SHARING

SELF-ORGANIZED HETEROGENEOUS ADVANCED RADIO NETWORKS GENERATION

Deliverable D2.3 v0

Dissemination and exploitation report

Date of delivery	03/04/2015
Contractual date of delivery	28/02/2015
Project number	C2012/1-8
Editor(s)	Arturo ORTEGA (FT)
Author(s)	Arturo Ortega (FT), Berna Sayrac (FT), Engin Zeydan (AVEA), KhanfouciMourad (MERCE), Jussi Turkka (MAGISTER), Antonio Cipriano (TCS), Kimmo Hiltunen (ERICSSON), Yolanda Fernandez (TTI), Mohamad Assad (SUP), Mehdi Bennis (UOULU), Sylvie Mayrargue (CEA)
Dissemination level	PU
Workpackage	2
Version	V1.5
Total number of pages	27

Abstract:

This deliverable gives an overview of all public documents (deliverables, publications, presentations, press releases) generated by the project; as well as an insight on the dissemention effort and exploitation activities. For more details you can refer to the exploitation and dissemination plan deliverable D2.1 released in October 2013.

Keywords: dissemination, exploitation

Document Revision History

Version	Date	Author	Summary of main changes
1.1	19/01/2015	Berna Sayrac (FT)	Input for sections 2.1.1 and 3.1.3
1.2	25/03/2015	Arturo Ortega (FT)	First complete version
1.3	03/04/2015	Arturo Ortega (FT)	Final version

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1   INTRODUCTION

SHARING project will contribute, through the dissemination and promotion of project results, to the medium-to-long term evolution of future mobile networks. Many partners of the consortium are active in different standardization bodies and research fora; their collaborative work in SHARING will contribute to inspire a coherent and consolidated development of system specifications.

Dissemination

SHARING will use different means to leverage the dissemination and promotion of the project results:

- Project web site
- Press releases
- Contributions to international conferences and journals
- Organization or participation to international workshops and events
- Contributions to standards

Exploitation of the project results

The SHARING consortium comprises industry partners (comprising operators, manufacturers and SMEs) and academic partners (universities, engineering schools and a public R&D center). For each category, the exploitation strategy will be targeted to address specific needs:

Network operators involved in the SHARING project are well aware that standards will continue to play a crucial role in market development strategies. Operators will take advantage of the project's results to help standards and regulation bodies to specify appropriate system requirements and solutions, in collaboration with the NGMN initiative when suitable.

The main objective of manufacturers and SMEs involved in SHARING is to benefit from the know-how acquired during the project to be ahead from their competitors when technologies dealt within the project come to real life. As a consequence of their contribution to early system specifications and thanks to their IPRs, manufacturers and SMEs will be in the position to exploit the project results by addressing the market with competitive products at the appropriate time.

Academic partners participating in the SHARING consortium are naturally interested in building on and further developing their existing research achievements and know how in radio communications. Their participation will allow them to keep track of the industrial realities, and therefore to address the relevant challenges in a realistic way.

The management of knowledge, intellectual property and other aspects of innovation will be handled in the Consortium Agreement. After the necessary steps for ensuring the protection of IPRs have been made, information will be disseminated within the project and to external bodies, in the form of publications and presentations to regulatory and standards bodies.

For more details you can refer to the exploitation and dissemination plan deliverable D2.1 released in October 2013.

2   EXPLOITATION AND DISSEMINATION

2.1 Overall description

2.1.1 Operators

Operator participation in SHARING has been mainly based on skill development, internal and external dissemination as well as pre-integration technology development through a demonstration platform. The individual exploitation and dissemination activities of the two operators of the project are detailed below:

FT-Orange(FT – T, France)

During the first year of the project, FT-Orange has developed/enhanced its capabilities and know-how on a large variety of topics such as flexible interference management, multi-node coordination, advanced receivers, next generation SON functionalities and environment-aware radio resource management for intra-LTE heterogeneous networks, device-to-device communications and the corresponding architectural impacts. This know-how serves the operator in multiple ways: (1) helps better determine/steer the Group's standardization strategy in accordance with its mid-term interests, (2) provides input to internal studies/work which supplies the Group affiliates with recommendations on the deployment of new LTE-A features, (3) training of the Group employees on new LTE-A features in order for them to develop new skills / knowledge on the upcoming technologies, and (4) provides input to discussions with the vendors which take place within the context of Request for Proposals (RFPs) or (pre-deployment) trials.

One very important dissemination event for Orange has been the annual Orange Labs Research Exhibition (OLRE) which took place in November 2014. A SHARING-sponsored demonstration has been presented in this important event. The demonstration included the presentation of the concept of Virtual Small Cells (VSC), which is studied / explored within SHARING (Task 4.1 – D4.2). The VSC demonstration shows the effectiveness of VSCs on increasing the network capacity, making networks greener, with a more flexible infrastructure, all this at a lower CAPital Expenditures (CAPEX). The demo was well attended and considerable interest was shown by participants. We were visited by a very diverse public coming from different Orange entities as well as numerous VIP and Executive Committee members. Also, more than 30 companies, universities and research centers attended the demonstration. The demonstration showed that VSCs, when reconfigured according to traffic fluctuation, can provide a 50% throughput increase and reduce the global network consumed power in a 27% compared to an only-macrocell deployment in a dense urban scenario and full buffer traffic mode.

FT-Orange has also lead/participated to the organization of SHARING-related workshops and special sessions as part of project dissemination. More details on these workshops and special sessions can be found below in section 3.1.3.

AVEA (AVEA – T, Turkey)

As being one of the major telecom operators in Turkey, AVEA has been experiencing rapid growth in its data traffic due to growing number of subscribers. Big portion of this traffic stems from multimedia applications such as video, high definition contents, etc. In observance of this fact, AVEA has been seeking alternative solutions as means to offload most of its data traffic to alternative networks such as Wi-Fi, especially in major meeting/crowding locations, such as the airports, concerts or stadiums.

AVEA is interested in using Wi-Fi Offload platform being developed in SHARING project to open up new opportunities for coverage and capacity improvements as well as instantiating new services and business models.

In that regard, SHARING project will help AVEA to develop innovative offloading solutions to alternative technologies by developing a Wi-Fi based solution on a multi-operator (fixed and mobile network operators) environment platform that can support AVEA's drive towards

improved capacity. This new integrated Wi-Fi Offload approach – that AVEA plans to incorporate to their own infrastructure – will add a key competitive advantage over other mobile operators operating in the same region.

2.1.2 Manufacturers

Manufacturer participation in SHARING includes inputs to related standardization forums, patenting, different kinds of prototyping and demonstration efforts, as well as contributions to various conferences and workshops. Furthermore, the work in SHARING is expected to provide valuable inputs to the development of future products and services. The individual exploitation and dissemination activities of the three manufacturers and six SMEs are detailed below.

