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SEVENTH FRAMEWORK PROGRAMME

Network of Excellence

NEWCOM#

Network of Excellence in Wireless Communications#

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WP4.1 – Direction and quality assurance of scientific activities

D41.3
Second yearly report on scientific management and network promotion plan

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Executive Summary

This document presents a summary of the NoE activity in the second reporting period, and illustrates the most crucial steering and coordination functions of Project Coordination. Both general achievements and specific WP and Track activities are discussed, assessing whether all WPs in the Joint Program of Activities are actually making adequate progress towards their goals and delivering the planned documentation in due time and with the expected level of quality. The document also refers about the initiatives about internal and external promotion of NEWCOM#, in particular its impact on new external affiliations from industry and Academia to the NoE.

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1. Summary of the project

1.1 Project description

NEWCOM#

Network of Excellence in Wireless COMmunications#

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Partners: CNIT (IT), Aalborg University (DK), Bilkent University (TK), CNRS (FR), CTTC (ES), IASA (GR), INOV (P), Poznan University of Technology (PL), Technion (IL), Technische Universitaet Dresden (D), University of Cambridge (UK), Université de Louvain (BE), Oulun Yliopisto (FIN), Technische Universitaet Wien (A).

Duration: November 2012 – October 2015
Total Cost: € 5,550,980

EC Contribution: € 2,845,999

NEWCOM# is a *research ecosystem* to nurture a new generation researchers, and to help creating Institutions featuring excellent researchers with an inherent attitude to work in line with the NoE philosophy: *interaction, cooperation, integration*. The **core concept** of NEWCOM# is an NoE of a relatively large size, created for the purpose on one hand, **to address medium-to-long term complex, interdisciplinary, fundamental research problems in the field of wireless communications and networking;** and, on the other, **to create a distributed European laboratory for the future Wireless Internet (EuWIn) to also foster experimental research in the field.**

As a consequence of this concept we may delineate the **Scientific Objectives** of NEWCOM# as follows:

1. Optimize the design of relay networks, develop capacity-achieving channel codes, propose optimal distributed signal processing techniques, develop novel network models and analyze their performance.
2. Develop algorithms and protocols to enhance the efficiency of future networks, with special emphasis on power-efficient terminals, interference management in wireless networks, and resource allocation for heterogeneous radio-access mechanisms.
3. Define suitable performance measures that take into account the wireless channel nature (ergodic and outage capacity, bit-frame error rate, etc.).
4. Study of the low-energy-consumption and low-emission technologies in the field of radio interfaces, and their interplay with high spectral efficiency (MIMO) techniques.

Beyond the research objectives, NEWCOM# has **Integration and Spreading-of-Excellence objectives,** such as:

I. Building a strong link with the EC to interface with other projects and events, and exploit possible synergies with the Future Network and Mobile Summit and the RAS cluster.
II. Offer attractive opportunities for joint teaching activities, hands-on instruction, and increased student mobility through the issue of NEWCOM# Mobility Awards, and by assisting with the preparation of proposals for other EC mobility grants (like Marie Curie Fellowships).
III. Contribute to the long-term sustainability of the NoE by creating a permanent environment for cooperative research: the EuWIn lab (multisite European Laboratory of Wireless communication for the future Internet).

IV. Disseminate its results across the scientific community through jointly written papers, special sessions and journal issues, and improving dissemination of the research results to European industry organizing events hosted by Associate Partners at their own premises to facilitate participation of their staff members.

Further details about the expected impact of the Project, the Consortium composition and strength, as well as the Joint Program of Activity, can be found in D41.1 or on the project website http://www.newcom-project.eu.

1.2 Recommendations concerning future work

In the following, we describe the different actions carried out by the Coordinator to make sure that the recommendations for future work formulated by the EC Reviewers after the 1st year review are taken into account. Part of the recommendations are also included and commented into Sect. 2.2 of D43.3, still, the original numbering has been kept, for clarity and consistency

2) *Specify the planning of joint activities of Track 1 and Track 2 on the EuWin sites (besides the seasonal schools and workshops).*

The planning of joint activities has been set up in the joint Track1/2 meeting in Jan. 2014 as follows:

JRA 1.2.1.5	Clusters organization for multi-hop cooperative communications
JRA 1.2.2.1	Opportunistic relaying and forwarding
JRA 1.2.3.1	Multiple source detection, localization, and transmit power estimation in lognormal fading environment
JRA 1.2.3.5	Energy-efficient data collection and estimation in wireless sensor networks
JRA 1.3.2.A	Advanced MIMO techniques (virtual MIMO, MIMO-FBMC) for low-interference transmission
JRA 2.1.2.A	Enhanced NC-OFDM transmission with reduced spurious emission level
JRA 2.1.4.B	Practical implementation of polar codes
JRA 2.2.2.3	Experimental activity on data sensing and fusion

This list of JRAs can now be found on the project webiste under the Inter-track JRA's menu option.

Some of these JRAs have been presented during EuCNC'14, as they contributed to the special sessions organized by NEWCOM# in such context. During the EuCNC'14, Prof. Davide Dardari of CNIT/UniBo has convened the two Track Chairs to discuss the status of inter-Track activities.

Track1/2 coordination activities will go on in year 3 of the project, with a Joint Track1/Track2 meeting to be held in Athens in Jan. 2015, and with the organization of another training school in February/March 2015; with a structure similar to the one organized in Barcelona in November 2013, featuring three lab sessions embedded into a program of theoretical lectures.

3) *Harmonize as much as possible the access policies to the three EuWIn Lab sites and integrate the documentation generated by each Lab site into one unified EuWIn docu-*

ment for wide dissemination towards the interested parties, already supporting the sustainability needs of the project.

Integration across EuWIn has started from the reorganization of the website, which can be reached directly from the NEWCOM# website, and presents the lab with an integrated vision, with lots of information about activities going on. Concerning access policies, the already delivered document presents a vision that is already sufficiently integrated, and is reported on the EuWin website (http://www.euwin.org/index.php/access). A specific integration document is also attached to D23.3 as Annex III, and is also included in the lab website.

To further foster the integrated view, the three Deliverables that has been follow a common format, with a table of contents as follows:

1. Introduction (incl. list of JRAs, list of main achievements after Y2) - 2 pages
2. Joint Research Activities - 1 page each, common format to Track1
3. Conclusions (incl. description of contributions to EuWIn repository) - 1 page
4. Annexes:
   A1. Technical Achievements (detailed description) - N pages
   A2. Validation document - 22 pages
   A3. Integration document (common document to the three Deliverables) -10 pages

5) *Foster the collaboration with US and Japan and report on the outcomes of the discussions with the Advisory Board members. Act upon the valid comments of the Board concerning the work and deliverables and report on the follow-up actions.*

Cooperation with US and Japan comes from some papers signed with US authors, whilst cooperation with Japan comes from the inclusion as Associate Partner Type II of a Japanese Institution, which is also contributing in the evaluation of NEWCOM# awards. The remarks made by the AB have been implemented into the preparation of deliverables of Y2, that are being checked by the Board itself. The AB also called for more integration between the tracks, and this is what has been done as reported above.

6) *Concentrate on the eminent issues of EU regulatory work and report on the bilateral discussions with national regulators.*

In our understanding, the notion of Newtork of Excellence was something aimed at nurturing the attitude towards integrated research, especially in younger generations. This is also why we did not include in our DoW specific WPs on regulatory issues. Specifically, our DoW reports, concerning ***B.3.1.4 Contributions to standards and regulation as well as the related IPRs, with a predominant role for Europe in standardization bodies and for a* and *Industry adoption of spectral-efficient broadband wireless systems, novel Internet architectures and technologies*:**
"*The NEWCOM# consortium is entirely formed by academic partners and research institutes. Hence, a direct participation in standardization bodies is not envisaged since, clearly, it is not part of any project partner's mission*".

We believe that our contact with our industrial associate partners and with external companies during dissemination events, as well as the active participation in the organization of events like EuCNC and DySPAN (just to mention a few) will be sufficient to keep the NoE aware of the main issues that are being discussed in the main regulatory bodies, and steer its own activity towards the same goals at large.

7) *Involve stakeholders outside the consortium more proactively – namely through fostering the industry liaison with clear objectives and action plans for follow-up, widening the dissemination of the project events and materials emphasizing their open/public nature. Define more in detail the research areas of interest of affiliated partners and other industrial players. The objective and the date of the dissemination events should be published in sufficient time before the event (e.g. 3 months) in order to ensure success. Clear conclusions should be made from the various events held and the influence on the future project work should be specified.*

We started to plan the next dissemination events with due advance and included some lessons learnt from the first one (see the updated D34.2), and we have started collecting information on follow-up activities resulting from in-company dissemination events. As an example, CNIT/Bologna reported a 4-week measurement campaign sponsored by NEC resulting from the event held in NEC Heidelberg. The goal is to gain insights on the performance of home networks under Wi-Fi interference (NEC is member to the home-gateway initiative). Besides, CTTC reported the key participation on Alcatel-Lucent in a project proposal for an Initial Training Network (Marie Curie Actions) stemming from the event held in Alcatel-Lucent in Stuttgart.

On a different topic, the EuWIn website has also been improved based on the comments received by the panel of EC evaluators, to simplify and better emphasize the liaisons with industries. In particular, the EuWIn home page has been revamped and now reports:

"The European Laboratory of Wireless Communications for the Future Internet addresses two separate goals: on one hand it aims at supporting industries, providing an Open Platform for Innovation; on the other it fosters a new generation of scientists willing to perform research through both theoretical and experimental approaches, under the motto "Fundamental Research Through Experimentation. Industries can find information on the EuWIn Open Platform for Innovation concept here."

More details about (industrial) dissemination events can be found in D34.3

1.3 Achievements during the second year

The activities developed in the second year of the project have been mostly compliant with the Description of Work (DoW) and the related expectations. In terms of management, all project Boards have actively worked toward the achievement of their own objectives.

The Executive Board (EB) members have met two times face-to-face, and three more using the videoconference tool SCOPIA licensed by CTTC at the beginning of the project to this purpose to all partners.

The NEWCOM# Office, has been in charge of the many day-by-day operations needed to synchronize the various activities with the deadlines set by the DoW in terms of deliverables and milestones.To be noticed that Eva Hernandez (CTTC) replaced May Rosa Martinez CTTC) since May 2014.

The Advisory Board (AB) has (partially) met in Bologna in June 2014 at EuCNC, has received a presentation of the forthcoming activity in Y2/3 of the project, and will examine some deliverables from Y2 for further comment, and especially to check through a comparison with Y1 documents about the project's progress towards its objectives, as well as about the effective adoption of AB's suggestions from previous year.

The NEWCOM# web site www.newcom-project.eu is fully operational and fulfils its role of repository of the working WP documents and materials, as well as a source of information for all network researchers and external users as a dissemination instrument. It has been enlarged with further sections, in constantly updated with more material and news, and is fully integrated with the "twin" website of EuWIn www.euwin.org .

Track 1, about fundamental and theoretical research, has issued 3 very "dense" deliverables that report i) an introduction to the general subject the WP is concerned with, ii) the description of the Joint Research Activities that has been carried out within the various WPs, with results and plans for the next reporting period (Y3), and iii) conclusions and prospects. They all follow a common format resulting from the Reviewers' remark after Y1 review. Integration with Track 2 has been fostered with the organization of a specific inter-Track meeting in Lisbon in Jan. 2014.

Track 2, "the European Laboratory of the Future Wireless Internet EuWIn", has also issued three deliverables with the same overall organization as the deliverables in Track 1. The documents focus on the experimental activities carried out at the different sites of the lab (CTTC, CNIT/UniBO, CNRS/Eurecom), with particular emphasis on relation with external partners (partricularly rich for CNRS/Eurecom, and also very good for the other two sites), that represents one of the best outcomes and "success stories" of the Track. Document D22.3 is supplemented by the Annexes containing i) a validation document of the facilities at the EuWIn sites (D22.3 Annex II), and ii) the integration document already mentioned in the previous section (D22.3 Annex III).

All research deliverables have been released in due time (with a short extension agreed with the Project Officer) and in addition, 100 joint papers and 114 individual papers with project acknowledgement have been presented at international conferences or accepted/published by international peer-reviewed journals. Publications can thus be regarded as one of the main achievements of the project in the second year, as happened in the first year. In Section 3, we carry out an in-depth analysis of those publications and other dissemination activities carried out by NEWCOM# partners – we just wish to anticipate that the figures exhibit a substantial increase wrt to Y1 of the project, as expected, as a results of full attained activity of all WPs. The complete list of publications can be found in Annex III.

Track 3 has developed through a number of dissemination activities. Direct scientific dissemination have concerned various contributions to international conferences in terms of special sessions organized by NEWCOM# researchers, as well as the usual launch and publication of a few special issues in international journals with editorial committees assembled within NEWCOM#. One of the main outcomes of the period has also been the contribution in terms of tutorials, workshops, and special sessions to the Conference EuCNC in Bologna in early June.

Dissemination through liaison with industries has been carried out organizing four dissemination events: at NEC Labs (Heidelberg, Germany), Alcatel-Lucent Bell Labs (Stuttgart, German), Avea Labs (Istanbul, Turkey) and Nokia Networks (Munich, Germany).

Training has also developed though the organization of three well-attended one-week schools, devoted to PhD students and young researchers to help them in choosing and focusing their research activity. The schools were held in Castelldefels (Barcelona), Pisa (Italy) and Rennes (France).

Valorization of human capital has been achieved through the launch of the calls for selection of the Best Paper Award, the Best Student's Paper Award, and the Distinguished Research

Award. The selection has been somewhat postponed to Y3 since the awards will be materially presented to the winners at EuCNC '15 in Paris, and the project office wouldn't want so much time to elapse between the communication of the awards and its "material" presentation. NEWCOM# is also contributing to the EC concertation activities, and in particular to the Radio Access & Spectrum (RAS) cluster.

The agreement with ACROPOLIS that was signed in Y1 has developed into the association of King's College London (KCL) to the NoE as Associate Partner Type II. This will help going on with the spectrum occupancy measurement campaign started within the previous agreement and actually led by KCL, with the participation of a few NEWCOM# partners.

To be noted is also the request of four Research Institutions to become Associate Partners Type II (Academic or Public Research Institutions) of NEWCOM#: the University of VIGO (Spain), JAIST- Japan Advanced Institute of Science and Technology (Japan), King's College London (United Kingdom).

Finally, under Track 3, NEWCOM# has prepared during Y2 four (4) issues of the Newsletter that can be found here:
http://www.newcom-project.eu/index.php?option=com_content&view=article&id=23&Itemid=113 and describe in close detail the everyday life and of the NoE and the persons that are involved into research.

In the Coordinator's opinion, NEWCOM# has fulfilled in a more than satisfactory manner its second year goals, and starts its third year of activity with an established set of actions, as well as a good plan for project conclusion. The challenge of Y3 still remains the issue of survivability after the EC grant is over. On the negative side, the only aspects worth mentioning are a somewhat less-than-expected attendance to collective events like training schools, and the incomplete involvement into joint activities by a few partners.

2. Project activities in year 2

In this section, a detailed description of the activities developed during Y2 of the project is reported for each of the work packages identified in the DoW. As the individual descriptions show, the work progress did not significantly deviate from the work plan: all the deliverables of Y2 have been produced and delivered in time, and the milestones have been achieved with a few minor delays approved by the Contract Officer. So, the project is in line with its expectations.

2.1 Project objectives for the period

As was done in the corresponding deliverable of Y1 D41.2, we will make a distinction between MACRO objectives and MICRO objectives of our work. The description in terms of micro-objectives is the subject of the detailed activity report that is done on a WP basis in a later section, whilst we just discuss here the macro-objectives of the projects in Y2 on a synthetic Track-by-Track approach.

The main objective of the WPs in Track 1 was continuing and consolidating the approach to joint theoretical research, through a number of Joint Research Activities. At the end of Y1 we had 35 JRA in total (Track1/2), they are now 31 in Track 1 and 16 in Track 2. AS already mentioned, the progress of Track 1 is mainly testified by the increasing number of joint (as well as individual) publications resulting from such JRAs (from 33 in Y1 to 100 in Y2).

Track 2 features now a consolidated structure of the EuWIn lab sites (certified by the validation document, Annex II of D22.3), and a number of experimental activities (JRAs) taking advantage of such facilities. Publications are coming, although at a slower pace than in Track 1, and on top of this, what is also coming is interest and recognition of the work done coming from external companies and Institutions. There is a record of involvement on experimental activities of researchers coming from external Institutions, as well as a number of activities carried out jointly and on behalf of external companies. The latter (external recognition and access) was from the onset of the NoE one of the main objectives of EuWIn.

Coming to Track 3, the objectives were mainly of further developing the various activities already launched in Y1. This was done as planned, we just wish to mention the signature of the Associate Partners Agreement with 3 new academic partners (7 in total since the starting of the project) including one from Japan, and the organization of *three* training schools in Y2, i.e., one more than was planned. Details on the many micro-objectives that the project has successfully reached is reported in Track 3 deliverables.

