smart Internet Lab is to develop all necessary technologies and their interconnection to enable smarter cities and a better digital life for citizens. Therefore, new technologies researched and developed in 5GCity project are relevant for the Smart Internet Lab and will be maintained and exposed to the public and the stakeholders in its Smart City testbeds. Besides, the University of Bristol as part of the 5G urban showcase and as part of West of England Combined Authority is working to continue the deployment and test of 5G mobile technology and demonstrate innovative use cases.

As a result, during the three years of 5GCity project, technical experience and scientific insides have been exploited to enhance the capacity of Smart Internet Lab to design, install, and demonstrate 5G technology and verticals in the region. We resume chronologically fundamental exploitations of 5GCity project by the University of Bristol through the Smart Internet Lab.

In the first year of the project, the research and technical interchange between projects partner's during the design of the 5GCity Testbed of Bristol and the 5GCity Platform nurtured:
   a) The enhancement of the 5G UK Test Network to allow more verticals showcases.
   b) Design of open source projects to improve the ETSI OSM Network Function Virtualization (NFV) orchestration for multiple Virtual Infrastructure Management (VIM). Not only for 5GCity Framework but future projects and developments using multiple virtual domains orchestration.

The second year of the project, 5GCity continued to contribute to the Smart Internet Lab with the following:
   a) An essential expansion of 5G UK Test Network to the Harbourside and MShed resulted from the deployment of a large part of the 5GCity Testbed (i.e., radio and edge servers) by enhancing the experimental capabilities of the Test Network.
   b) The creation of capabilities to deploy and demonstrate Neutral Host, Smart City, and Media Services using 5G technology in urban deployments.

During the third year of the project, key exploitations activities from the first and second year were consolidated by opening several opportunities for current and future projects and industrial collaborations. Some crucial contributions of 5GCity project to the Smart Internet Lab in the last year are:

   a) Enhanced 5GUK Test Network for a recent 5G urban showcases (e.g., Bristol Harbour Festival 2019) by using the experimentation capability deployed by 5GCity project in Harbourside and MShed.
   b) Multiple existing and new 5G and Smart City projects are exploiting the functionalities and coverage 5GCity Testbed (i.e., Neutral Host and Edge Computing) and the Experiences acquired by the Smart Internet Lab researchers from 5GCity project.

Regarding future innovation, the University of Bristol is working in partnership with TM Forum, an industry association leading digital business transformation, and Bristol City Council to develop the Bristol Institute for Digital Futures. As this one develops, it will adopt and co-develop TM Forum's Open Digital Architecture (ODA) and Open APIs as an architectural foundation to its emerging laboratory. TM Forum's defacto standards provide an open, industry-endorsed approach to connecting the burgeoning number of industry vertical digital ecosystems.

Hence, Neutral Hosting and Smart City services, systems and platforms will profit from those developments and provide an excellent base for alignment with the 5GCity model and technical contributions. And for the Smart Internet Lab role in future projects and collaborations with industrial and academic partners in the region and UK located projects via the fibre connectivity linking the University of Bristol with several other regions' testbeds and research locations.

4.1.7. Comune di Lucca

Exploiting 5G communication in the area of city surveillance, especially in relation to possible threats and crimes, is again clearly among the relevant areas of interest for the City of Lucca, as the mid/sized town is willing to increase the quality of the historic environment and safety for visitors, tourist and its citizen.

5GCITY provided to the town a relevant experience in understanding and managing 5G infrastructures, also useful for the preparation of the design of more effective services the city of Lucca in order to deliver to citizens an increased environment monitoring, higher quality of life and security.

In particular, the project activities provided higher understanding about the do and don'ts related to:

- Designing better architecture to supply video-surveillance service;
- UHD video distribution together with partners;
- Set up of 5G networks in city environments, especially for aspects related regulations and bylaws to environmental electromagnetic pollution and optimization of the radio network devices to be integrated into an existing environment with constrains related to preservation of the local architectural heritage.

In brief the plans of the city of LUCCA for the future are the following:

- Continuous consolidation of knowledge generated by 5GCity technical and legal topics
- Exploitation of 5GCity project outcomes useful for video surveillance and 5G network set up optimization, as above described
- Exploitation of 5G services to boost access to contents, primarily targeted for tourists and visitor.

4.1.8. Italtel

During all the project duration, Italtel put a strong attention to the progress of 5G specifications and developments, being 5G a perfect unifying framework for present and future applications. Indeed, Italtel is actively working to improve customer satisfaction focusing on designing 5G solution and supplying virtualized applications able to run at the edge of the networks, where latency can be minimized, high data rates can be achieved and real-time information about radio link status or consumer geographical position can be

exploited to develop high-value services. To this aim, the integration in 5G networks of the ETSI MEC (Multi-Access Edge Computing) architecture is fundamental as it gathers compute and storage functions closer to the end user, at the edge of the network. In this context, a topic of significant interest for Italtel is the integration of MEC with NFV. Mobile network operators, in fact, aim to consolidate Virtual Network Functions (VNFs) and Mobile Edge (ME) apps on top of the same infrastructure, to maximize their return of investment in virtualization technology.

In this scenario, Italtel R&D is keep working in the extension of the product portfolio considering two main topics:

- Development of a proprietary MEC platform in order to host MEC applications;
- Development/Adaptation of Media management applications (i.e. Real time video streaming and transcoding, Immersive Video Services in crowded events, Video analytics, Augmented Reality) to run in the MEC environment (use of MEC platform and compliance with MEC applications requirements).

The participation to 5GCity increased the Italtel capacity to bring virtualization and cloudification paradigm to the extreme edge of the network leveraging 5G and MEC, enabling development and deployment of new applications for emerging markets and verticals.

Addressing this scenario, Italtel has designed and is developing a smart application named IVAS (Immersive Video and Advanced Service), able to run in whatever virtualized environment located very close to the final user and in line with NFV. IVAS is an application able to run over a MEC infrastructure performing scenarios of massive video transcoding, real time video streaming, 360° video management and virtual caching. Within this context, IVAS can offer a set of Context-Aware and Location-Aware services performing use-cases of Augmented Reality leveraging data caching at the edge and proper intelligence, which assure high responsiveness, low latency, and near real-time operation. Moreover, Italtel is developing and implementing infrastructure and different MEC-Apps and UE-Apps to fulfil Use Cases regarding Industry 4.0, E-Health and Environmental Monitoring (to keep under control in real time bridges and other entities).

4.1.9. Barcelona – IMI

Barcelona Municipal Institute of Information Technology (IMI) provide ITC services to Barcelona City Council. The IMI is key player defining eGovernment strategy and ITC architecture for the Municipality. During the last years the Institute has been developing and executing the Strategic Plan for Information Services and Modelling ITC superblock model at urbanistic level.

Currently Superblock model identifies several city areas focused in city optimization. In the last years the city has put extensive effort into developing an overall coordinated strategy and approach towards these main twelve city areas: Environmental; ITC; Mobility; Water; Energy; Matter (waste); Nature; Built Domain; Public Space; Open Government; Information Flows, Services,...; where ITC is a transversal infrastructure for all areas.

IMI participates in 5GCITY to evolve ICT model for 4G and WIFI technologies to 5G technologies thinking in different issues with interest for Barcelona City Council: how to build, repeatability, multi-operator integration, impact in urban furniture, neutral host and impact in digital divide.

Barcelona's IMI participate mainly in WP2 and WP5 activities, focusing on the requirements gathering process from the city perspective, and the neutral host case in detail; and in the city-wide pilot's deployment, set-up, implementation and validation in the Barcelona city.

5GCity also derives a 5G integration and rollout model from an urbanistic and business point of view, based on an analysis performed in the 22@ area in Barcelona. By determining an adequate power level for each small cell, while looking for a compromise between coverage and overlapping of neighbouring nodes and

taking into account the performance requirements of the UCs, a series of recommended physical settings are identified. Based on these settings and the requirements of the services to be delivered, several dimensioning factors are derived, such as an optimal small cell density, radio settings to assure a flat coverage in terms of signal-to-noise ratio, required availability of on-street furniture to host the radio equipment, as well as the necessary IT infrastructure, e.g. fiber connectivity or the number of street cabinets to host MEC compute nodes. The model determined by this detailed analysis, reported in d5.3, performed by IMI along with Agencia d'Ecologia Urbana de Barcelona (TP), serves as a guideline for applying the neutral hosting model in modern cities, such as Barcelona, from an urbanistic point of view and it is used as reference for the neutral hosting business model and ITC planification (e.g., multi-operator small cells and Edge Based Infrastructure) of superblocks in Barcelona as support of outdoor municipal services.