Mitsubishi Electric R&D Centre Europe (MER - M, France)

In 1995, Mitsubishi Electric, a leading company in electronics and telecommunication, created a research laboratory in France, formerly named ITE/TCL (Information Technology Europe - Telecommunication Lab) focused on future generations of wireless communication systems. This laboratory recently evolved to include technologies related to energy and environment, and is now named Mitsubishi Electric R&D Centre France (MERCE-France). This laboratory employs today about 25 engineers. Current activities in the telecommunication field cover short-term studies and developments addressing the fiber optic (EPON and evolutions) development in France and advanced research on future cellular systems (B3G 3GPP/LTE, 4G IMT-Advanced). MERCE has participated to various European and French RNRT projects, and is taking active part to relevant standardization bodies (SMG/3GPP, ETSIBRAN, IEEE, etc.). Moreover, direct collaborations with European universities and research laboratories are established.

In the field of mobile communications, MERCE developed an expertise that encompasses advanced architecture for mobile communication networks, digital communications (modulation, channel coding, equalization, smart antennas, space-time codes, etc.), protocols (multiple access protocols, error detection and correction, resource allocation, handover, etc.), implementation (hardware and software architecture and technologies). In particular, MERCE has participated in numerous national and European collaborative projects related to digital communications all of them targeting B3G and 4G cellular systems and based on MIMO and multicarrier technologies.

MERCE is mainly active in SHARING WP4 by providing a complete set of radio resources management algorithms for heterogeneous networks (HetNet) deployment scenarios and setting and leading task 4.4 on spectrum allocation for heterogeoenous networks. The other major contribution of MERCE is on energy saving techniques for HetNets as described in WP4 task4.3.

As a research laboratory of Mitsubishi electric, MERCE will disseminate the SHARING project results and follow standardization of 3GPP RAN WG2 and RAN WG 3 on small cells within the framework of release 12, 13 and beyond. More precisely MERCE will follow the discussions of the standardization on small cells enhancement and energy saving.

MERCE is also planning to disseminate the most advanced results of SHARING project in relevant academic conferences.

Thales Communications & Security (TCS - M, France)

Thales Communications & Security (TCS) is one of the few companies in the world to address all telecommunications segments. TCS is a major branch of the Thales Group. The Thales Group revenues total €12.7 billion, half from the civilian businesses and half in the defence

domains. TCS division revenues reached € 2.8 Billion employing 13,000 people in 20 countries. The division addresses all the segments of the telecommunications market: radio-communications, IP networks, satellite communication, network administration and security.

TCS has a long experience in mission critical Information Systems and secure infrastructures for systems and networks, including Internet and Intranets. R&D investment is realized by over 10,000 engineers, including 4,200 researchers and concretized by more than 1,500 patents filed.Within Thales Communications and Security (TCS), the R&D Signal Processing & Multimedia team performs advanced studies on signal and antenna processing techniques, digital wireless communication, cross layer optimization and cognitive radio. Platforms are developed for feasibility studies. The team maintains close links with the French administration, SMEs, University laboratories and European research actors.

In SHARING, TCS is mainly involved in WP3 "Flexible air interface", and WP5 "Advanced relaying and D2D solutions". In WP3, TCS studies advanced MIMO schemes and flexible interference concept. In WP5 TCS focuses on advanced relaying techniques and resource allocation especially for multi-hop scenarios in mesh deployments.

TCS has strong experience in taking part to industrial and cooperative international projects, and more especially to projects related to MIMO and relaying techniques. Through Sharing, TCS targets the following business segments:

• Radiocommunication products (aeronautic use, surveillance,..);
• Private radiocommunication products (police, firefighters...);
• Spectrum monitoring products (for spectrum surveillance, signal and interference analysis).

PMR solutions are used by public safety officials such as the police, fire-fighters, medical professionals, or local government authorities who need to rely upon dedicated networks for day-to-day missions as well as crisis or special event management. Over the past ten years, PMR systems used by public safety and law enforcement professionals all over the world are mainly focus on voice, text messaging and low data rate services. In addition to voice and text, PMR users have emerging needs driven by the fast changing technological environment: now a PMR system needs to offer rich multimedia services such as images, video, face recognition and database access.TCS has been proposing PMR solutions for a long time, with its TETRA networks called Digicom25, and also with proprietary solutions based in WiMAX. Recently TCS extended his offer of PMR systems by revealing NEXIUM Wireless which is the first LTE-based solution adapted to civil and security forces' mission-critical applications. It offers high speed data services (based on LTE 4G international standard), including broadband video applications, while still providing existing PMR services. This offer also includes a new professional smartphone, TeSquad, delivering broadband mission-critical applications in a ruggedized form-factor and enabling secured communications. TeSquad integrates a solution "push-to-talk" enriching NEXIUM Wireless by offering professional services (group communication, conference, emergency calls) to protection forces. Finally, Thales launched in 2014 a MVNO offer: Eiji. It is a suite of secure mobile telecommunications services for professional.

TCS will promote the exploitation of the results of SHARING in its product portfolio and more specifically regarding its activities linked with the next generation of high data rate professional mobile radios (PMR) based on LTE-A, i.e the Wireless NEXIUM line. The exploitation plan for the possible integration of SHARING innovations into NEXIUM is to foster innovation transfer by regular dissemination of the project results to the business line in charge of this product. Also there will be a regular synchronization and exchange of information about the most interesting standardization activities involving the SHARING consortium members. Finally, SHARING work will help TCS to strengthen its position within the PMR market which is estimated to grow by 40% each year between 2017 and 2023.

TCS also provides a complete set of spectrum monitoring solutions worldwide for regulation and spectrum monitoring authorities. With the deployment of LTE/LTE-A, new spectrum monitoring tools will be needed and adapted to the different LTE deployment configurations

(macro/micro/femto/pico cellules, and next evolutions).The work in SHARING will help to accelerate the implementation of the required evolutions in the current spectrum monitoring products, and especially with a special focus on the configurations where multiple antennas are used.

The objective of the team involved in the project is to bring state-of-the-art innovations to the products. It makes the bridge between fundamental R&D and TCS products; hence its activities reach the maximum TRL (Technical Readiness Level) of 5. Through the project, TCS team reinforces its skills in advanced MIMO antenna processing and develops new receivers with interference mitigation capabilities (TRL 2 à 4).

Finally, TCS expects to reinforce its skills and Intellectual Property Rights in signal and antenna processing in interference cancellation digital techniques.