The objectives of Track 4 in terms of scientific management were those of a close coordination between the scientific activities of Track 1 and Track 2, and this was achieved through organization of a joint workshop held in January 2014 in Lisbon (next one scheduled in Athens in January 2014), plus a number of discussions and resulting coordination actions at the many meetings of the Executive Board (see the detailed list reported later on). And last but not least, promotional material has been disseminated at many occasion with good acceptance.

2.2 Work progress and achievements during the period

We recall that the general organization of NEWCOM# revolves around three main axes called Tracks: 1) Theoretical research, 2) Experimental research, 3) Dissemination, Training and Human Capital, 4) Management. This deliverable reports on the main work and achievements from Track 1 to Track 3, whereas those corresponding to Track 4 can be found in the companion deliverable D43.3 (‘Administrative Management’).

2.2.1 TRACK 1

Track leader: Pierre Duhamel (CNRS)

In the "Theoretical Research" Track, NEWCOM# pursues medium to long term, interdisciplinary research on the most advanced aspects of wireless communications like the Computation of the Ultimate Limits of Communication Networks, Opportunistic and Cooperative Communications, or Energy and Bandwidth Efficient Communications and Networking.

WP 1.1 Performance Limits of Wireless Communications

WP Leader: Merouane Debbah (Supelec)

This WP in the Track of theoretical research faces difficult and long-term challenges in terms of deriving the performance limits of Wireless Communications. With respect to similar activities carried out in the past, the focus is "beyond point-to-point": in addition to the classical issues related to the development of capacity-achieving and/or non-binary channel codes for communication links (an area in which NEWCOM# researchers reach absolute world excellence), the WP also tackle more modern problems, like multiuser capacity, capacity of and optimal signal processing techniques for large networks, the achievement of communication security through features of the PHY layer (only), just to mention a few. Particular attention is devoted to issues related to cooperative communications via relays and network modeling, to identify optimal relaying strategies and the relevant ultimate capacity.

A summary of WP1.1 progress towards objectives

The WP is divided into three Tasks, each with specific scope and objectives:

- Task 1.1.1 "Theoretical Limits of Communications and Networks";
- Task 1.1.2 "Relaying and Resource Allocation in Wireless Networks";
- Task 1.1.3 "Capacity-reaching channel codes". For each Task, there are 3 JRAs which address some of the fundamental open issues in the respecting thematic areas.

Task 1.1.1 "Theoretical Limits of Communications and Networks"

Task Leader: Merouane Debbah (Supelec)

- JRA 1.1.1.1: Performance limits of Sparse Bayesian Learning with application to wireless communication systems
  Leader of the JRA: Remy Boyer (CNRS)
  Main partners: Bernard-Henri Fleury (AAU), Pascal Larzabal and Mohammed Nabil El Korso (CNRS)

The objective of this JRA is to derive fundamental lower bounds (specifically, Cramér-Rao bounds (CRBs)) on the MSE of sparse estimators for linear models in. A particular interest was devoted to sparse Bayesian learning in which a hierarchical probabilistic model is de-fined that produces sparsity-inducing priors.
The JRA focuses on two types of CRBs, the Bayesian CRB and an expectation of the deter-ministic CRB, the expectation being over the a-priori distributions of the random matrix the parameter vector of the linear model. It can be easy shown that the latter is above the latter.
These investigations are extended to systems of large dimensions. This assumption allows to exploit some recent results from the Random Matrix Theory.

- JRA 1.1.1.2: An Information-Theoretic Perspective of Cooperation and Secrecy in

Multi-User Communications
Leader of the JRA: Pablo Piantanida (CNRS-SUPELEC)
Main partners: Meryem Benammar, Mari Kobayashi, Merouane Debbah, Gil Katz and Sheng Yang (CNRS-SUPELEC), Luc Vandendorpe (UCL), Shlomo Shamai (TECHNION)

The objective of this JRA proposal is to study the information-theoretic fundaments and limits of multi-terminal communications. We shall focus on the study of three central research, which are described below:

- On the Compound Broadcast Channel: Multiple Description Coding and Interference Decoding

This part investigates the general two-user compound Broadcast Channel (BC) where a source wishes to transmit two private messages and a common message to two receivers of a BC, while being oblivious to the two channels realizations controlling the communication. The focus is on the characterization of the largest achievable rate region resorting to more evolved encoding and decoding schemes than standard coding techniques for the BC, i.e Marton's coding.

- Dirty-paper Coding Techniques for Compound MISO Broadcast Channels: A DoF Analysis

This part investigates optimal Degrees of Freedom (DoF) achieving schemes for the MISO Compound Broadcast Channels (BC) where a source is equipped with M antennas, and communicates with 2 single antennas receivers. A modified Dirty Paper Coding scheme that yields the optimal DoF for some Compound MISO BCs in the complex field, is developed.

- Secrecy Capacity Region of Some Classes of Wiretap Broadcast Channels

This part investigates the secrecy capacity of the Wiretap Broadcast Channel (WBC) with an external eavesdropper where a source wishes to communicate two private messages over a Broadcast Channel (BC) while keeping them secret from the eavesdropper. A non-trivial outer bound on the secrecy capacity region of this channel is derived. In the absence of security constraints, it reduces to the best known outer bound to the capacity of the standard BC.

- JRA 1.1.1.3: Communications Performance of Large Dimensional Systems
  Leader: Romain Couillet (CNRS-SUPELEC)
  Main partners: Pablo Piantanida, Merouane Debbah and Marco Di Renzo (CNRS-SUPELEC), Alessandro Guidotti and Giovanni Emanuele Corazza (CNIT-UniBO), Maxime Guillaud (VUT), Aris Moustakas (IASA)

This JRA is at the border between information theory and random matrix theory/stochastic geometry to study the rate performance of large dimensional systems of the multi-cell type, along with the error rate performance of finite block length communications in MIMO fading channels (following the works in the SISO AWGN case).

This JRA addresses the following open issues:

- Determining optimal power control startegies in multicell settings for large dimensional communication channels
- Determining the optimal probability of error in point-to-point communications in the MIMO setting, assuming large number of antennas and large but finite communication blocklengths
- Modeling and analyzing in a tractable way the distribution SINR of large multi-cellular environments from a stochastic geometry approach.

Task 1.1.2 Relaying and Resource Allocation in Wireless Networks
Task Leader: Savo Glisic (UOULU)

- JRA 1.1.2.1: Network Coding schemes for relay channels.
  Leader: Stephan Pfletschinger (CTTC)
  Main partners: Carmine Vitiello and Marco Luise (CNIT-UniPI), Stephan Pfletschinger and Monica Navarro (CTTC)

This JRA considers different decoding options for the joint decoding of the channel and the network code in the multi-way relay channel, starting with the important special case of two-way relaying. For this particular case, it has been found earlier that joint decoding of both the network-coded as well as the individual messages, joint decoding can perform significantly better than individual decoding and for low rates even shows better results than lattice coding. Here a decoding options for different channel codes is considered, which is particularly interesting for the practically relevant cases of asymmetric channel conditions. In this respect, it defines joint and separate decoding strategies for trellis codes, turbo codes and non-binary LDPC codes as the most general case and evaluate their performance for the AWGN and for fading channels. It extends these decoding strategies to more than two users and consider the related scenario of uncoordinated multiple access schemes, among which the most prominent ones are known as coded slotted ALOHA.

This JRA addresses the following open issues:

- Optimum decoding strategies for uplink of the two-way relay channel, in particular for realistic modulation and coding schemes
- Achievable rates with functional decoding, which recovers the network-coded packet at the relay without necessarily decoding the involved packets individually
- How to best combine channel and network coding with higher-order modulations

Main Scientific Achievements

• Application of trellis codes to physical layer network coding in the two-way relay channel: With trellis codes, we have developed a joint decoder which allows to decode combinations of different codes of possibly different rate in the multiple-access phase. The decoder applies the Viterbi algorithm on an extended trellis which combines both users' codes. This approach can be extended to turbo codes.

• Joint vectorial decoding of non-binary LDPC codes. The belief-propagation decoder for non-binary LDPC codes has been extended to a joint decoder for multiple superimposed codewords, as they appear in the multiple-access phase of the two-way relay channel or in a more general sense in uncoordinated multiple-access schemes.

- JRA 1.1.2.2: Optimization approaches for heterogeneous networks
  Leader: Beatriz Lorenzo and Savo Glisic (UOULU)
  Main partners: Jordi Perez-Romero, Ramon Agustì (UPC), Luisa Caeiro, Sina Khatibi and Luis M. Correia (INOV)

The general framework for this JRA focuses on heterogeneous networks comprised of multiple technologies such as cellular, wireless local area networks, etc., and including also the possibility of resource virtualization. Under this main general framework the global objective of this JRA is the development of efficient resource allocation strategies to ensure the QoS requirements and the efficiency in the resource usage. In this respect, the activity has been organized around the following scenarios:

- Scenario 1: Heterogeneous Wi-Fi and Cellular with Multi-Hop capabilities. It assumes a network architecture in which a given terminal can receive a mobile service either by connecting directly to the cellular base station or by connecting through another terminal that

acts as Access Point (AP) and relays the traffic to/from the cellular base station (e.g. through Device-To-Device technologies such as LTE D2D, Wi-Fi Direct, etc. In this scenario, given the randomness associated to the propagation, as well as the variability in the generation of data traffic, there will be situations in which it may be more efficient for a certain mobile terminal to connect to one or another terminal acting as AP or to connect directly to the infrastructure. In this respect, the activity investigates the optimization of the connectivity of the different terminals with the target to minimize the total transmission power in the scenario.

- Scenario 2: Dynamic Network architecture scenario: In this scenario, we consider an advanced wireless technology where certain class of wireless terminals can be turned temporarily into an access point any time while connected to the Internet. This creates a Dynamic Network Architecture (DNA) since the number and location of these access points vary in time. DNA provides significant soft capacity in the network enabling wide range of adaptations to traffic demand variations without any change in the fixed network infrastructure. An optimization framework is developed to optimize different aspects of this new architecture. First, we optimize the network by choosing the most convenient set of available APs to provide the QoS levels demanded by the users. To exploit the soft capacity provided by the DNA, an economic model is developed to award the users by adding a credit (negative price) to their bills while acting as APs for other users in their vicinity. This serves as an incentive for the users to efficiently use the network resources. Different options for the pricing mechanism are presented for wired and wireless Internet backhaul. As the change in the terminal´s role (from user to AP) can make the system prone to eavesdropping, the user's requirements in terms of security are also considered in the selection of the AP.

- Scenario 3: Radio Resource Management for Virtual Radio Access Networks: In this scenario, it is assumed that multiple Virtual Network Operators (VNOs) with different requirements, objectives, and SLAs (Service Level Agreements) co-exist on the same physical Radio Access Network (RAN) infrastructure. The existing solutions, e.g., RAN sharing, divide the radio resources either statically or dynamically among VNOs. In contrast, the approach considered in this section is to aggregate and manage all the radio resources while offering the VNOs isolation in addition to simplicity-of-use (i.e., non-transparency), multi-RATs (Radio Access Technologies) and network element abstraction. By means of virtualisation of radio resources, the VNOs are served by connectivity per service class upon their request. Each VNO may have different requirements and objectives. Meeting these objectives while optimising the resource usage and the other additional objectives (e.g., guaranteeing fairness among multiple instances) make Virtual Radio Resource Management (VRRM) an elaborated procedure. The importance and complexity of VRRM is the reason to count it as the milestone in realisation of end-to-end virtual radio network.

- JRA 1.1.2.3: Traffic dynamics - routing and topology reconfiguration
  Leader: Panayotis Mertikopoulos (CNRS)
  Main partners: Aris L. Moustakas (IASA)

This JRA focuses on increases in the performance of a wireless network that result from optimizing packet traffic routing - possibly over several different paths, or by adapting to a changing network topology (such as the one induced by users going online and offline). Specifically, we focus on multi-path routing techniques that are known to yield significant increases in terms of packet latencies and achieved throughput. Despite their projected efficiency, such techniques are hampred by the massive size of current wireless networks, so it is not clear how an optimized multi-path routing scheme may be implemented in a decentralized way; furthermore, such considerations should also take into account the fact that wireless users are also interested in maximizing the rate of their transmissions (and not only their latencies). In view of the above, we examine distributed learning schemes for throughput-efficient multi-path routing. Our approach incorporates techniques from game theory, learning and online optimization and we focus on the development of algorithms that

optimize the traffic distribution in the network in a robust and decentralized way. In these considerations, a major challenge occurs when delays and/or packet loss probabilities fluctuate unpredictably due to random exogenous factors (such as packet drops, fluctuations in link quality, etc.). In the presence of such perturbations, we examine the robustness of the proposed algorithms and determine conditions under which this distribution is near-optimal with high probability.

During the current reporting period, OULU expressed interest in JRA 1.1.2.3 and potential learning and game-theoretic approaches for efficient routing and scheduling in cognitive radio environments were identified after a series of Skype meetings; work on this direction is ongoing and is currently at an exploratory phase. Regarding work that was started during the previous reported period, a semester-long visit of the JRA leader was organized to IASA in order to finalize the development of fully decentralized and asynchronous algorithms for multi-path routing in networks with possibly changing topologies [MM14]. This work was based on recent learning techniques based on powerful stochastic approximation tools that were developed by CNRS in the framework of this JRA during the current and previous reporting period [CGM14]. The research output of these activities is summarized in the publications section below and consists of 1 accepted journal paper, 1 submitted and 1 more that is currently in preparation.

Task 1.1.3 Capacity-reaching channel codes
Task Leader: Erdal Arikan (Bilkent)

- JRA 1.1.3.1: Spatially Coupled Codes
  Leader: Michael Lentmaier (ULUND)
  Main partners: Iryna Andriyanova (CNRS), Najeeb ul Hassan (TUD)

This JRA investigates spatially coupled codes in wireless communication scenarios. Three activities were ongoing during this reporting period: i) Spatially coupled codes for block-fading channels, ii) Spatially coupled code design for flexible rates, and iii) Non-uniform windowed decoding schedules for spatially coupled codes.

The mobile-radio channel can be modelled as a slow, flat fading together with additive noise. In many cases, the channel coherence time is much longer than one symbol duration. Thus several symbols are affected by the same fading coefficient. An example of such a channel model is the *block-fading* channel. In the block-fading channel, coded information is transmitted over a finite number of fading blocks to provide diversity. The diversity order of the code is an important parameter that gives the slope of the word error rate of the decoder. Convolutional codes, in general, are known to be suitable for transmission over block-fading channels and the diversity can be increased by increasing the constraint length of the code. Whereas, strong error correction codes like low-density parity-check (LDPC) codes fail to provide diversity gains without a special structure of the code. An example of such a structure is given by the root-LDPC codes introduced in [BG$^+$10]. However, designing root-LDPC codes with diversity order greater than 2 requires codes with rate less than $1/2$. The special structure of the codes makes it a complicated task to generate good root-LDPC codes with high diversity (and thus low rate). Rate flexibility and efficient window decoding, on the other hand, are mentioned in a recent survey among the open research problems related to the practical realization of SC-LDPC codes [CD$^+$14].

- JRA 1.1.3.2: Non Binary Codes
  Leader: Guido Montorsi (CNIT-PoliTO)
  Main partners: Guido Masera and Muhammad Awais (CNIT-PoliTO), David Declercq and Florence Alberge (CNRS)

As higher spectral efficiency and throughput targets are set for future communication systems, existing capacity-approaching channel coding schemes need to be developed further to work under more demanding scenarios. In general, Task 1.1.3 aims to develop capacity-approaching channel codes for diverse set of future application scenarios. The intended work JRA 1.1.3.2 within this task is to consider efficient decoding algorithms (message-passing) for non-binary LDPC and related codes and the design of good class of non binary codes. Non binary codes are a natural choice for systems achieving large spectral efficiencies employing high cardinality modulation sets. Recently considerable steps forward have been made in this field with the introduction of decoding algorithms like the Extended Min Sum (EMS) or the Analog-Digital Belief Propagation (ADBP) which are competitive in term of complexity with those of binary codes. These algorithms use messages relative to non binary quantities allowing to easily couple the iterative decoders with non binary detectors that typically are present in receiver for highly bandwidth efficient systems. In this activity, starting from EMS and ADBP solutions, we develop several density evolution algorithms achieving different trade-offs between performance and complexity to further improve the efficiency of the non-binary decoding algorithms and to provide design and analysis tools for the correspondent encoders. We also investigate a new class of non-linear iteratively decodable non-binary codes that show promise with respect to performance attained for high spectral efficiency at low block lengths.

Non-binary LDPC codes [1][2][3] have shown improved performance over binary LDPC codes especially for short-length frames. Even if more complex than the binary case, the decoding of non-binary LDPC codes remains tractable. An iterative decoding based on the sum-product algorithm was proposed by Davey and MacKay in [1]. MacKay and Davey introduced a Fast-Fourier-transform (FFT) in the decoding process to reduce computational complexity [4]. This contribution was further improved in [5], and [6] and motivated more research effort for reaching good trade-off between complexity and efficiency [7][8].

Message passing for decoding non-binary LDPC shares common features with extrinsic information passing used in turbo-codes. Another amount of research focused on the design of non-binary LDPC codes by extending standard tools such as EXIT charts from binary to non-binary codes. In [12], an EXIT analysis is provided to visualize the exchange of information between the variable node decoder and the check node decoder leading to betters codes compared to [13]. A similar work is proposed in [14] using an index-based approach. The extrinsic information can be computed with low complexity thanks to an alternative to the histogram approach.

