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Abstract

This deliverable provides a final report on dissemination activities implemented within iJOIN. In particular, this report summarises the results of these activities according to the target audience they intended to address: general public, scientific community and industry. The report collects all the publications and presentations produced in the context of the project, as well as the demonstrations that were carried out.

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Abbreviations

3GPP	3rd Generation Partnership Project
Bps	bit per second
EAB	External Advisory Board
EAB	(iJOIN) External Advisory Board
EPC	Evolved Packet Core
Gbps	Gigabits per second
IaaS	Infrastructure as a Service
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
iJOIN	Interworking and JOINt Design of an Open Access and Backhaul Network Architecture for Small Cells based on Cloud Networks
IP	Internet Protocol
iSC	iJOIN Small Cell
LTE	Long Term Evolution
LTE-A	Long Term Evolution Advanced
MIMO	Multiple-Input Multiple-Output
MWC	Mobile World Congress
NFV	Network Function Virtualisation
NGMN	Next Generation Mobile Networks
QoE	Quality of Experience
RAN	Radio Access Network
SDN	Software Defined Networking
SON	Self-Organising Network
VM	Virtual Machine

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1 Executive Summary

This deliverable provides a review of the dissemination activities performed during the whole lifecycle of the iJOIN project. The main areas reported are:

General public dissemination. The project has made an effort to convey the value that the project has for the European industry as well as for the citizens, which are the ultimate users of the technology developed by the project. The means employed to this aim include:

- **Project web page.** The project web page provides a summary of the project and its aims, as well as the main achievements of the project and extensive documentation of the results.
- **Dissemination in traditional communication channels.** Among the dissemination through traditional communication channels it is worth highlighting the substantial impact on traditional newspapers as well as the award received by the project in the region of Madrid.
- **Active presence in the social networks.** In addition to the traditional communications channel, the project has also been active in social networks such as YouTube and Twitter. It is particularly worth highlighting the number of videos available in the project's YouTube channel, including a video on the general presentation of the project as well as some other specific videos of various events (demos, presentations, the project's winter school, etc.).

Scientific dissemination. With the goal of having a long-term impact into future mobile communications technologies, the project has widely disseminated its results through their publication in impactful journals and magazines as well as through the organization of specialized workshops:

- **Publication of project technical achievements in journals and conferences.** The project results have been published in journals and magazines (8 papers published and 11 additional ones accepted) as well as conferences and workshops (27 papers presented and 8 additional ones accepted), which makes a total of 54 papers. Although this is a very remarkable number, it is worth highlighting that the aim of the project has rather been to target highly prestigious venues rather than a large number of publications.
- **Impact of publications.** The ultimate aim of the scientific dissemination is to have impact on the research community. Even though it is still too early to evaluate the impact of the publications resulting from the project, some of the publications have achieved a remarkable number of citations and download despite being very recent, which shows that they have a great potential for impact.
- **Organisation and co-organisation of workshops.** The organization of workshops allows to gather the key experts on iJOIN related activities, which is an excellent means for disseminating the project results to the most influential researchers in the area as well as to get their feedback. The project has organized a total of 6 workshops, some of them in cooperation with other FP7 projects. Of those, it is worth highlighting IWCPM, which is organized exclusively by iJOIN and has a special focus on iJOIN related technologies. This workshop has been held twice, co-located with the two most prestigious conferences in the area (IEEE ICC and IEEE GLOBECOM). In both cases, the workshop attracted key experts in the area and was very successful.

Dissemination towards innovation. The project has also disseminated its results to industry and innovation related fora with the goal of having direct impact into the ongoing roadmaps for communications products and services. As compared to scientific dissemination, these activities target shorter term impact into the technology. Among the various activities conducted towards this aim, we can highlight the following ones:

- **Involvement with industry forums and special interest groups.** The project has participated to various industry forums and events, including the various concertation organized by the commission which typically have an innovation-oriented scope. Among those, we can highlight the IWPC workshop organized by Telecom Italia; IWPC is one of the flagship industrial workshop and attracts the main industrial players worldwide.
- **External Advisory Board.** The External Advisory Board (EAB) of the project includes the main industrial partners in Europe and is thus an excellent means of disseminating the project results to the European industry outside the consortium. Project results have been regularly presented to the EAB members, and their have been collected and addressed in the project.

- **Live demonstrations of iJOIN technology.** The demonstration of the technology developed by the project in real-life testbeds is an excellent means of showing the potential of the project results and their feasibility. Among the various demonstrations shown by the project, the one at the **Mobile World Congress (MWC) 2015** was particularly impactful and attracted the attention of many industrial players.

Full details about the demonstrators of the project, that have been defined and developed in the context of WP6 activities, are provided in a separate deliverable (D6.2). Similarly, standardisation activities, which represent one of the main means of dissemination and impact of iJOIN results, are reported in deliverable D7.3.

2 Introduction

The iJOIN project has developed novel operation and management algorithms to (i) optimally operate a very dense mobile network, (ii) flexibly split functionality between RANs and the RANaaS environment, and (iii) jointly operate the access and backhaul network layer. The ultimate goals of the technology developed by iJOIN are (i) optimise the RAN system throughput, and (ii) provide services instantly and efficiently in terms of cost, energy, complexity and latency wherever and whenever the demand arises. The iJOIN project has defined and proposed the various protocols and algorithms and the corresponding mobile network architecture needed for this purpose.

In the above context, iJOIN has looked at very advanced technologies that (i) bring important benefits to society and users, by providing higher speed Internet access and mobility support at lower cost; (ii) have strong scientific value, as they rely on disruptive ideas and lead to new paradigms; and (iii) have a high potential impact to industry by making European companies more competitive and thus strengthening the job market on high advanced technologies. For these reasons, the project has put a strong effort in making these results visible to the various actors that may benefit from iJOIN, by disseminating the project results to the different communities.

The objective of this deliverable is to report on the dissemination activities carried out by the project, how they were implemented, and the achieved results. These activities had the objective to ensure that the results of the project were properly advertised during its time span and made available to the scientific community as well as to industry. The deliverable does not only describe the activities performed by the project but also the main outcomes and impact of these activities during the project lifetime.

The deliverable is structured into three main sections, each one corresponding to the target audience of the dissemination activities. Section 3 focuses on the dissemination actions that have been carried out in order to make the project known to the general public that is interested in mobile technology and 5G. Section 4 is devoted to the activities performed to disseminate the project results within the scientific community, such as the publication of papers in scientific journals, the presentations in top conferences and the organization of workshops, as well as the live demonstrations shown in several events. Finally, Section 5 describes the dissemination efforts towards the industrial players that may implement the technological innovations proposed by the project, including the participation in industrial forums and European innovation initiatives.


Complementary to this deliverable, D7.3 reports on the exploitation plans of the partners in order to incorporate the project results into product and services, as well as the standardisation efforts that have been undertaken by the project towards facilitating the exploitation of its results.

3 Project public presentation

In this section, we present the activities undertaken to promote the knowledge of the project for the general public that may be interested in the evolution of the mobile technologies. In this sense, it is important to highlight that Europe is making a very significant bet on 5G and it is important to convey the importance and advantages of this strategy to the general public. iJOIN has made an effort to present its work in a comprehensible way, using for this purpose different communication channels.

3.1 Project web site

The project created and has been maintaining a web site that can be found at: <http://www.ict-ijoin.eu/>



**Interworking and JOINT
Design of an Open Access
and Backhaul Network
Architecture for Small Cells
based on Cloud Networks**

Home Description Partners Deliverables Dissemination Related initiatives News

iJOIN is an FP7 STREP project co-funded by the European Commission under the ICT theme (Call 8) of DG CONNECT.

Facts

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Estimated effort:	517 PM
Call identifier:	FP7-317941

Brief

Future mobile networks will have to provide an exceptionally greater traffic volume in the near future, expecting an increase of up to 500-1000 times today's throughput by 2020. Since the improvement in the transmission rate obtained with physical layer techniques is limited, the best solution to increase the system throughput is by spatial reuse. In this sense, the use of very dense, low-power, small-cell networks with a very high spatial reuse appears to provide a promising option to handle future data rate demands. Nevertheless, this approach faces several challenges: first, small-cell deployments will require a high degree of coordination due to strong inter-cell interference. Furthermore, heterogeneous backhaul solutions will be used to connect small-cells and core network, but so far, access and backhaul are individually designed and therefore not optimised jointly.

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Figure 3-1: iJOIN project website

This web site contains information such as:

- General information on the project organisation and the consortium.
- Access to public deliverables, papers and presentations produced by the project.
- Reference to the latest news and upcoming events in the field of interest of the project.
- Access to the videos produced by the project, including the public presentations in the iJOIN Winter School.
- Access to the web sites of related FP7 projects that have cooperated with iJOIN.

This web site has been regularly updated in order to reflect the project progress.

3.2 Project presence in social networks

iJOIN has made use of other communication channels in order to make people aware of and disseminate its results. In this sense, it has shown an active presence inside social networks.

The project set up the Twitter account @ICT_ijoin, which provides not only information about the project activities, meetings and events iJOIN is involved, but also technical information (links to news, papers, etc.) that may be of interest to people following the project. The account has more than 60 followers, mainly researchers from wireless technology field, but also the official Twitter accounts of several EU projects.

An example of the iJOIN activity in Twitter is shown in Figure 3-2, which shows four tweets related to the project demo at the Mobile World Congress (MWC) 2015. One of them was generated by the project itself, while the others were made from other accounts (including Mario Campolargo's) and retweeted.



Figure 3-2. Some highlights of the iJOIN Twitter activity during the MWC 2015

The project has produced a total of 22 videos, which is an impressive amount of video material, accounting for almost 10 hours of playback time. 16 of these videos show talks given during the 2015 Winter School, 3 videos cover iJOIN presence in MWC 2015 and EUCNC 2014, and 3 videos have been produced for the sake of general project dissemination. Of those, we can highlight a video that has been produced in order to explain the main project ideas and goals at a level that can be understood by the general public. In order to facilitate the access to this material, the project has set up a YouTube channel.