Oy LM Ericsson Ab (ERICSSON - M, Finland)

Ericsson is a world leading provider of telecommunications equipment and related services to mobile and fixed network operators. Ericsson systems handle about 40 percent of the world's mobile traffic. Oy LM Ericsson AB (Ericsson Finland) represents Ericsson in the SHARING project. Ericsson Finland has a long history of R&D in the telecommunication area and is currently focusing on 3G/4G and core network products. The research department at Ericsson Finland has an extensive experience in concept development, IPR creation and standardization, especially in 3GPP and IETF.

In SHARING, Ericsson Finland is involved in WP2 and in WP4. A clear majority of the work is in WP4, where Ericsson Finland has contributed to HetNet mobility (HSPA connected cell, and uplink/downlink split within a heterogeneous LTE-A network deployment) and energy efficiency (utilizing eNodeB sleep mode and fast cell DTX within a heterogeneous LTE network deployment).

The obtained results related to energy efficiency have been partially presented in one conference and in one workshop paper. Furthermore, part of the results has been published as part of one doctoral dissertation. The work on HetNet mobility has been related to the ongoing discussions within 3GPP aiming to standardize Release-12 HSPA and LTE technologies. Furthermore, the work on uplink/downlink traffic split has been published as one master's thesis.

For the remaining technical work within SHARING, Ericsson Finland plans to disseminate the obtained results to selected telecommunications conferences, workshops and journals. Furthermore, related standardization contributions submitted to 3GPP are possible.

Sequans Communications (SEQ - S, France)

SEQUANS Communications is a French SME, world-leading 4G chipmaker, supplying LTE and WiMAX chips to equipment manufacturers and mobile operators globally. Founded in 2003 to address the WiMAX technology for which it is now a global leader, SEQUANS expanded in 2009 to address the LTE market. SEQUANS' chips are inside the world's leading WiMAX networks and will soon be inside LTE networks. SEQUANS is based in Paris, with additional offices throughout the world, including USA, United Kingdom, Israel, Hong Kong, Singapore, and Taiwan.

In SHARING, SEQUANS is mostly involved in WP3 through the development of advanced MIMO receivers for next generation LTE products. The know-how gained during the project will help to optimize the complexity/performance ratio of embedded algorithms (both hardware and software) of next generation chipsets. Moreover, SEQUANS has contributed to an exploratory work towards 5G, by evaluating the promises of a new modulation scheme, namely, enhanced spatial modulation. The work performed by SEQUANS in SHARING has also been disseminated through publications and a patent filing.

IDATE Consulting and Research (IDATE - S, France)

IDATE has established itself over the years as one of the leading centres for exchange and analysis in Europe, specialising in the Telecommunications, Internet and Media Industries and markets.

IDATE's vocation is to lead a number of original initiatives, a European Forum furthering the debate of ideas and the exchange of experiences between the players in these domains.

Highly reputed teams of consultants and analysts conduct numerous reports and consultancy missions and participate in the continual investment in a worldwide observatory on the markets and strategies of those players in the Information Technology and Communication sectors.

In SHARING, IDATE is involved in WP2 and in WP4 with a majority of the effort focoused on market studies (WP2).

As a market research company, IDATE will take advantage of SHARING research to enhance its future market reports and seminars related to femtocells, Wi-Fi and HetNets with specific focus on market forecasts. Those reports will be used by all stakeholders involved in the industry to design future sustainable access networks. The SHARING project will help strengthen IDATE position as a reference in international centre of excellence for mobile and wireless markets.

SIRADEL (SIRADEL - S, France)

SIRADEL (http://www.siradel.com) is a high-tech company (Small Medium Enterprise) created in 1994 based in France, China (Hong-Kong) and Canada (Toronto). SIRADEL provides Products and Services for the ICT Industry and the Wireless Telecommunications in particular. The portfolio of the company is composed of:

- Data: digital geographical 3D representation of environments, accurate and reliable RF measurements.

- Software: edition and licensing of leading Scientific Tools (Volcano, VolcanoLab) to simulate the EM wave propagation (Radio Coverage of Wireless networks) and realistic channel models (System performances of radio access network and equipment).

- Consulting: technology (coverage analysis, emerging wireless systems) and management (organizational management) to optimize the wireless networks deployment and equipment design.

More than 50 people work at SIRADEL across the world and serve more than 250 Customers in about 50 countries. SIRADEL's solution brings more reliable and realistic assessments of wireless network and wireless equipment performances. SIRADEL's customers profile encompass: wireless carriers, radio access equipment manufacturers, regulation bodies and consultants.

SIRADEL has been participating, as Task and Work Package Leader, in more than 30 funded research projects. SIRADEL's teams have a strong background and expertise in scientific simulations, signal processing, field experimentation, complex system analysis of radio-wave and optical wave propagation. SIRADEL has a background at the research frontier in advanced wireless system and propagation computations. Experimentations and investigations are required to obtain highly reliable software and expertise, the recent research focus is on energy and spectrum efficient networks, as well as on heterogeneous wireless networks, and Smart City Data Infrastructure.

SIRADEL is involved in WP2, WP3 and WP4 for the elaboration of a realistic environment simulation framework using 3D map data and a ray-based propagation model. MIMO technologies, interference reduction schemes and 4G heterogeneous network performance can then be assessed considering realistic macro- and small-cell deployments. The exploitation plan can be outlined as follows:

- Development of an industrial solution for realistic MIMO channel modeling, plugged into dynamic system simulation and / or radio-planning tools.

- Enhancement of our system simulation tools related to:

  - Small-cell backhaul – Industrial and commercial stand-alone product;

  - Heterogeneous networks (realistic network and resource allocation, along with inter- and intra-system offloading) – Advanced simulation tools dedicated to expertise studies (i.e. evaluation of new topologies and techniques) and network design.

- Development of engineering services for the deployment of advanced features of LTE-A.

TTI Norte, S.L. (TTI - S, Spain)

TTI is focusing its efforts in WP3 and WP7 in the study and development of a hardware prototype for carrier aggregation. The study is evaluating the requirements of a reconfigurable power amplifier to support intra-band carrier aggregation providing energy savings versus a conventional power amplifier. A hardware prototype will be developed to evaluate the proposed reconfigurable solution. Addtionally, the prototype will also enable inter-band carrier aggregation. TTI is acquiring wide experience on this topic performing LTE lab measurements. This knowledge will increase the expertise of TTI and it could extend its business on RF products for 4G cellular systems and future 5G cellular systems. Moreover, the development of reconfigurable RF products provides to TTI a strong competitive asset.

Furthermore, different transistor technologies such as LDMOS and GaN have been evaluated to perform real-time tuning to optimize the power consumption. This knowledge will be exploited in future power amplifiers developments for cellular communications and satellite communications which is one of main TTI business.