- JRA 1.1.3.3: Coding for Multiterminal Communication Systems
  Leader: Erdal Arikan (BILKENT)
  Main partners: Shlomo Shamai (TECHNION), Saygun Onay (BILKENT), Pierre Duhamel (CNRS)

This task comprises three research subjects.
- Information-Estimation Paradigm and Code Design
- Secure Transmission over Networks
- Polar Coding for Multiterminal Systems
- Cooperative Coding

The common thread of these subjects is the quest for understanding characteristics of capacity-achieving code constructions in the multiterninal scenarios. The information-estimation relation investigates the basic features of 'good' (capacity approaching) codes operating on a Gaussian channel. Polar coding has proven very effective in constructing capacity achieving codes for a number of multiterminal coding scenarios and we seek to build a general theory for the application of polar codes in multi-terminal settings. In secure transmission, we seek

to develop physical layer security methods over networks. In cooperative coding, we study relaying in connection with forward error correction.

The methods investigated in this JRA aim to improve the efficiency of wireless networks through more advanced signalling and coding techniques. The methods are developed with an overriding concern for low-complexity and suitability for practical implementation. At the moment, no joint activity with Track 2 has taken place; however, feasibility studies are underway for demonstration of relaying techniques developed under this JRA using Track 2 facilities.

The ultimate goal of this JRA is to design capacity-achieving signalling and coding schemes in the multi-terminal settings. Thus the work in this JRA lies at the main research frontier in wireless communications. The methods used in this JRA combine basic tools of multi-user information theory with models relevant to wireless networks envisioned for present or future applications. Understanding fundamental principles of good system architectures and design of low-complexity schemes in accordance with such architectures is the main aim. These aims are fully consistent with the goals of this Work Package on “Performance Limits in Wireless Networks”.

Significant results

- Invited talk (speaker: N. ul Hassan, TUD Germany) at the Seventh IEEE Workshop on Advanced Information Processing for Wireless Communication Systems Aalborg, Denmark 14-15 Nov. 2013. This workshop was co organized by NEWCOM#.
- M. Lentmaier (Lund University, Sweden) gave an invited talk at Chalmers University of Technology, Gothenburg, Sweden on Dec. 3, 2013.
- A joint paper resulting from collaboration within NEWCOM# partners (N. ul Hassan and G. Fettweis (TUD Germany), I. Andriyanova (CNRS France) and M. Lentmaier (Lund University Sweden)) is submitted to ISIT 2014. The results of collaboration were presented in the N# event on 21-23 January in Lisbon.
- A joint paper from a collaboration of NEWCOM# partners (Walter Nitzold, Gerhard Fettweis (TUD, Germany), M. Lentmaier (Lund University, Sweden)) is accepted for publication at ICC 2014. The results of the collaboration were presented at the N# event on 21-23 January in Lisbon.
- As a result of the cooperation between CNIT-CT and UOULU across WP1.1. and WP.1.2, a NEWCOM# Special Session is being organised in RAWNET workshop to be held jointly with WiOpt 2014, Hammamet, Tunisia, May 2014. More information can be found in http://www.wi-opt.org/w5-rawnet.html.
- The workshop is about RESOURCE ALLOCATION IN WIRELESS NETWORKS and is relevant to the topics addressed in N# Track 1, WP 1.1 and 1.2.
- Accordingly we have invited contributions from several N# researchers.
- The accepted papers will appear in IEEExplore and authors will be invited to give a presentation of their work.
- Attendace from UOULU to Track 1&2 meeting in Lisbon, January 2014.
- Organization of CROWNCOM conference 2014 by UOULU, June 2014, in Oulu, Finland.
- N. Ul Hassan (TUD Germany) was invited talk in the Seventh IEEE Workshop on Advanced Information Processing for Wireless Communication Systems Aalborg, Danmark 14-15 Nov. 2013. This worshop was co-orginized by NEWCOM#.N. Ul Hassan (TUD Germany) give a talk in the TwinLab 3DSC Workshopin Masdar Institute of Science and Technology Abu Dhabi 25-26 Nov. 2013.
- A joint resulted forum collaboration within NEWCOM# partners (N. Ul Hassan and G. Fettweis (TUD Germany), I. Andriyanova (CNRS France) and M. Lentmaier (Lund

University Sweden)) is submitted to ISIT 2014. The results of collarobation were presented in the first N# event on 21-23 January in Lisbon.

- Lisbon Dissemination Day, 23/1/2014. Presentation given by E. Arıkan about Task 1.1.3 activitişes to industry delegates as part of the General N# Dissemination Day.
- M. Lentmaier has been invited to give a talk on Spatiallly Coupled Codes at Ericsson Research, Sweden on May 22.
- Jossy Sayir gave a presentation on “Coding Technologies for 5G” at FIA pre-workshop in Athens in presence of other EC projects and the EC's project officer team.
- POLITO has succeeded in building an Analog Digital Belief Propagation (ADBP) decoder that can work at virtually unbounded spectral efficiencies. This work promises to be of great interest for applications where extremely high spectral efficiencies are required at low implementation complexity, such as wireless backhaul
- Y. Liang, G. Kramer, H. V. Poor and S. Shamai, "Compound Wiretap Channels", EURASIP Journal on Wireless Communications and Networking, vol. 2009, Article ID 142374, 12 pges, 2009.doi:10.1155/2009/142374. This paper won the 2014 EURASIP Best Paper Award for
- the EURASIP Journal on Wireless Communications and Networking. (to be granted at EUSIPCO 2014, Lisbon, Portugal, September 1-5, 2014)
- S. Shamai Listed in the 2014 Thomson Reuters "The World's Most Influential Scientific Minds"

WP1.2: Opportunistic and Cooperative Communications
WP Leader: Sergio Palazzo (CNIT)

This WP addresses the many theoretical aspects related to the various emerging opportunistic and cooperative networking techniques, with the objective of assessing them, and finding the most suited to increase the capacity and/or the availability of wireless networks. In a cellular network scenario, attention is focused on the study of intra-cell relaying among nodes and inter-base station cooperation to achieve significant capacity and multiplexing gain, as well as to decrease the loss probability, and to improve timeliness in data delivery. In the context of “occasional” and sporadic communications, the WP investigates the techniques for distributed and cooperative resource allocation and routing in delay-tolerant networks, and those for medium access, routing and power-adaptation in Mobile Ad-hoc NETworks (MANETs, also in their special flavour of Mobile Clouds). Particular attention is finally devoted to the theme of the study and optimization of cooperative sensing in unstructured networks.

A summary of WP1.2 progress towards objectives

The WP is divided into three Tasks, each with specific scope and objectives: Task 1.2.1 “Cooperative multi-user communication”; Task 1.2.2 “Optimal design of opportunistic networks and mobile clouds”; Task 1.2.3 “Cooperative sensing”. During the second year, a JRA which was removed for inactivity, has been reactivated. Thus, in the second year the WP 1.2 hosts 12 JRAs whose activities carried out in the second year are described in detail in the Deliverable D1.2.2.

Task 1.2.1 Cooperative multi-user communication
Task Leader: Ivan Stupia (UCL)

- JRA 1.2.1-1 on information-theoretic perspective of cooperation in multi-user communications
  Main partners: M. Benammar (SUPELEC-CNRS), P. Piantanida (SUPELEC-CNRS) and S. Shamai (Technion)

This first is active, although it currently has no new results to provide for the reporting period considered in this deliverable. The JRA leader has declared to expect a lot of significant results on a new problem they have recently faced, which will be included in the next incoming reports.

- JRA 1.2.1-2 on Network coding for MARC
  Main partners: M. El Soussi (UCL), A. Zaidi (CNRS- Université Paris-Est Marne-La-Vallée), and L. Vandendorpe (UCL)

This second JRA considers a system in which multiple users communicate with a destination with the help of multiple half-duplex relays. Based on the compute-and-forward scheme, each relay, instead of decoding the users' messages, decodes an integer-valued linear combination that relates the transmitted messages. Then, it forwards the linear combination towards the destination. In this work, the relays do not coordinate among themselves in computing the linear combinations. Thus, given these linear combinations, the destination may or may not be able to recover the transmitted messages since the linear combinations are not always full rank. Therefore, this JRA proposes an algorithm where we optimize the precoding factor at the users such that the probability that the equations are full rank is increased and that the transmission rate is maximized. In the second year the collaboration between UCL and CNRS/MLV, led to the publication of a joint paper to an international journal.

- JRA 1.2.1-3 on Message-passing methods for distributed wireless network organization
  Main partners: Mihai-Alin Badiu (AAU), Maxime Guillaud (VUT), Bernard Fleury (AAU)

The third JRA aims at designing distributed interference management schemes requiring only local information exchange at any given point of the network, while retaining the performance of centralized schemes.
So far, the focus is on the interference alignment (IA) strategy, as it is a promising technique for achieving the full degrees-of-freedom of the interference channel. The objective is to develop algorithms that find solutions to the IA problem in the MIMO interference channel. The algorithms should admit distributed implementation -- this property is highly desirable in networks with large number of nodes. Since message-passing techniques provide a systematic methodology for designing algorithms that perform distributed computations, the applicability of algorithms such as sum-product (belief propagation), min-sum or variational message-passing is explored.
AAU and VUT collaborated on this JRA during the second year and two joint papers has been presented at two distinct international conferences.
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- JRA 1.2.1-4 on Distributed learning schemes for interference management and signal optimization in large networks
  Main partners: P. Mertikopoulos (CNRS), E. V. Belmega (CNRS), S. D'Oro (CNIT-CT), A. L. Moustakas (IASA), S. Palazzo (CNIT-CT)

The fourth JRA includes two sub-activities carried out by two research groups: Group 1 consists of CNRS and IASA. Group 2 consists of CNIT-CT, IASA and CNRS.
In this second year, researchers focused on developing distributed learning algorithms for efficient and robust signal optimization in multiple-input, multiple-output (MIMO) uplink multiple access channels, and optimizing the throughput of opportunistic wireless users in MIMO-OFDM cognitive radio networks. Given the importance of conserving battery power in wireless transmissions, we also developed an adaptive transmit policy for efficient power allocation in multi-carrier. During this second year, research activities between CNRS, CNIT-CT and IASA led to one international journal paper and three international conference papers.

- JRA 1.2.1-5 on Clusters organization for multi-hop cooperative communications

Main partners: Riccardo Andreotti (CNIT-Pisa), Paolo del Fiorentino (CNIT-Pisa), Filippo Giannetti (CNIT-Pisa), Vincenzo Lottici (CNIT-Pisa), Ivan Stupia (UCL), Chiara Buratti (CNIT-Bologna), Stefan Mijovic (CNIT-Bologna), Alberto Zanella (CNIT-Bologna)

The fifth JRA considers a Wireless Sensor Network (WSN), where nodes form Virtual Antenna Arrays (VAAs) and use cooperative beamforming to transmit toward a sink. On one hand cooperation greatly increases link capacity, but on the other, it introduces a certain overhead. This tradeoff is analyzed by properly formulating the VAA formation problem as a noncooperative game with complete information, where sensor nodes aim at forming VAAs to maximize their own successful transmission rate, while keeping under control the energy consumed for the signaling within VAAs. Based on this analysis, we then introduce a communication protocol for VAA formation. In the second year the collaboration between CNIT-Pisa, CNIT-Bologna and UCL, led to the publication of a joint paper to an international conference.

Task 1.2.2 Optimal design of opportunistic networks and mobile clouds
Task Leader: Laura Galluccio (CNIT-CT)

- JRA 1.2.2-1 on Opportunistic relaying and forwarding
  Main partners: Beatriz Lorenzo Veiga and Savo Glisic (UOULU), Laura Galluccio(CNIT-CT)

The first JRA includes two sub-activities carried out by two research groups: Group 1 consists of CNIT-CT and CNIT-BO and is involved in a theoretical joint research activity converging into the experimental activities which will be carried out in WP2.2 “Networking technologies for the Internet of Things (IoT) with mobile clouds”. In particular, the feedback obtained by theoretical studies on opportunistic networking will be used by CNIT-CT researchers working in Track 2 to appropriately design algorithms to be tested in the EuWIN platform. Currently the first subJRA involving CNIT-CT and CNIT-BO does not have new results to provide for the time period considered in this deliverable.
Group 2 consists of CNIT-CT and UOULU and is involved in a theoretical joint research activity activity. In the second year the collaboration between CNIT-CT and UOULU, led to the publication of a joint paper to an international conference and the submission of a journal paper to an international journal.

- JRA 1.2.2-2 on Game theoretic approach to timing channel communications
  Main partners: Salvatore D'Oro, Laura Galluccio and Giacomo Morabito (CNIT-CT), Fabio Martignon and Lin Chen (CNRS)

During last year, research activities carried out within the second JRA have been focused on the extension of a previous work on game theoretic analysis of jammed timing channels. More in detail, researchers aimed at proposing a more realistic scenario where the considered utility functions reflect the real concerns of each player. Furthermore, the considered transmission scheme has been modified so that the proposed study also applies to a wide range of possible wireless applications and scenarios where security and energy consumption are critical issues.
Researchers have focused on the study of the Nash Equilibrium (NE) in order to prove its uniqueness and demonstrate how each player can individually reach such an equilibrium in a distributed fashion.
In this JRA a hierarchical game where the target node anticipates the strategy of the jammer has been also considered. In fact, we expect that such hierarchy helps both players in improving their own utility.
In order to take into account the imperfectness of the information on some system parameters, the impact of imperfect knowledge on the outcome of the game has also been investigated. As imperfectness could strongly affects the outcome of the game, researchers are

searching for any analytical/heuristic rules that allow the target node in achieving a high pay-off even in the imperfect knowledge case. A joint journal paper has been submitted to an international journal and already passed the second revision stage.

Task 1.2.3 Cooperative sensing
Task Leader: Aris L. Moustakas (IASA)

- JRA 1.2.3-1 on Multiple source detection, localization, and transmit power
  Main partners: Ioannis Dagres (IASA) – George Arvanitakis (Eurecom) - Adrian Kliks (PUT)

The first JRA focuses on analyzing the performance of RSS based localization, for first time in a correlated log-normal environment. The main goal was to answer the following questions: a) what is the needed density of a (real-time) measurement network for a target localization performance? b) what is the density reduction requirement when utilizing past measurements? A rather simple analytic model for the propagation environment will be assumed in order to assess the performance gain of utilizing past measurements. Finally, the last and most important question is: how close are those conclusions to the true performance encountered in practice?
This is a difficult question, since any experimental setup represents just one realization of the random performance of a specific situation. As long as the theoretical model is close to the real one, you expect at least the general conclusions to be in agreement with experimental results. There exists though, a lot of work in the literature which shows a qualitative agreement on the potential gains [1] when exploiting spatial correlation. In order to have also a quantitative one, a large number of experimental campaigns is needed. This JRA also provides a considerable contribution to this collective effort by one more experimental campaign in an indoor environment using the OpenAirInterface (OAI) platform. Based on the collected measurements, various options for modelling the spatial correlation were assessed.

- JRA 1.2.3-2 on Cooperative simultaneous localization and tracking
  Main partners: Florian Meyer (TUV), Burak Cakmak and Bernard Henri Fleury (AAU)

The second JRA exploits a recently developed theoretical framework to compare belief propagation and mean-field approximation approaches and possibly combine them for distributed localization in cooperative networks.
The JRA will also address complexity issues of existing particle-based localization algorithms based on message passing. This will be done by finding efficient approximate representations for messages and beliefs with the goal of making the algorithms feasible for large-scale localization scenarios with mobile nodes.
Finally, researchers aim to develop distributed algorithms that jointly estimate the locations and clock parameters of the network nodes in a fully decentralized fashion.
A joint journal paper has been accepted for publication in an international journal and two international conference papers have been accepted and presented.

- JRA 1.2.3-3 Source detection in the presence of interference and noise
  Main parnters: Aris Moustakas, Spyridon Evangelatos (IASA) – Erwin Riegler (TUV)

The purpose of the third JRA is to provide a method to obtain fundamental limits for the detectability of multiple primary sources from a sensor network in the presence of interference and noise. The basic tools are borrowed from statistical physics and the theory of spin glasses.
Researchers have applied a two-pronged approach to the problem. In the first, it is assumed that the connectivity matrix is sparse with a finite number of connections for each source and sensor. This problem can be solved using the theory of dilute spin glasses. The pros of this analysis are the fact that it is more realistic while the cons are the complexity of the solution.

In contrast the second approach is to assume a full connectivity limit. In this case, the matrix can more accurately include details of the channel, such as fading, which can be dealt with much easier. In contrast, of course the full matrix approximation is expected not to be too accurate in the 2-dimensional setting.
The above approach can provide closed form expressions that are valid for arbitrary random networks. These can then be used to compare with results in JRA1.2.3-1 and JRA1.2.3-2.
A joint conference paper has been presented in an international conference.