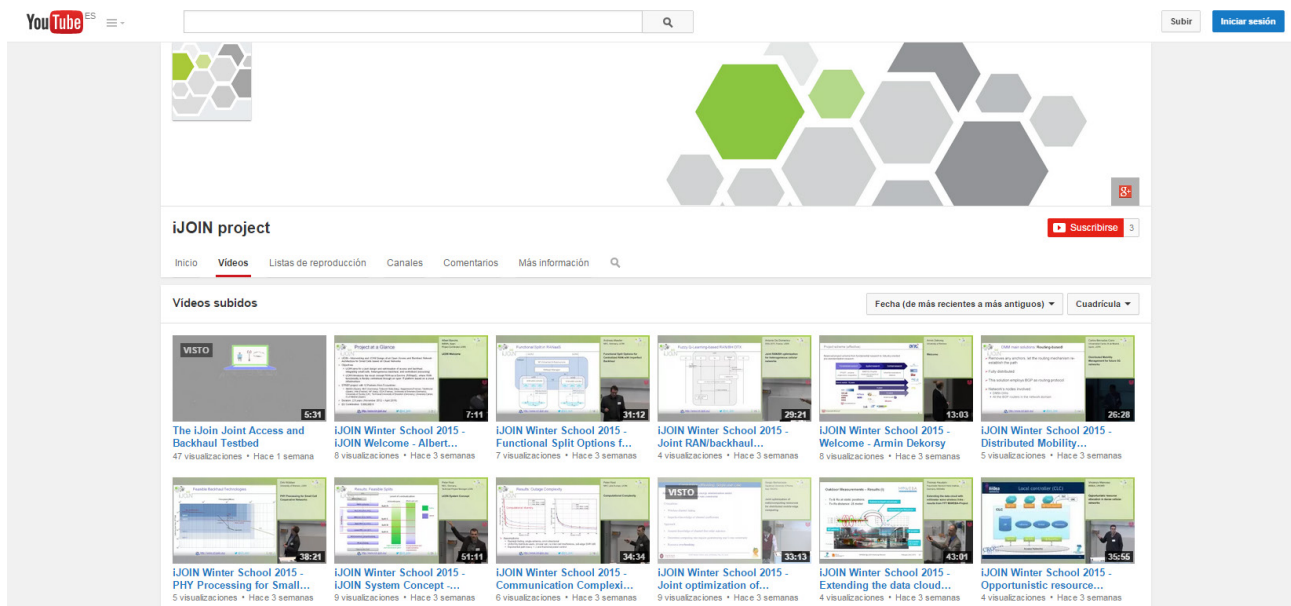


Figure 3-3: iJOIN YouTube channel

3.3 Wikipedia presence

The 5G keyword is one of the best ways of reaching out the general public, as this term is becoming widely known and perceived to an innovative technology. In this respect, it is very useful for the dissemination of iJOIN to be associated to 5G. iJOIN has been quite successful in associating itself to 5G, as shown by the media press articles reported in this deliverables as well as the presentation of the European commission which include iJOIN as one of the flagship European projects on (pre-)5G technologies. In particular, it is important to highlight that the iJOIN project is mentioned in the Research Projects and History sections of the 5G entry in the Wikipedia, along with other EU funded projects like METIS or CROWD.



Figure 3-4: Mention of iJOIN project in the Wikipedia 5G entry (<http://en.wikipedia.org/wiki/5G>)

3.4 Project presence in other media

The project has also been willing to have a presence in traditional media. In this sense, iJOIN has been mentioned by several traditional media, including:

- Spanish press: AlphaGalileo [17], Madrimasd notiweb (the Madrid regional government press) [18], madridiario [19].
- German press: nwzonline[20], heise.de [21], automotiveIT [23], among others.

The project also published an article on the DG Connect's research*EU Focus Magazine special issue on 5G ("Why the EU is betting big on 5G", February 2015) [24].

Also, the following press releases have been generated by the project, or anyhow mention iJOIN:

- Press release of the Madrid Government regarding the iJOIN project [22].
- Press release published on the IMDEA webpage. Also appeared in the research sites AlphaGalileo and Madrimasd Notiweb (November 2012) [2].
- Press release of the European Commission listing iJOIN as one of the 5G key projects (February 2013) [1].
- Press release by the German VDI (Society of German Engineers) explaining iJOIN and its relevance for 5G (January 2014) [10].
- Press release of the European Commission listing iJOIN as one of the key projects on what 5G can do for you (February 2014) [11].
- Press release of the European Commission listing iJOIN as one of the key projects for the 5G to become a leap forward (July 2014) [12].
- Press releases covering the presence of iJOIN on MWC 2015: press notes published on the IMDEA webpage [14].
- iJOIN has also contributed to the dissemination of activities to the general public on 5G. Europe is making a bet on 5G and iJOIN has helped conveying the importance and advantages of this bet to the general public. An example with some news (Spanish media) is shown in Figure 3-5. Other examples of mentions of iJOIN in relation to 5G can be found in [25][26][27][28][29].

The figure displays four examples of news articles from Spanish media outlets related to 5G technology and iJOIN. The articles are:

- Top Left:** A screenshot of a news article from **TECNOLOGÍA** with the headline "Redes 5G: claves de la revolución tecnológica (y social) que está por venir". It features a video player and a search bar for "EFE: FUTURO".
- Top Right:** A screenshot from **EL MUNDO** (Edición España) with the headline "El 'epicentro' de todas las redes". It lists several bullet points about technology transfer and research projects.
- Bottom Left:** A screenshot from **EFE: FUTURO** with the headline "Redes 5G: la revolución de las comunicaciones. Por Arturo Azcorra". It discusses how 5G will transform our perception of the world.
- Bottom Right:** A screenshot from **SINC** (La ciencia es noticia) with the headline "Redes 5G, la comunicación futurista para el usuario del presente". It mentions that 5G will become a reality in 2020.

Figure 3-5: Some examples of iJOIN presence in Spanish national news related to 5G

On top of this, on October 2013 the iJOIN research project was recognized in the Ninth madri+d Awards, receiving a Runner-up prize for Best European R&D Cooperative Project [5]. This category awards research projects approved by the European Commission and funded under the Cooperative Program of the Seventh Framework Program that are coordinated by research groups from universities or public research centers that are a part of the madri+d system.



Figure 3-6: Albert Banchs, Coordinator of the iJOIN project, receives the prize from the President of the Madrid Regional Government

The prize has been awarded to iJOIN for its focus on technology that is key for the proper utilization of a scarce and strategic resource such as the radio spectrum, and for its contribution to place the Madrid region in the forefront of scientific leadership in a highly innovative sector.

iJOIN has been further listed in multiple analyst reports. Those reports are usually issued by independent analysts who investigate a certain industry, its main stakeholders, and business outlook. iJOIN has been mentioned by Mobile Experts report “Cloud-RAN: Enabling NFV in Mobile Networks” as one the main research initiatives in this area (as the only EC funded project). Again, iJOIN’s results on backhaul and fronthaul requirements are listed in Mobile Experts’ forecast on for split-baseband RRH deployment over the next five years.

iJOIN is also one of the projects identified by 4G Americas as one of the most relevant European ones for 5G definition as of the first quarter of 2014, in its report “4G America’s Summary of Global 5G Initiatives” [13].

4 Scientific dissemination

One of the main objectives of the project is to ensure that the knowledge created and the results obtained by iJOIN are known to the people working in the research community. For this purpose, the research results from iJOIN have been disseminated in a number of conferences and journals, as well as through focused events and workshops. This section provides an overview of the chosen publication targets, and indicates where the output from work in specific work packages (WPs) has been published. It also reviews the impact that the outcomes of this activity so far. The full list of papers submitted and/or published by project members is collected in Appendix A. Table 4-1 summarises the dissemination numbers.

Table 4-1: Summary of scientific dissemination

	Accepted/Published	Submitted
Journals/Magazines	18	6
Conferences and workshops	35	5
Presentations	19	N/A
Demonstrations	5	N/A

4.1 Journals

The iJOIN project has submitted several papers to specialized peer reviewed journals and magazines, as well as to wider scope magazines which focus on providing current information on hot topics, implementations, and best industry practices.

Overall, iJOIN has produced – as of 30th, April 2015 – 23 articles for journals and technical or information distributing magazines. 8 papers have been already published (2 of them in IEEE Access open journal), 6 have been already accepted and 9 are still in the evaluation phase. The full detailed list is available in *Appendix A: Scientific dissemination activities during the project lifetime*.

In the category of journals and technical magazines, publication targets have been of outstanding excellence, including, among others, the following (we also include the Impact Factor as well as the position of the journal according to the Journal Citation Report of 2013):

- IEEE Transactions on Wireless Communications (Impact Factor: 2.762, 8/78 in Telecommunications).
- IEEE Journal on Selected Areas in Communications (Impact Factor: 4.138, 4/78 in Telecommunications).
- IEEE Transactions on Communications (Impact Factor: 1.979, 14/78 in Telecommunications).
- IEEE Transactions on Information Theory (Impact Factor: 2.650, 37/248 in Engineering, Electrical & Electronic).
- IEEE Transactions on Vehicular Technology (Impact Factor: 2.642, 10/78 in Telecommunications).
- IEEE Transactions on Mobile Computing (Impact Factor: 2.912, 6/78 in Telecommunications).
- EURASIP Journal on Wireless Communications and Networking (Impact Factor: 0.805, 55/78 in Telecommunications).

In the category of general information magazines, the following publications have been addressed:

- IEEE Access (N/A).
- IEEE Communications Magazine (Impact Factor: 4.460, 3/78 in Telecommunications).
- IEEE Communications Surveys and Tutorials (Impact Factor: 6.490, 2/78 in Telecommunications).
- IEEE Wireless Communications Magazine (Impact Factor: 6.524, 1/78 in Telecommunications).
- IEEE Wireless Communications Letters (Impact Factor: 1.463, 27/78 in Telecommunications).
- IEEE Signal Processing Magazine (Impact Factor: 4.481, 9/248 in Engineering, Electrical & Electronic).
- Communications of the ACM (Impact Factor: 2.863, 5/105 in Computer Science, Software Engineering).