Finally, in WP4 TTI is also studying several enhancements regarding protocols and algorithms able to improve and increase the flexibility and QoS of the radio access network. This is achieved by providing mechanisms to autonomously reconfigure the cells according to their current traffic load, and proposing management schemes and procedures in order to efficiently handle the number of active cells inside the network. Through the creation of an innovative middleware, entities in the network will be well aware of the surrounding conditions and thus be capable of exchange useful information, in their way to improve the overall network performance. In addition, a network planning tool has been developed to simulate different LTE scenarios where the aforementioned ideas can be translated to a close to real life situation allowing in this way to assess the benefits of the proposed solutions. Through all these activities, TTI is consoldationg its software development capabilities.

European Communications Engineering Ltd (ECE - S, Finland)

ECE is a Finnish SME company, providing network planning, optimisation, and cloud software services. In SHARING, ECE participates in WP6, exploiting performance evolution of small cells as well as antenna smart grid solutions for outdoor DAS. The work so far has resulted in co-operation and contribution with Magister solutions on smartphones measurements for locations based services verifications; as well as a contribution in form of papers and submissions in the area of Antenna Smart Grid. ECE expect further contributions in the relevant research areas of smartphones utilisations and smart antenna grid areas.

Magister Solutions Ltd (MAGISTER - S, Finland)

Magister Solutions has exploited the SHARING project results to further develop it's know-how on various aspects on LTE network architecture. This know-how has engouraged us to develop novel enhancement to LTE Minimization of Drive Tests functionality to address the problems that has recently arised e.g., in 3GPP LTE/WLAN Interworking study. Our goal is to find industrialpartners for further developing the proposed *Generalized MDT* (GMDT) concept in a hardware demonstration in live LTE-A network with MDT capable UEs.

2.1.3 Universities

Academic partners participating in the SHARING consortium are naturally interested in building on and further developing their existing research achievements and know-how in radio communications. Their participation will allow them to keep track of the industrial realities, and therefore to address the relevant challenges in a realistic way. SHARING's academic partners already have long standing records of contributions in the field of mobile communications, as well as numerous collaborations with the industry in this field. Their expertise, enriched by the project, will permeate into the daily university life and will be exploited within academia education, especially at Masters and PhD students' level, contributing in this way to better educate future European mobile communication experts.

University of Oulu (UOULU – U, Finland)

So far, UOULU has exploited and disseminated its innovations to top conferences, journal submissions, as well as workshop organizations, and tutorials. Through SHARING project, we will build on our expertise in the field of Heterogeneous and small cell networks. UOULU has already given four tutorials, and is thus planning to continue this trend. Likewise, UOULU has organized four workshops on HetNets. By the end of 2014 beginning of 2015 UOULU will publish a book on recent advances on small cell networks.

Institut Eurecom (EUR – U/I, France)

In addition to contributing to academic exploitation of results through scientific publications in the highest-level conference proceedings and journals, through SHARING EURECOM is continuing to promote the use of open-architecture, and in particular, open-source radio systems. The equipment and software developed by EURECOM SHARING's context is made available to the public-domain for future use in collaborative initiatives. In particular, the software generated during the project contributes to the OpenAirInterface Software Alliance making its use possible in future collaborative projects and by industry and academia around the world. EURECOM will also promote the development in SHARING through official communications in the context of the OAI Software Alliance events and publications.

Supelec - Ecole Superieure d'Electricite (SUP – U, France)

SUPELEC has been participating in SHARING project in WP2, 3, 4 and 7. So far, SUPELEC has exploited the results obtained in SHARING through academic dissemination (conferences, workshops), new projects applications (French ANR, European H2020 call). As a consequence, SHARING's results gives to SUPELEC the opportunity to promote new ideas on advanced HetNets, relaying, distributed strategic learning in heterogeneous networks and strategies for power amplifier energy savings.

2.1.4 Research Centres

Commissariat a l'Energie Atomique et aux Energies Alternatives (CEA – I, France)

One of CEA-LETI main vocations is to help companies to increase their competitiveness through innovation and research-to-industry technological transfer. Therefore, one goal of CEA-LETI in SHARING is to enlarge its portfolio of know-how in order to increase its potential clients range. In addition, CEA-LETI plans to disseminate the project results in conferences and journal papers. Up to now, two papers have been submitted to conferences.

2.2 Exploitation report

2.2.1 Standardisation

Below, you can find the short description of relevant standardization bodies (3GPP, IEEE), other fora/alliances (NGMN, Small Cell Forum, Wireless World Research Forum ...) and their relevance to SHARING.

3rd Generation Partnership Project (3GPP)

The purpose of the 3GPP is to unite 6 telecommunications standard development organizations to provide an environment to produce reports and specifications that define 3GPP technologies such as GSM, WCDMA, HSPA and LTE/LLTE-A. Since the completion of the first LTE and the Evolved Packet Core specifications (EPC), 3GPP has become the focal point for mobile systems beyond 3G. The 3GPP organization consists of four technical specification groups being Radio Access Networks (RAN), Service & Systems Aspects (SA), Core Network & Terminals (CT) and GSM EDGE Radio Access Networks (GERAN). Each of the four groups has a set of working groups focusing on different areas of the technology and meeting regularly several times a year to discuss and define the technological aspects of the developed system.

Currently the focus in 3GPP is on Release 12 finalization and the initiation of the Release 13 specifications of LTE advanced systems. Some of technical specifications / reports that are the most relevant to SHARING project are listed below as well as the corresponding SHARING research topics:

Device to device communications:

- RP-140518: LTE Device to Device Proximity Services. The related technical report is TR 36.843 (RAN1/RAN4)
- RP-140518: LTE Device to Device Proximity Services. The related technical document is TR 36.877 (RAN4)

Interworking between LTE and WLAN:

- RP-132086: Multi- RAT joint coordination, the related technical document is TR 36.870 (RAN3)
- RP-132101:WLAN/3GPP radio interworking at RAN2, the related technical document is TR 37.834(RAN2)

ON/OFF energy savings:

- RP-122035: Study on energy saving enhancement for E-UTRAN, the related technical document is TR 36.887 (RAN3)
- Small cells:
- RP-122033: Study on small cell enhancement for E-UTRA and E-UTRAN higher layer aspects. The related technical document is 3GPP TR36.842 (RAN2).
- RP-122032: Study on small cell enhancement for E-UTRA and E-UTRAN phyiscal layer aspects. The related technical document is 3GPP TR36.872 (RAN1).
- RP-121418: Scenarios and requierements of LTE enhancement of small cells. The related technical document is 3GPP TR36.932 (RAN2).

The technical contributions that are related to the innovations of SHARING and that were presented in 3GPP strandardisation are summarized in the table below.