City-wide pilots focusing on the three type of use cases scenarios, i.e. neutral host, media industry, and city services, are one of the fundamental components of the project. IMI participates in validation city pilots deployed in Barcelona against a set of pre-defined KPIs in a demonstrable scenario in which the integrated testbed will enable advanced functionalities with great context awareness in a city scale experiments.

Through this project, and the correlation with other EU projects (FLAME, CAPTOR ad GROWSMARTER) , the city provide a tool to facilitate the use of public spaces in the city of Barcelona to carry out tests and pilot programs on products and services with an urban impact, which are in the pre-market stage and in line with the Barcelona City Council's aims, priorities and lines of action.

5GCity's outcomes, use cases and 5G infrastructure, will be evaluated by IMI to meet the Barcelona City Council's real needs. IMI will learn and to create new products or services that can bring improvements to Barcelona's residents. Eventually, the solutions presented are expected to impact directly on City Public Procurement about the services provided by the City Council itself, benefiting residents by providing: Better products, better solutions, and better municipal services. On the other hand, the urban planning department will gather all the lessons learnt and best practices to deploy and scale up the future 5G infrastructure in the city in a sustainable way.

In order for 5GCity to have a bigger impact on the industry, it is very important to make itself visible by organizing/participating in events about 5G and edge technologies. IMI participates actively to highlight 5GCITY project given support in specialized events in Barcelona: Industrial IOT World Congress, Smart City Expo World Congress and Mobile World Congress (events in Barcelona). Additionally, we present project and results in several conferences and standardization bodies where IMI participates as Barcelona City Council representative, such as:

- as members in UNE CTN 178 Committee focused on Smart Cities and City Protocol Society
- as members in City Networks as RECI (Spanish Cities), EUROCITIES, Major Cities of Europe or WeGo;
- as support of SESIAD (Spain Government) and UNE(Spain Standardization Body) in ITU and ISO (Sustainable Communities) events

4.1.10. Betevé

betevé is a broadcaster company owned by the municipality of Barcelona. One of the public services of betevé is the live transmission of events of any kind, from concerts to manifestations and also popular festivals. To achieve it, betevé is working with up to 7 transmission systems working over 4G technology. The transmission system consist of a computer contained in a backpack, this computer receive the video signal coming from a camera compress it to reduce the needed bandwidth to transmit it, and then using bonding technology, divides the signal in as many parts as 4G modems that are connected to the system, normally up to 6, 2 from each major operator. This technology works fine but when in very crowded events such as manifestations, it's almost impossible to stablish a transmission, going live then trough satellite with all the constrains and cost that implies.

betevé is participating in the 5GCity project to define the needs of a broadcaster and experiment with new technology to avoid the actual constrains of the 4G technology.

betevé looks to achieve Qos in their transmissions, something possible using 5G technology, as can use one dedicate slice for his connection, with a very low latency, actually is almost impossible to use this technology to make a remote interview.

During the project life, betevé has participated in defining the specification for a broadcast company to use the 5G network to make live transmissions and programs. Has participated in the deployment and validation of the network, and in the trial of his UC, testing the network deployed and checking for the defined KPI's

4.1.11. MOG

MOG Technologies is a technology provider, developing solutions (hardware and software) to enable different types of media workflows. Despite its strong presence in the broadcasting area (SONY, ADOBE, AVID, Al-Jazeera, Disney, HBO, Apple, BBC, RTVE and FOX are among its clients), in more than 40 countries, using cloud computing and state of the art telecommunications technologies like 5G for the professional media sector is relatively new for MOG. Therefore, incorporating this knowledge inside the company was already a very important way to exploit the project results and activities. When the project started, MOG only had one researcher with skills in 5G Technology while now there are 4 people with relevant knowledge in this area. In the broadcasting sector, MOG will use the developments from 5GCITY to target broadcasters and media production companies, publishers (e.g. newspapers) and similar organizations. Event organizers, like municipalities or cultural/sports associations are also another important target marketing group for the company as they can use the application to cover events lease the equipment (cameras, cables, etc.) from MOG and use the virtual newsroom application to deliver a high quality personalized edited video to a large number of users. It´s important to note that MOG's strategic alliance with Level 3 Communications, a major global cloud provider, will facilitate MOG's market penetration, in this specific segment, and the creation of new business opportunities.

Therefore, the company intends to develop a novel marketing strategy for this new area, which includes participation as an exhibitor in the most relevant trade fairs like IBC, NAB and WEB Summit and a strong web presence. Main competitors in the broadcasting industry are AVID, which has a strong presence in professional editing, or Anvato/Live U or Telestream that have technology capable of live streaming events and cloud production. However, the market still does not offer a solution capable off seamless editing on the fly, through a multiplayer interface, several broadcast high quality feeds; and, this solution coming out of 5GCITY could be further combined with those of the competitor companies, having a multiplier effect.

MOG is mainly a product-oriented company, thus the developments of 5GCITY will be incorporated in existing products (ingest line) as innovative new features or will be used to increase the company portfolio and then sold/licensed. MOG will also be able to provide and sell training and consultancy services to the set of clients described above that need to increase the visibility of a brand or increase their actual sources of revenues.

During the first year of the project, MOG was busy defining the requirements, technical specifications and architecture of the crowdstreaming ecosystem for live events capture. During this time, a special emphasis was placed in mapping the cities' infrastructures (Barcelona, Bristol) with the use case requirements, in order to prepare the city-wide live pilots. Therefore, the outcomes of these actions are mainly documents, which can´t be easily directly exploited, given its nature.

However, there are some key exploitation activities that should be highlighted

- New internal business area and commercialization plan: The developments of 5G City led to the creation of a new business area inside MOG Technologies, focused on the development of "New Media" solutions. This new area deals with commercial licencing of technologies based on OTT (Over The Top Television), Digital Advertising, Mobile Media App development, Content Management and

distribution systems, VR/AR technology and new interactive paradoxes. In this area, we will use the knowledge gathered in 5G City to identify possible exploitable assets from the project and define upscaling and commercialization timelines for them

- Training of highly skilled personnel: During the first project year, one MSc thesis was completed, focused on mobile crowdstreaming scenarios. At the same time, internal trainings took place to make the project results available to the entire company.

- Market Analysis: MOG has been analysing the media and entertainment market to check the business potential of the use case. The results have been promising. Livestreaming is becoming more and more a part of our daily lives. A study from Koeppeldirect[4], indicates that 64% of smartphone users watched at least one live online video during last year. The same study, shows that 41% of the viewers' preferences for live videos goes to the coverage of breaking news, while other interests include events (e.g. sports, or festivals) or videos made by family and friends. In parallel, crowdstreaming platforms such as Twitch[5] are able to engage 9.7 million daily users who spend an average of 106 minutes/day watching live videos and include more than 2 unique million streams/month. According to Livestream[6], the global events industry, where crowdstreaming is gaining more and more momentum, is expected to generate 18 billion dollars of annual revenue by 2018. The ease of application of crowdstreaming techniques to news, events and social interaction demonstrate clear the potential market value of the technology

During the second year, MOG continued the exploitation activities of the first year. At the same time, it further developed the crowdsystem ecosystem necessary to implement and deploy the use case in the 5G City framework. During this year, MOG has carried on with the following activities

- Identification of key stakeholders and target groups for exploiting the UC results. These were more elaborately detailed in D2.4 and include: a) Worldwide event organizers who need to create new experiences in their events b) broadcasters, media groups and media production companies who need to reduce their live event production costs c) media integrators who can use the crowd streaming ecosystem for projects with final clients and d) sport clubs who want to use the ecosystem to engage their fans in matches.