- Elsevier Ad Hoc Networks (Impact Factor: 1.943, 16/78 in Telecommunications).
- Springer Telecommunication Systems (Impact Factor: 1.163, 37/78 in Telecommunications).
- ITG News (N/A).

4.2 Conferences and events

The project has contributed to various scientific conferences in the area of mobile communications. Overall, iJOIN contributed with submissions to 37 events during its lifetime, whose detailed list can be found in *Appendix A: Scientific dissemination activities during the project lifetime*. Hereafter we list some of these events:

- IEEE Global Communications Conference (GLOBECOM 2013-2014-2015).
- IEEE International Conference on Communications (ICC 2013-2014-2015).
- IEEE International Symposium on Personal, Indoor and Mobile Radio Communications (PIMRC 2013-2014).
- IEEE Vehicular Technology Conference (VTC 2014-2015).
- IEEE International Symposium on Information Theory (ISIT 2013).
- European Conference on Networks and Communications (EuCNC 2014-2015).
- International ITG Workshop on Smart Antennas (WSA 2013-2014).
- European Conference on Networks and Communications (EuCNC 2014-2015).
- International Symposium on Wireless Communication Systems (ISWCS 2014).
- International ITG Conference on Systems, Communications and Coding (SCC 2015).
- European Wireless Conference (2014).
- International Conference on Mobile Networks and Management (ICMNM 2014).
- VDE ITG Zukunft der Netze (2014).

In addition to these peer-reviewed international conferences and workshops, iJOIN was invited to participate on the panel discussion of the Radio Access and Spectrum (RAS) meeting that took place the day before the 11th Future Networks Concertation plenary meeting in Brussels. The topic of the iJOIN contribution was “Benefits and challenges of cloud technologies for 5G”.

4.3 Organization of workshops and other events

In order to more effectively disseminate its results, iJOIN committed to collaborate in and lead the organisation of several workshops. In order to maximise their impact, they were collocated with some of the conferences cited in the previous section, usually the day before or after the main event. Across these workshops, overall 19 presentations from the project were carried out, and panels as well received an active contribution from iJOIN.

We next list the workshops that have been organised by iJOIN:

- **CLEEN 2013**: First International Workshop on Cloud Technologies and Energy Efficiency in Mobile Communication Networks.

It took place in conjunction with IEEE VTC 2013 fall, 2-5 September 2013, Las Vegas, USA.

This workshop was a joint initiative organised by three ICT projects funded by the European Commission under the Seventh Framework Programme (FP7), and it covered common aspects of interest about new technological trends in mobile communications. Specifically, the collaborating projects were: iJOIN, TROPIC and Mobile Cloud Networking (MCN). The detailed workshop agenda can be found at [6][1][6].

The workshop explored novel concepts to allow for flexibly centralised radio access networks using cloud-processing based on open IT platforms, to allow for a high quality of experience for mobile

access to cloud-processing resources and services, and to allow a future network evolution focused on energy efficiency and cost-effectiveness. In fact, all future innovative network solutions will be conceived and deployed with a long term perspective of sustainability, both in terms of energy consumption of mobile network (and related interoperability with terminals) and cost efficiency of the different deployment and management options. This requires new concepts for the design, operation, and optimization of radio access networks, backhaul networks, operation and management algorithms, and architectural elements, tightly integrating mobile networks and cloud-processing. The workshop covered technologies across PHY, MAC, and network layer, as well as technologies which translate the cloud-paradigm to the radio access and backhaul network, and analysed all the network evolutions from the energy efficiency perspective. It also studied the requirements, constraints, and implications for mobile communication networks, and also potential relationship with the offered service, both, from an academic and industrial point of view.

- **IWCPM 2013:** The First International Workshop on Cloud-Processing in Heterogeneous Mobile Communication Networks.

This workshop was organised by the iJOIN project and took place in conjunction with IEEE Globecom 2013, Atlanta, Georgia, December 13th, 2013 (<http://www.ict-ijoin.eu/iwcpm2013>). In addition to the presentation of eight scientific presentations from academia and industry addressing novel technologies for flexibly centralized radio access networks using open IT platforms, high profile speaker from NTT DoCoMo (Japan), Nokia Solutions and Networks (USA), Huawei (China), NEC (USA), and University of Aalborg (Denmark) shared their views in keynote talks and a panel. The detailed workshop agenda can be found at [7].

- **CLEEN 2014:** Second international workshop on Cloud technologies and Energy Efficiency in mobile communication Networks. Also co-organised by iJOIN, TROPIC and MCN, in conjunction with IEEE WCNC 2014 – April 6, 2014 – Istanbul, Turkey.

The project objective was to explore novel concepts to allow for flexibly centralised radio access networks using cloud-processing based on open IT platforms, to allow for a high quality of experience for mobile access to cloud-processing resources and services, and to allow a future network evolution focused on energy efficiency and cost-effectiveness.

- **iJOIN Winter School “5G Cloud Technologies: Benefits and Challenges”:** February 23rd- 24th 2015, Bremen. This two-day workshop hosted a number of presentations from iJOIN and other research projects (MiWeBa, HARP, TROPIC, CROWD, METIS, MCN), companies (Nokia, Intel), operators (Vodafone, Telefónica I+D, Telecom Italia) as well as the Small-Cell forum looking at the role of cloud computing in 5G networks. The program as well as the presentations are available on the webpage (<http://www.ict-ijoin.eu/ijoin-winter-school/>). Additionally, video recordings of the talks have been published in iJOIN’s Youtube channel [9].

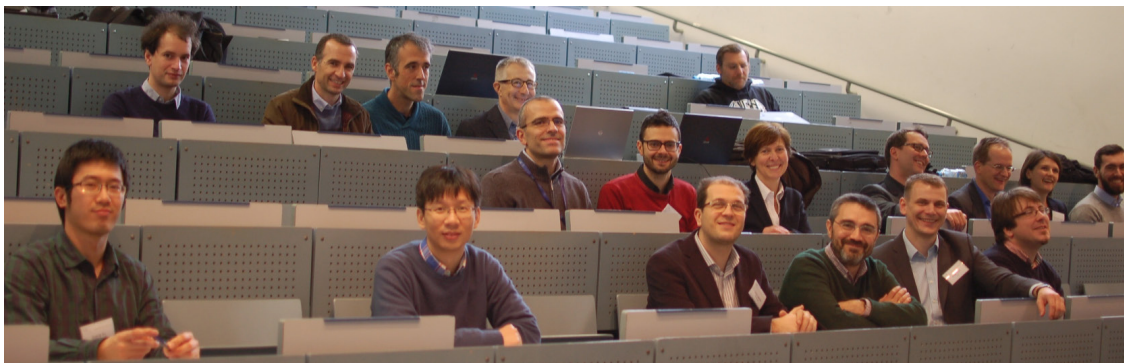


Figure 4-1: Participants in the iJOIN Winter School, 2015

- **IWCPM 2015:** The Second International Workshop on Cloud-Processing in Heterogeneous Mobile Communication Networks.

It will take place in conjunction with IEEE ICC 2015, London, UK, June 13th, 2015 (<http://www.ict-ijoin.eu/iwcpm2015/>). The detailed program can be found at [8].

Heterogeneous radio access networks where macro-cellular networks are complemented by dense small-cell deployments promise to provide exceptionally greater wireless area capacity through an increased spatial utilisation of the spectrum. Due to strong inter-cell interference, heterogeneous networks will require a high degree of coordination as offered by centralised processing. The IWCPM workshop explores novel concepts to allow for flexibly centralized radio access networks using cloud-processing based on open IT platforms, and to allow for a high quality of experience for mobile access to cloud-processing resources. This requires new concepts for the design, operation, and optimisation of radio access networks, backhaul networks, operation and management algorithms, and architectural elements, tightly integrating mobile networks and cloud-processing. The workshop covers technologies across physical layer, medium access control layer, and network layer, and technologies translating the cloud-paradigm to the radio access network and backhaul network. It studies the requirements, constraints, and implications for mobile communication networks.

This workshop provides the presentation of ten peer-reviewed research papers and keynote speeches from well-known experts from NEC (UK), Samsung (UK), Nokia (Germany), Small Cell Forum, and Alcatel-Lucent (Germany).

- **5GArch 2015:** iJOIN is co-organizing together with the EU project METIS the 1st International Workshop on 5G Architecture (5GArch 2015), co-located with VTC-spring-2015 in Glasgow. The scope of this workshop is on novel mobile network architectures for 5G, which is the focus of the two EU projects organizing the workshop. Indeed, today's radio and core network architectures do not provide the required flexibility to cope with requirements from new 5G applications like low latency, high reliability, or deep indoor coverage. Furthermore, applications like machine type, public safety, ultra dense networks are supported by today's architectures in suboptimal ways. Addressing these challenges calls for new architectural designs based on flexible allocations of functions, Network Function Virtualization and software-defined implementations, which is precisely the focus of this workshop.
- **CLEEN 2015:** Third international workshop on Cloud technologies and Energy Efficiency in mobile communication Networks. Co-organised by iJOIN, TROPIC and CROWD projects, in conjunction with EuCNC2015 – June 29, 2015 – Paris, France. This workshop has been confirmed shortly before the publishing of the present deliverable, and will take place two months after iJOIN formal conclusion.

4.4 Demonstrations

Another key dissemination vehicle of the iJOIN project have been demonstrations. The live demonstrations of iJOIN technology allowed to showcase relevant technologies for the project with early prototypes of our work. The main events where iJOIN showed a demo are listed below:

- IEEE WoWMoM 2013, “Mobility Management in Next Generation Mobile Networks”, June 2013. This demo showed the main advantages of adopting a Distributed Mobility Management (DMM) approach, using the open source implementation maintained by the project available at <http://www.odmm.net/>. A video of this demo (<https://www.youtube.com/watch?v=D5vM-xhuDMo>) is available on the iJOIN YouTube channel.
- EuCNC 2014, “SDN-based mobility”, June 2014. This demo showed the first version of the SDN-based mobility approach developed within WP4. It validates the design decisions the project took in terms of the mechanisms adopted to manage, monitor and control the backhaul, which namely consist in using OpenFlow to orchestrate the operate of the network from a logically \square unneling \square d controller. This is basically an initial version of the demonstrator shown at the Mobile World Congress 2015 (described later in this deliverable). A video of this demo (<https://www.youtube.com/watch?v=giP46Xk47ts>) is available on the iJOIN YouTube channel.