Contribution	3GPP technical group	SHARING partner, date
R1-144242, Deployment scenarios for LAA-LTE and simulation assumptions for coexistence evaluation	RAN1	Orange, October 2014
R1-143358, Results for 3D Channel Model Calibration Phase 2	RAN1	Orange, August 2014
R1-141623, Impact of D2D on cellular traffic - Necessary further evaluation	RAN1	Orange, April 2014
R3-140784, Energy saving TR: technical annexes on potential ES gains	RAN3	MERCE, April 2014
R3-140901, ES solution evaluation for TX power optimization scenario	RAN3	MERCE, April 2014
R3-140915, Evaluation of the need for switch ON mechanism enhancement	RAN3	MERCE, April 2014
R3-140876, ES solution evaluation for switch ON enhancement.	RAN3	MERCE, April 2014
R1-140781, Network control and flexible resource sharing between cellular and D2D communication within network coverage	RAN1	Orange, February 2014
R3-140408, Overlaid coverage scenario showcase, performance and solution requierements	RAN3	MERCE, February 2014
R3-140428, Energy saving TR: technical annexes on potential ES gains	RAN3	MERCE, February 2014
R1-135548, Text Proposal for turbo-CWIC receivers System Level Modeling Methodolog	RAN1	Orange, November 2013
R1-135549, Initial results for 3D Channel Model Phase 2 and different UE attachment options	RAN1	Orange, November 2013
R1-135550, Shadow fading modeling for microcell scenario based on a measurement campaign	RAN1	Orange, November 2013
R3-132174, Further clarification on optimized distributed TX power setting for LTE coverage layer	RAN3	MERCE, November 2013
R1-134818, Scenarios and requirements for Public Safety an related TP to 36.843	RAN1	Orange, October 2013

R1-133671, Results for 3D Channel UMa Calibration Case 1	RAN1	Orange, October 2013
R3-131901, Optimized distributed TX power control for LTE coverage layer	RAN3	MERCE, October 2013
R3-131863, Evaluation method and metrics for ES solutions	RAN3	MERCE, October 2013
R3-131922, TP on ES evaluation criteria	RAN3	MERCE, October 2013
R1-133722, Physical layer abstraction for turbo-CWIC receivers	RAN1	Orange, August 2013, [resubmitted at RAN1#74bis as R1-134799]
R1-133720, Initial results for 3D Channel Model UMa Calibration Case 3	RAN1	Orange, August 2013
R1-133719, Initial results for 3D Channel Model UMa Calibration Case 1	RAN1	Orange, August 2013
R2-131678, Further discussions on UL-DL split	RAN2	Ericsson, May 2013
R1-131596, Literature review on user antenna height correction factor for 3D-channel model	RAN1	Orange, April 2013
R1-131633, Views on network-assisted interference cancellation and suppression	RAN1	Orange, April 2013
R1-131594, Scenarios for network-assisted interference cancellation and suppression	RAN1	Orange, April 2013
R2-131381, Improving offloading potential with UL DL split	RAN2	Ericsson, April 2013
R2-130416, Small cell challenges and benefits of dual connectivity	RAN2	Ericsson, January-February 2013
R3-130393, Summary of offline discussions of clarifications of use cases and requirements for non overlapping energy saving	RAN3	MERCE, January 2013

Specifics in relation with 3GPP standardisation effort

Magister Solutions goal is to propose an enhancement to 3GPP MDT functionality to support user-plane GMDT as part of the Release 13 work if a proper work/study items are active in 2015. One option is the foreseen study item for enhancing indoor positioning in Release 13.

2.3   Dissemination report

As mentioned in **Erreur ! Source du renvoi introuvable.**, the project planned to publish its results in prestigious journal and magazines, such as IEEE Transactions, EURASIP Journal on Wireless communications and networking, and IEEE Communications Magazine. This was done with a special focus on IEEE Transactions on Wireless Communications (7 papers), IEEE Transactions on Information Theory (4 appers), EURASIP Journal on Wireless communications

and networking (2 papers), and IEEE Communications Magazine (2 papers). Targeted conferences listed in **Erreur ! Source du renvoi introuvable.** were reknowned IEEE Conferences), as well as EUCAP (European Conference on Antennas and Propagation). They have been covered with a focus on IEEE Vehicular Technology Conference (6 contributions), EUCAP (3 contributions), Personal, Indoor and Mobility Radio Conference PIMRC (3 contributions). In addition, 5 papers were contributed to a conference which was not listed in [2], IEEE international Symposium on Wireless Communication Systems (ISWCS). In addition, several books/book chapters have been contributed with SHARING results, two Doctorate dissertat and one Master thesis have been defended, two patents have been filed, two SHARING-related workshops and one SHARING special session have been organized.

A website (http://www-sharing.cea.fr/) is maintained with the list of publications and of public deliverables.

2.3.1 Publications

In the following, can be found the list of SHARING publications:

- Journal papers (27)
- Conference papers (55)
- Workshop papers (6)
- Book (1),
- Book chapters (3)
- Doctorate thesis (2), Master Thesis (1)

Journal Papers

S. Lakshminaryana, M. Assaad and M. Debbah, "Energy Efficient Cross Layer Design in MIMO Multi-cell Systems", IEEE Journal on Selected Areas in Communications (JSAC), to appear, October 2015.

M. Simsek, M. Bennis, and I. Guvenc, "Learning Based Mobility Management Enhancements in HetNets: A Reinforcement Learning Approac," EURASIP Journal on Wireless Communications and Networking, to appear, August 2015.

Subhash Lakshminarayana, Mohamad Assaad and Merouane Debbah "Asymptotic Analysis of Distributed Multi-cell Beamforming", IEEE Transactions on Information Theory, to appear, July 2015.

A. Destounis, M. Assaad, M. Debbah and B. Sayadi, « Traffic-Aware Training and Scheduling in MISO Downlink Systems », IEEE Transactions on Information Theory, to appear, June 2015.

O. Semiari, W. Saad, S. Valentin, M. Bennis, and H. V. Poor, "Context-Aware Resource Allocation in Small Cell Networks: How Social improves Wireless," IEEE Transaction in Wireless Communications, to appear, March 2015.

M. Simsek, M. Bennis, and I. Guvenc, "Learning Based Frequency- and Time-Domain Inter-Cell Interference Coordination in HetNets", IEEE Transaction in Vehicular Technology, to appear, March 2015.

E. Bastug, M. Bennis, M. Kountouris and M. Debbah, "Cache-enabled Small Cell Networks: Modeling and Tradeoffs", EURASIP Journal on Wireless Communications and Networking, to appear, March 2015.