- Associated with the stakeholders listing, the proper exploitation channels were highlighted: a) 5GCity partners interested in this use case will use their salesforce who will promote the ecosystem through direct contact, b) sectorial relevant industrial fairs, such as NAB or IBC can be used to present the ecosystem to a large diversity of key market stakeholders, c) social media using specific campaigns and platforms, d) in Academic Conferences enhancing the innovative project components to validate the product as a scientific breakthrough e) presence in the media (newspaper, radio, TV) through the preparation of specific press releases and f) in Standardization forums such as SMPTE, AMWA or others showcasing the ecosystem interoperability features

- Continue the work regarding market surveillance and analysis further detailed in D6.4. According to Price Waterhouse Coopers report "Perspectives from the Global Entertainment & Media Outlook 2018–2022", indicates that the entertainment market, which television, film and video production accounts for a significant share will steadily grow 4,4% until 2022. Consumers are expected to spend more time engaging in Entertainment and Media with an increase of 25,4% in data consumption related to video until 2022. According to Deloitte, in 2018, video and audio will generate 89% of this year's consumer Internet data traffic. eMarketer forecasts that the number of people who normally watch digital video at least once a month in the U.S. will reach 248.9 million by 2022, up from 228.8

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[4] https://www.koeppeldirect.com/drtvblog/rise-of-livestreaming-marketing-trends-tips/

[5] https://twitch.tv

[6] http://lp.livestream.com/rs/582-GOU-684/images/The%20Ultimate%20Guide%20to%20LS.pdf

million this year. People ask for information and recommendations to other people in early infancy and the same process is repeated until they die. Throughout the ages, governments, public entities and private business have been used, with great success, to tackle different types of challenges. As an example, in the 19th century, James Murray, a British philosopher asked his readers to send him different references to different types of words. The challenge had a great success with a huge number of respondents and was used as the initial base for the Oxford English Dictionary. Nowadays, Wikipedia is one of the most famous examples of crowd's power, an online encyclopedia, edited by more or less anonymous users throughout the world. The power crowd sourcing for different areas (crowdsolving, crowdvoting, crowdfunding…) is been recognized as a major driver of innovation. In 2016, crowdfunding platforms added up to a total of $34.4 billion dollars, with crowdsourcing being a key enabler of freelance business. A 2012 survey from Crowdsourcing.org indicates that there are different ways to engage crowds, namely through crowd creative applications such as the one connected with the use case. It is expected that, in 2020, users will spend 65 minutes per day watching videos, accounting for 22% of the total time. At the same time, online video and advertising will grow significantly, when compared to other traditional media channels such as TV or newspapers.

- Further research, namely by fostering the creation of related MSc and PhD thesis and the design of new R&D projects. During this year, MOG has been awarded with the H2020 ICT ARTICONF project. This is a project; which main goal is to develop a toolbench for creating democratic decentralized social networks. In it, MOG will further develop the crowdstreaming ecosystem to support blockchain based transactions, introducing a rewarding mechanism for content producers.

- Analysed and studied potential IPR measures that can be applied to 5GCity results. In this particular axis, exploitable results were identified and matched with potential IPR mechanisms. So far, the conclusions were to use secret know-how as the main method of IP protection. A deeper and extensive study will be carried during the upcoming period.

- MOG continued to develop the use case components in order to scale up their TRL. During this year, a version of the system was presented in ICT 2018 Conference and the Mobile World Congress 2019.

- Identified possible third parties that can benefit from the project results. During this year, MOG has further developed its partnership with Century Link (Level 3 Communications) so that the later can host the crowdstreaming platform. An experimental trial of the use case was also made with the support of Jornal de Notícias. Jornal de Notícias is one of the largest Portuguese newspaper and a potential user/client of the project results.

During the final period, MOG continued to exploit the results of developing the use case components in connection with the 5G City ecosystem. It concluded the developments and tested them in real life scenarios, namely in Bristol and Barcelona. In this period, MOG:

- Created the final business case for the crowd streaming ecosystem based on a collective regional hub approach

- Strengthened the partnership with other project members to develop post-project exploitation activities. A case that should be highlighted was the collaboration with Betevé. Being a broadcaster, Betevé needs to endogenize new technologies to support new forms of user engagement. At the same time, it wanted to use more intensively social networks to promote that same content. In order to align both companies' expectations, MOG discussed with Betevé the possibility to jointly organize the use case pilot in Barcelona. In the end, Betevé journalists worked together with MOG´s technical personal in the pilot and the edited live user generated content that resulted from the editing process was sent to Youtube. This cooperation will continue after the project lifetime as Betevé plans to use MOG´s technology for other type of events and live shows. This cooperation will further include other partners such as i2cat, Cellnext or the Municipality of Barcelona that will ensure the 5G infrastructure that will support the application.

- Concluded the market surveillance study, in order to evaluate trends, countries, business models and sectors of application. Due to the multiple dimensions of crowd-critical applications, in terms of its applications or types of collaboration between users, it is challenging to get the exact value and size of the market. With the increase of multiple online viewing platforms, the media and entertainment industry consider today live videos as one of its major sources of revenues in the near future. A study from the Interactive Advertising Bureau24 indicates that 70% are consuming digital video content via a 'connected device' (PC/laptop, smartphone, tablet or connected TV) several times a day/once a day. At the same time, the paradigm of TV stations broadcasting contents to a passive end user no longer exists, sites like YouTube or Twitch showing that the users now have a more active role in the media production process itself. Crowdsourced videos provide new ways of covering live events (e.g., music festivals and sports matches), citizen-based journalism, and storytelling. According to Massolution[7], the crowdfunding market alone in 2015 raised $34.4 billion. At the same time, IBISWorld[8] estimated in 2016 that the US market for crowdsourced service providers was about $1 billion. A parallel Crowdsourcing.org study demonstrated that there were 1,755 crowdsourcing sites in the world classified according to the following categories: distributed knowledge, crowdfunding, crowd creativity, open innovation, tools and cloud labour. Another source of inspiration for the increase in this type of applications are the crowd driven innovation prizes, such as the $30 million Google Lunar XPRIZE, the $25 million Michelson Prize or the £10 million 2014 Longitude Prize. Allstate[9], one of the largest US insurance companies, sponsored a prize in which the crowd created a liability prediction model that was 271% more accurate than the original. Delloite[10] indicates that, "reputation aside, the earnings of the most successful crowdsourcing challenge participants can now also easily exceed $500,000 per annum". Throughout 2016, millions of users around the world visited crowdsourcing sites to participate in incentive competitions and other crowd-based projects[11]. While the present scale is significant, organizations and individuals begin to realise the value of "innovation management" as the art and science of cultivating new, better, and/or disruptive concepts and products. The year 2016 saw crowdsourcing provide spectacular results for many organisations - in a world where less than one out of 1,000 people understand or participate in crowdsourcing. Crowdsourcing is growing in a future where companies, governments, organizations, and individuals can ask millions of the best and brightest colleagues to participate and collectively shape the way we answer our most challenging questions. The world-changing goal of crowdsourcing as a whole is developing platforms that support billions of users and create space for community solutions to be developed and chosen in a digital town square. This is a form of real-time democracy and intellectual evolution at a scale never seen before.

- Promoted the creation of derived R&D, namely by identifying individual and/or collaborative R&D projects in which it can participate. During the final period of the project, MOG participated in H2020 proposals that aimed to further develop the crowdstreaming use case so that it could include more functionalities such as a communication module between the producer and the journalists or the deployment of the use case in distributed events scenarios such as a cycling race or a marathon. MOG was also succeed in securing funding for the Eurostars VAPOR Project which aimed to revolutionize the delivery of immersive videos with the inclusion of seamless native in-video advertising. In this application scenario, MOG will not directly develop on top of the use case but it

[7] https://dazeinfo.com/2016/01/12/crowdfunding-industry-34-4-billion-surpass-vc-2016/
[8] https://www.ibisworld.com/industry-trends/specialized-market-research-reports/advisory-financial-services/outsourcedoffice-functions/crowdsourcing-service-providers.html
[9] https://money.usnews.com/money/business-economy/articles/2012/05/15/allstate-taps-the-crowd-to-predict-insuranceclaims
[10] https://www2.deloitte.com/content/dam/Deloitte/de/Documents/Innovation/us-cons-enterprise-crowdsourcing-andgrowing-fragmentation-of-work%20(3).pdf
[11] https://herox.com/news/716-crowdsourcing-in-2017-trends-and-predictions

will evaluate how 5G networks, and more concretely the 5G City platform, can be used to enhance the massive delivery of the video content.