- JRA 1.2.3-4 on Hybrid spectrum sensing architecture for cognitive radio: overcoming noise uncertainty
  Main parnters: Amor Nafkha (SUPELEC/CNRS), Malek Naoues (SUPELEC/CNRS), Adrian Kliks and Krzysztof Cichon (PUT)

The fourth JRA addresses the problem of SNR-wall in non-cooperative systems where the spectrum sensor suffers from a minimum SNR below which it is impossible to reliably detect the primary user's signal. The main objective through this JRA is to develop and implement two low-complexity spectrum sensing schemes in order to overcome the problem of the noise uncertainty. Two methods are applied in this activity; the first one is based on a combination of energy detector (ED) and cyclostationnary feature detector (CFD), the other one makes use of a double threshold sequential energy detector (SED).
The SED processes similarly as the traditional ED but its application can reduce the sensing time. The main idea here is based on the assumption that for a strong primary user signal (resp. no primary user signal), the number of used samples that should be collected to make a decision can be drastically reduced. The combination between the ED and the CFD detectors adopts the following principle: two fixed thresholds are considered for sensing decision, if the value of the test is between the considered thresholds, the CFD detector is applied. In the second year the collaboration between SUPELEC/CNRS and PUT, led to the publication of a joint paper to an international conference.

- JRA 1.2.3-5 on Energy-efficient data collection and estimation in wireless sensor networks
  Main partners: Michel Kieffer, Francesca Bassi, Wenjie Li (CNRS-UniPS), Davide Dardari, Vincenzo Zambianchi, Gianni Pasolini (CNIT-UniBo), Sophie Fosson, Enrico Magli (CNIT-PoliTo), Javier Matamoros, Carles Anton-Haro (CTTC)

The fifth JRA is a cross-WP activity that refers to both WP 1.2 and WP 1.3. Therefore, for the sake of completeness, its definition and roadmap have been also included in D13.2. The goal of the JRA is to leverage the different experiences and expertises of the partners, already active in this research domain, in order to provide innovative solutions for energy-efficient data dissemination and collection in sensor networks. In the second year the collaboration among partners led to the publication of a joint journal paper and three conference papers.

Significant results

- P. Mertikopoulos (CNRS) contributed as a technical program co-chair in WiOpt '14: the 12 International Symposium and Workshops on Modeling and Optimization in Mobile, Ad Hoc, and Wireless Networks.
- L. Galluccio (CNIT CT) and B. Lorenzo (UOULU) organized The 10th International Workshop on Resource Allocation in Wireless Networks (RAWNET 2014), May 12-16, 2014, Hammanet, Tunisia, technically supported by N# and jointly held with WiOpt 2014. The workshop had more than 30 attendees and was the one with the largest number of attendees among the WiOpt 2014 workshops.
- A cross-WP (WP11 and WP1.2) special issue of the TRANSACTIONS ON EMERGING TELECOMMUNICATIONS TECHNOLOGIES has been organized by

two N# members, S. Palazzo (CNIT-CT) and M. Payaró (CTTC) (together with R. Tafazolli and Robert W. Heath Jr.) on the topic of “Enabling 5G: Energy and Spectrally Efficient Communication Systems“.

- E. Riegler (TUV) was co-chair of the 2014 PHYSCOMNET Workshop held in conjunction with WiOpt2014.
- A NEWCOM# special session has been held in conjunction with the European Conference on Networks and Communications (EUCNC), Bologna, Italy, June 23/26, 2014. The main conference EUCNC hosted the Special NEWCOM# technical session on "Opportunistic and cooperative communications", organized by S. Palazzo (CNIT/UniCT), where the following contributions have been presented:
- Opportunistically Cooperating Radios in Action (invited talk), A. Polydoros (University of Athens, Greece)
- VAA Formation Game for Cooperative Wireless Sensor Networks, R. Andreotti (CNIT at University of Pisa, Italy), S. Mijovic (CNIT at University of Bologna, Italy), I. Stupia (UCL, Spain), C. Buratti (CNIT at University of Bologna, Italy), A. Zanella (CNIT at University of Bologna, Italy) F. Giannetti (CNIT at University of Pisa, Italy)
- Multiple relay selection in underlay cognitivenetworks with per-relay constraints,L. Blanco (CTTC, Spain), M. Nájar (UPC, Spain)
- On the impact of sociality in multicast delay tolerant networks with adaptive infection recovery, B. Lorenzo (formerly University of Oulu, Finland now moved to University of Vigo, Spain), S. Glisic (University of Oulu, Finland), L. Galluccio (CNIT at University of Catania, Italy)
- A Game-Theoretic Analysis of Anti-Jamming Timing Channels, L. Chen (CNRS, UPS, France), S. D’Oro, L. Galluccio (CNIT at University of Catania, Italy), F. Martignon (CNRS, UPS, France), G. Morabito, S. Palazzo (CNIT at University of Catania, Italy).

WP 1.3 Energy- and Bandwidth-Efficient Communications and Networking
WP leader: Andreas Polydoros (IASA)

The role of this WP is to investigate and propose bandwidth and energy efficient techniques for current and emerging wireless systems and networks. Based on the participants’ interests and expertises the WP is divided into three Tasks, each with specific scope and objectives.
• Task 1.3.1 “Techniques for power-efficient communications” deals with techniques for power efficiency and minimization at the transceiver and network level.
• Task 1.3.2 “Low-interference, low-emission, radio interfaces” deals with the handling of interference by appropriate low interference transmission techniques (e.g. beam-forming, MIMO, GMC).
• Task 1.3.3 “Resource Allocation for optimized radio access”: is about Radio Resource Management (RRM) and Interference Management (IM) – for a given interference level – in selected scenarios, including HetNets and multi-tier networks.
The research work is organized in 10 Joint Research Activities (JRAs). JRA 1.3.3D was included in the second year of the project, after a SWOT (Strengths Weaknesses Opportunities Threats) analysis that was presented and assessed at the NEWCOM# WP1.3 meeting in Lisbon on January 2014.

A summary of WP1.3 progress towards objectives

IASA as the WP leader, worked for the harmonization of the various research efforts and for the preparation of the D13.2 deliverable. The final version of D13.2 deliverable was submitted in October 2014. It presents a complete analysis of the achievements of each JRA. This analysis includes a description of each activity, an illustration of the adherence and relevance with the identified fundamental open issues, a short presentation of the main results, a roadmap for the future joint research, and a list of the produced publications. The

main technical details of these achievements are reported in the Annex at the end of the D13.2 deliverable.
A summary of these achievements per Task is given below:

Task 1.3.1: Techniques for power-efficient communications
Task leader: Jesus Gomez (CTTC)

In this task various communication strategies and techniques have been developed for multi-user scenarios for which energy efficient operation is mandatory, such as nodes powered from harvesting ambient energy or networks of sensors. This task has also conducted MAC layer optimizations, and developed promising cross-layer techniques such as JPCD. The main results obtained for each JRA in this task are the following.

- JRA 1.3.1A on resource allocation and scheduling strategies for energy harvesting devices
- Development of optimal strategies to recharge the batteries wirelessly in order to prolong the network lifetime while maximizing the sum rate have been proposed for multiuser MIMO networks
- Design of a procedure for switching on and off BSs solely powered with an energy harvesting source (e.g., solar panels) and a finite battery, in order to reduce around 15-20% the size of the solar panels and the batteries.
- Proposal of user association strategies to achieve load balancing in heterogeneous networks where the BSs were solely powered with finite batteries and energy harvesting sources that allowed the BSs to recharge their batteries.

- JRA 1.3.1B on energy-efficient data collection and estimation in wireless sensor networks

- Work on distributed in-network reconstruction of sparse signals. Proposal of a decentralized scheme, referred to as Distributed iterative Thresholding (DiT). The convergence of the corresponding algorithms has also been studied.
- Design of distributed algorithms for the characterization of non-asymptotic confidence region in sensor networks. A variant of the sign-perturbed-sum algorithm by Campi et al. has been proposed.
- Development of an iterative algorithm for outlier detection in wireless sensor networks. The algorithm proposed is able to isolate more than 30% of sensors providing outliers. The equilibrium properties and dynamics of the algorithm are studied.

- JRA 1.3.1C on Joint Protocol Channel Decoding (JPCD)

- Joint protocol-channel decoding techniques have been developed to improve the estimation quality of the type of a packet corrupted by transmission errors. Optimal and a suboptimal estimation algorithms have been developed.

- JRA 1.3.1D on energy efficient probing in CSMA based multi-rate ad hoc networks

- Design of a cross-layer energy optimum adaptive modulation and coding policy which improves energy consumption significantly compared to a single-layer policy.
- Design of a cross-layer selection of transmission capacity and MAC layer attempt rate for an ALOHA underwater acoustic network. The proposed joint allocation reduces the energy consumption by allocating a higher MAC capacity but a lower physical layer capacity to nodes which have a greater distance to the base station.

Task 1.3.2: Low-interference, low-emission, radio interfaces
Task Leader: Adrian Kliks (PUT)

The main goal of this Task is to propose solutions for future wireless communication systems that would lead to an efficient use of resources (e.g., energy, assigned spectrum) and to the minimization of the interference induced to neighboring systems. In the first JRA, the problem of energy-efficient communications for body area networks (BAN) is considered together with the application of a very efficient FBMC technique for out-of-band emission minimization. In the second JRA, the problem of non-linearities in the context of non-contiguous systems is considered, concentrating on the out-of-band emission reduction techniques. The main achievements are listed below:

- JRA 1.3.2A on advanced MIMO techniques (virtual MIMO, MIMO-FBMC) for low-interference transmission

- The detailed derivation of the impact of the precoding applied to the MIMO-FBMC scheme on the average transmit power has been obtained; the results of this work has been published in a joint Journal paper.
- A new algorithm for multi-user scheduling utilizing application of FBMC modulation in MIMO systems has been proposed. MIMO schemes have been also investigated in the context of body area networks.The efficiency of the novel solution has been verified by computer simulations. In particular, the BAN has been treated as an ad-hoc MIMO system that can be utilized for improvement of regular connection between the user and the distant access point.

- JRA 1.3.2B on advanced filtering and adaptive signal processing (OOB, PAPR, SIC)

  The main effort has been put on the derivation of advanced and computationally efficient solutions for the reduction of out-of-band emission in the non-contiguous transmission scenario. The analysis of the PAPR characteristics in such systems has been also provided.

Task 1.3.3: Resource Allocation for optimized radio access
Task Leader: Luca Sanguinetti (CNIT)

This Task focus on the development of energy-efficient algorithmic solutions for the management of resources and for controlling interference in wireless networks. Special emphasis is given to HetNet topologies (including relaying nodes, stationary and mobile nodes, femtocells, picocells, and others) in different operating conditions and scenarios. The Task consists of four JRAs, and the main achievements are listed below:

- JRA 1.3.3A on interference management techniques for heterogeneous networks

- A REM-based architectural framework has been proposed for supporting interference management techniques in HetNets including both LTE and Wi-Fi technologies. It consists of general layered architecture that considers the inclusion of global and local REM databases at different nodes of the network.
- A neighborhood cooperation algorithm for deciding the TVWS spectrum assignment to small cells has been proposed and evaluated.
- In conjunction with JRA#G in WP2.1, the computation of the maximum allowed transmit power so as not to interfere with TV receivers when TVWS are allocated to small cells has been carried out based on real measurements performed in an indoor building.

- An interference coordination scheme for HetNets that jointly exploits the frequency, power and time dimensions has been proposed and assessed.

- JRA 1.3.3B on game-theoretic energy-efficient control and resource allocation algorithms in heterogeneous networks

- A distributed power allocation scheme has been proposed for energy-aware, non-cooperative wireless users with minimum-rate constraints in the uplink of a multicarrier heterogeneous network.
- A non-cooperative game has been formulated modelling the power allocation problem that arises in a heterogeneous multipoint-to-multipoint network wherein each transmitter and receiver pair can arbitrarily choose whether to selfishly maximize its own spectral or energy efficiency.
- Proposal of an iterative and distributed algorithm inspired by best response dynamics in which (at each step) every transmitter updates its power exploiting a local estimate of its current SINR at the receiver. The performance of the proposed solution has been evaluated by means of numerical results in the uplink of a small cell network.

- JRA 1.3.3C on self-configuration and optimization of a hybrid LTE Femto - M2M network for smart city applications

- Evaluation of M2M Scheduling Opportunities in a LTE Small Cell Network for Smart City Applications.
- Definition of a Mixed Integer Linear Programming (MILP) model for the LTE Uplink radio resource assignment problem.

- JRA 1.3.3D on Radio resource allocation algorithms in cognitive radio networks with outdated CSI

- Development of a new RA technique for CR BIC-OFDM systems with outdated CSI, which exploits a Link Performance Prediction (LPP) scheme based on the ESM technique.
- Extension of the scenario to the case of a generic number of decode-and-forward relay nodes for a dual-hop transmission (source-relay-destination). A “best relay” selection mechanism is defined, exploiting the goodput metric. A new objective function for the resource allocation (RA) problem is formulated that considers the total PER for the source-relay-destination transmission.
- Derivation of an enhanced RA technique, suitable to a realistic scenario, where only imperfect CSI is available at the transmitter for a dual-hop transmission. In this scenario, a new channel prediction model is exploited in the LPP ESM technique.

Significant results

In this WP, as part of Track 1 of NEWCOM# project, the research work is concentrated on the algorithmic development of the various WP-relevant solutions. The outcomes of these efforts are disseminated through scientific publications and are reported in D13.2 deliverable. In most cases, although the work is theoretical, practical issues are taken into account by appropriate modelling of the uncertainties of the real world. In order to better investigate the practical implementation of the proposed solutions, various JRAs established a connection to Track 2 activities.
In Task 1.3.1, significant achievements have been obtained by the NEWCOM# researchers. First, in the area of communication with energy harvesting nodes, where several scenarios have been addressed and techniques have been proposed. An important aspect of this work

was the initiation of a connection to a Track 2 JRA in which the researchers worked jointly on the energy modelling and profiling of the physical layer of a modern wireless communication system and developed a hardware implementation of an interference mitigation technique for LTE systems. The outcomes of this activity are reported in a series of publications and in deliverable D13.2. Second, an activity on the signal detection solutions has been initiated and will continue in the next year. The promising results on outlier detection for wireless sensor networks will be tested in the context of the DATASENS platform. Third, initial promising results on the novel concept of JPCD have already been obtained in the context of a Wi-Fi network. The related objective in the third year will be to extend these results to LTE, LTE-A, and address new issues pertaining to these communication architectures. Some of the obtained results are to be translated to the OpenAirInterface platform of WP 2.3: Flexible communication terminals and networks. Finally, the first results obtained during this second year on energy efficient probing in CSMA based multi-rate ad hoc networks are ready for publication. The work in the third year will focus energy efficiency of underwater acoustic networks.

In Task 1.3.2 the work on FBMC modulation for MIMO systems was focused on the practical realization of the FMBC based systems for future wireless applications. The findings presented by the NEWCOM# researchers at major conferences and in journals allow the conclusion that the FBMC-oriented transmission scheme can be viewed as one of the key candidates for future advanced communication systems. Furthermore, the observed average rate in the scenario when BANs are utilized as ad-hoc MIMO system supporting regular transmission proved the validity of this important concept. It opens new research directions for the practical application of smart clothes in everyday life. In direct cooperation with Track 2, the algorithms developed for out-of-band emission reduction in the non-contiguous schemes, as well as PAPR analysis, have been partially verified in hardware implementations, thus proving the validity of the concept of primary and secondary system coexistence when the former utilizes a very narrow frequency band.

In Task 1.3.3 in the activity that proposes allocation strategies of shared spectrum (TVWS) in small cell scenarios, it is shown that the frequency assignment needs to take into account the spectrum availability at the TVWS band and perform a smart assignment which ensures there is no harmful interference generated to primary users. In this respect, in conjunction with JRA#G of WP2.1, a computation of the maximum allowed transmit power so as not to interfere with TV receivers when TVWS are allocated to small cells has been carried out, based on real measurements performed in an indoor building. Similarly, a connection to a Track 2 activity has been established in the JRA dealing with hybrid LTE Femto - M2M networks. More specifically, within Track 2 the real behavior of different protocols in terms of Packet Error Rate (PER) and signaling overhead – which has to be transmitted over the LTE network and towards the M2M server – has been evaluated, and this input will help in the adaptation of the M2M model used in this activity.

There was also a significant number of dissemination activities in the second year of the project. Some selected activities are listed below:

- Kliks (PUT), J. Pérez-Romero (UPC), L. Boukhatem (UniPS), A. Zalonis (IASA), are jointly working on the special issue entitled "Technical Advances in the Design and Deployment of Future Heterogeneous Networks" in EURASIP Journal on Wireless Communications and Networking. The submission deadline was closed on August 8th and a total of 36 papers were received. The editors are currently involved in handling the revision process.
- IASA, as the WP1.3 leader, organized the NEWCOM# Special Session on Advanced techniques for energy- and bandwidth-efficient communications for EuCNC 2014 in Bologna, Italy, June 2014, in which the results from the various WP1.3 research

activities were presented.