A detailed description of the demo is included next. The proposed SDN-based Mobility Management solution uses OpenFlow 1.3 as Southbound API and RYU as Network Controller. The Network Controller it is responsible to store the users' mobility sessions and to configure properly the anchors. By the access network's point of view, any OpenFlow-enabled node can play the role of anchor. Unlike classical protocol such as GPT and PMIPv6, our solution does not involve any \square unneling mechanism. This can be done by having an IP-based access network where the internal routing is independently driven by MPLS or 802.1Q VLANs. Our implementation deals only the

case where the whole access network is Ethernet based. The internal routing is thus performed using 802.1Q VLANs. As a use case to show the benefits of our SDN-based solution, the MN run multiple flows and a different anchor is selected for each flow. The anchor selection is based on the characteristics of the flows. Furthermore, we cover the use case of network reconfiguration, namely the case when a branch of the network is switched-off for energy saving purpose. In case of anchors placed in the switched-off branch, that have been already assigned and are still active, we show the anchor reassignment mechanism where new anchors are selected in the active branch of the network.

- EuCNC 2014, “Evaluation of a 3GPP LTE turbo decoder implementation on general purpose hardware”, June 2014. This demo showed the first version of the Cloud-RAN scheduling demo presented at Mobile World Congress 2015 that demonstrates the decoding of 3GPP LTE turbo codes in a RANaaS implementation using general purpose CPUs. A video of the demo can be found in iJOIN’s YouTube channel at <https://www.youtube.com/watch?v=fR4A1mhrSas>. For details, the reader shall be referred to the description below. However, compared to the version presented at MWC 2015, this version did not yet expose all the features and contained an earlier version of the scheduling algorithm.
- Grand opening 5Glab Germany, “60/300 GHz Short-Range Transmission: A Multi-Gbit/s Wireless Data Link”, September 2014. During the opening event of the 5G Lab Germany [16], iJOIN’s joint access and backhaul testbed, which includes a 60 GHz wireless link, was showcased in the context of 5G technologies. It demonstrates millimeter wave wireless technology in general as well the joint coding approach discussed in deliverable D2.3. The setup was identical to the one specified in deliverable D6.2, which is also described in one of iJOIN’s youtube videos <https://www.youtube.com/watch?v=TctCMAE1dml>.
- Mobile World Congress 2015, March 2015, two demos from iJOIN. Given the industrial scope of this event, we have described it in Section 5.2.1 along with the innovation-focused dissemination activities of the project.

After the completion of iJOIN, a permanent demonstration of iJOIN technologies will remain available at the premises of Telecom Italia.

The *Appendix A: Scientific dissemination activities during the project lifetime* reports the detail of all live demonstrations.

4.5 Impact of dissemination

The iJOIN project has achieved a significant impact in the scientific community. A simple, but very representative, figure of merit to assess the scientific impact is the number of times a publication has been accessed/downloaded and its number of citations. The following papers stand out for the number of citations (as provided by Google Scholar) and downloads (provided by IEEE Xplore Digital Library), as of April 27th, 2015:

- 1) P. Rost, C. J. Bernardos, A. D. Domenico, M. Di Girolamo, M. Lalam, A. Maeder, S. Sabella, D. Wübben, “Cloud technologies for flexible 5G radio access networks”, *Communications Magazine*, IEEE 52 (5), 68-76, 2014. 39 citations/1138 downloads.
- 2) J. C. Zuniga, C. J. Bernardos, A. de la Oliva, T. Melia, R. Costa, A. Reznik, “Distributed mobility management: a standards landscape”, *IEEE Communications Magazine* 51 (3), 80-87, 2013: 26 citations/780 downloads.
- 3) D. Sabella, P. Rost, Y. Sheng, E. Pateromichelakis, U. Salim, P. Guitton-Ouhamou, M. Di Girolamo, G. Giuliani, “RAN as a service: Challenges of designing a flexible RAN architecture in a cloud-based heterogeneous mobile network,” *Future Network and Mobile Summit (FutureNetworkSummit)*, 2013, 1-8, 2013: 15 citations/804 downloads.
- 4) C. J. Bernardos, A. de La Oliva, P. Serrano, A. Banchs, L. M. Contreras, H. Jin, J.C. Zúniga, “An architecture for software defined wireless networking,” *Wireless Communications*, IEEE 21 (3), 52-61, 2014: 15 citations/1502 downloads. This publication appears shortlisted in the top 50 most

frequently downloaded documents (occupying the 22nd place) for IEEE Wireless Communications magazine according to the most recent monthly usage statistics.

- 5) D. Wübben, P. Rost, J. Bartelt, M. Lalam, V. Savin, M. Gorgoglione, A. Dekorsy, G. Fettweis, "Benefits and Impact of Cloud Computing on 5G Signal Processing," IEEE Signal Processing Magazine 31 (6), pp. 35-44, Nov. 2014: 8 citations/1055 downloads.

It is also important to highlight that the paper 4) in the list above was selected by IEEE Communications Society as free article of the month.

Additionally, as iJOIN has also contributed to open access publications, like IEEE Access, it is possible to know the number of times the papers have been viewed and/or downloaded. In this sense, the paper "Energy Efficiency Benefits of RAN-as-a-Service Concept for a Cloud-Based 5G Mobile Network Infrastructure," authored by D. Sabella, et al., published in IEEE Access in December 2014, has been either downloaded or viewed as full text in HTML 774 times. The paper "Graph-based Multi-cell Scheduling in OFDMA-based Small Cell Networks", authored by E. Pateromichelakis et al., and published in IEEE Access in August 2014, has been downloaded or viewed a total of 310 times.

In addition to journals and magazines, iJOIN has also achieved a remarkable impact via papers presented in conferences. On this matter, we want to highlight the number of citations obtained by the following papers:

- 1) D. Sabella, P. Rost, Y. Sheng, E Pateromichelakis, U. Salim, P. Guitton-Ouhamou, M. Di Girolamo, G. Giuliani, "RAN as a service: Challenges of designing a flexible RAN architecture in a cloud-based heterogeneous mobile network," Future Network and Mobile Summit (FutureNetworkSummit), 2013, 1-8, 2013: 15 citations.
- 2) C. J. Bernardos, A. de Domenico, J. Ortin, P. Rost, D. Wübben, "Challenges of designing jointly the backhaul and radio access network in a cloud-based mobile network," FUNEMS, June 2013: 10 citations.

It should be noticed that also some of the iJOIN contributions to standards (more details can be found in D7.3) have also achieved a significant number of citations by scientific papers. Due to this, we also highlight next the most representative standards contributions in terms of number of citations:

- 1) C. J. Bernardos, "Proxy Mobile Ipv6 extensions to support flow mobility," Internet draft, 2015: 48 citations.
- 2) C. J. Bernardos, A. de la Oliva, F. Giust, "A PMIPv6-based solution for distributed mobility management," Internet draft, 2015: 29 citations.
- 3) C. J. Bernardos, "PMIPv6-based distributed anchoring," Internet draft, 2015: 20 citations.

5 Dissemination towards innovation

This section collects the activities that have been carried out by the project in order to maximise the impact of the project results on the industry, either by direct interaction with the stakeholders of the mobile systems realm or through the concertation mechanisms facilitated by the European Commission.

5.1 External Advisory Board (EAB)

The project has established an external advisory board formed by leading figures in the fields of electrical engineering and telecommunications.

The list of members of the EAB is the following:

- Dr. Götz P. Brasche – European Microsoft Innovation Center (later Huawei Technologies).
- Dr. Sajal K. Das – National Science Foundation (USA).
- Dr. Ralf Imer – Vodafone Group Research & Development.
- Dr. Gerhard Kadel – Deutsche Telekom.
- Dr. Reza Karimi – Ofcom (UK).
- Dr. Takehito Nakamura – NTT Docomo (Japan).
- Prof. Theodore Rappaport – New York University.

Most of the EAB members have a very strong industrial profile that complements the profile of the project partners. Their involvement pursues a double objective: *(i)* to get their feedback and suggestions in order to steer the project in the right direction, and *(ii)* to disseminate the project results to key industrial stakeholders in order to maximise the impact of the project results.

EAB members received concise iJOIN updates which reported its progress and main achievements. In particular, iJOIN organised three joined phone conferences with the EAB and invited the EAB to its final workshop in February 2015 (iJOIN winter school). The EAB provided valuable inputs during the initial phase in which iJOIN identified use cases, scenarios, and requirements. In addition, the EAB provided important feedback after the first 12 months of the project, in order to evaluate the project progress and to identify the technology focus for the second phase of the project. Finally, iJOIN discussed its results with members of the EAB as well as external industry representatives during its Winter School.

As a summary, the EAB represented an efficient and useful tool to gather input from stakeholders that would otherwise not be involved in the project, and to disseminate the project results. This ensures a better long-term impact of the project.

5.2 Industry forums

As part of its dissemination activities, the project also looked for engagement with industry forums that may facilitate the exchange of viewpoints and ideas with other stakeholders of the mobile communications sector.

For its special relevance, the participation in the MWC 2015 is covered in a separate section.

International Wireless Industry Consortium (IWPC)

One of the forums iJOIN has interacted with is the International Wireless Industry Consortium (IWPC). IWPC mission is to facilitate global knowledge-capital collaboration, delivering unfiltered real time insight into vital technology, market and ecosystem evolution. IWPC intends to accomplish its mission by organizing very specific Workshops to meet the needs and interests of the industry, IWPC members, and the Original Systems Specifiers (Carriers, Automakers, Government Agencies, etc.).

In this regard, Telecom Italia hosted a workshop organised in cooperation with the IWPC that took place in Turin (12-14 November, 2013). Also, Telecom Italia made a presentation at IWPC workshop on “Network Virtualization” that took place in Dusseldorf, 20-21 January 2015.