- In the end, MOG analysed different protection measures for the software developed for the use case in the context of 5G City and decided to keep the secret know-how as the most effective way to protect the R&D findings. Keeping it as a trade secret means that it can be protected indeterminately as long as they are kept secret, however it is will not be able to protect it against similar products or reverse engineering.

- During this final period, MOG tested the use case prototype in two cities: Barcelona and Bristol. The details of the testing are document in D5.3. The first use case trials were held between 29th and 31st of October 2019 in Barcelona. The scenario used for the pilot validation consisted in deploying the MOG's use case (UC3) at the intersection between Carrer de Sancho de Ávila and Carrer de Roc Boronat. This intersection is covered by three Wi-Fi access points and connected to the edge computing system in the betevé datacentre. A second trial was performed in Barcelona to test the scaling mechanism. These tests were held in the Barcelona infrastructure after the street trials, between 11th of and 20th of December 2019. In Barcelona's trial we conducted several integration tests with UC3 and UC5. This integration was not initially proposed but turned out to be a great way to explore joint exploration between consortium partners. The tests conducted during EuCNC 2019 is demonstrated by the successful number of live interviews conducted and the observed interest in the UC3 and UC5 integration in the 5GCity booth. The scenario used for validating the MOG's use case deployment in the Bristol pilot, in February 7th 2020, was composed of several Wi-Fi access points available in different locations across the city, namely: The University of Bristol, the Millennium Square and the MShed. In order to support a higher number of users, all four access points were used during the trial: one in University of Bristol, one in the south part of the Millennium Square and, finally, two others in MShed (one to the east and the other to the west). These Wi-Fi APs are connected to the computing resources in the Saturn datacentre located in MShed. The tests focused essentially on the scaling feature and its results were very good. In this particular use case, a very good relation was established between the University of Bristol and MOG that can be further exploited after the project ends.

- Finished the identification of third parties who can serve as initial beta testers of the prototype. MOG identified three parties who can act as initially beta testers for the use case. Jornal de Notícias (JN) (www.jn.pt) is one of the oldest (1888) and largest of the Portuguese daily newspapers. Jornal de Notícias is very interested in using the project results as it co-organizes different types of events (sports, cultural) in which the solution could be used. It should be stated that after an initial test last year, a more technical and editorial test was performed this year to evaluate features that the crowdstreaming ecosystem could include in order to make it more appealing as a product for the professional users (journalists). A larger pilot is planned for this year summertime. Another interested company was Publico (www.publico.pt), another reference in Portuguese newspapers, which also sees the potential in crowdstreaming, namely for crowd journalism purposes in which normal citizens co-exist with journalists in capturing the video from a specific breaking news event such as a terrorist attack. Finally, Canal 180 (https://www.canal180.pt) , is a Portuguese open source TV station that encourages creative processes in video creation and that is also in charge of live streaming large music festivals. MOG´s solution is seen as a way of engaging the audience in a more immersive experience in the festival, creating different points of view for the event and therefore increasing the audience.

The individual exploitation and pre-exploitation work have been presented above and represent a wide range of activities to demonstrate a clear strategy to ensure the use case sustainability after the project lifetime.

4.1.12. RAI

RAI Radiotelevisione Italiana, the Italian Public Service Broadcaster and Italy's largest radio-television broadcasting company, has played a major role in shaping the country's life and customs over the last decades. During the project duration, For RAI, project results will be mainly constituted by the results of the experimental network pilots, in order to gain knowledge about new features offered by 5G technology in the areas of interest of a media company. RAI will exploit project results in two different areas, the final user area to enrich the television experience and in the television production area to use the new network to facilitate the covering of events, exploiting 5G features by providing new services: from audio/video UHD video distribution also as 360° video experience up to the virtual/augmented/mixed reality for immersive services. In particular:

- Knowledge in IP-end-to-end highly distributed broadcast production workflow, cloud/edge-based video and audio encoding, mixed reality for improved TV entertainment

- New TV formats enabled by new features offered by the 5GCity technologies

- Integration of the media company production workflow with new distributed edge network and computing technologies.

The participation to 5GCity increased the RAI knowhow and capacity to bring virtualization paradigm to the extreme edge of the network leveraging 5G also in the media company, enabling development and deployment of new services for emerging markets.

In particular RAI collaborated with other partners of the project for the creation of state-of-the-art television products in order to exploit 5GCity technologies in the area of the television production and in the area of distribution, taking into account UHD content and Immersive experiences in relevant cities. In this environment a particular focus of exploitation activities for RAI is about:

- OTT services in the 5G era.
- Cultural heritage for touristic and museums services.

In particular for the first point, at this stage it is difficult to say if the Broadcaster or OTT services providers will need 5G. The end users will make the decision of adopting 5G based on the flexibility, additional functionality and the cost effectiveness that 5G will provide. We can expect that the video content distribution and services will evolve towards 5G and will use it as a complement to the already existing technologies e.g. the Television broadcasting ones.

For RAI the 5G technology is expected to build on and integrate the previous generations of wireless networks. 5G will support the expected broadcasters' mobile data growth, and at the same time will allow new services for final users and advertisement.

5G will bring network performance enhancements and agility in the network characteristics, and with that, will play an important role in supporting the growth and development of many industries, the broadcasting and media factories included.

In particular for the second point about Cultural Heritage RAI collaborated with the other Italian partners of the project in the production of new content specifically studied for the city of Lucca also in collaboration with the "Giacomo Puccini Foundation" which lead the "Giacomo Puccini house Museum" (http://www.puccinimuseum.org).

In Lucca, as part of the project, RAI realized in collaboration with the Television Production Centre of Torino:

- A 4K-HDR A/V product to be used both for technical distribution tests on the 5G network and as a promotional/informative video of the project.

- A 360° product audio and video as an example of "immersive" experience focused mainly at the Casa Puccini Museum.

More in general, RAI, as leader of the UC4 (UHD Video Distribution and Immersive Services) developed all services needed to run the use case in Lucca and Bristol (Real time video distribution, VoD and Hololens augmented reality) , this experience, as knowhow about 5G service layer, will be precious also for future works (research and industrial) in the environment of new generation networks.

4.1.13. INCITES Consulting SARL

INCITES Consulting SARL is taking advantage of 5GCity project to enhance its knowledge, future market reports and seminars related to 5G networks that will be deployed in future Cities with specific focus on business cases and commercial opportunities via advanced innovative use cases.

More specifically the involvement in 5GCity will give INCITES the opportunity to:

- Enhance its future market reports and seminars related to 5G networks with specific focus on new business cases and opportunities arising from the Neutral Host model.
- Exploit new business models regarding 5G networking and provide technical competitive edge in the drafting of regulatory frameworks for the future digital service economy.
- Provide consulting services to operators regarding the future deployment of 5G networks, cost charging mechanisms and sharing schemes using the Neutral Host model.
- Will be able to perform techno-economic analysis for future investment plans that include various types of technologies and architectures.
- Strengthen INCITES Consulting SARL position as the reference international center of excellence for 5G networking

In detail, during the 5GCity project, INCITES had the opportunity to conduct a survey (as part of MWC19) in order to understand operators' and stakeholders' concerns about the NH model and other issues like spectrum ownership, regulatory considerations, the role of municipalities etc. The analysis of the collected questionnaires provided INCITES with all the necessary details in order to help its clients make informed decisions. Moreover, by leading business modelling and regulatory considerations activities, INCITES had the opportunity to investigate the value proposition and charging schemes of the 5GCity NH model. The gained knowledge allowed INCITES to enhance the Luxembourg's 5G strategy report with both the NH and the edge computing concepts as well as to propose the necessary regulatory intervention.