- The Workshop “Interference and Design Issues for Future Heterogeneous Networks”, was held on April 6th at IEEE WCNC 2014 conference (Istanbul). Detailed information can be found at http://www.wcnc-futurehetnets.org/. Chairs: Hanna Bogucka (PUT), Adrian Kliks (PUT), Jordi Pérez-Romero (UPC). A total of 12 techical papers were presented covering different aspects of HetNets such as the deployment aspects, the physical layer issues, radio resource management and interworking between different technologies. In addition to the technical papers, the workshop also included two keynote speeches.
- The N# special session at IEICE ICTF event was held in Poznan in May 2014. The title of this session was “NEWCOM# Energy - and Bandwidth-Efficient Communications and Networking”.
- WP1.3 participation at the NEWCOM# dissemination event, Nokia Networks, Munich, 29 October 2014: F. Bassi (CNRS/UPS) on behalf of the JRA: Task 1.3.1, JRA 2 (Energy-efficient data collection and estimation in wireless sensor networks) presented an overview of the JRA activities and results. Abrignani, Giupponi, Lodi, Verdone; “On Self-configuration and Optimization of a Hybrid LTE Femto - M2M Network for Smart City Applications”
- A presentation entitled “Radio Access Management techniques for Heterogeneous Networks”, including some results of the JRA 1.3.3A was given by J. Perez-Romero at the Industry Dissemination Events in Stuttgart (Alcatel-Lucent, 20th March 2014) and Istanbul (AVEA Labs, 4th April 2014).

2.2.2 TRACK 2

Track Leader: Roberto Verdone (CNIT)

Track 2 is devoted to the “EUropean laboratory of WIreless communications for the future INternet” (EuWIn) that hosts researchers from within the network, from external Academic Institutions, and from European companies. EuWIn is organized as a collaborative effort of the constellation of all NEWCOM# partners orbiting around three different reference sites at three different NEWCOM# Institutions. Through its activity on themes like Radio Interfaces, Internet of Things, and Flexible Communication Terminals and Networks, the Lab allows the experimental verification of some of the results produced in Track 1. The hosting Institutions of the three EuWIn nodes offers facilities and personnel to host researchers performing the different cooperative research actions described later on in the Joint Program of Activities. EuWIn has the ambition of creating a permanent environment for cooperative research that survives the NoE with the contribution of the hosting Institutions.

WP 2.1 Radio interfaces for next-generation wireless systems

WP Leader: Miquel Payaro and Carles Fernandez (CTTC)

This Work Package is devoted to set up, operate, and maintain the EuWIn facilities at the Centre Tecnològic de Telecomunicacions de Catalunya (EuWIN@CTTC). The general focus is on the implementation of radio interfaces with emphasis on low energy consumption, low emission, and high spectral efficiency, as well as on localization techniques in wireless communication terminals. In order to assess the performance of these radio interfaces in close-to-real-world situations, a set of realistic channel models is also developed within this WP.

The lab is open to all NEWCOM# partners for the possible implementation, experimental validation and performance assessment of research results from Track 1, especially Task 1.1.1 “Theoretical limits of communications and networks”, Task 1.1.3 “Capacity-reaching

channel codes", Task 1.3.1 "Techniques for ultra-power-efficient terminals", and Task 1.3.2 "Low-interference, low-emission, radio interfaces". Part of the results in this implementation-oriented WP is also fed back into the theory-oriented WPs in Track 1, so that the theoretical models and results can be further refined taking into account practical constraints.

The lab contributed specific EuWIn training sessions to the dissemination and training activities organized under WP3.2 'Education and Training'. In order to foster industry-academia cooperation, WP2.1 organizes activities such as lab visits and/or virtual tours to its premises. Besides, it reports on lab activities and results at some of the in-company dissemination events organized by NEWCOM#. Where appropriate, WP2.1 stimulates NEWCOM#'s Affiliate Partners (or other companies') participation in its activities.

A summary of WP2.1 progress towards objectives

During the first year, this WP established a clear structure in terms of Tasks and Task leaders, and the different Joint Research Activities (JRAs) consolidated and started proper operation in the vast majority of cases. In this second year, researchers are enjoying fruitful collaboration and have made relevant progress in their activities. Hereafter, we report as usual a list of the most relevant outcomes from the work performed within the different JRAs, summarizing their aim and status.

Task 2.1.2 Low-energy-consumption and low-emission radio interfaces
Task Leader: Amor Nafkha (Supelec)

- JRA#A Enhanced NC-OFDM transmission with reduced spurious emission level

The aim of this JRA is the reduction of subcarrier spectrum sidelobes and intermodulations in the transmitter, which will allow for dynamic generation of signal well localized in frequency, i.e. with "clean" power spectrum density plot. Algorithms other than digital filtering are being considered as they can provide lower computational complexity and higher flexibility in comparison to typical digital filtering. The effort in the reporting period was concentrated on proposing an algorithm for reduction of both intermodulation and subcarrier spectrum sidelobes, exhibiting low computational complexity, as well as an enhanced version that makes use of the context information on the Primary Users, that can improve spectrum shaping performance.

Task 2.1.3 Hybrid localization techniques for wireless terminals
Task Leader: Carles Fernández-Prades (CTTC)

- JRA#F Design and experimental validation of algorithms for active and passive indoor positioning

This JRA addresses different aspects and technologies for indoor location, namely: i) estimation and tracking algorithms for indoor UWB positioning. Theoretical bounds for UWB ranging will be also addressed, ii) other positioning schemes based on receiving power indicators of wireless communication networks such as WiFi and Bluetooth, in combination with inertial measurement units will be explored, building proof-of-concept prototypes based on COTS components and Bayesian filtering theory, and, finally, iii) the problem of multi-source localization will be addressed and tested via a simulation tool developed within this JRA. After a survey of the current available technologies for indoor positioning, researchers have continued the development of an open, reliable and modular system for testing several technologies and collect the data measurements, as well as the development of algorithms for indoor positioning exploiting data fusion between WiFi RSS and inertial measurements. During this second year, a robotic platform has been developed in order to provide

repeatability in the experiments performed in real-life environments.

Task 2.1.4 High spectrally-efficient radio interfaces
Task Leader: Guido Masera (CNIT)

- JRA#B Practical implementation of polar codes

Polar codes have proved to achieve capacity under specific conditions. Different algorithms have been proposed for decoding polar codes with different tradeoffs between decoding complexity and performance. This JRA addresses the design of efficient hardware architectures for decoding polar codes. Among the algorithms that are studied are belief propagation decoding and successive cancellation decoding. This activity is focused on the VLSI implementation of the Belief Propagation (BP) Algorithm applied to the decoding of Polar Codes. A first BP decoding architecture has already been developed and synthesized to have a preliminary comparison with respect to alternative decoding approaches and codes. Notwithstanding, the different clock frequencies, BP decoder achieves a higher throughput than Successive Cancellation (SC) decoding, confirming that BP decoding is a promising approach to target high throughput applications. In terms of occupied area, the BP decoder is larger than both SC solution and a fully parallel LDPC decoder. This difference can be reduced by means of specific optimizations in the architecture design.

- JRA#H Impact of channel model in the performance evaluation of wireless systems

In this JRA, the performance of a wireless communications system (e.g., based on IEEE 802.16 or LTE) will be evaluated under different channel propagation conditions. The performance metric will be related to the quality of the received signal (e.g., in terms of BER or EVM). All the stages of the communication (signal generation, modulation, propagation, acquisition, channel estimation, demodulation, etc.) will be implemented in the GEDOMIS® platform. The channel propagation conditions were uploaded in CTTC's channel emulator and the models for the channel were chosen from the different models that will be developed within JRAs C, D and/or E.
Scientific achievements: The initial scientific results of this JRA have been that an LTE-based PHY-layer has been implemented in the GEDOMIS® testbed, on top of which the impact of the channel model can be evaluated. Precisely, the developed system consists of a hard-ware-efficient implementation of a Femtocell/Macrocell interference-mitigation technique for LTE-based systems. Based on this hardware setup initial actions were made to evaluate the performance of the real-time LTE-based interference-mitigation scheme under realistic oper-ating conditions. The evaluation was comprehensive enough to validate the impact that dif-ferent channel models (i.e., ITU Pedestrian B and 3GPP Extended Pedestrian A, at different speeds) have on the effectiveness of the evaluated interference-mitigation scheme and, ulti-mately, on the performance observed for the primary communication link.

Task 2.1.5 Channel measurements, modelling and databases
Task Leader: Troels Pedersen (AAU)

- JRA#C Assessment and development of multi-link channel models

This JRA ambitions to develop and experimentally validate accurate and computationally effective multilink channel models applicable to cooperative and interference-limited net-works. Regarding the assessment, a draft of the review paper has been circulated among partners and is under revision by the partners. The plan is to pursue and finalize this activity in the next period. Regarding the development of channel models, three activities are cur-rently on-going: i) Development of indoor multi-link channel models (UCL, UGent): a first model was designed and the resulting submitted paper is now in revision. It is now being

extended to include angular properties, as well combined with room-electromagnetic theory to include late components. This model also serves as a basis for interaction with JRA-H. A joint UCL-UGent experimental campaign was carried out in February 2014 to estimate the channel dynamics in various indoor environments. Measurement results are currently being analyzed; ii) Dense multipath depolarization modeling: the polarimetric properties of so-called Dense Multipath Components were investigated in various outdoor and indoor environments, relying on broadband measurements and Ray-Tracing simulations; and iii) Extended ray-tracing modeling for UWB transmissions: an existing ray-tracing tool is being extended with UWB capability.

- JRA#G Spectrum occupation measurements and database exploitation

During the last years, and starting in NEWCOM++, UPC has built a semi-public database that contains spectrum occupancy measurements in different bands and locations in the area of Barcelona and neighborhoods. Measurements have been obtained by means of a handheld Anritsu MS2721B Spectrum Analyzer. Similarly, also PUT has performed some spectrum occupation measurement works in the area of Poznań. Based on the available information from measurements in these two sites, the purpose of this JRA is to update the current measurements with additional ones and to exploit them for the development of RRM strategies making use of flexible spectrum management.
Several frequency bands from 200 MHz up to 3 GHz have been measured up to date in the two sites, both Poznan and Barcelona. Obtained results show significant amount of unused spectrum, with similar results for both sites when analyzed globally (average spectrum occupancy of 27% in Poznan and 22% in Barcelona). On the contrary, when going to the detailed analysis of some specific bands, more relevant differences are obtained. These differences have been observed mainly in the Terrestrial TRunked Radio (TETRA) bands that in Poland are also used by Code Division Multiple Access (CDMA) 450, as well as in the bands of the Global System for Mobile communications (GSM) due to the effects of Universal Mobile Telecommunications System (UMTS) refarming in the 900 MHz band.

Significant results

Concerning joint research activities, the main achievement has been the joint Track1/Track2 meeting held in Lisbon on January 21/22, 2014, followed by the workshop on “Future Wireless Communications” on the 23rd, see http://www.newcom-project.eu/index.php?option=com_content&view=article&id=106:newcom-track1-2-meeting-and-workshop-on-the-future-of-wireless-communications-,-lisbon-21st-23rd-january-2014&catid=10&Itemid=132. The event was a success with more than 70 persons attending. The Joint Track1/2 workshop was a good occasion to coordinate inter-Track action about the experimentation at one of the EuWIn sites of some technologies investigated theoretically in Track 1. The workshop was planned as one of our industry dissemination events and saw the participation of a number of different Portuguese companies in the field of telecommunications.

- Track 2 researchers from UCL, CNIT/Bologna, and CTTC prepared a joint NEWCOM#/COST IC1004 traininng school on experimentation (Claude Oestges is the COST IC1004 chair of Radio Channel WP). The school took place during 25 – 28 November 2013 and was hosted by CTTC. The title of the school was “Beyond 4G Networks in Cities: from Theory to Experimentation and Back” and the detailed technical program can be found at http://www.euracon.org/b4gc2013. The school was attended overall by more than 60 people making it a clear success. A more detailed report appeared in NEWCOM#’s newsletter.

- A joint supervision of two PhD theses was initiated between UCL and UGent (theses of Evgenii Vinogradov and Brecht Hanssens). This has led to joint measurement campaigns in April 2014, using UCL Elektrobit Channel Sounder. The campaigns focused on dynamic channel models in peer-to-peer networks for two scenarios (terminal-to-terminal in large empty/crowded halls and body-to-body in corridor/office areas).
- The 7th IEEE Workshop on Advanced Information Processing for Wireless Communication Systems took place on 14-15 November at AAU. More information on the workshop (programme, participants, slides of the presentations, etc.) can be found on its web-site: http://www.es.aau.dk/navcom/events/7th-ieee-ws-aipwcs/
- About 50 participants, from both academia and industry, attended this event, which was sponsored by Intel Mobile Communications. Several N# partners contributed and/or attended the workshop. The scientific topic of the workshop covered mainly WP1.1, WP1.2, and WP2.1.
- Researchers from PUT and CNRS/Supelec working in JRA#A were invited to submit a paper to CROWNCOM. The research leading to the results that will be published in this invited paper is a mixture of both theory and experimentation (it deals with hardware implementation aspects) and, thus, it is an inter-Track activity (T1.2.3 in Track 1 and T2.1.2 in Track 2).
- Researchers from CTTC working in JRA#H were invited to submit a paper to SAM conference. The reported results deal with energy consumption measurements in the GEDOMIS® testbed, which is of paramount importance when assessing the evaluation of the performance of wireless communication systems.
- Researchers Marco Luise, Sinan Gezici and Carles Fernández-Prades were invited to serve as editor of the Special Issue on "Signal Processing Techniques for Anywhere, Anytime Positioning" in EURASIP Journal on Advances in Signal Processing.
- Organization of a Special Session on “From Theory to Practice: Experimental Research Activities in NEWCOM#’s EUWIN Labs”, in the European Conference on Networks and Communications, held in Bologna, Italy, from June 23 to 26, 2014. The Special Session was on Thursday, June 26, 2014, at 09:00-10:30, and was chaired by Dr. Miquel Payaró (CTTC, Spain). The list of presented papers represents a showcase of the joint research activities performed in the framework of NEWCOM#, as well as the high degree of collaboration within the partners:
    - Testing Protocols for the Internet of Things on the EuWIn Platform, Sebastiano Milardo (Università degli Studi di Catania, Italy), Gordana Gardasevic (Università di Bologna, Italy), Melchiorre Danilo Abrignani, Andrea Stajkic, Stefan Mijovic (Università di Bologna, Italy), Giacomo Morabito (Università degli Studi di Catania, Italy), Chiara Buratti, Roberto Verdone (Università di Bologna, Italy).
    - A VLSI Implementation of the Belief PropagationAlgorithm Applied to the Decoding of Polar Codes, Andrea Biroli, Guido Masera (Department of Electronics and Telecommunications, Politecnico di Torino, Italy).
    - Measurement Based Modeling of Time-Variant Fading Statistics in Indoor Peer-to-peer Scenarios, Evgenii Vinogradov (ICTEAM/Electrical Engineering, Université catholique de Louvain, Belgium), Joseph Wout (Dept. of Information Technology (INTEC-WICA), Ghent University/IMinds, Belgium), Claude Oestges (ICTEAM/Electrical Engineering, Université catholique de Louvain, Belgium).
    - RSS based localization: Theory and experimentation, Ioannis Dagres (Institute of Accelarating Systems and Applications, National Kapodistrian University of Athens, Greece), George Arvanitakis (Eurecom, France), Adrian Kliks (Poznan University of Technology, Poland), Andreas Polydoros (Institute of Accelarating Systems and Applications, National Kapodistrian University of Athens, Greece).

  - Exploitation of TVWS measurements in indoor/outdoor scenarios for HetNets deployment, Jordi Perez-Romero (Universitat Politècnica de Catalunya, Spain), Adrian Kliks (Poznan University of Technology, Poland), Anna Umbert (Universitat Politècnica de Catalunya, Spain), Pawel Kryszkiewick (Poznan University of Technology, Poland), Ferran Casadevall (Universitat Politècnica de Catalunya, Spain).
- Invited paper to the 9th International Conference on Cognitive Radio Oriented Wireless Networks (CROWNCOM), held in Oulu, Finland, June 2-4, 2014.
- During this second year, Giacomo Calanchi (student from CNIT/UNIBO that spent a research stay at CTTC in the framework of this Project in the former months) presented his M.Sc. Thesis at the Università Di Bologna:
  - Giacomo Calanchi, “Design and Test of a Prototype for Indoor Positioning”, M.Sc. Thesis, Dipartimento di Ingegneria dell’energia Elettrica e dell’informazione Guglielmo Marconi, Università Di Bologna (Italy), April 2014.
- The European Space Agency awarded CTTC for the succesful Galileo position fix achived with the GNSS software receiver developed within EUWin, issuing a Certificate for the first 50 users of the Galileo system, worldwide.
- On January 23rd, 2014 a delegation of NEWCOM# researchers participated in an Industry Dissemination Event with representatives of the following Portuguese operators: PT, Vodafone and ZonOptimus. The event consisted in a series of presentations followed by rounds of discussion from researchers from Newcom. The main goal of this event was to give a NEWCOM# project overview and to disseminate the planned activities and obtained results within the NEWCOM# frame to researchers that were with the above mentioned Portuguese operators.
- On March 20th, a delegation of NEWCOM# researchers participated in an Industry Dissemination Event at the premises of Alcatel-Lucent (ALU) in Stuttgart. The event consisted in a series of presentations by both NEWCOM# and ALU researchers followed by rounds of discussions among them. The main goal of this event was to give an overview of the NEWCOM# project and to disseminate the planned activities and obtained results within the NEWCOM# frame to ALU researchers.
- A Track 1 & 2 meeting took place in Lisbon during 21st – 23rd January, 2014. The meeting consisted of a series of technical presentations from all the JRAs in the project. Concerning WP2.1, all 8 active JRAs were presented as planned in the morning on January 21st and everything went smoothly.
- Organization of Conference: European Wireless 2014 The 20th European Wireless (EW) Conference took place in Barcelona, Spain, from May 14 to May 16, 2014, and was organized by the Centre Tecnològic de Telecomunicacions de Catalunya (CTTC). The event was publicited to the research community and to the ICT industry all around the world. NEWCOM# was a Technical Sponsor of the event, and EURACON (http://www.euracon.org/) and Scytl (http://www.scytl.com/) were the Sponsors. The 2014 edition of EW was aimed at addressing a key theme on "Energy- and Spectrally-Efficient Broadband Communication Systems". The attendants to the Conference enjoyed Keynote Speakers’ talks, coming both from the academia and the industry:
  - Prof. Andrea Goldsmith, who is the Stephen Harris professor in the School of Engineering and a professor of Electrical Engineering at Stanford University, and previously held industry positions at Maxim Technologies, Memorylink Corporation, and AT&T Bell Laboratories,;
  - Nuria Oliver, currently Scientific Director at Telefonica Research (Barcelona, Spain) and being responsible for the Multimedia, HCI, Mobile Computing, Big Data Mining & User Modeling Research areas; and
  - Frank H. P. Fitzek, Professor in the Department of Electronic Systems, University of Aalborg, Denmark, heading the Mobile Device group.