Figure 5-1: Dario Sabella, WP5 leader, and Valerio Palestini, organizers of IWPC workshop in Turin

Other Industrial Forums

iJOIN was also represented by Telecom Italia in both the “SON and CLOUD RAN USA workshop” and “Fronthaul & Cloud RAN Summit” that were organised by Informa Telecom in May and October, 2014. In both events were attended by representatives of the industry, including operators, network equipment providers and services providers.

Also, the project, through some of its partners, has contributed to NGMN (Next Generation Mobile Network) Alliance. The NGMN Alliance is a forum to share, assess, and drive aspects of mobile broadband technologies, actually focused in LTE and Evolved Packet Core (EPC) and 5G. The NGMN Alliance complements and supports the work within standardisation bodies and industry forums by providing a coherent view of what the operator community is going to require for successful deployment and in order to deliver mobile broadband technology quickly and cost-effectively and serve the benefits of the end-user. Several iJOIN partners are members of NGMN.

For the preparation of the NGMN 5G White Paper that was published during MWC 2015, iJOIN members participated in the Work Stream 3 dealing with Architecture and technologies. In this WS they contributed the ideas proposed by the project to serve as a basis of the foreseen 5G architecture.

iJOIN was presented to members of Wireless World Research Forum (WWRF) at the WWRF#33 meeting in Guildford. WWRF is a forum where companies, research institutes, and universities share recent results and challenges in the context of wireless communications. The forum aligns views and initiates collaborative research projects.

Finally, the dissemination of the iJOIN results towards the industry will continue after the project has finished. In this sense, Telecom Italia is organising an internal event on 5G, inviting also some important stakeholders from the industry, where iJOIN results will be presented. The event will take place the 14th of May in Turin and preliminary title will be “TILab Techno event: 5G dream or reality?”. The attendance of Telecom Italia CEO and CTO is confirmed.

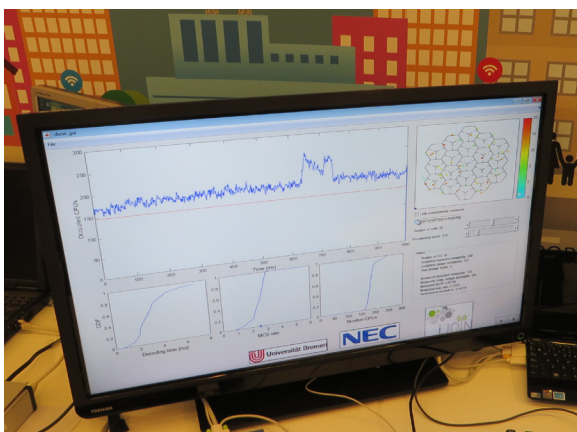
5.2.1 Mobile World Congress 2015

For the first time, the European Commission has been represented at the Mobile World Congress 2015 in order to present and discuss its vision for the the next generation of mobile communications. In particular, the EC organized an exhibition booth to explain its 5G Public Private Partnership programme (5G-PPP). Some of the currently running or just concluding collaborative projects organized in the 7th Framework Programme (FP7) are considered as frontrunners of Europe’s 5G initiative and the 5G-PPP, respectively. The EC mentions specifically the projects METIS, 5GNOW, iJOIN, MiWEBA, CREW, and EVARILOS as

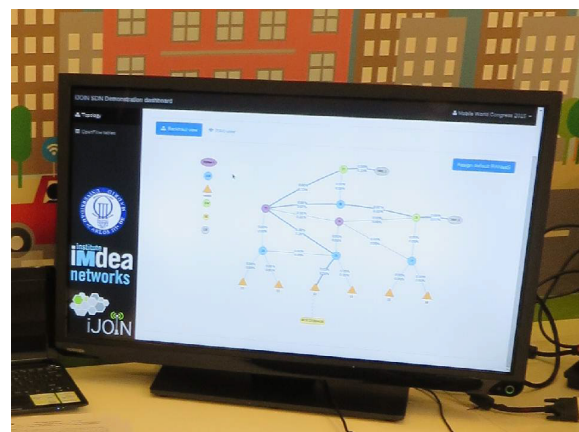
flagship projects which investigate ground-breaking technology progress¹. Accordingly, these projects have been chosen by the EC to represent its 5G initiative at the EC's booth inside MWC'15.

Figure 5-2 shows a photography of iJOIN's two demonstrators showcasing iJOIN's RANaaS and SDN concepts. The iJOIN demo consisted of the following two parts:

- In part one, we focused on the data center demonstrator, which implements a network of a few hundred of base stations. The demo runs on commodity HW and implements a standard compliant 3GPP LTE uplink decoding process. If the Cloud-RAN is congested an inter-Cloud-RAN load-balancing is initiated, which is done by means of mobility techniques. This second part has been addressed by the second demo based on a scenario with few base stations.
- In part two, load-balancing across data servers is performed. This is done by handing over the mobile terminals to different data centers. This process may trigger a different functional split configuration. This step also involves additional use cases related to mobility, such as the creation of a new flow or a real handover to a new base station.



a) iJOIN's RANaaS demonstration



b) iJOIN's SDN demonstration

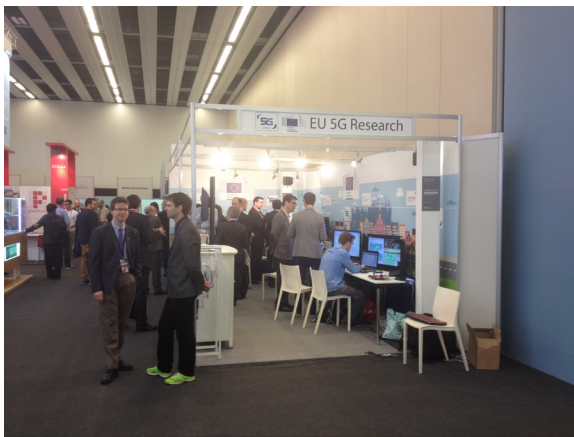
Figure 5-2: iJOIN's demonstrators showcasing RANaaS and SDN concepts

The RANaaS platform, which was showcased in the first demo at MWC 2015, implemented an Infrastructure as a Service (IaaS) model where resources are provided on a "as a Service" paradigm. These resources may be limited, which requires an active management of Cloud-RAN resources in order to avoid a computational outage rather than channel outage. This active management is performed without degradation of the system-throughput or degradation of network reliability. A full description of this demo is provided in Section 4.1 of D6.2.

The second demo showcased a flexible Software Defined Networking (SDN) platform which allows for fast and simple implementation of network management algorithms. For that purpose, we extended the SDN paradigm with an OpenFlow-enabled architecture, showcased in the demonstrator using the Ryu controller and OpenvSwitch network nodes. A full description of the demonstrator is given in [D6.2, Section 4.3].

The EC exhibition booth in general and the iJOIN demo in particular gained quite good interest from visitors. Besides many visitors who initiated discussion with iJOIN representatives at the booth, we introduced the iJOIN concept to high-profile guests Commissioner G. Oettinger, Vice-President A. Ansip, and Director M. Campolargo (DG CONNECT).

¹ See EC's press release in the context of MWC'15: <https://ec.europa.eu/digital-agenda/en/news/5g-european-research-and-vision-showcased-blueprint-showcased-mobile-world-congress-2015>



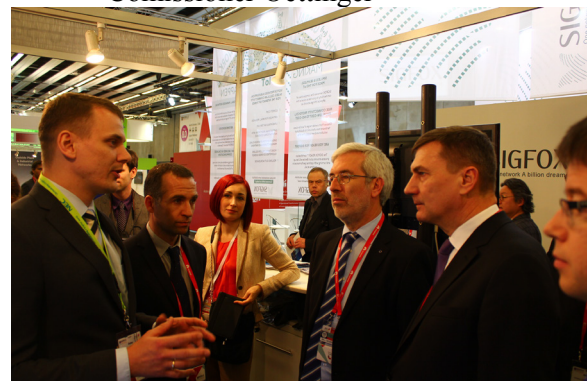
a) The EC booth



b) Dr. Rost and Dr. Banchs introduce iJOIN to Commissioner Oettinger



c) The complete team with Vice President Ansip and Director Campolargo



d) Dr. Rost and Dr. Banchs introduce iJOIN to Vice President Ansip and Director Campolargo

Figure 5-3: Impressions from the Mobile World Congress 2015

5.2.2 Industrial impact of events

Some events, previously described in Section 4, offered iJOIN the opportunity to promote its results to a significant representation of the industrial community. Two cases worth being mentioned here are the Mobile World Congress and the iJOIN Winter School, that took place in 2015.

The Mobile World Congress is the largest yearly event for the industries working in the mobile telecommunication domain, including operators, service providers, network equipment vendors and IT Companies. Just to give a number, about 5,000 CEOs are estimated to have been present at the 2015 edition. It was hence a huge showcase for iJOIN in front of a full C-level representance of the industry segment which iJOIN itself targets.

The iJOIN Winter School, besides hosting other research projects and academical guests, had also important representatives from the industry present. Speakers from Vodafone, Nokia and Intel² gave their presentations, in addition to iJOIN itself industrial partners, and that was another chance to open up iJOIN achievements to the industry through suitable events.

² On behalf of the Small Cell Forum

5.3 European innovation and concertation activities

One of the iJOIN project goals has been to establish links with other related ICT projects to have both a better knowledge of existing solutions and to take advantage of possible advances in the considered fields. This aim has in particular been carried through several collaboration actions.

Bilateral project liaisons

The project established contacts with other projects that presented significant synergies with iJOIN: TROPIC [3], Mobile Cloud Network [4], and METIS.

- An iJOIN project presentation was carried out in the TROPIC Project Plenary meeting held in Grenoble and the TROPIC workshop held in Rome, and iJOIN was represented at the 5G METIS Global Conference in Berlin on October 2014.
- The coordinator of iJOIN gave an invited presentation titled “Benefits and challenges of cloud technologies for 5G” in the METIS workshop at EuCNC, Bologna, June 2014. A similar presentation was also given at the European Wireless in May 2014 (invited presentation).

As indicated above, iJOIN has collaborated with other projects in some of the activities indicated in the previous section.