Luxembourg 5G Strategy

Expert Report

September 2018

The technoeconomic analysis of immersive video services through the NH network provided INCITES with necessary knowledge in order to perform such analyses in similar cases. Indicatively, INCITES has performed a technoeconomic analysis in order to assess the deployment of 5G networks on behalf of the Luxembourgish Government. As part of a consortium, INCITES is now providing advice to the Luxembourgish Government in 5G policies including the Neutral Host concept.

4.1.14. WIND3

WIND3 is the leading operator in the Italian mobile market, with more than 30 million of customers and a market share above 37% for the mobile access. Wind Tre is achieving significant efficiencies and important investments in digital infrastructures. The move towards LTE and LTE-A has been carried out in all the geographic areas where such generations of cellular system were required according to service demand.

5GCity architecture is designed to be compliant to a wide range of use cases according to the fulfilled requirements, especially in terms of latency, resilience, coverage, and bandwidth. One of the challenges is to provide end-to-end network and cloud infrastructure slices over the same physical infrastructure to meet vertical-specific requirements as well as mobile broadband services in parallel. 5GCity has identified three main scenarios which groups the project Use Cases, namely the Neutral Host, Industry vertical (Media and Entertainment) and city services.

In the first scenario (Neutral Host), 5GCity leverages its virtualization platform to enable the cities (or any infrastructure provider) to create dynamic end-to-end slices containing both virtualized edge and network resources and lease it to third-party operators or verticals. The scenario consists of managing the underlying physical infrastructure to offer a set of virtual resources to an operator, who builds, on top, its own services ready for end-user consumption.

The second scenario (Industry vertical) is strictly related to different aspects of the media and entertainment industry, which are strictly integrated into 5GCity project, and encompass all the Use Cases pivoting around video acquisition, editing and delivery.

The third scenario is related to Smart City which is tailored to the specific needs of a city (WIND3 is focusing on the city of Lucca).

Concerning the second scenario, immersive experience with high quality video (HD or UHD videos) for tourists, including 3D video, 360-degree video, Augmented Reality (AR) and Virtual Reality (VR) applications, can be considered. The third scenario exploits the cities' surveillance cameras by deploying a virtualized monitoring service that can process video streams near cameras automatically to identify illegal dumping, and for autonomous mobility in the city to enhance public transportation. Of course, the first scenario is a profitable enabler for all the use-cases belonging to the families of the first and second scenarios.

WIND3 is exploring how to evolve the business opportunities in relation to the current and expected requirements coming from its future customers, either business or consumer. These includes also the Public Authorities that are in charge of managing important events to improve the advanced solutions for Tourism or for new advanced services for the cities. Mobile edge computing (MEC), small cells, network function virtualization (NFV), software defined networking (SDN), orchestration on a multi-tier platform as 5GCITY offered are new achievements to empower the traditional cellular systems. The investigated potentiality of 5GCITY will be very useful for the implementation in WIND3's future 5G infrastructure. We wants to highlight that the participation in the 5G CITY project allows WIND3 to analyse the sustainability of new solutions from technical and economic perspective so as to have a complete vision of all opportunities, in particular profitable business models are concerned with the high investments in the cellular infrastructure and the constraints on sustainability suggest the establishments of partnerships on both service provisioning and infrastructure provisioning, as indicated in the Neutral Host Model. 5GCITY project represents a very useful starting points, to design and deploy new solution to offer solutions for the market needs and improve the competitiveness. WIND3 is involved in the 5G evolution collaborating with different "actors" to create an ecosystem able to introduce and push the innovative technology solution. The 5G technology is significantly more complex than those of the previous generations of cellular systems and requires an approach like that to improve the value because of its introduction. 5GCITY will accelerate with the proposed solutions the IoT and high-quality video services (also in crowded areas) and will enable the «next generation services» for the Entertainment, Smart City.

4.1.15. Accelleran

Accelleran exploitation strategy is based around the following pillars:

- Evolution and enhancement of the disaggregation of the Small Cell software components and the virtualisation of vRAN Control Plane (L3 Control Plane) in the context of the 5GCity virtualisation

- Enablement of the local breakout of the user plane at the Edge/MEC server in the context of the use cases needing Edge/MEC functionality

- Enhancements of multi-operator neutral-host capabilities using standard 4G 3GPP functionality and upcoming 5G-based slicing technologies

- Integration into 5GCity orchestrating platform

- Use of these enhancements in future projects and the exploitation of Accelleran flexible RAN/vRAN software solutions product proposition and the availability of Small Cell products leveraging on those.

Accelleran has already been showing neutral host demos in different events along the lines of the use of Small Cell solutions for Neutral Hosts and private LTE networks (Mobile World Congress Barcelona 2018, CBRS Annual Members Meeting Washington 2018, Small Cell World Summit London 2018) in 3-layer architectures with virtualisation of small cell components running in edge servers.

Accelleran has defined NETCONF model for virtualisation of the Small Cell aligned with i2CAT model for WiFi APs. This model is being used to enable the control and management of the Small Cell from the SDN controller. It is worth to note that this approach (the use of Netconf) is currently being proposed as some of the mechanisms in O-RAN Alliance (www.o-ran.org) for the configuration of the network components from the SMO (Service Management and Orchestration platform).

These technologies are delivered and tried in the city pilots in Barcelona, Bristol and Lucca (https://www.5gcity.eu/2020/01/07/neutral-host-modelling-2-2/) and were used as pilot trials and showcases for other RAN/vRAN products supporting distributed cloud radio platforms to enable neutral host 5G smart city projects such as the one doing jointly with Ubiwhere in 5G Guimaraes (https://www.accelleran.com/vranneutralhostguimaraes/).

These technologies are feeding directly into the commercialisation of Accelleran Small Cell solutions and products. One important example of this is the official launch during MWC2019 of the Accelleran dRAX™ Open Interface RAN Intelligence virtual RAN solution which delivers a true multi-vendor, disaggregated and virtualised RAN Intelligent Control Plane as per O-RAN Alliance. This Cloud Native solution managed and orchestrated through Kubernetes (containers) or OpenStack (VMs) supports key 5G paradigms and enables true scalability and interoperability with carrier and mission critical grade software quality (MISRA). One of the key reference use cases for Accelleran dRAX virtualised RAN solution as indicated in the dRAX™ product brief is the 5GCity project, where Accelleran Small Cells and vRAN components are being used to enable the 5GCity city pilots and 5G neutral host technologies (https://www.accelleran.com/wp-content/uploads/2019/10/Accelleran_DS_dRAX.pdf).

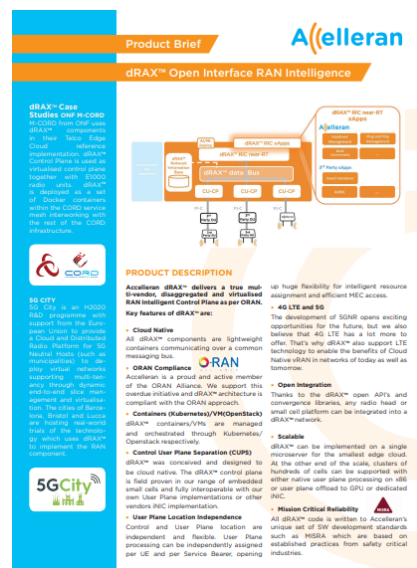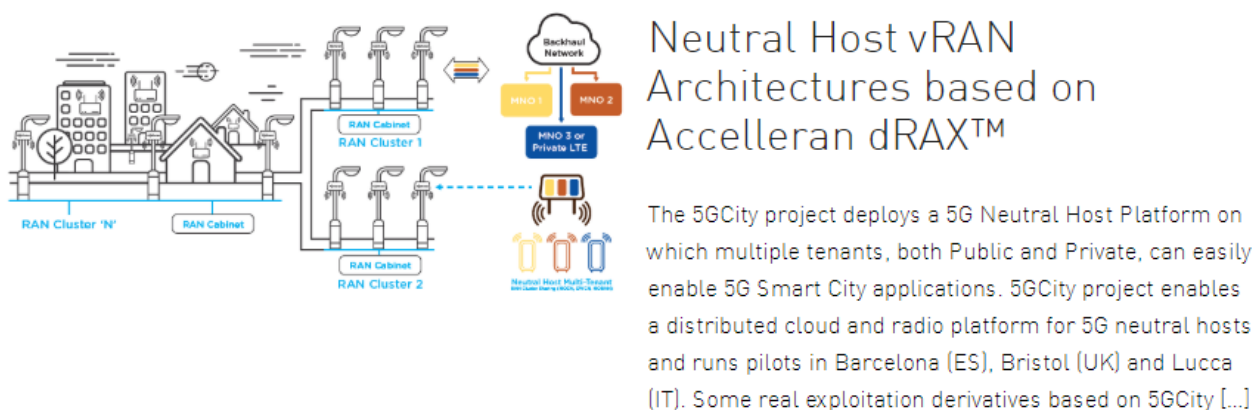Figure 12 - Accelleran dRAX™ Product Brief