Tutorials were as well of special interest and relevance to NEWCOM# core topics. Dr. Ali Imran talked about “SON for Energy and Spectral Efficiency: Research Challenges in the Key Enabler of 5G and Beyond”, Dr. Deniz Gunduz about “Designing Intelligent Energy Harvesting Communication Networks”, Dr. Frank H. P. Fitzek about “Network Coding: Theory and Implementation”, and Dr. Marco Di Renzo about “Spatial Modulation for MIMO Wireless Systems”.

- Organization of a Special Issue at the EURASIP Journal on Advances in Signal Processing, entitled “Signal processing techniques for anywhere, anytime positioning”. The Special Issue was edited by Prof. Marco Luise, Prof. Henk Wymeersch, Prof. Sinan Gezici and Dr. Carles Fernández-Prades, and showcases the latest research results on signal processing for ubiquitous positioning, and in particular on the techniques to increase the accuracy, availability, and reliability of position indication of a user terminal, including indoor environments. This Special Issue can be accessed online from http://asp.eurasipjournals.com/series/AAP

WP 2.2 Networking technologies for the Internet of Things (IoT) with mobile clouds
WP Leader: Davide Dardari (CNIT)

This Work Package aims to set up, operate, and maintain the EuWIn facility at the University of Bologna (EuWIN@CNIT/Bologna). The general focus is on networking technologies for the Internet of Things (IoT) with mobile clouds, with particular emphasis in Smart City as well as indoor applications. The lab is open to all NEWCOM# partners for the implementation, experimental validation and performance assessment of research results from Track 1.

A summary of WP2.2 progress towards objectives

The second year of activity has been mainly devoted to the test of EuWin@CNIT/BO platforms and the consolidation of joint research activities (JRAs).
As will be detailed in the following, some JRAs are inter-WP and inter-Track. The former are oriented to increase the integration between the distributed EuWin laboratories. The latter demonstrates the utility of EuWin for the experimental validation of theoretical schemes investigated in Track 1. The outcome of such activity has been described in Deliverable D22.3 released at M24.

Within EuWIn a particular effort has been devoted to demonstration activities, workshops, and to the organization of training schools dedicated to experimental research. In order to foster industry-academia cooperation, WP2.2 has organized jointly with WP2.1 and WP2.3 in-company dissemination events to report on lab activities and results carried out at EuWin. Starting from this dissemination campaign, some collaborations with companies willing to exploit the capabilities of the EuWin platfiorm for experimental research have been established.

For instance, CNIT-UNIBO worked on an activity commissioned by NEC, Germany, through the HGI (Home Gateway Initiative), related to “Testing the impact of IEEE 802.11 over Zigbee networks”. The activity has the objective of measuring the performance of a point-to-point Zigbee network in the presence of interference generated by different Wi-Fi access points. The measurements have been carried out at UNIBO through the Flextop EuWIn facility.

Task 2.2.1 Lab set-up, maintenance and planning
This task is mainly related to platforms maintenance and testing of the 3 different platforms designed and deployed at EuWin@CNIT-BO during the first year. These platforms offer more than 200 wireless nodes implementing different types of radio interfaces: Flexible Topology

Testbed (FLEXTOP), Data Sensing and Processing Testbed (DATASENS), and Localization Testbed (LOCTEST).
In particular, it is worth to remark that one of the objectives of FLEXTOP is to perform pre- and post- deployment tests, mainly with reference to testbeds developing IoT or smart city applications. To this aim some successfully tests have been done at EuWin@CNIT-BO in order to compare a smart city real testbed, deployed in the park of the Engineering School at the University of Bologna, with a down-scaled testbed developed using FLEXTOP. The development of a testbed deployed into a laboratory, that is in a stable and controllable environment, precisely reproducing a real testbed deployed outdoor, may drastically reduce the costs of the testing and parameters tuning phases in the real deployment.
For what the DATASENS platform is regarded, an experimental validation as been performed during the EUCNC 2014 Conference, which took place in Bologna on June 23-26 2014. More than 40 mobile DATASENS devices were given to conference attendees. The experiment allowed the collection of the inter-contact time statistics. The measured data will be made available in the EuWIN website repository.
With reference to the objective of benchmarking wireless network simulators using the FLEXTOP platform, CNIT/UniBO performed some tests for comparing FLEXTOP results with an IEEE 802.15.4/Zigbee simulator, implemented in NS-3.
As further described in JRA#1 – Task 2.2.2, a particular effort has been devoted to the design and development of an open platform for positioning experimentation which is common to both EuWin@CNIT-BO and EUWin@CTTC. This has facilitated the set up of intra- and inter-WP JRAs under the same hat of common research themes (lab of labs).

Task 2.2.2 Large-scale wireless sensor networks: routing protocols, network topologies and cooperative localization
Two JRAs have been consolidated, covering all the topics addressed by the Task and using the available facilities. JRA#3 is the experimental counterpart of theoretical JRAs in Track1 and hosted the algorithms developed there.

- *JRA#1 Design and experimental validation of algorithms for active and passive indoor positioning*

Within the inter-WP JRA#1 a researcher mobility action between EuWin@CNIT-BO and EuWin@CTTC has taken place. In particular, the research activity, carried out at CTTC, was focused on the development of an indoor positioning system, both from a hardware and software viewpoint. First, an open-source, low-cost, modular and completely configurable platform was deployed, featuring several sensors and interface (e.g. inertial measurement unit and WiFi adapter); then, an algorithm for indoor positioning featuring data-fusion of inertial measurements and WiFi RSS data was developed.
Successively, the indoor localization platform has been integrated with DATASENS and LOCTEST platform at EuWin@CNIT-BO site. Specifically, Zigbee and ultra-wideband interfaces has been added with the purpose to test localization and tracking algorithms, with particular attention to the fusion of measurements coming from heterogeneous devices (e.g., RSS, UWB, inertial, etc.). The platform can be considered general purpose and algorithm-independent. In fact, the modular architecture of both hardware and software allows the platform to be used in a wide range of indoor positioning scenarios.

- *JRA#3 Experimental activity on data sensing and fusion*

This JRA is related to distributed signal processing techniques and exploits the DATASENS platform. In particular, the distributed algorithms for the detection of defective nodes in wireless sensor networks designed in WP 1.2 Task 1.2.3 have been implemented using the DATASENS platform. A test bed composed of 40 wireless nodes equipped with sensors deployed in a real environment has been set up. The effects of MAC protocol and time-variant

network topologies are under investigation. To this purpose, a research mobility action took place where a researcher from CNRS/SUPELEC has been hosted at CNIT/Unibo. Measurement data will be made available in the EuWin website repository.

Task 2.2.3 Experimental Activities on Opportunistic Networks with Mobile Clouds
So far one JRA has produced significant results in this Task during the second year.

- *JRA#6 Testing IP-based Wireless Sensor Networks for the Internet of Things*

The main objectives of this JRA are the implementation and testing of different upper layers protocols for IEEE 802.15.4 networks and the comparison between two different paradigms for the Internet of Things. In particular, the JRA is focused on: i) comparing different solutions for the implementation of the Internet of Things (IoT) paradigm; ii) applying the Software Defined Networking (SDN) paradigm to WSNs.
With reference to the first objective the following solutions have been compared: IPv6 over Low power Wireless Personal Area Networks (6LowPAN), using IPv6 addresses, and Zigbee, using IEEE 802.15.4 MAC addresses. For what concerns the second objective, the distributed routing protocols used in Zigbee and 6LowPAN have been compared to the centralised approach implemented in the case of SDN, where routing policies are defined by an external controller that could be anywhere in the network.
A researcher from CNIT-CT visited the EuWin site in Bologna (EuWin@CNIT-BO), while a researcher from University of Banja Luka spent 9 months in Bologna. During the visit many experiments have been conducted on the Flextop platform of EuWIn. The results of the JRA have been submitted to the IEEE Journal on the Internet of Things. In particular, Zigbee, 6LowPAN and a software-defined wireless networking (SDWN) solutions were compared through experiments performed on the FLEXTOP platform at the University of Bologna.

CNIT-BO is also involved in a research activity related to the design and testing of network protocols for linear wireless networks, where nodes in the network are distributed along a straight line. The latter topology comes up in many smart city applications, for example, when nodes are distributed on lamp posts of the city. The peculiarity of the topology of these networks motivates the design of specialized protocols, taking advantage of the linearity property.
Different novel solutions, based on broadcasting and priority-based CSMA protocols, have been investigated. The latter have been designed in the last months and they are currently tested on the Flextop platform available at EuWin@CNIT-BO. The designed protocols have been compared to standard solutions, like IEEE 8021.15.4/Zigbee.

Significant results

The main achievements of the WP can be summarized as follows:

- Finalization of the 3 platforms available at EuWin@CNIT-BO and corresponding validation tests.

- Advancement of experimental research within the joint research activities (JRAs) carried out using the EuWin platforms. Some JRAs are inter-WP and inter-Track. The former are oriented to increase the integration between the distributed EuWin laboratories. The latter demonstrates the utility of EuWin for the experimental validation of theoretical schemes investigated in Track 1.

- Establishment of activities developed in collaboration with industries outside the network of excellence NEWCOM#.

- Dissemination activities in the form of papers, workshops, tutorials and other events.

WP 2.3 Flexible communication terminals and networks
WP Leader: Raymond Knopp (Eurecom)

In general, the workpackage is very active with 6 active JRAs (and one dormant JRAs). Several joint papers were produced and some papers are in the pipeline. Moreover, the OpenAirInterface platform, which is the core product of the EuWin@EURECOM lab is gaining significant attention, both within the network and outside (academic and industry).

OpenAirInterface currently provides a standard-compliant implementation under a GNU GPLv3 license of a subset of Release 10 LTE for UE, eNB, MME, HSS, SGw and PGw on standard Linux-based computing equipment (Intel x86 PC architectures). It can be used in conjunction with standard RF laboratory equipment available in many labs (i.e. National Instruments/Ettus USRP and PXIe platforms) in addition to custom RF hardware provided by EURECOM to implement these functions to a sufficient degree to allow for real-time interoperation with commercial devices. Some industrial users have working OpenAirInterface-based systems integrated with commercially-deployable remote radio-head equipment and have provided demonstrations at major industrial tradeshows (Mobile World Congress Asia 2014, Mobile World Congress Barcelona in 2013, IMIC 2013). The current major industrial users of OpenAirInterface for collaborative projects are Agilent, China Mobile, IBM, Alcatel-Lucent, Thales, National Instruments and Orange. The primary future objective is to provide an open-source reference implementation which follows the 3GPP standardization process starting from Rel-12 and the evolutionary path towards 5G and that is freely-available for experimentation on commodity laboratory equipment.

The output of this WP2.3 will help extend OpenAirInterface to help towards the definition of 5G systems. In particular the open-source policy will hopefully help to drive innovation in 5G by following the standard as it is being drafted and to leverage the crowdsourcing effect both from industrial and academic users. To this end, the JRAs #1 (cloud RAN), #3 (4G/5G coexistence), and #7 (exploiting TDD reciprocity) are a first step in this direction. The resulting development can be used in both publicly-funded collaborative projects as well as industry-driven initiatives aiming to demonstrate 5G features at the earliest possible stage. Moreover, the results can be replicated in several locations independently through the combination of open-source and commodity hardware. This then becomes a truly distributed experimental facility with a very large number of potential contributors.

Significant results

- A batch of 20 new ExpressMIMO2 cards was delivered to EURECOM. Several cards were further sold to partners, such as IASA and Alcatel-Lucent Bell Labs Nozay (Paris).
- In terms of JRAs, the most active ones were
  - JRA#1 on cloud RAN, which produced 2 joint papers and lead to the integration EURECOM/Inov work on CRAN transport mechanisms in OAI. Moreover and exchange student from Polito visited Bilkent for joint work on efficient polar decoding architectures.
  - JRA#3 on 4G/5G coexistene, which resulted in a joint experiment between Eurecom and TUD
  - JRA#6 on localization, where measurements collected with OpenAirInterface were exploited (publication pending)
  - JRA#7 on exploiting channel reciprocity, which produced also 1 paper.
- WP2.3 showed a strong presence at EUCNC Bologna with
  - An exhibition booth showing for the first time the OpenAirInterface eNB communicating with an off-the-shelf UE

o A presentation of Joint IASA/EURECOM localization measurement JRA at EUCNC
o A presentation of Joint Inov/EURECOM/Bilkent/Polito CRAN JRA at EUCNC

• EURECOM has initiated contact with National Instruments regarding the integration of OpenAirInterface.org software on the newest generation of USRP platforms. National Instruments is primarily interested in exploiting OAI's open-source development to provide a large user base in the USRP community and in particular to help promote the development. Both NI and Eurecom will demonstrate OpenAirInterface LTE eNB running on the Ettus/NI B210 platform at the Wireless Innovation Forum in November 2014 in Rome.

• EURECOM has been officially integrated as a partner in Mobile Cloud Network FP7 project to strengthen work on CRAN architectures. This will lead to more joint work within N# with Inov and Orange.

• OAI equipment currently being used in the OFCOM TV White Space Trial in London, England.

Spreading of results

• OAI's LTE basestation software and ExpressMIMO2 were demonstrated by Agilent and IBM China at the Mobile World Congress in Barcelona (Feb. 24-27) as an enabling technology for CloudRAN.
• Integration of OAI's LTE basestation software with two industrial core network (EPC) implementations has be inititated. Firstly, with Alcatel-Lucent's "LTEBOX" which is a single-server EPC solution. Secondly, the German network testing company, NG4T, has provided their EPC solution for the purpose of evaluating OAI's basestation implementation.
• EURECOM has also recently performed interoperability testing of the OAI LTE basestation with the French company, ERCOM, who provides a full-RF synthetic testing environment for stimulating commercial basestations with emulated terminals. This will allow for future development on abstraction methodologies for real-time testing systems, in particular for interference scenarios in hetnets.
• Presentation of WP2.3 JRAs at 3 dissemination events (NEC Heidelberg, Alcatel-Lucent Bell Labs Stuttgart, AVEA Labs Istanbul)
• Membership of OAI team within the NGMN (Next Generation Mobile Networks) association.
• Alcatel-Lucent Bell Labs New Jersey now a user of OAI in addition to Bell Labs – Paris
• China Mobile to publicise the use of OAI in CRAN trial in Shanghai. Regular interactions with Agilent and China Mobile of integration of OAI in their CRAN demonstrator using commercial remote radio-head technologies
• Discussions with IBM Watson Laboratory in New York for collaboration around OAI emulation methodologies

2.2.3 TRACK 3

Track Leader: Luis Correia (INOV)

The third track, in addition to the activities on training, human capital, and dissemination in the research community that is detailed later on, pays special attention to relations with European companies that participate to the NoE life as "Affiliate Partners", with the right to take part into events and technical meetings, and with the commitment of organizing and participating into periodic dissemination events in different countries. Some companies became Affiliates of NEWCOM# at the proposal phase of the project, others during this first year of activity.

WP 3.1 NEWCOM# Conferences, Workshops and Special Sessions

WP Leader: Claude Oesteges (UCL)

Dissemination of research results produced within the NoE starts of course from the organization of dedicated events and from the participation in the major scientific events of the international research community. As a consequence, the main objectives of this work-package are the following:

- Organize an annual NEWCOM# conference with peer review and proceedings (in the second and third year).
- Interface with other EC projects and events and exploit possible synergies with the Future Network and Mobile Summit, concertation events, etc.
- Promote the involvement of NEWCOM# in the organization of major, already existing international conferences and workshops.
- Organize special sessions within the framework of NEWCOM# during major international conferences on the subject of wireless communications and related issues.