- We invited several EU projects (TROPIC, MCN, HARP) to the IWPC event indicated in Section 5.2., and to the iJOIN winter school (TROPIC, HARP, MCN, METIS).
- iJOIN contributed to the 5G book project of METIS (Chapter 11 on 5G Architecture).
- iJOIN has also collaborated with the COST Action 1004 Cooperative Radio Communications for Green Smart Environments, which addresses research issues in the field of cooperative radio communications to make our society cleaner, safer, and more energy efficient. A representative of Telecom Italia has been invited to impart a talk in Training School “From HetNets to Cloud Radio Access Networks”, organized by COST IC1004 (21-23 April 2015, University of Luxembourg) [15].

Concertation meetings and cluster-related activities.

The project has been present in different meetings and cluster-related activities.

- iJOIN has participated in the Future Network and Mobile Summit (FUNEMS) 2013 that took place in Lisbon, Portugal, 03 – 05 July 2013. FUNEMS is an annual Conference supported by the EU Commission to share experiences and research results, identify future trends, discuss business opportunities and identify opportunities for international research collaboration under the ICT Theme of Framework Programme 7 (FP7). Two papers were presented in the context of the Summit (they are collected in the table in the Appendix A), and there was also a panel presentation by the project.
- iJOIN provided presentations in the Future Networks 11th FP7 Concertation meeting that took place in Brussels on 27-28 February 2013, in the same concertation meeting on October 23rd, 2014 in Brussels, and the concertation meeting on March 25th 2015 in Brussels.
- Furthermore, iJOIN has participated in all concertation meetings during the project lifetime. Concertation meetings bring together EU research-funded projects in the area of communications networks with a view of facilitating the exchange of latest research findings and of ideas for future activities, and take place twice a year.
- The project was also present in the Future Internet Assembly held in Dublin, 7-10 May, 2013, where a project presentation was carried out. Two panels presentations were delivered in the Pre-FIA event in Athens on March 17-18, 2014 (Workshops on Virtualization and Radio Access and Spectrum innovations for 5G). FIA is a research community driven initiative supported by more than 150 research projects that have recognised the need to strengthen European activities on the Future Internet (FI) to maintain European competitiveness in the global marketplace. Participants are members of the FI community, who include the national and EU project coordinators and partners of FP7 funded projects both academic and industry researchers.

- iJOIN further actively contributed to the 5G experiments meetings organised to prepare the exhibition booth of the European Commission at Mobile World Congress 2015. In addition, iJOIN supported the EU-JP symposium in October 2014, e.g. as rapporteur of the 5G session. Finally, iJOIN contributed to the RAS cluster's white paper on 5G Network Architecture.
- It should also be mentioned that the European Commission invited iJOIN to publish a summary of the project to the DG Connect's research*EU Focus Magazine special issue on 5G (as mentioned earlier).

6 Summary and Conclusions

This deliverable provides an overview of the dissemination activities that have been conducted within the iJOIN project. These activities can be largely classified in the following three categories: (i) dissemination to the general public, (ii) dissemination to the scientific community, and (iii) dissemination towards industry and other innovation-oriented forums. As shown by the results reported throughout this deliverable and summarised hereafter, the dissemination attained by the project can be considered highly successful in all these three fronts.

The iJOIN project considers that dissemination to the general public is important in order to create awareness of the importance that this and other projects have for the society. In terms of dissemination to the general public, the following activities and results can be highlighted:

- iJOIN has produced a **video** that explains in a way that can be understood by the general public the key ideas and advantages of the technology developed by the project, as well as its potential impact.
- iJOIN had active presence in the social networks through a **YouTube channel and a Twitter account**. A YouTube channel was been created that included the video mentioned above among others.
- iJOIN had substantial presence in the **general press**, specially in Spain and Germany, and articles published by the project members on the general 5G technology as well as iJOIN specific results have appeared in several national-level newspapers.
- iJOIN was awarded the **runner-up prize to the best collaborative project in the Madrid region**, which gave substantial visibility as well as press coverage to the project.

The project has been particularly active in the dissemination of its results towards the scientific and academic communities. This is considered crucial in order to ensure the long-term impact of iJOIN, as the scientific community is shaping the far future with technologies that will appear in the market in 5, 10 or more years from now. Among others, the following scientific results are worth highlighting:

- The project has published **8 articles in peer-reviewed technical journals and magazines**, including 2 in an open access publication. On top of this, 9 submitted papers have already been accepted and 6 additional ones are in the evaluation process. iJOIN has also presented **25 papers in international conferences and workshops**, plus 7 additional ones that have been already accepted and another 6 that are pending evaluation. These figures confirm the project's success in the scientific front.
- Rather than the number of publications, one of the key objectives of the project was to be present in the **most prestigious scientific forums**. The project results have been published in journals as prestigious as IEEE Transactions in Wireless Communications, IEEE Communications Magazine and IEEE Journal on Selected Areas of Communications, and top conferences such as IEEE VTC, IEEE ICC, IEEE PIMRC and IEEE Globecom. These are the best venues in our field, and the ones that provide real visibility and impact.
- Even though all the project results are very recent and it is too early to evaluate their actual impact, some of the results already had a **very remarkable impact**. Indeed, a considerable number of our publications already received more than 10 citations and have been downloaded more than 1000 times, which suggests that they will have a very profound impact.
- iJOIN has **organised 2 workshops** that focus specifically on the project's technology. These workshops have been co-located with the most important conferences in our area (IEEE VTC 2013 and ICC 2015), and were very well received by the scientific community. In addition, iJOIN has also **co-organised 3 additional workshops** on related areas jointly with other European projects (TROPIC, MCN, CROWD), also co-located with leading conferences (IEEE Globecom 2013, IEEE WCNC 2014 and EuCNC 2015).
- The **iJOIN Winter School** was one of the project's flagship events. It featured presentations of top researchers in our field and attracted the attention of the key players in the area, with very strong academic as well as industry participation. The event stimulated many lively discussions that were not only useful to the PhD students attending the event but also to the project as a whole and to the rest of the audience.

- The project dissemination to the scientific community has not been only limited to articles and presentations but has also included **live demonstrations** that confirm the feasibility of the technology developed by the project and show their performance in a real-life setting.

In addition to the above, the project has also devoted very substantial efforts to the dissemination of its results to industry in order to maximise its impact onto future products and services in a shorter timeline:

- Many of the activities mentioned above, such as the organisation of workshops or the summer school, involve the **participation of industrial partners**, and hence also serves to disseminate the project results towards industry.
- In addition to the scientific events mentioned above, the project also organised more **industry driven events**, such as the IWPC workshop organized by Telecom Italia, which attracted key industrial players from outside the iJOIN consortium.
- The **External Advisory Board (EAB)** is formed by leading industrial partners outside the consortium, and therefore it is an excellent means to disseminate the project results to industry. During the project execution, several audio conferences with the EAB members have been held, which provided very useful feedback for the project.
- It is also worth highlighting the **internal dissemination conducted by the project industrial partners** within their company – for instance, Telecom Italia organised a 5G event and installed one of the iJOIN demonstrations in their premises to be able to show this demo in a regular basis.
- The project has also been very active in several **innovation driven forums organised by the European Commission**, such as the concertation meetings among European projects and some other related events. The Project Coordinator and the Technical Manager have regularly attended this meetings, where they have given several presentations and participated in several panels.
- One of the key iJOIN results was the **demonstration** shown in the 5G booth organised by the **European Commission in the Mobile World Congress 2015**. Based on the technical quality and potential impact of the project results, and the proof of concept efforts conducted by the project, iJOIN was selected for this booth over other projects with substantially larger budgets. This event served to show the project results to the most relevant industrial venue in the area, and was very useful towards promoting the project at an international level.
- Finally it is also worth highlighting the active participation of the project in the **key standardisation forums**, which are an excellent means to promote the project results to industry. These activities have been described in deliverable D7.3 along with the exploitation results of the project.

In summary, we believe that iJOIN dissemination activities have been very successful in all fronts and have contributed to *(i)* creating awareness in the society about the importance of this kind of projects, *(ii)* position iJOIN as one of the key research projects in the area of 5G, and *(iii)* ensure the impact of the project towards commercial technologies and services.

7 Appendix A: Scientific dissemination activities during the project lifetime

The following table collects the papers that have been either submitted, accepted and/or presented to different events.

Table 7-1: List of iJOIN papers in conferences and events

Event	Date	Location	Type of contribution	Title	Author(s)
Future Internet Assembly	May 08, 2013	Dublin	Project Presentation	iJOIN	C. J. Bernardos (UC3M)
FP7 Future Networks Concertation, Plenary Meeting	February 28, 2013	Brussels	Panel presentation	Benefits and challenges of cloud technologies for "5G"	P. Rost (NEC)
VTC 2013 Spring	June 2-5, 2013	Dresden (Germany)	Exhibition booth	iJOIN	J. Bartelt (TUD), P. Rost (NEC)
FUNEMS 2013	July 3-5, 2013	Lisbon (Portugal)	Article	RAN as a Service: Challenges of designing a flexible RAN architecture in a cloud-based heterogeneous mobile network	D. Sabella (TI), P. Rost (NEC), Y. Sheng (UNIS), E. Pateromichelakis, U. Salim (IMC), P. Guitton-Ouhamou, M. Di Girolamo, G. Giuliani (HP)
FUNEMS 2013	July 3-5, 2013	Lisbon (Portugal)	Article	Challenges of designing jointly the backhaul and radio access network in a cloud-based mobile network	C. J. Bernardos (UC3M), A. De Domenico (CEA), J. Ortin, P. Rost (NEC), D. Wübben (UoB)
FUNEMS 2013	July 3-5, 2013	Lisbon (Portugal)	Panel presentation	Benefits and Challenges of Cloud Technologies for 5G Networks	A. Maeder, P. Rost (NEC)
Mobile Cloud Network Project Plenary Meeting		Paris (France)	Presentation	iJOIN Project presentation	X. Pérez Costa (NEC)
TROPIC Project Plenary meeting	January 21-22, 2013	Grenoble (France)	Presentation	iJOIN project presentation	D. Ktenas (CEA)
CLEEN workshop	September 2013	Las Vegas (USA)	Panel participation	iJOIN representation	C.J. Bernardos (UC3M)