Figure 13 - 5GCity Neutral Host vRAN based on dRAX™

4.1.16. Comunicare Digitale

Comunicare Digitale APS – CoDi, with its twenty years' experience in the organization and promotion of new digital technologies for the media and broadcasting industry, participating at the 5GCity project has substantially increase its knowledge on 5G networks, study its future markets, and best practices for the promotion of 5G services, new business, and commercial opportunities.

The results obtained in the communication and dissemination activities have been very positive and so well received that CoDi has participated in another call for a 5G PPP Phase 3, Part 4: 5G Long Term Evolution. It is one of the 13 partners in the **5GZORRO** project- Zero-tOuch secuRity and tRust for ubiquitous cOmputing and connectivity in 5G networks.

In the 5GCity project, CoDi has analysed and promote important events participation, organizing conference, seminars and hackathon related to 5G ecosystem. As previously stated, in these past years, since it has form part of the project; it has included in its major event the **European Digital Forum**, in Lucca the inclusion of 5G discussion and adoption in the media industry. For the 18th edition, the organization of a **5G Forum**, a half day study on the topic has been included.

In the near future, CoDi is also planning the creation and organization of *ad hoc event* that will gather all together the three cities involved in the project: Barcelona, Bristol and Lucca, to create a *5GCity Smart Cities Summit* that will include also other European and worldwide cities involved in the 5G revolution. CoDi will in this way promote liaison activities between all the cities that will activate 5G services and establish commercial opportunities in Europe and abroad. Networking is a "focus goal" to connect and act in Europe; so CoDi will continue to enlarge and strengthen the 5G audience with professionals, companies, associations, stockholders, institutions, public and private entities.

As stated in previous deliverables, CoDi's involvement in 5GCity project has given the opportunity to:

- Deeper its future market liaison and networking opportunities in the 5G ecosystem, between operators, companies, research and European institutions. Cooperation between the various subjects embodies the principle of the European Union. In a continuous effort to build a strong collaboration between them to open new collaborative projects, to strengthen efforts on research, and to cooperate in a concrete way to obtain higher results.

- Creating new promotion and communication opportunities for those business models that will be active in the 5G networking, among the media and entertainment industry. The media represents the first front runner of the development of this new technology, thanks to an "immersive experience", with 4K / UHD and 360º. What it is called the "NGX" (new generation experience) is what CoDi wants to promote. In this sense, with its direct involvement in 5GCity project, and thanks to related events going on in Lucca, and for the history of the demos that have made Lucca visible to the main stakeholders, the proposal is carried forward with important results and appreciations from relevant organizations; such as HD Forum Italia, DPP, Ultra HD Forum.

- Providing consulting services for future investment plans in the future digital economy; on new business arising from the video acquisition and production, UHD video distribution, or immersive services use cases. CoDi will be supporting and adjusting future scenarios on the verticals for a successful European industry in a highly competitive sector. A sector that today sees large companies as protagonists, predominantly based in the United States. The success of the European creative industry, it also passes through 5G deployment; throughout the extraordinary European "open-air library"; the important historic and cultural heritage of each country member; the industry that can speak with only one language in the agri-food, environment, and architecture sectors. In this sense, the video, the quality of distribution and the involvement of a wider audience can create great benefits.

- Strengthening Comunicare Digitale APS international position as the promotion, communication, and networking reference for the excellence of 5G European networking. The mission of evangelization has always been the principal activity of CoDi. It was with DVBT, with DVBSH, with 4K/UHD, 8K, 3D, and today with 5G, also for a holistic view of the connection system.

CoDi has played a circular role in the various activities carried out in the project and in favour of 5G. Events, workshops, meetings, seminars, communication, information, production were the pillars of the various activities that took place in the main European cities.

For the first time, a RAI 360º production was made at **Puccini's House Museum** to verify a series of expected results: quality production, network transport, and mobile devices, immersive involvement of the public, and interaction between them. The production was showcased during the **Lucca Comics and Games 2018** edition, an event that sees and involves many millennials. An audience attentive to technologies and new languages. Taking advantage of a high- level production; a unique European content well known all over the world.

The growth of interest in 5G, as well as, its market applications will create an environment ready to exploit the capabilities and peculiarities at European level by strengthening the proposal and guaranteeing the best possible offering for industrial, institutional, and civil applications.

Maintaining and reinforcing important actions in information, dissemination, promotion and visibility of the various activities are fundamental in this last part of the 5G project for a successful 5G experience in Europe.

4.1.17. **Ubiwhere**

Ubiwhere intends to capitalise on the innovation brought forth within 5GCity, aligned with the company's goals of providing 5G Neutral Hosting solutions. Specifically, in the scope of Smartlamppost, a Joint Venture which Ubiwhere has co-founded, Ubiwhere has been designing and implementing a multi-stakeholder marketplace for site acquisition and lease management, in the form of a web application. One of the main goals of such a marketplace is to easily allow different Operators from different verticals (Telecom, e-Mobility, etc.) to more easily find suitable and available sites which can even take the form of multi-purpose smart urban furniture such as lampposts, bus stops, street cabinets, etc. Thus, Ubiwhere hopes to extend the exiting Smartlamppost Platform with new functionalities that may have been developed under the scope of 5GCity, such as specific components used in 5GCity Dashboard.

Going forward, the company hopes also to extend the work carried out in 5GCity regarding LTE configuration using Accelleran's Netconf interface and further extend the Smart Lamppost Platform functionality, following the same principles adopted in 5GCity which have already even been integrated into 5GCity Dashboard. The initial steps towards such integration have already been demonstrated in June 2019, when both partners collaborated in a real deployment of a private 4G network in the city of Guimarães, Portugal, using one the Smart Lamppost product to host Accelleran's Small Cells.

As for the company's proposed use case on CCAM (Cooperative and Connected Automated Mobility), entirely designed and developed within the scope of the project, the ITS-G5 based solution may now enter the company's portfolio. At the moment, Ubiwhere is targeting different smart city verticals with complete end-to-end solutions from hardware, communications and software (data acquisition, processing and visualisation): smart traffic, smart parking, waste management and air quality monitoring. Having created both a low-cost OBU (On-board Unit) and RSU (Roadside Unit) for this particular scenario, based on low-cost hardware, the company intends to further explore and possibly exploit such assets providing their value for both smart city deployments and transportation.

4.1.18. NEC

NEC is actively seeking to exploit the Unikraft technology partially developed in 5GCity in a number of its business domains. Unikraft allows for automatically building extremely efficient, specialized software stacks resulting in orders of magnitude less resource consumption, boot times, and trusted compute base. As such, it is ideally suited for exploitation in a number of NEC domains. First, this technology can help NEC enhance its cloud-based services, allowing for much more efficient deployment of micro and lambda services.

Second, we are actively in discussions with NEC business units to leverage 5GCIty-develped technologies towards improving our company's IoT portfolio. For instance, many of the deployed solutions rely on Linux distributions, which, while functionally great, consume inordinate amount of resources (e.g., memory) out of the resource-constrained devices that IoT solutions are based on; the effort here is to develop IoT-specialized software stacks with Unikraft.

A final domain which goes beyond the scope of 5GCity but is enabled by some of the groundwork carried out in 5Gcity is automotive, where the need to have a software stack an operating system that is (a) resource efficient (b) provides short delays in support of real time scheduling and (c) has a small trusted compute base for certification cost reasons and security ones make Unikraft particularly well suited for the task; we are starting active discussions with NEC business units and potential third-party partners in this direction.