Hana Baili and Mohamad Assaad, "Optimal Scheduling and Power Allocation in Wireless Networks with Heavy Traffic", Mathematical Modeling of Dynamical Systems Journal, to appear, March 2015.

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M.U. Sheikh, J. Sae and J. Lempiäinen, "Evaluation of SPMA and Higher Order Sectorization for Homogeneous SIR through Macro Sites", Springer Journal on Wireless Networks (Status: Submitted October 2014 and currently under review).

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Matha Deghel, Mohamad Assaad and Merouane Debbah, "system Performance of Interference Alignment under TDD Mode with Limited Backhaul", in proc of IEEE ICC, June 2015.

M. Simsek, M. Bennis, I. Guvenc, "Context-Aware Mobility Management in HetNets: A Reinforcement Learning Approach," in Proc. of the IEEE WCNC 2015, New Orleans, USA, March 2015.

F. Pantisano, M. Bennis, W. Saad, and M. Debbah, "In-Network Caching and Content Placement in Cooperative Small Cell Networks", in Proc. of the 1st International Conference on 5G for Ubiquitous Connectivity, Levi, Finland, November 2014.

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I. Maaz, J-M. Conrat, J.Ch. Cousin, « Path Loss Models in NLOS Conditions for Relay Mobile Channels", VTC Fall, Vancouver, Canada, Sept 2014.

M.S. ElBamby, M. Bennis, W. Saad and M. Latva-aho, "Content-Aware User Clustering and Caching in Wireless Small Cell Networks," in Proc. 11th International Symposium on Wireless Communication Systems (ISWCS), Barcelona, Spain, August 2014.

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S. Lakshminarayana, M. Assaad and M. Debbah, "Energy Efficient Design in MIMO Multi-cell Systems with Time Average QoS Constraints", in IEEE SPAWC, Germany, June 2013.

M. Simsek, M. Bennis, M. Debbah, and A. Czylwik, "Rethinking Offload: How to Intelligently Combine Wi-Fi and Small Cells?", in Proc. IEEE ICC, Budapest, Hungary, June. 2013

Khan, Y.; Sayrac, B.; Moulines, E., "Surrogate Based Centralized SON: Application to Interference Mitigation in LTE-A HetNets," Vehicular Technology Conference (VTC Spring), 2013 IEEE 77th, vol., no., pp.1,5, 2-5 June 2013.

Chien-Chun Cheng, Serdar Sezginer, Hikmet Sari, and Yu T. Su, "Robust MIMO-OFDM detection with channel estimation errors," Telecommunications (ICT), 2013 20th IEEE International Conference on, 6-8 May 2013.

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E. Bastug, M. Bennis, and M. Debbah, "Anticipatory Caching in Small Cell Networks: A Transfer Learning Approach", in Proc. of the 1st KuVS Workshop on Anticipatory Networks, Stuttgart, Germany,September 2014

E. Bastug, M. Bennis and M. Debbah, ""Social and Spatial Proactive Caching for Mobile Data Offloading,", in Proc. of the IEEE International Conference on Communications, workshop on Small Cell and 5G Networks, Sydney, Australia, June 2014.

F. A. Tuzunkan, C. Gungor, E. Zeydan, O. Ileri and S.Ergut, "Seamless Mobile Data Offloading in Heteregenous Wireless Networks based on IEEE 802.21 and User Experience", in Proc. of Self Organizing Networks (SONETs) Workshop, IEEE Wireless Communications and Networking Conference (WCNC'14), Istanbul, Turkey, April 2014.

Khan, Y.; Sayrac, B.; Moulines, E., "Active antenna systems for centralized self-optimization of capacity in LTE-A," IEEE Wireless Communications and Networking Conference Workshops (WCNCW), 2014, vol., no., pp.166, 171, 6-9 April 2014

K. Hiltunen "Improving the Energy-Efficiency of Dense LTE Networks by Adaptive Activation of Cells", in Proc. ICC 2013 SmallNets Workshop, Budapest, Hungary, June 2013

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Book Chapters

E. Baştuğ, M. Bennis and M. Debbah, "Think Before Reacting: Proactive Caching in 5G Small Cell Networks", Towards 5G: Applications, Requirements and Candidate Technologies", Wiley, 2015

M. Simsek, M. Bennis, and I. Guvenc, "Time and Frequency Domain e-ICIC with Carrier Aggregation in HetNets", book chapter in Design and Deployment of Small Cell Networks , Cambridge University Press, 2014

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Others

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A. Ratilainen, "Protocol Performance of Uplink/Downlink Separation in LTE Heterogeneous Networks", Master's thesis, Aalto University, School of Electrical Engineering, 2014.

2.3.2 Presentations

Two presentations have been made:

1. **Presentation of the SHARING vision at the 1st FP7 SEMAFOUR interim workshop, September 25 2014, Braunschweig/Germany (in conjunction with the ITG/VDE Future Networks 2014 Conference)**.

Title: Self-Organized Heterogeneous Radio Access for Future Wireless Networks: SHARING vision

Abstract — Considered as a major economic driver, wireless broadband industry is facing increasing challenges due to the vast growth in data traffic demand together with the scarcity and high cost of (radio) resources. This challenge sets strong requirements on coverage, capacity and cost improvements of mobile networks in the horizon of 5 to 10 years. Therefore, it is vital to define highly spectral-, energy- and cost-efficient mobile broadband systems to satisfy these impending requirements. In parallel, considering emerging services and new spectrum regimes, offloading solutions also need to be strongly improved as an important leverage to avoid the saturation of future mobile networks. This paper presents the vision of the CelticPlus project SHARING (Self-organized Heterogeneous Advanced RadIo Networks Generation) whose aim is to address these challenges. To this end, SHARING focuses on Heterogeneous Networks (HetNets), including innovative concepts such as advanced relaying and Device-to-Device (D2D) communications. HetNets is a concept which has been introduced as a promising solution to the foreseen massive traffic overload over the horizon of 2020. Consisting of a wide area coverage layer of high-powered macro cells together with a layer of short range, low-powered small cells (micro/pico/femto cells and Wi-Fi access points), HetNets push for densification of the cellular networks towards smaller and smaller cells whilst offloading part of the traffic overload burden from macro cells: 1-towards micro and pico cells in outdoor environments, and 2-towards femto cells and Wi-Fi hotspots in indoor (residential, corporate etc.) environments (indoor small cells also enhance indoor coverage). Calling for a substantial increase in the number of network nodes, this densification necessitates the development of automated operation and management solutions to avoid the related increase in costs. Therefore, self-organization of operation and management tasks is an inevitable component of the HetNet solution for future radio access networks. Combined with the breakthroughs in radio link spectral efficiency (transmitter cooperation, advanced receivers, link-level

interference management techniques) and mature solutions such as D2D communications (allowing higher data rates, power saving and better resource utilization due to shorter radio path), self-organized HetNets constitutes the most promising and viable solution to face the forthcoming capacity crunch.