Event	Date	Location	Type of contribution	Title	Author(s)
CLEEN workshop	September 2013	Las Vegas, USA	Poster presentation	iJOIN representation	C.J. Bernardos (UC3M)
IWPC Workshop “Advanced Small Cell Deployments and Cloud Technologies”	November 12-14, 2013	Turin, Italy	Presentation	Cloud Technologies to Improve the Performance and Efficiency of Mobile Networks	D. Wübben (UoB)
FP7 Future Networks Concertation, Plenary Meeting	October 23, 2014	Brussels, Belgium	Panel presentation	Benefits and challenges of cloud technologies for “5G”	A. Banchs (IMDEA)
Brussels EC concertation	October 10, 2012	Brussels. Belgium	Project presentation	iJOIN	A. Banchs, P. Rost (IMDEA). Presented by C.J. Bernardos (UC3M)
Future Internet Assembly, Pre-FIA Workshop on Virtualization	17/18 March 2014	Athens. Greece	Panel presentation	iJOIN vision towards 2020 radio access technologies	P. Rost (NEC)
Future Internet Assembly, Pre-FIA Workshop on Radio Access and Spectrum innovations for 5G	17-Mar-14	Athens, Greece	Panel presentation	iJOIN vision towards 2020 radio access technologies	P. Rost (NEC)
Layer123 Webinar	41892	Online	Presentation	Centralized RAN – Factors of Success	P. Rost (NEC)
5G Global Conference (METIS)	21-Oct-14	Berlin, Germany	Presentation	Flexible Cloud-RAN	P. Rost (NEC)
6th International Conference on Mobile Networks and Management	Sept. 22-24, 2014	Wuerzburg, Germany	Panel	Cloudification of mobile networks - Expectations, Challenges, and Opportunities	A. Maeder (NEC)
VDE ITG Zukunft der Netze	Sept. 25-26	Braunschweig, Germany	Presentation	Cloudification of the 5G Radio Access Network	A. Maeder (NEC)

Event	Date	Location	Type of contribution	Title	Author(s)
IEEE PIMRC 2013	September 8-11, 2013	London, UK	Article	A Backhaul-Aware Cell Selection Algorithm for Heterogeneous Cellular Networks	A. De Domenico, V. Savin, and D. Ktenas (CEA)
17th International ITG Workshop on Smart Antennas (WSA 2013)	March 13-14, 2013	Stuttgart, Germany	Article	Distributed Consensus-Based Linear Estimation with Erroneous Links	H. Paul, B. Shin, A. Dekorsy (UoB)
CLEEN2013	September 2, 2013	Las Vegas, USA	Article	In-Network-Processing for Small Cell Cooperation in Dense Networks	H. Paul, B. Shin, D. Wübben, A. Dekorsy (UoB)
CLEEN2013	September 2, 2013	Las Vegas, USA	Article	Heterogeneous Backhaul for Cloud Based Mobile Networks	J. Bartelt, G. Fettweis (TUD), D. Wübben (UoB), M. Bold, B. Melis (TI)
IWCPM 2013	December 13, 2013	Atlanta, USA	Article	Centralised Power Setting for Femtocell Cluster	M. Lalam, T. Lestable, M. Maqbool (Sagencom)
IWCPM 2013	December 13, 2013	Atlanta, USA	Article	Radio-Over-Radio: I/Q-Stream Backhauling for Cloud-Based Networks via Millimeter Wave Links	J. Bartelt, G. Fettweis (TUD)
IWCPM 2013	December 13, 2013	Atlanta, USA	Article	Reduced Overhead Distributed Consensus-Based Estimation Algorithm	B. Shin, H. Paul, D. Wübben and A. Dekorsy (UoB)
IEEE ICC 2013	June, 2013	Budapest, Hungary	Article	On the Interference Channel with Causal Cognition	M. Cardone (Eurecom), D. Tuninetti (University of Illinois), R. Knopp (Eurecom), U. Salim (IMC)

Event	Date	Location	Type of contribution	Title	Author(s)
IEEE ICC 2013	June, 2013	Budapest, Hungary	Article	Gaussian Half-Duplex Relay Channels: Generalized Degrees of Freedom and Constant Gap Results	M. Cardone (Eurecom), Daniela Tuninetti (D. of Illinois), R. Knopp (Eurecom), U. Salim (IMC)
IEEE ISIT 2013	July, 2013	Istanbul, Turkey	Article	The symmetric sum-capacity of the Gaussian Half-Duplex Causal Cognitive Interference Channel to within a constant gap	M. Cardone (Eurecom), Daniela Tuninetti (D. of Illinois), R. Knopp (Eurecom), U. Salim (IMC)
IEEE ISIT 2013	July, 2013	Istanbul, Turkey	Article	The Capacity to within a constant gap of the Gaussian Half-Duplex Relay Channel	M. Cardone (Eurecom), Daniela Tuninetti (D. of Illinois), R. Knopp (Eurecom), U. Salim (IMC)
IEEE ICC 2014	June, 2014	Sydney, Australia	Article	An Analysis of Backhaul Costs of Radio Access Networks using Stochastic Geometry	V. Suryaprakash, G.P. Fettweis (TUD)
IEEE ICC 2014	June, 2014	Sydney, Australia	Article	Achievable Rate Optimization for Coordinated Multi-Point Transmission (CoMP) in Cloud-Based RAN Architecture	Y. Qi, M.A. Imran, A. Quddus, R. Tafazolli (UNIS)
IEEE ICC 2014	June, 2014	Sydney, Australia	Article	On the capacity of full-duplex causal cognitive interference channels to within a constant gap	M. Cardone (Eurecom), Daniela Tuninetti (D. of Illinois), R. Knopp (Eurecom), U. Salim (IMC)

Event	Date	Location	Type of contribution	Title	Author(s)
18th International ITG Workshop on Smart Antennas (WSA 2014)	March 12-13, 2014	Erlangen, Germany	Article	Fast Distributed Consensus-based Estimation (Fast-DiCE) for Cooperative Networks	G. Xu, H. Paul, D. Wübben, A. Dekorsy (UoB)
IEEE BWA workshop at GLOBECOM 2013	December 9, 2013	Atlanta, USA	Article	Energy Efficient Small Cell Activation Mechanism for Heterogeneous Networks	A. Prasad, A. Maeder, Ch. Ng (NEC)
EuCNC 2014	June 23-26, 2014	Bologna, Italy	Article	Comparative Study of Distributed Consensus-based Estimation Schemes for Small-Cell Networks	D. Wübben, H. Paul, B. Shin, G. Xu, A. Dekorsy (UoB)
EuCNC 2014	June 23-26, 2014	Bologna, Italy	Article	Towards a Flexible Functional Split for Cloud-RAN Networks	A. Maeder (NEC), M. Lalam (SCBB), A. De Domenico (CEA), E. Pateromichelakis (UNIS), D. Wübben (UoB), J. Bartelt (TUD), R. Fritzsche (TUD), P. Rost (NEC)
IEEE VTC Fall 2014	October 15-18, 2014	Vancouver, Canada	Article	Energy Saving Enhancement for LTE-Advanced Heterogeneous Networks with Dual Connectivity	A. Prasad (NEC), A. Maeder (NEC)
IEEE PIMRC 2014	September 02-05, 2014	Washington DC, USA	Article	Robust Proportional Fair Scheduling with Imperfect CSI and Fixed Outage Probability	R. Fritzsche (TUD), P. Rost (NEC), G. P. Fettweis (TUD)

Event	Date	Location	Type of contribution	Title	Author(s)
IEEE Globecom 2014	December 8-12, 2014	Austin, USA	Article	Reducing the Energy Consumption of Small Cell Networks subject to QoE constraints	N. Sapountzis, S. Sarantidis, T. Spyropoulos, N. Nikaen, U. Salim (IMC)
WONC@IEEE Globecom 2014	December 8-12, 2014	Austin, USA	Article	An Improved Decoder for Cloud-Based Mobile Networks under Imperfect Fronthaul	J. Bartelt, G. Fettweis (TUD)
IEEE Globecom 2014	December 8-12, 2014	Austin, USA	Article	The Role of Computational Outage in Dense Cloud-Based Centralized Radio Access Networks	M. C. Valenti, S. Talarico, P. Rost (NEC)
ISWCS 2014	Aug-14	Barcelona, Spain	Article	Robust Precoding for Network MIMO with Hierarchical CSIT	P. de Kerret, R. Fritzsche, D. Gesbert, and U. Salim (IMC)
EuCNC 2014	June 23-26, 2014	Bologna, Italy	Article	Decoder Implementation for Cloud Based Architectures	D. Wübben (UoB), H. Paul (UoB), P. Balleydier (CEA), V. Savin (CEA), P. Rost (NEC)
IEEE BWA workshop at GLOBECOM 2014	December 8-12, 2014	Austin, USA	Article	Distributed Consensus-based Estimation for Small-Cell Cooperative Networks	D. Wübben, H. Paul, B. Shin, G. Xu, A. Dekorsy (UoB)
10th International ITG Conference on Systems, Communications and Coding (SCC 2015)	February 2-5, 2015	Hamburg, Germany	Article	Distributed Augmented Lagrangian Method for Cooperative Estimation in Small Cell Networks	G. Xu, H. Paul, D. Wübben, A. Dekorsy (UoB)