A summary of WP3.1 progress towards objectives

Since October 1, 2013, the leadership of WP3.1 was taken over by UCL (C. Oestges).

Task 3.1.1 NEWCOM# annual conference

Task Leader: Roberto Verdone (CNIT)

The first NEWCOM# annual conference was successfully held in Bologna (Italy) on 23-26 June 2014, in conjunction with EuCNC 2014. The NEWCOM# annual conference consisted of two tutorials, one workshop, four technical sessions covering Tracks 1 and 2, one exhibition, one Advisory Board meeting, as well as one General Assembly meeting.

Task 3.1.2 EC concertation activities

Task Leader: Claude Oestges (UCL)

Following the 12th FP7 Concertation Meeting held in Brussels on 22 October 2013, several NEWCOM# partners contributed to the final version of the RAS White Paper on “High Capacity PHY for Future Radio Access and 5G”. Furthermore, NEWCOM# participated in a pre-FIA workshop on “Radio Access and Spectrum Innovation for 5G” which was held in Athens on 17 March 2014 . Jossy Sayir (UCAM), representing NEWCOM#, was able to make quite an impact and push NEWCOM# to the forefront. His presentation aimed to highlight coding research carried out within NEWCOM# and was well received. Further to this presentation, Jossy Sayir was asked by the deputy head of the DG-INFSO unit in charge of NEWCOM# (Bernard Barani) to participate in the end of day panel session on "What are the key RAN innovations to ignite 5G?". A draft paper resulting from this overview presentation, coordinated by Jossy Sayir and including contributions by Michael Lentmaier, Guido Montorsi, Pierre Duhamel, Jossy Sayir, Erdal Arikan and several other authors from those institutions (TUD, Polito, CNRS/SUPELEC, UCAM, and Bilkent) was presented at EuCNC 2014.

Task 3.1.3 Conference workshops and special sessions

Task Leader: Giacomo Bacci (CNIT)

The WP and task leaders have been sending emails to gather the information and stimulate initiatives. A total of 5 workshops were organized by NEWCOM#:

- Seventh IEEE Workshop on Advanced Information Processing for Wireless Communication Systems (AIPWCS),

- Workshop on Cognitive Radio Advances, Applications and Future Emerging Technologies (CRAFT) @ ISWCS 2013,
- Workshop on Interference and Design Issues in Future Heterogeneous Networks @ WCNC 2014,
- Workshop on Advances in Network Localization and Navigation (ANLN) @ ICC 2014
- Workshop on Physics-Inspired Paradigms in Wireless Communications and Networks, (PHYSCOMNET) @ WiOpt 2014.

Furthermore, 4 NEWCOM# special sessions were held at various conferences:

- NEWCOM# Special Session on Energy - and Bandwidth-Efficient Communications and Networking @ IEICE Information and Communication Technology Forum 2014,
- NEWCOM# Special Session on Interference Mitigation in Modern Wireless Systems @ European Wireless 2014,
- NEWCOM# Special Session @ RAWNET 2014,
- NEWCOM# Special Sessions @ CROWNCOM 2014.

NEWCOM# also technically sponsored one major international conference (2013 IEEE International Symposium on Information Theory).

Significant results

The annual event was held at EuCNC 2014 (at the same time, many NEWCOM# partners participated in the organization of EuCNC 2014 itself). As far as workshops and special sessions are concerned, 10 events (including ISIT 2013) were already organized, consuming approximately 12 person-months. The remaining manpower was dedicated to RAS-related activities.

For the next period, a number of workshops and special sessions are already in preparation.

- In 2014: for ISWCS 2014 (to be held in August 2014), A. Kliks (PUT) is organizing the CRAFT (Cognitive Radio Advances, Applications and Future Emerging Technologies) workshop, with a submission deadline on May 10, 2014.
- In 2015: at EuCNC 2015 and ICC2015, several special sessions/workshops will be held; the sponsorship of conferences will also be renewed, e.g. with ISWCS 2015.

WP 3.2 Education and Training

WP Leader: Gerald Matz (VUT)

Three Seasonal Schools, one Training Session, and an Emerging Topics Workshop have been organized in year 2 of NEWCOM#. The Seasonal Schools typically lasted for several days and consisted of short-courses and tutorials on advanced topics in wireless communications. These courses were given by leading experts from within and outside NEWCOM# and were supplemented with discussion sessions that gave PhD students the opportunity to exchange ideas with their peers and with senior experts.

The Emerging Topic Workshops (ETW) in year 2 was dedicated to new paradigms in 5G cellular. It was intended to foster the exchange of ideas regarding new trends in wireless communications and to provide a platform for PhD students to identify practically relevant and scientifically challenging topics. The ETW also was an excellent meeting point for interaction with the industry.

The theory-oriented seasonal schools and ETW were complemented with a practical hands-

on training session at EuWIn@CTTC.
For most of the events, a detailed summary including course material and presentation slides are available at the Euracon website (www.euracon.org). This has the advantage that the pertinent material is also available to the non-NEWCOM# public.

A summary of WP3.2 progress towards objectives

Task 3.2.1 Seasonal Schools
Task Leader: Roberto Verdone (CNIT)

During the second year of NEWCOM#, three Summer Schools have been organized by NEWCOM# researchers. The details of these events are as follows:

Winter School (64 attendees)
Title: "Beyond 4G Networks: From Theory to Experimentation and Back"
Chairs: Davide Dardari (CNIT), Claude Oestges (UCL), Miquel Payaro (CTTC), and Roberto Verdone (CNIT)
Venue: CTTC, Castelldefels (Spain)
Date: Nov. 25-28, 2013
URL: http://www.euracon.org/b4gc2013

Spring School (73 attendees)
Title: Advanced Signal Processing Techniques for Heterogeneous Networks
Chairs: Filippo Giannetti, Giacomo Bacci, and Luca Sanguinetti (Univ. Pisa)
Venue: Pisa, Italy
Date: March 18–20, 2014
URL: http://www.euracon.org/asphen2014

Spring School (50 attendees)
Title: Flexible Multi-carrier Waveforms for Future Communications Wireless Networks
Advanced Signal Processing Techniques for Heterogeneous Networks
Chairs: Carlos Faouzi Bader (Supélec) and Adrian Kliks (PUT)
Venue: Rennes, France
Date: May 21–23, 2014

Task 3.2.2 EuWIn Training Sessions
Task Leader: Sylvain Azarian (Supelec)

A training session was held in conjunction with the winter school at CTTC.

Task 3.2.3 Emerging Topics Workshops
Task Leader: Miquel Payaro (CTTC)

Second Emerging Topics Workshop (39 attendees)
Title: D2D and mmW – New Paradigms for 5G
Chairs: Gerald Matz, Christoph Mecklenbräuker, and Markus Rupp (VUT)
Venue: Vienna University of Technology, Vienna
Date: Oct. 27-28, 2014

All events attracted a large number of attendees and have been a huge success with the

participants due to the high quality of the technical programs. All WP3.2 milestones during year 2 have thus been achieved.

Significant results

The NEWCOM# events have more and more a global reach (e.g., the last school had attendees from 4 continents) and they reflect increasing industry outreach. In particular, the Emerging Topics Workshop in Vienna had three speakers (Dahlman/Ericsson, Sanchez/Nokia, Nekovee/Samsung) from industry and three speakers (Lozano/Bell Labs, Trikkonen/Nokia, Widmer/Docomo) who have been with industry before their current academic affiliation. In addition, there have been workshop participants from other companies (e.g. Huawei).
The combination of a Winter School with a Training Session at CTTC provided an excellent opportunity to promote interaction of the experimental activities in Track 2 of NEWCOM# with the theoretical work in Track 1.

WP 3.3 Journal special issues, books and book chapters

WP Leader: Luc Vandendorpe (UCL)

In NEWCOM#, WP3.3 deals with «Journal special issues, books and book chapters». These tools have been identified as possible instruments to disseminate the research results produced by NEWCOM# researchers, as well as to increase the recognition of the network within the related international research community. The objectives of this WP3.3 are therefore as follows:

- To foster the design and implementation of Journal Special Issues in international peer reviewed journals, dealing with the main research topics addressed in NEWCOM#.
- To stimulate the participation of NEWCOM# researchers as prospective authors in the journal special issues organised either by NEWCOM# or by third parties.
- To trigger and organise the writing of book chapters and books. Book chapters will be devoted to the state-of-the-art and the recent advances of specific scientific and technological topics addressed by NEWCOM# researchers while books will be reserved for the results of Track 1 of the project.

A summary of WP3.3 progress towards objectives

Task 3.3.1 Identification of topics for SIs, book chapters, books, journals, and monitoring of CfPs.

Task Leader: Luca Vandendorpe (UCL)

The first activity of the WP was the creation of the list and the description of journals (EURASIP, IEEE and others) which are of interest for special issues organized by NEWCOM# researchers, or to which NEWCOM# could contribute. A list of main book and book chapters publishers (e.g. Wiley, Springer, Cambridge University Press, etc.) was also created with the cooperation of which NEWCOM# authors could disseminate their production. Finally, a preliminary list of topics that have been identified as potential topics for special issues to be launched by NEWCOM# members as well as the associated WP/tasks was edited as well. Workpackage and task leaders have been regularly contacted to take initiative and have discussion in their respective WP/task in order to identify new topics or new opportunities for dissemination

Task 3.3.2 Organization of SIs and writing of books and book chapters.

Task Leader: Claude Oesteges (UCL)

Researchers from within the NoE (spontaneously or after appropriate solicitation actions by the Task leader) took an active role in proposing and organizing special issues on journals, taking the initiative to publish books containing the results of the JRAs, both as a self-standing volume or as contributions to multi-author books. Being aware that journals may be subject to different formatting rules and editorial restrictions, the following *acknowledging* strategies and statements have been suggested:

- To explicitly mention NEWCOM# in the text of the corresponding Call for Papers.
- To insert the NEWCOM# logo on the cover of the journal special issue.
- To explicitly mention NEWCOM# in the title of the special issue (e.g. 'NEWCOM# Special Issue on…').
- To include a sentence in the guest editorial such as '*This special issue has been supported by the European Network of Excellence NEWCOM#*'.
- To point out in the guest editorial that (part of) of the team of guest editors are involved in NEWCOM#.

During the first 24 months of the project, explicitly mention NEWCOM# in the guest editorial has been the most used acknowledgement formula.

The Journal Special Issues originated by NEWCOM# activities published or launched so far are as follows:

- *Enabling 5G: Energy and Spectral Efficient Communication Systems*, to be published in the Transactions on Emerging Telecommunications Technologies;
- *Indoor Localization, Tracking, and Mapping with Heterogeneous Technology*, to be published in the IEEE Transactions on Vehicular Technologies;
- *Machine-to-Machine: An Emerging Communication Paradigm*, published in the Transactions on Emerging Telecommunications Technologies;
- *Special Issue on Signal Processing Techniques for Anywhere, Anytime Positioning*, published in the EURASIP Journal on Advances in Signal Processing ;
- *JCN Special Issue on Advances in Channel* Coding to be published in the Journal of Communications and Networks;
- *Special Issue on Technical advances in the design and deployment of future heterogeneous networks* to be published in the EURASIP Journal on Wireless Communications and Networking.

The published books are as follows:

- *Machine-to-Machine (M2M) Communications, Architecture, Performance and Applications*, Woodhead Publishing Ltd.
- *Opportunistic Spectrum Sharing and White Space Access: The Practical Reality* will be published by Wiley.

The following book chapters have been written by NEWCOM# members:

- "*Null-space precoder for dense 4G and beyond networks*" included in the book entitled *Resource Allocation and MIMO for 4G and Beyond,* Springer ;
- "Future challenges in efficiently supporting M2M in the long term evolution (LTE) standards", in "Machine-to-Machine (M2M) Communications, Architecture, Performance and Applications." Woodhead Publishing ;
- "An introduction to M2M", in "Machine-to-Machine (M2M) Communications, Architecture, Performance and Applications." Woodhead Publishing.

This task also includes the edition of NEWCOM# White Book (in electronic format) which will summarize the main scientific outcomes of the project along with a number of open issues to

be addressed in the years to come.

Task 3.3.3 Promotion activities
Task Leader: Adrian Kliks (PUT)

Activities aimed at adequately publicizing these Special Issues both within and outside the NEWCOM# community: to maintain e-mail reflectors, to ensure the widest possible circulation of the corresponding call for papers through e-mail reflectors, etc. One page of the NEWCOM**#** website, called "Journal special issus" is devoted and maintained with the related information (link to Call for Papers, editors, etc ..). The address of this page is: http://www.newcom-project.eu/index.php?option=com_content&view=article&id=17&Itemid=110

Furthermore, NEWCOM# inspired JSIs has been announced by means of:

- Portals and websites,
  - NEWCOM# portal (http://www.newcom-project.eu).
  - Society webpages (e.g. http://www.signalprocessingsociety.org).
  - Publisher's or journal webpages.
  - Personal webpages.
- Newsletters,
  - NEWCOM# newsletter.
  - Societies' Newsletters.
- Mailing lists.
  - Mailing lists run by various IEEE technical committees.
  - COST2100 mailing list.
  - Personal mailing lists.
  - NEWCOM# mailing lists.

Besides, paper copies of the CFPs have been distributed in various conferences and workshops where guest editors regularly participate in the months preceding the submission deadline.

Significant results

During the first 24 months of NEWCOM#, a total of six NEWCOM# JSIs have been implemented. Out of them, only one JSI is now open for manuscript submission and one has been already published.

Taking into consideration the unavoidable latency associated with the launch of JSIs and the time spent in the consolidation of the JRAs, the current status can be regarded as very encouraging. We expect a further increase in the number of such special issues during the last year of the project. Moreover, two books, and three book chapters have been implemented and published by major publishers like Springer, Wiley and Woodhead publishing.

WP 3.4 Industry Liaison and Dissemination
WP Leader: Hikmet Sari (Supelec)

One of the main objectives of NEWCOM# is to improve dissemination of the research results produced by the NoE towards the European wireless communications industry. The general aim of the activity is to support and possibly drive to some extent the research performed at companies to help them innovate and maintain a strong position in the international competition. Dissemination is mainly carried out by organizing periodic dissemination events

hosted by Affiliate Partners from industry. The rationale is that organization of such events at the premises of the Affiliates facilitates participation of their engineers, managers, and other employees without incurring any significant travel cost. Also, the dissemination events are advertised and are open especially to companies in the same country as the hosting Affiliate to maximize participation by reducing traveling costs. By organizing a sufficiently large number of events (2 in the first year, up to 4 in the second and third year) most countries and regions in Europe are covered. During the events, the Host and other interested Institutions are requested to highlight their needs and expectations in terms of R&D to possibly find a match of interests with the (mainly) academic research performed by NEWCOM#, and the NoE presents its experimental facilities at EuWIn to possibly foster cooperative research. The Dissemination Events also have the function of facilitating contacts between young researchers in the NoE and representatives of European companies for possible recruiting opportunities. Prior to the organization of the Dissemination events, a survey was carried out to focus and steer in advance the dissemination program.

A summary of WP3.4 progress towards objectives

Task 3.4.1 Survey of the Research Needs of European Companies
Task Leader: Hikmet Sari (Supelec)

This survey was made in the first year of the project and the results were included in Y1 Annual Report.

Task 3.4.2 Periodic Dissemination Events
Task Leader: Hikmet Sari (Supelec)

As it was reported in the Y1 Annual Report, only one dissemination event was held by the end of the end of October 2013, which concluded the first year of the project. To catch up and with the initial plans and have 6 dissemination events held by the end of the second year, a significant effort was made to find Associate partners which are willing to organize an event and to schedule and prepare these events.

The first event held during the second year of the project took place in Lisbon on 23 January 2014 and gathered representatives from all cellular operators in Portugal (Portugal Telecom, Vodafone, and ZonOptimus). Although this event was actually held during the second year of the project, we count it as the second event of the first year, which was supposed to be held before 31 October 2013. NEWCOM# became very active and successful in its dissemination activities during the first four months of 2014. Immediately after the Lisbon event, 3 additional events in a period of 2 months:

- NEC Labs, Heidelberg, Germany, 19 February 2014
- Alcatel-Lucent Bell Labs, Stuttgart, Germany, 20 March 2014
- Avea Labs, Istanbul, Turkey, 4 April 2014

With 4 events held during the period of January – April 2014, it was decided to have a break until the end of the summer and organize the final event of the second year of the project in October 2014. In May 2014, Nokia networks in Munich was identified as an Associate partner for holding the final event of the second year of the project, and after a number of conference calls, the date of 29 October 2014 was selected for this event. This dissemination event has just been held and was very successful in terms of both participation and technical excanges.

We are now ready to start discussions with other Associate partners from industry for

planning the third year dissemination events.

WP 3.5 Development and valorization of human capital
WP Leader: Kenza Hamidouche (SUPELEC-CNRS)

This WP implements a number of actions to facilitate the development of personal skills and the growth of professional competence in research.
The instruments to achieve this are special grants for PhD and early-stage researcher to spend research period at the NEWCOM# EuWin Lab, a number of awards for papers and in general achievements obtained within the NoE, and a set of gender actions to promote the participation of female researchers. Communications of the outcomes of such actions are given with emphasis at the main NEWCOM#-related events and on the NEWCOM# newsletter and website to highlight at best their relevance in the context of a NoE.