2. **Project presentation to the Advisory Board (AB), telephone meeting, March 17 2015.**
   The presentation contains a general overview of the project vision and objectives, as well as a detailed presentation of selected technical innovations of the project such as intra-cell offloading, multi-node cooperation schemes and device-to-device communications.

2.3.3 Workshops

During the first year of the project, two SHARING-related workshops and one SHARING special session were organized:

3. **The 1st IEEE International Workshop on Self-Organizing Networks (SONETs)**, in conjunction with IEEE WCNC 2014, April 6th 2014, Istanbul, Turkey.
   http://open-innovation.alcatel-lucent.com/www/sohnets/index.html
   Full-day workshop.
   30-40 attendees.
   Keynotes: Colin Willcock, Ismail Guvenc.
   12 papers in 4 technical sessions.

4. **The 2nd International Workshop on Small Cell Wireless Networks (SmallNets)**, in conjunction with IEEE ICC 2013, June 9th 2013, Budapest, Hungary.
   http://www.cwc.oulu.fi/smallnets2013/program.php
   Full-day workshop.
   40-50 attendees.
   Keynotes: Satoshi Nagata, Amitava Ghosh and Holger Claussen, Gerhard Fettweis.
   22 papers in 4 technical sessions.

5. **SHARING special session within European Wireless 2014 (EW'14)**, May 14th 2014, Barcelona, Spain.
   http://www.ew2014.org/workshop-program.html#A1
   Half-day session.
   15-20 attendees.
   4 papers from SHARING authors.
   The SHARING paper "*On the Feasibility of Cellular Resource Reuse for Device-to-Device Communication under 3GPP Network Constraints" by* Abdoulaye Bagayoko (NEC Technologies, France); Dorin Panaitopol (NEC Technologies, France); Christian Mouton (NEC Technologies, France) was awarded by the ***best paper award* (among all the papers of the conference EW'14)**.

Another SHARING-related workshop is currently being organized: **The 1st International Workshop on Intelligent Design and Performance Evaluation of LTE-Advanced Networks**, in conjunction with VTC2015-Spring, May 11 2015, Glasgow, Ireland.
http://lia.univ-avignon.fr/idefix/workshop-LTE-A-Design
This workshop is co-organized with the French ANR project IDEFIX. At the moment of writing this deliverable, the paper review process is ongoing.

It is foreseen to organize a final dissemination event before the end of the project. To this end a Special Session proposal has been sent to ISWCS 2015 (http://www.iswcs2015.org/), August 25-28 2015, Brussels which has been accepted.

2.3.4 Demonstrations

No formal demonstration have been done so far; however the project mid-term horizon demonstrations described below will be shown in project mid-term review or/and in the

Vienna Celtic Event (April 27-28th 2015). The end of project horizon demonstartions are expected to be available for the final project review.

Project mid-term horizon demonstrations

Demo 1: Connectivity Management Platform Using Multiple Attribute Decision Making in Heterogeneous Networks (AVEA)

Mobile operators are thus looking for cost-effective solutions to overcome the capacity bottlenecks especially in high contention traffic scenarios. Offloading a portion of the mobile data traffic to Wi-Fi networks is a promising solution to overcome the capacity bottleneck. However, thereby Wi-Fi networks may get easily congested as well. A centralized connectivity management mechanism can be used to solve this dilemma. In this demo, a novel centrally controlled Wi-Fi offloading platform for heterogeneous wireless networks is presented. For a given user, a centralized management server collects information regarding the quality of service and experience from all accessible data networks, then selects the data network that maximizes the overall system performance, finally the decision is sent to the application on the mobile phone for execution. The intelligent decision process uses an algorithm that is shown to be robust and also flexible to adapt to the needs of different mobile operators.

Demo 2: Radio fingerprint positioning demo (MAGISTER / ECE)

Coverage measurements with detailed location information are an important asset in self-optimization of wireless networks. When correlating location and coverage 3G/LTE measurements with coverage WLAN measurements i) the positioning accuracy can be significantly improved and ii) knowledge about joint coverage of heterogeneous 3G/4G/WLAN networks can be obtained. However, currently, there exists no standardized method to combine 3G/4G measurements with WLAN measurements. In this demo, LTE and WLAN radio fingerprint positioning accuracy is visualized utilizing field measurements from commercial LTE network. The demo tracks several mobile users showing their exact and estimated location on top of a map utilizing novel architecture that enables combining MDT 3G/4G and WLAN fingerprint measurements. Applications: In addition to provides a convenient and novel way of visualizing the content of MDT 3G/4G trace records, this approach is valuable for network vendors and operators who are keen on automating the collection of radio coverage measurements for improving their radio fingerprint positioning capabilities.

Demo 3: Dual band / dual access antenna exhibit (CEA)

Integration of small cell base stations to urban environment requires a miniaturization effort compared to regular base stations. In addition, increasing base stations capacity is a hot topic that can be handled thanks to Carrier Aggregation (CA) which consists in simultaneously using several carriers (within the same band or not). CEA active dual band / dual access antenna design, covering 2100 and 800 MHz LTE bands, has been optimized to take into account these requirements. Since the antenna size increases with its bandwidth, the antenna system bandwidth has been reduced as far as possible, to only cover the required bandwidth for a given CA configuration. Frequency agility has been introduced to make the antenna system compatible with a subset of CA configurations recommended by the standards. This bandwidth reduction has led to a miniaturization of the antenna system without degrading its performance.

End of project horizon demonstrations

TTI is developing a proof-of-concept demonstrator for carrier aggregation to validate the WP3 study on the topic of reconfigurable power amplifiers. The prototype will support intra-band contiguous and intra-band non-contiguous carrier aggregation providing energy savings versus a conventional power amplifier and it will also support inter-band carrier aggregation. The demonstrator will operate in LTE-A band 7 for intra-band carrier aggregation and in LTE

band 20 and band 7 for inter-band carrier aggregation. The prototype is focused on a downlink LTE-A transmitter for a small cell scenario. The power amplifier requirements will be evaluated for different carrier aggregation modes, proposing different power amplifier operating points which will enable to fulfill 3GPP specifications and provide energy savings compared to conventional amplifiers.

This hardware demonstrator will be combined with a dual band antenna system developed by CEA. This antenna system is composed of a first antenna covering the whole band 7 and of a second antenna covering one channel (Rx/Tx) of band 20 at a time. Frequency agility is used to make this second antenna cover the whole band 20 by tuning the antenna frequency according to the selected band 20 channel. This antenna system can cover all possible intra-band and inter-band carrier aggregation configurations. This technique enables miniaturization of the band 20 antenna without jeopardizing the whole system radiated performance.