Event	Date	Location	Type of contribution	Title	Author(s)
European Wireless Conference	14-16 March 2014	Barcelona, Spain	Article	Enhancing User QoE in Multi-Carrier LTE Dense Networks via Multi-Path Support	K. Samdanis, D. Kutscher (NEC), A. Ripke
IEEE VTC Spring 2015	11-14 May 2015	Glasgow, UK	Article	Benefits and challenges of cloud technologies for 5G architecture	D. Sabella (TI), P. Rost (NEC), A. Banchs (IMDEA)
IEEE ICC 2014, IWCPM	8-12 June 2014	London, UK	Article	Quantizer Optimization for Cloud-Based Radio Access Networks With Imperfect Fronthaul	J. Bartelt, L. Landau, G. Fettweis (TUD)
IEEE ICC 2014, IWCPM	8-12 June 2015	London, UK	Article	Implementation and Analysis of Forward Error Correction Decoding for Cloud-RAN Systems	H. Paul (UoB), D. Wübben (UoB), P. Rost (NEC)
IEEE VTC Spring 2015	11-14 May 2015	Glasgow, UK	Article	Localized Mobility Management for SDN-Integrated LTE Backhaul Networks	D. Wang, L. Zhang, Y. Qi, A.U. Quddus (UNIS)
IEEE ICC 2015, IWCPM	8-12 June 2015	London, UK	Article	On-Demand Radio Resource Management for Multi-Point Turbo-Detection in Dense Small Cell deployment	M. Lalam, T. Lestable (SCBB)
EuCNC 2015	June 29- July 2, 2015	Paris, France	Article	SDN-based Joint Backhaul and Access Design for Efficient Network Layer Operations	D- Wang, E. Katranaras, A.U. Quddus (UNIS), Luca Cominardi, Carlos J. Bernardos (UC3M), Ignacio Berberano (TID)

Event	Date	Location	Type of contribution	Title	Author(s)
EuCNC 2015	June 29- July 2, 2015	Paris, France	Article	A Flexible Cloud-RAN Architecture for 5G Networks	A. Maeder (NEC), M. Lalam (SCBB), A. De Domenico (CEA), C.J. Bernardos (UC3M), M. Di Girolamo (HP), P. Rost (NEC), D. Wübben (UoB)
IEEE SPAWC 2015	June 28- July 1, 2015	Stockholm, Sweden	Article	Uplink Capacity and User Association for Cooperative Heterogeneous Cellular Networks	Z. Mheich, A. De Domenico, V.Savin (CEA)
IEEE Globecom 2015	December 6-10, 2015	San Diego, USA	Article	Fuzzy Q-Learning based Small Cell Control in Dense Heterogeneous Cellular Networks	A. De Domenico (CEA), V. Savin (CEA), D. Ktenas (CEA), A. Maeder (NEC)
ICTON 2015	Juky 5-9, 2015	Budapest	Artcle	Fixed-Mobile Convergence and Virtualization in 5G optical transport networks	J. Montalvo, M. Arroyo, J.A. Torrijos, J. Lorca, I. Berberana (TID)

The following table collects the papers that have been submitted to different publications during the project lifetime.

Table 7-2. List of iJOIN articles in journals and magazines

Publication	Title	Author(s)	Status
IEEE Access	Graph-based Multi-cell Scheduling in OFDMA-based Small Cell Networks	Emmanouil Pateromichelakis, Mehrdad Shariat, Atta Ul Quddus and Rahim Tafazolli (UNIS)	Published
IEEE Transactions in Information Theory	On the Gaussian Half-Duplex Relay Channel	Martina Cardone (Eurecom), Daniela Tuninetti (University of Illinois), Raymond Knopp (Eurecom) and Umer Salim (IMC)	Accepted
IEEE Transactions in Wireless Communications	Cell Selection for Joint Optimization of the Radio Access and Backhaul in Heterogeneous Cellular Networks	Antonio De Domenico, Valentin Savin, and Dimitri Ktenas (CEA LETI)	Submitted

Publication	Title	Author(s)	Status
Elsevier Ad Hoc Networks	Joint route selection and resource allocation in multihop wireless networks based on a game theoretic approach	Jorge Ortín (UC3M), Jose Ramon Gallego, Maria Canales (Universidad de Zaragoza)	Accepted
IEEE Communications Magazine	Cloud Technologies for Flexible 5G Radio Access Networks	Peter Rost (NEC), Carlos Jesús Bernardos (UC3M), Antonio De Domenico (CEA), Marco Di Girolamo (HP), Massinissa Lalam (SCBB), A. Maeder (NEC), D. Sabella (TI), Dirk Wübben (UoB)	Published
IEEE Signal Processing Magazine	Benefits and Impact of Cloud Computing on 5G Signal Processing	Dirk Wübben (UoB), Peter Rost (NEC), Jens Bartelt (TUD), Massinissa Lalam (SCBB), Valentin Savin (CEA), Matteo Gorgoglione (CEA), Armin Dekorsy (UoB), Gerhard Fettweis (TUD)	Published
IEEE Transactions on Vehicular Technology	Joint TDD Backhaul and Access Optimization in Dense Small Cell Networks	Mehrdad Shariat, Emmanouil Pateromichelakis, Atta Ul Quddus and Rahim Tafazolli (UNIS)	Accepted
IEEE Transactions on Mobile Computing	Analytic Evaluation and Experimental Validation of a Network-based IPv6 Distributed Mobility Management Solution	Fabio Giust, Antonio de la Oliva and Carlos J. Bernardos (UC3M)	Published
IEEE Wireless Communications Magazine (Special Issue on Research & Standards: Leading the Evolution of Telecom Network Architectures)	An Architecture for Software Defined Wireless Networking	Carlos J. Bernardos (UC3M), Antonio de la Oliva (UC3M), Pablo Serrano (UC3M), Albert Banchs (IMDEA), Luis M. Contreras (TID), Hao Jin, Juan Carlos Zúñiga	Published
White Paper by RAS Cluster	5G Radio Network Architecture	RAS Cluster; from iJOIN: A. Banchs (IMDEA) and P. Rost (NEC)	Accepted (by EC)
IEEE Wireless Communications Letters	Opportunistic Hybrid ARQ – Enabler of Cloud-RAN over Non-Ideal Backhaul	Peter Rost (NEC)	Accepted
IEEE Journal on Selected Areas of Communications	Are Heterogeneous Cloud-Based Radio Access Networks Cost Effective?	V. Suryaprakash (TUD), P. Rost (NEC), G. Fettweis (TUD)	Accepted
Springer Telecommunication Systems	Backhaul-aware Energy Efficient Heterogeneous Networks with Dual Connectivity	A. Prasad, A. Maeder (NEC)	Accepted

Publication	Title	Author(s)	Status
IEEE Transactions on Wireless Communications	Robust Rate Adaptation and Proportional Fair Scheduling with Imperfect CSI	R. Fritzsche, P. Rost (NEC), and G. Fettweis (TUD)	Submitted
IEEE Transactions on Wireless Communications	The Complexity-Rate Tradeoff of Centralized Radio Access Networks	P. Rost (NEC), S. Talarico, M. Valenti	Submitted
IEEE open Access	Energy Efficiency benefits of RAN-as-a-Service concept for a cloud-based 5G mobile network infrastructure	D. Sabella (TI), A. De Domenico (CEA), E. Katranaras (CEA), M. Imran, M. Di Girolamo (HP), U. Salim (IMC), M. Lalam (SCBB), K. Samdanis (NEC), A. Maeder (NEC)	Accepted
IEEE Communications Magazine	Distributed Mobility Management for future 5G networks: overview and analysis of existing approaches	Fabio Giust (UC3M), Luca Cominardi (IMDEA), Carlos J. Bernardos (UC3M)	Published
IEEE Communications Magazine	Benefits and Challenges of Virtualization in 5G Radio Access Networks	P. Rost (NEC), I. Berbarana (TID), A. Maeder (NEC), H. Paul (UoB), V. Suryaprakash (TUD), M. Valenti, D. Wübben (UoB), A. Dekorsy (UoB), G. Fettweis (TUD)	Submitted
IEEE Wireless Communications Magazine	Fronthaul and Backhaul Requirements for Flexible Centralization in Cloud Radio Access Networks	J. Bartelt (TUD), P. Rost (NEC), D. Wübben (UoB), J. Lessmann (NEC), B. Melis, and G. Fettweis (TUD)	Submitted
IEEE Wireless Communications Magazine	Adaptive Mechanism for Distributed Opportunistic Scheduling	Andres Garcia-Saavedra, Albert Banchs (IMDEA), Pablo Serrano (UC3M) and Joerg Widmer (IMDEA)	Accepted
ITG News	Virtualisierung in 5G-Mobilfunknetzen	Dirk Wübben (UoB), Peter Rost (NEC)	Published
IEEE Network	An OpenFlow Architecture for Energy Aware Traffic Engineering in Mobile Networks	Carlos Donato, Pablo Serrano, Antonio de la Oliva, Albert Banchs, Carlos J. Bernardos (UC3M)	Accepted
IEEE Communications Magazine	An SDN-based architecture for 5G networks: design and proof of concept	Luca Cominardi, Carlos J. Bernardos, Pablo Serrano, Albert Banchs, Antonio de la Oliva (UC3M)	Submitted
IEEE Transactions on Wireless Communications	Performance Analysis and Optimal Cooperative Cluster Size for Randomly Distributed Small Cells under Cloud RAN	Lei Zhang, Atta Ul Quddus, Efstathios Katranaras (UNIS), Dirk Wübben (UoB), Yinan Qi, Rahim Tafazolli (UNIS)	Submitted

The following table lists the details of live demonstrations:

Table 7-3: List of iJOIN live demonstrations

Description	Participants	Venue	Date	In cooperation with	iJOIN WP
Mobility Management in Next Generation Mobile Networks	Fabio Giusti (IMDEA), Antonio de la Oliva (UC3M), Carlos J. Bernardos (UC3M)	IEEE WoWMoM 2013	June, 4-7, 2013	CROWD project	WP4
SDN-based mobility	Luca Cominardi (IMDEA)	EuCNC 2014	June, 24-26, 2014	iJOIN project	WP4, WP6
Evaluation of a 3GPP LTE turbo decoder implementation on general purpose hardware	Ban-Sok Shin (UoB)	EuCNC 2014	June, 24-26, 2014	iJOIN project	WP2, WP6
60/300 GHz Short-Range Transmission: A Multi-Gbit/s Wireless Data Link	Jens Bartelt (TUD)	Grand opening 5GLab Germany	September 24 2014		WP6
iJOIN demo	Peter Rost (NEC), Luca Cominardi (IMDEA)	MWC 2015	March 2-5, 2015	iJOIN project	WP3, WP4

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