4.2. Final Joint Exploitation Plans and Activities

5GCity project has created a vast number of joint activities that can envision future joint exploitations. On previous documents the activity carried out has been extensively described, although we will summarize here the key activities, proposals, and results.

A consortium of 18 partners is large to guarantee a common and joint exploitation, either commercial exploitation or of any other type. For that reason, it was decided during the project realisation to split any potential collaboration among the geographical territories where 5GCity is present, namely Barcelona, Bristol and Lucca.

Each of those areas was entitled to support a "hub" where joint exploitation was expected, focusing on the use cases more appropriate for each of them. Those use cases are based on the same use cases of the 5GCity project itself.

Based on these hubs, 4 joint exploitation plans were selected. Some of these plans have been reflected on real joint exploitations, some others are expected to do so after the 5GCity project is finished.

4.2.1. Joint exploitation proposed plans

Four key scenarios for joint exploitation have been selected within 5GCity project. Specific hubs have analysed each of the plans, although all of them are targeted to be applicable in the 3 participant cities in 5GCities, and to any future city deploying the same NH proposed model.

The two first plans have been designed within the Barcelona Hub, the next plan comes from the Lucca Hub and the last from the Bristol Hub.

4.2.1.1. E2E Multi-carrier NH platform deployment and commercialization

As part of the Neutral Host (NH) model described and analysed in the project, the infrastructure deployment and commercialization are the basis for any future revenue generation based on the multiple possible use cases.

This joint exploitation scenario has been further analysed among i2CAT, Cellnex, VoSYS, Accelleran, Incites and IMI. Most suitable scenario for commercial joint exploitation may arrive through all or part of these partners, as the expertise to provide such solutions is distributed among different entities.

The target of this analysis has been the definition of the underlying platform to be used in a city-wide NH platform that can be offered to other cities beyond the participants in 5GCity project.

4.2.1.2. Video acquisition service using dedicated slices of the NH infrastructure

One of the first use cases expected to work over the 5G NH infrastructure is based on video acquisition. This solution aims to offer the ability to produce video content in a city-wide environment, uploading the content through dedicated slices of the network. This procedure can ensure the availability of the high-demanding network resources needed to upload properly contents generated on the spot, seamlessly, from every location in the city environment.

This joint exploitation has been analysed by BTV, MOG, Ubiwhere, IMI, Cellnex and Incites. The focus of the analysis has been around the equivalent Use Case of the 5GCity project tested, with the aim to potentially extend it to other equivalent areas.

4.2.1.3. Immersive Video Services for Smart Cities

A more city-oriented joint exploitation has been designed, aiming to create an offering for tourism enhancement. Different immersive video experiences shall be offered to a Municipality, in order to greatly improve the tourist experience. This can include Augmented Reality over real city monuments or buildings, or virtual reality to present additional information, virtual recreations, etc.

This joint exploitation has been analysed by Accelleran, Nextworks, Italtel, the Municipality of Lucca, RAI, WindTre, Incites and CoDi. Each of the partners has provided its own expertise on the different parts of the proposed solution, in order to suggest potential joint exploitations.

4.2.1.4. (360) Video content distribution in real time

Finally, another joint exploitation plan has been designed to take advantage of the 5GCity activities, oriented to the 360-video distribution on real time. This scenario has proved to have a huge potential for further exploitation, as it can bring real experiences to users that cannot enjoy a physical presence on specific events or locations.

RAI, the University of Bristol, Accelleran and Incites teamed-up for this joint exploitation plan, trying to define potential actions.

4.2.2. Joint exploitation actions occurred during the project

Based on the described plans created by the different hubs, at least one real commercial joint exploitation has been already carried out, and some others are in discussion or planned.

4.2.2.1. Smart Lamppost

 and Accelleran have jointly created a product called "Smart Lamppost", a new kind of multi-tenant and multi-technology street urban furniture, offering Neutral Hosts the chance to use common multi-purpose streetlight poles to provide cellular infrastructure and connectivity. The Smart Lamppost (http://smartlamppost.com) solution, co-developed by Ubiwhere, has integrated both an Electrical Vehicle Charging Station, alongside a fully functioning LTE network, made possible by Accelleran's E1000 Small Cells and Accelleran RAN/vRAN solutions. The unveiling of the solution took place during the kickoff of "Guimarães 5G Ready" project - a long-term vision of the city of Guimarães to digitalise common infrastructure to build

a network of connected things, empowering new businesses and universities, accelerating the research and development of new and innovative services.

Figure 14 - Smart Lamppost (EV Charging & Telco modules)

More information about this joint exploitation and the event presentation can be found here: https://www.5gcity.eu/2019/07/04/ubiwhere-accelleran-league-finals/

4.2.2.2. New Joint Research Projects

As mentioned earlier that most of the planned joint exploitation ideas couldn't materialize with in the life-time of the project due to either difference of priorities in each organization or painstaking slow commercialization process. However, much of the technological advancements combined with the business concepts, was indeed exploited by multiple consortium partners in form of future H2020 proposals. The main idea was to build on top of 5GCity results and enhance beyond the achievements of 5GCity project. Some of the successful joint proposals are given below.

Project Title: *H2020 5GZORRO*

Common Partners: i2CAT, NXW, UBI, and CoDi

5GCity result to be exploited: 5Gcity Platform

Description: i2CAT is the project coordinator and NXW is the technical manager of this project. 5GZORRO uses distributed Artificial Intelligence (AI) to implement cognitive network orchestration and management with minimal manual intervention (Zero-Touch Automation). Distributed Ledger Technologies (DLT) are adopted to implement flexible and efficient distributed security and trust across the various parties involved a 5G end-to-end service chain.

Project Title: *H2020 5GaaS*

Common Partners: i2CAT, NXW, UBI, and Accelleran

5GCity result to be exploited: 5GCity Platform

Description: This project has been funded under the Fast Track to Innovation (FTI) call. 5GaaS intends to develop and launch a new product in the form of a decentralised marketplace for the telecom ecosystem, under a new Joint Venture. This new platform is the culmination of three major components, two of them currently already available in the market: a centralised marketplace for site leasing and tenant management, from Ubiwhere, and dRAX, from Accelleran, an interoperable, standards-based and software-focused implementation of 5G networks. The other innovative component will come out of H2020 5GCity project, to which 5GaaS partners have collaboratively contributed to by building an automated 5G network slicing engine for Neutral Hosts. 5GaaS expands these layers, implementing a decentralised marketplace connecting the whole 5G value-chain of stakeholders such as MNOs, site owners, system integrators and hardware and software vendors, using blockchain technology

4.2.2.3. Common Wireless Interface

Based on developments by Accelleran and i2CAT, and as part of the full 5GCity NH platform, a joint solution including both Wi-Fi and small cell radio access. A common NETCONF management and control interface was defined that integrates both Small Cell and Wi-Fi node control and management plane, allowing for i2CAT's SDN controller to configure both types of devices.

Further exploitations based on this joint asset are under analysis by both partners.

4.2.2.4. Barcelona TV video acquisition

Based on the proposed plan for video acquisition based on 5G dedicate slices in a NH environment, IMI has expressed a real interest to deploy commercially an equivalent solution. BTV, jointly with Cellnex, are working on potential solutions to cover this interest.

Different initiatives have been discussed about this, and among them, a potential new funded project has been applied, under the framework of the "5G Trials" of the Spanish Government. Resolution of this initiative is expected during 2020.