2.3.5 Press release

The project launch was promoted with the publication of the press release shown in the appendix.

2.3.6 Web site

SHARING website URL is http://www-sharing.cea.fr/. There can be found the summary and objectives of the project, the consortium description, the list of publications (which is regularly updated), the list of deliverables, with links to already published deliverables.

2.3.7 Public deliverables

The list of completed deliverables is shown in the table below:

	Deliverable	**Month**
D2.1	Dissemination and exploitation plan	Oct-2012
D2.2	Scenarios, KPIs and Evaluation Methodology for Advanced Cellular Systems	Jan-2013
D2.3 V0	Dissemination and exploitation report	Feb-2015
D2.4 V0	Market analysis and performance targets	Sep-2014
D3.1	New opportunities, challenges and innovative concepts candidates for Multi-point transmission and reception	Jul-2014
D3.2	Multi-point cooperation schemes at the transmitter: innovative concepts and performance evaluation	Jan-2015
D3.3	Advanced Transceivers and interference cancellation schemes at the receiver: innovative concepts and performance evaluation	Feb-2015
D3.4	Flexible interference management concept: innovative concepts and performance evaluation	Jan-2015
D3.5	Progress in RF Front-End, Antenna Design	Jan-2015
D4.1	New opportunities, challenges and innovative concepts candidates for SON/Heterogeneous Networks	Jun-2014
D4.2	Intra-system offloading: innovative concepts and performance evaluation	Dec-2014
D4.3	Inter-system offloading: innovative concepts and performance evaluation	Dec-2014
D4.4	Power control: innovative concepts and performance evaluation	Feb-2015

D4.5	Spectrum allocation: innovative concepts and performance evaluation	Jan-2015
D5.1	Advanced Relays: innovative concepts and performance evaluation	Dec-2014
D6.1	Requirements and progress on architecture issues	Sept-2014
D6.3	Localization architecture for multi-layer, multi-RAT heterogeneous network	Feb-2015
D7.1	Selection of scenarios for proof of concept test-beds, specifications and recommendations on key building blocks for implementation	Mar-2014
D7.2	Selection of key algorithms and technologies with Integration into platforms	Feb-2015

2.3.8 Patent applications

The patents listed in this section were submitted during the project up to the current date of delivery.

Patent: Multi User Multi Attribute Decision Making Method for Wireless Network Access

- Authors: EnginZeydan, Ahmet Serdar Tan, Omer Ileri, SalihErgut, FazilAykutTuzunkan, CagriGungor
- Title: Kablosuz Ağ Erişimi için Çoklu Kullanıcılı Çoklu Kriterli Karar Verme Yöntemi (Multi User Multi Attribute Decision Making Method for Wireless Network Access)
- Assignee: Avea Iletisim Hizmetleri A.S.
- Nationality: Turkey
- Patent number: 2014/09831
- Document identifier: 2014-G-22464
- Filing date: 21.08.2014
- Granting date: N/A
- Publication date: N/A
- Abstract of the patent: Buluş, heterojen kablosuz ağların bulunduğu alanlarda, operatörlerin, kullanıcı ekipmanlarının, hangi kablosuz ağı seçeceğine karar vermesini sağlayan, çoklu kullanıcılı çoklu kriterli karar verme yöntemi ile ilgilidir (The invention is on a multi user multi attribute decision making method proving the user equipment of operators to choose a network to connect in an area with heterogeneous wireless network access).

Patent: Method of combining user reported information with Minimization of Drive Tests trace records.

- Inventor: Jussi Turkka, Magister Solutions Ltd.
- Assignee: Magister Solutions Ltd.
- Nationality: Finland
- Patent document number: 20150058
- Filing date: 20.02.2015
- Granting date: N/A
- Publication date: N/A
- Abstract: A method for collecting and correlating Minimization of Drive Test trace records with other types UE reported performance measurements e.g., WLAN radio measurements, is disclosed in this patent to better support network operation and optimization in next generation heterogeneous cellular networks.

3   CONCLUSION

This document summarizes all the dissemination and exploitations efforts achieved up to the project mid-term. A final version of this document will be released at the end of the project (February 2016).

APPENDIX

Celtic-Plus SHARING project – Press Release

The collaborative research project SHARING – Self-organized Heterogeneous Advanced Radio Networks Generation – opens up new perspectives for the improvement of user experience in 4G networks

Paris, November 2013

The SHARING project, launched by the Celtic-Plus European research initiative in September 2013, aims to stimulate the evolution of 4G mobile network standards by developing innovative technologies designed to improve network performance and user experience. The project follows other European industry–driven schemes led by initiatives such as FP7 and Celtic, including WINNER, WINNER+, ARTIST4G and BeFemto. These have all successfully leveraged European expertise on mobile technologies and the impact of technological developments on mobile network standards.

Due to the increased use of smartphones and tablets, the market is currently experiencing unprecedented growth in wireless traffic. To efficiently address this challenge, a consensus has now emerged that, given the current scarcity of spectrum, future wireless networks will need to be built across heterogeneous access (macro, micro, pico and femto cells) that incorporate multiple technologies (cellular and WiFi access points). Clearly, managing and optimizing such networks will be highly complex, particularly due to the interference caused by numerous neighbouring and overlapping cells. SHARING will seek to provide spectrally and energy efficient solutions for such heterogeneous networks, thereby helping to ensure that future wireless networks are able to offer the highest possible levels of quality and performance.

To this end, SHARING will explore new concepts with a special focus on the following areas: interference management; cost-power efficient small cell deployments; LTE-A / WiFi convergence; network controlled device-to-device communications; meshed relay-assisted networks; Self-Organized Network (SON) features and architecture evolutions for heterogeneous networks.

The project aims to develop solutions that will improve the overall user experience based on enhanced network performance (improved capacity, spectral efficiency and cooperation of different technologies and network layers).

SHARING brings together major actors from the mobile industry and the academic world to build consensus on standards development and the design of future wireless networks. The project partners are: Antenna Systems Solutions (Spain), Avea Itetisim Hizmetleri (Turkey), Commissariat à l'Energie Atomique et aux Energies Alternatives (France), Ericsson Finland (Finland), Eurecom (France), European Communication Engineering (Finland), Orange (France, project coordinator), IDATE Consulting and Research (France), Imperial College London (UK), Magister Solutions (Finland), Mitsubishi Electric R&D Centre Europe (France), NEC Technologies (France), Sequans Communications (France), Siradel (France), Supelec (France), Thales Communications and Security (France), TTI Norte (Spain) and the University of Oulu (Finland). The project will be completed in February 2016.