In parallel, a real commercial deployment is under study for an equivalent solution.
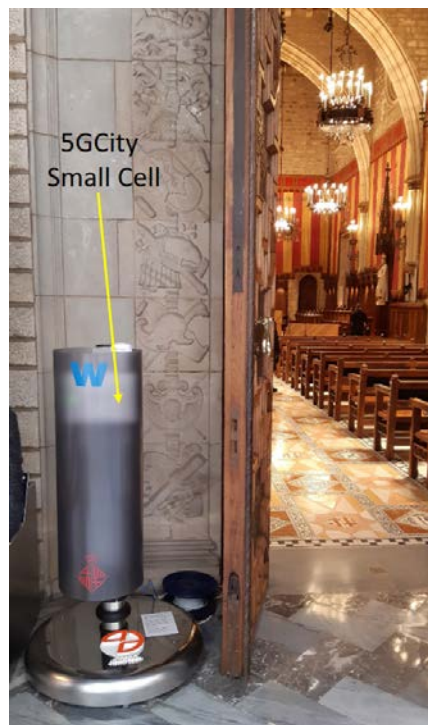
Figure 15 – Picture of the first demo in Barcelona City Council

5. Conclusions

This deliverable reported results of dissemination, exploitation and standardization activities carried out during the 5GCity project. In summary we can affirm that the consortium has successfully build a consistent and relevant impact through the project results.

Regarding dissemination actions, we have to highlight the relevant presence at international level events which maximised visibility for project concepts, progress, and results. The consortium also achieved a high level of relevance participating in international conferences and publishing the project results. In this sense we have to highlight the good result in terms of published papers (27 out of 30 submissions), being most of these papers results of joint collaborations between 5GCity partners.

The project also organised two hackathons, the 1st hackathon in July 2019 hosted by University of Bristol and 2nd one in November 2019 hosted by Commune di Lucca. The two hackathons not only tested the developed platform and deployed infrastructure but also helped improve it. Furthermore, both events highlighted the results of the project and enabled dissemination in open source communities such as ETSI OSM.

In reference to standardization, 5GCity progressed as well on part of contribution to SDOs and open source community with direct code contribution to Unikraft XEN project, ETSI OSM, and Eclipse fog05.

The document also presents the final individual exploitation report and post-project plans and has presented joint exploitation plans per city hub as clusters of different partners: "E2E Multi-carrier NH platform deployment and commercialization" and "Video acquisition service using dedicated slices of the NH infrastructure" plans for the Barcelona hub, "Immersive Video Services for Smart Cities" for the Lucca hub, the plan and "(360) Video content distribution in real time" for the Bristol hub.

Overall, the project has been very productive and successful for the communications, dissemination, standardization, and exploitation activities. However, due to circumstances beyond control, unfortunately the final results and demonstration, planned for MWC20 and a 5GCity workshop, could not be demonstrated publicly in an event.

5.1. Progress on 5GCity KPIs

Based on the related KPIs identified in the 5GCity Description of Action, the consortium achievements are summarized in the following tables.

KPI Identifier	Description	Status
KPI-O1-1	White paper with the architecture	**ACHIEVED**. Released at the end of the project on 5GCity website
KPI-O1-2	Publication of the architecture published in at least two scientific/industrial journals	**ACHIEVED**. 2 Journal publications done (IEEE Transactions on Broadcasting Volume: 65 Issue: 2 June 2019, and Computer Communications 149 2020 pages 232–240) 1 journal publication under evaluation and 1 more under preparation.
KPI-O1-3	At least one contribution to the 5G PPP architecture working group	**ACHIEVED.** 5GCity contributed to the new 5G architecture whitepaper version 2.0, presented in EUCNC 2019

KPI-O6-1	At least 20 publications in relevant conferences and journals	26 accepted/published out of 30 submitted
KPI-O6-2	At least 2 contributions to standardization bodies.	**ACHIEVED.** 6 contributions done
KPI-O6-3	At least 2 white papers	**ACHIEVED.** Contributed to 4 whitepapers among 5G PPP TB, 5G PPP SwNet WG, Mgmt WG, ETSI MEC
KPI-O6-4	At least 2 workshops organized.	**ACHIEVED.** 2 workshops organized at EUCNC2018 + 1 special session on ITALIA5G at IOTHINGS 2018 MILAN

2 workshops organized at EUCNC2019 Organized workshop on Edge & 5G at 8th ETSI OSM Hackathon, Lucca Nov 2019 |
| KPI-O6-5 | At least one pilot demo at MWC. | **ACHIEVED.** Preliminary demos by ACCELERAN at MWC2018. 5GCity platform demos organized at MWC2019 in MWCapital area. |

Table 6 – KPI progress as derived from 5GCity objectives

KPI	Description	KPI	Status
Open source contributions	Accepted contributions to open-source communities: (i) KVM community; (ii) QEMU developers' community; (iii) XEN community; (iv) Open Data Plane (ODP) project; (v) OPNFV project; and (v) Contributions to ETSI OSM	At least 3 accepted contributions to different communities during project lifetime	**ACHIEVED**.

Unikraft project activated on GitHub and as independent website (http://unikraft.org/)

fog-05 continued as Eclipse project and as independent website https://fog05.io/

Organized 8th ETSI OSM Hackathon in Lucca on Nov 2019, and organized two 5GCity hackathons |
Pilots and proof of concepts (PoCs)	Applications deployed in three cities: (i) Neutral host pilot (telecom pilot); (ii) Mobile backpack media unit (media pilot); (iii) UHD video distribution (media pilot); (iv) Video acquisition and edge/cloud production (media pilot); (v) Unauthorized waste dumping prevention (smart city pilot)	1 PoC pilot deployed per city; and one common pilot replicated in the three cities	**ACHIEVED**. All planned 6 use case trials executed in Barcelona, Lucca, Bristol.
Contribution to standards	Contributions to OpenFog consortium Contributions to ETSI NFV Other standards will be analysed in WP6 standardization task	At least 2 accepted contributions	**ACHIEVED.** 6 accepted contributions among OpenFog, ETSI MEC, SMPTE, AMWA
Industry events and ad-hoc meetings	Organization of workshops in national / international events	At least 2 workshops organized, at	**ACHIEVED**. 3 events executed in 2018 (14th EU Digital Forum Lucca, 5G

		gathering cities, 5G, and edge technologies. Participation in the most relevant world-wide events: (i) Mobile World Congress; (ii) Smart Cities World Congress; (iii) Industrial IoT World Congress; (iv) Fog computing Expo; (v) ITS World Congress; and (vi) TV Markets, European Digital Forum, UltraHD 4K Summit	least participation in 2 industry events per year	Barcelona events around MWC18, ITALIA 5G within IOTHINGS 2018 -MILAN) 3 events executed in 2019 (5G Barcelona events around MWC20, 15th EU Digital Forum Lucca, 8th ETSI OSM Hackathon) 2 organized in 2020 but cancelled due to COVID-19 outbreak.
Publications	**Industry-related**	Publications of White papers, magazines, technology roadmaps, and industry-led journals	At least 5	**ACHIEVED**. 6 newsletters issued 1 whitepaper on 5GCity architecture
	Scientific	Publication of scientific results to high-impact journals and leading conferences	At least 15	**ACHIEVED**. 26 accepted/published, 2 under evaluation, 2 in preparation.
	EU events	Presentation of 5GCity results, research and innovation activities, booth and demo set up	At least 1 participation in EU events per year	**ACHIEVED**. Participation to EUCNC2018 and EUCNC 2019 with booth, paper presentations and workshops Participated to ICT2018 Wien with booth and demos
Web site, social networks, press releases		Web portal and social media mechanisms will be employed to demonstrate the potential benefits of the solution that will be developed to highlight 5GCity use cases	Public website; 2 newsletters per year;	**ACHIEVED**. Website online 6 newsletters published
Web site, social networks, press releases		Web portal and social media mechanisms will be employed to demonstrate the potential benefits of the solution that will be developed to highlight 5GCity use cases	1 social networking tool utilized	**ACHIEVED**. Twitter+LinkedIn+Youtube accounts highly visible

Table 7 – 5GCity objectives dissemination specific objectives

6. Abbreviations and Definitions

6.1. Abbreviations

5G IA	5G Infrastructure Association
DoA	Description of Action
EC	European Commission
IPR	Intellectual Property Rights
MANO	Management and Orchestration
NFV	Networks Function Virtualization
NFVI	Networks Function Virtualization Infrastructure
NS	Network Services
PPP	Public Private partnership
SDO	Standard Developing Organization
VNF	Virtual Network Function
WG	Working group
WP	Work Package

6.2. Definitions

No definition is introduced by this document

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