A summary of WP3.5 progress towards objectives

Task 3.5.1 NEWCOM# mobility and "lab" grants
Task Leader: Luis M. Carreia

Two calls for mobility grant were launched this year. The first call is the regular one and was open on March 1, 2014 and the deadline was on April 1, 2014. The notification on the results of the call was given on May, using The NEWCOM# webpage, mailing list.

There were 6 researchers funded in this call for mobility grants, namely,

- Paolo Del Fiorentino (Pisa-CNIT)
- Giuseppa Alfano (Politecnico di Torino)
- Marwa Chafii (Supelec-CNRS)
- Najeeb ul Hassan (TUD)
- Li Wenjie (University of Paris Sud-CNRS)
- Alessio Zappone (TUD)

Four of them are PhD students, one is an experienced researcher and another one is a young researchers. Five of the recipients have spent/are spending one month in their hosting institution except the Phd student Li Wenjie who is spending 5 months at CNIT Bologna. Their research plans are well defined and provide great potential for writing highly visible scientific papers.

The second call is a special Track1-Track2 call, it was open on September 12, 2014 and the deadline was on October 10, 2014. The applicants will be notified on November 10, 2014. We received 5 applications and the review process is ongoing. The applicants are:

- Paolo Del Fiorentino (Pisa-CNIT)
- Carmine Vitiello (Pisa-CNIT)
- Georg Pichler (Vienna university of Technology)
- Yi Chu (University of York)
- Alejandro de la Fuente (University Carlos III of Madrid)

Four of the applicants are PhD students and one is a young researcher.

Task 3.5.2 NEWCOM# awards
Task Leader: Marco Luise (CNIT)

Similarly to the first year, three kinds of awards will be granted each year in order to promote

excellence in research within NEWCOM#:

- The NEWCOM# Best Paper Award (BPA)
- The NEWCOM# Best Student Paper Award (BSPA)
- The NEWCOM# Distinguished Researcher Award (DRA).

In the second year the call was open on October 16, 2014. Submission deadline is on November 17 and final decisions by the Committee will be made on December 22. The Awards Grants will be given during the annual NEWCOM# conference. The awardees are:

Significant results

Three out of six persons that received mobility grants has returned from their stays. Reports were collected and high visible publications are to arise in few months.

For the awards, we received two applications for the BSPA and three applications for the BPA. The call is still open until November 17 and we expect to receive more papers.

WP 3.6 The NEWCOM# Portal and related Web Presence Tools

WP Leader: Roberto Verdone (CNIT)

A fundamental and central instrument for dissemination, integration, and spreading of excellence is the NEWCOM# Portal that fosters communication among partners and with the NEWCOM# office, promotes a cooperative work environment, and showcase the life and achievements of the NoE. It will integrate as a heritage the Virtual Center of Excellence ViCE-WiCom tool which was developed in the framework of the NEWCOM++ project as an instrument to support knowledge sharing, and analysis of the relationships between content, people and activities into a knowledge map for the network. Besides, it also features dedicated sections on EuWIn where lab-specific information such as measurement campaigns, events, manuals or materials are posted, and hosts periodic issues of the "NEWCOM**#** NewsLetter" reporting on the life and achievements of the NoE. A videoconferencing tool named SCOPIA, allowing for a cost-effective realization of the meetings of the various NEWCOM# bodies, or daily interaction of groups of researchers was made available through the portal, as well. The portal manages the relevant security issues when it comes to the protection of information, considering that the users of such tools are of many kinds, namely: the governing bodies of the NoE (some with unlimited access), the EC representatives (with dedicated areas), the NEWCOM# partners, the affiliate partners (with some restrictions), and the remaining interested parties from outside the NoE.

A summary of WP3.6 progress towards objectives

Task 3.6.1 Development of the NEWCOM# Portal

Task Leader: Rosa Martinez (CTTC)

This Task is over after Y1.

Task 3.6.2 The NEWCOM# NewsLetter and Social Networking

Task Leader: Adrian Kliks (PUT)

The LinkedIn NEWCOM# group was set up at the beginning of the project and, after two years, consists of 68 members. Besides, a NewsLetter, featuring the life and achievements of the NoE, has been published on a quarterly basis on the portal. To edit it, a collection of news and preparation of reports on the activity of each WP has been carried out. Some interviews to relevant NEWCOM# members were realized and included. The NewsLetter has

been disseminated through the website and to the mailing list of NEWCOM#.

Task 3.6.3. Maintenance and Support
Task Leader: Giorgia Bertozzi, Lucia Vitiello (CNIT)

In the second year the contents of the portal (e.g. information on events, schools, uploading of documents) have been managed and continuously updated by CNIT. Help has been offered to users and contributors in what concerns both content management and technical support about the usage of the NEWCOM# portal and of its features.
During the year the EuWIn website has also been improved, based on indications received after the EC review meeting..

Significant results

All web related tools needed to support the networking and integration activities have largely facilitated a fruitful cooperation among scientists and the dissemination of project results.

A server hosting the NEWCOM# web tool is directly managed at CTTC. The features currently implemented are:

- a special restricted section for Advisory Board
- a special restricted section for the MPA
- a news and events public area
- a public area to showcase the NoE, its activities and public results (most of the deliverables) to the external scientific community
- a 'Mobility Grant' section
- a restricted areas to exchange documents, data and materials within the NoE
- a N# papers section
- a Schools section
- an “Awards” section

A server hosting the videoconference solution SCOPIA is directly managed by CTTC, as well as a hosted solution for more than 40 mailing lists.

A server hosting the EuWIn web tool is directly managed at CNIT.

2.2.4 TRACK 4 (WP 4.1)
Track Leader: Carles Anton-Haro (CTTC)

In this Deliverable only WP 4.1 is reported, since the other WPs of this Track (WP 4.2 and WP 4.3) are reported in Deliverable D43.2.

Broadly speaking, the management activities in a NoE, in addition to setting up and maintaining the legal basis for operation of the NoE, are instrumental to make sure that all partners follow the correct procedures in the administration of their own budget, and that prepare timely and accurate reports to the Coordinator and/or to the Commission where requested. In addition, the network management has also to implement due auditing actions to possibly identify spending unbalance issues among partners as well as possible non conformity of some partner’s activity to the work program of the NoE. In the case some non conformity (financial or scientific) is detected, proper corrective measures are proposed to the Executive Board of the NoE.
Complementarily, it also includes the yearly update and further refinement of the Joint

Program of activities taking into account inputs from the Advisory Board and EC project review meetings.
Along with that, some dynamic allocation of NoE budget according to individual partners' performance is also envisaged in NEWCOM#, in such a way that the potential of those having shown larger impact towards the project objectives can be increased.
Finally, another fundamental output of the management activities is a constantly updated review of the status of the NoE that will also allow to evaluate its sustainability after the Commission funding is over. This is done by implementing specific actions about promotion of the NoE activity and by identifying the most promising aspects in the network (e.g., the EuWIn lab) that can be possibly turned into some form of self-sustaining business. The Management activities within NEWCOM# are organized into three WPs, each regarding one of the main aspects mentioned above.

WP 4.1 Direction and quality assurance of scientific activities
WP Leader: Marco Luise (CNIT)

This WP summarizes the most crucial steering and coordination functions of the Project Coordinator for the everyday proper working of the NoE; it is related to the proper implementation and management of the research WPs (Tracks 1 and 2) and training and dissemination WPs (Track 3). There are numerous tasks carried out within this WP, most importantly:

- assessing/enhancing with the help of the Advisory Board the quality of the results produced by the NoE in terms of scientific and technical innovation;
- assessing/monitoring the quality and timely delivery of documentation (deliverables).

Potential deviations and/or critical issues (in terms of scientific content and/or documentation quality) are identified in due time and reported to the Executive Board, that takes appropriate actions towards the WPs to solve the issue. Network promotion and sustainability aspects are also addressed in this Work Package, together with the fundamental issue of the access policy to EuWIn.

A summary of progress towards objectives

This WP deals specifically with all aspects related to the proper implementation and management of the research WPs. This includes the assessment and possibly the enhancement of the quality of the results obtained from the NoE in terms of scientific and technical innovation. The WP activities are split into 3 tasks: Task 4.1.1 "Scientific quality control", Task 4.1.2 "Management of the Executive Board and the Advisory Board", Task 4.1.3 "Network promotion and sustainability".

Task 4.1.1 Scientific quality control
Task Leader: Marco Luise (CNIT)

One of the main, and more time-consuming activities of this WP has been the scientific quality control of the research deliverables and the coordination of Track1-Track2 activities and cooperation. Fifteen deliverables have been produced in Year 2 and each deliverable first underwent an internal (to the specific research WP) review, then has been reviewed by the Track Leader and finally it has been duly reviewed by NEWCOM# Scientific Director (Track 1, 2 and 3) and by the A&M Director (Track 4). In this way the Scientific Director has had an overall visibility of the network scientific production, and could provide actions to coordinate the deliverables content to avoid duplications and increase synergies.
The WP activity has been mainly accomplished by the NEWCOM# Scientific Director, in close cooperation with the Managing Director and NEWCOM# Office. The EB members have been actively involved in network management and committed to its proper functioning.

Task 4.1.2 Management of the Executive Board and the Advisory Board

Task Leader: Marco Luise (CNIT)

As to the management of the Executive Board (EB), 5 meetings have been held:

EXECUTIVE BOARD MEETINGS	
VENUE	**DATA**
virtual	November 15, 2013
virtual	December 18, 2013
Haifa, Israel	April 22-24, 2014
virtual	July 29, 2014
Barcelona, Spain	October 9-10, 2014

The General Assembly was held during the Annual Conference @ EuCNC in Bologna on 25th July 2014, and has approved (amidst other items) the change in the partners' budget related to the execution of the MPA procedure.

The meeting of the Advisory Board took place on June 25th during the Annual Event @ EuCNC in Bologna (Italy). The goal was to inform the AB of the progress of the scientific activities of the network. On that occasion, they have been asked to revise the next deliverable from the WP they revised during the first year: D11.2, D12.2,D13.2, D21.3, D23.3, D32.2 (not yet available).

Task 4.1.3 Network promotion and sustainability

Task Leader: Simona Moschini (CNIT)

This Task is discussed in detail in section 4 of this Deliverable.

3. Project publications during the reporting period

As Figure 3.1 left illustrates, during the second year, a total of 214 journal and conference papers (73 and 141, respectively) have been published or accepted for publication (the full list of publications can be found in Annex III). Hence, the scientific production of the project has more than doubled with respect to that of the first year (101 publications, see Annex IV). More importantly, 100 of those publications, or roughly 50%, turn out to be joint ones. This percentage evidences that the project has made a very substantial progress in terms of joint research activities even if, for the first year of the project, the level of integration was already very high (33% of joint papers). Not only that, bearing in mind the extra time and efforts required to produce a *joint* paper, the fact that 100 came into light during this year is, by itself, a major success: partners spent more time in joint papers than in individual ones. Further details on the number of contributing institutions to those publications can be found in Figure 3.1 right. As in the first year, joint publications where two partners collaborate are the most frequent ones (90% of joint publications).

Publications Y2	WP1.1	WP1.2	WP1.3	WP2.1	WP2.2	WP2.3	Total
Joint	**29**	**30**	**16**	**21**	**0**	**4**	**100**
2 partners/1 country	1	13	1	8	0	0	23
2 partners/2 countries	22	13	14	8	0	4	61
3 partners	6	4	1	5	0	0	16
4 partners	0	0	0	0	0	0	0
Individual	**32**	**36**	**28**	**16**	**2**	**0**	**114**

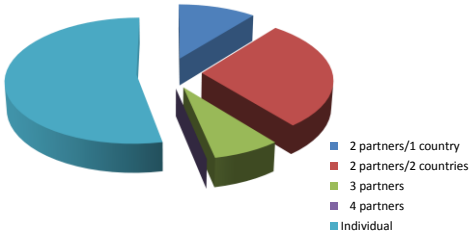


Figure 3.1: *Publications either published or accepted for publication during the second year of the project. Details on conference/journal and joint/individual (left) distribution, and on the number of contributing institutions (right).*

Figure 3.2 and Table 1 show the breakdown of publications into workpackages. Overall, the increase of the number of joint papers in all workpackages is very noticeable (and in particular for WP1.1 and WP1.3). The following trend, already observed in Y1, consolidates: the number of publications generated by Track 1 ('Theoretical') workpackages is substantially higher than that of Track 2 (EuWIN, 'Experimental'). This stems from the fact that, in general, the time needed to publish results based on experimental work is much higher. Despite of this, WP2.1 has managed to notably increase the number of publications well beyond its own levels in Y1, and also with respect to the average number of publications in Track 2 workpackages. This holds in particular for the joint publications that, interestingly, now exceeds the number of individual publications.

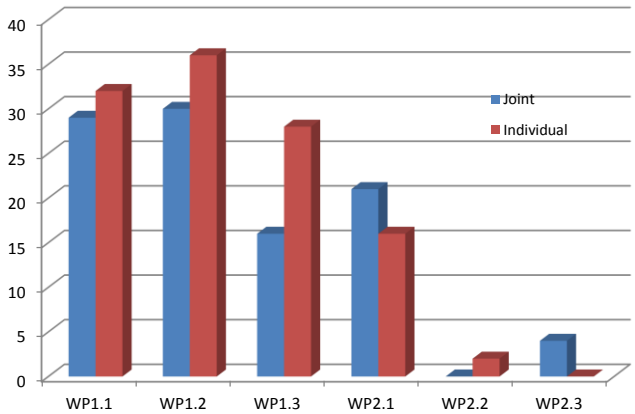


Figure 3.2: *Number of joint and individual publications per workpackage*.

Table 1: *Breakdown of publication type per workpackage*.

Publications Y2	WP1.1	WP1.2	WP1.3	WP2.1	WP2.2	WP2.3	Total
Joint	**29**	**30**	**16**	**21**	**0**	**4**	**100**
2 partners/1 country	1	13	1	8	0	0	23
2 partners/2 countries	22	13	14	8	0	4	61
3 partners	6	4	1	5	0	0	16
4 partners	0	0	0	0	0	0	0
Individual	**32**	**36**	**28**	**16**	**2**	**0**	**114**

4. Network promotion and sustainability

4.1 The questionnaire: NEWCOM# Consortium Feedback

The first step in the promotional strategy during the first year of the project (Y1) has been the creation of communication material (leaflets, bookmarks, gadgets) to advertise the network. The promotional materials were circulated in the NEWCOM# schools, workshops and dissemination events held in the first year.

The second step, taken in Y2, consisted in setting up and putting into action an effective promotion campaign that highlighted the benefits of keeping the network alive after the EC funding period. To that aim, an on-line questionnaire was prepared, the circulation of which was restricted to NEWCOM# partners and Affiliate Partners. It was aimed at identifying the benefits of the network on personal and organizational level, as well as possible critical deficiencies to be fixed. See the questionnaire in Annex I or online at
http://www.newcom-project.eu/index.php?option=com_content&view=article&id=126&Itemid=204

The outcome of the questionnaire will then be used in Y3 to setup a path through which refine and reshape the Promotional Strategy specially to be used for a "survival plan". In this latter respect, involvement of the EURACON association will be considered.

4.1.1 Target audience and setup

The questionnaire was delivered to all the NEWCOM# WP Leaders and affiliate partners in the middle of year 2. Its purpose is to understand better the researchers' activities and interests specially the commitment to use the NEWCOM# knowledge for its survivability after the grant from the EC is over. It will be submitted through the Google Forms facility, that allows users to create simple questionnaires, send them by email, and collect data results directly in a Google Excel file and in a Google Report, with charts and lists.

The questionnaire was sent by mail, with this introduction:
"*As part of the activities of WP4.1 about management, and upon specific request of our expert Reviewers, we have prepared a feedback questionnaire about the activities and the value of our Network of Excellence that you may find here:*
http://www.newcom-project.eu/index.php?option=com_content&view=article&id=126&Itemid=204
What we expect of you is to fill in the questionnaire with your opinions, and send it back to us (it takes less than 5 minutes) so that we can steer appropriate actions to improve NEWCOM# and plan for its survivability after the grant from the EC is over - your feedback is of course fundamental in this respect.".

4.1.2 Questions

Seven questions organized in three main blocks:

Questions 1. – 2.2. about NEWCOM# activities
Questions 3 - 4. about the evaluation of current NEWCOM# features
Questions 5 - 7. about possible evolutions of the network

4.1.3 Outcome

The analysis of the outcomes (not yet available) will be reported in the deliverable of Y3 D41.4 together with the relevant actions for survivability.

4.2 Other dissemination/promotion activities

NEWCOM# has been represented in several Radio Access and Spectrum (RAS) Cluster and Concertation meetings, where the project activities have been presented:

- Participation in a pre-FIA workshop on "Radio Access and Spectrum Innovation for 5G" Participation in the RAS Cluster Meeting held in Athens on 17 March, 2014 .
- Participation in the EuCNC - European.Conference on Networks and Communication held in Bologna on June 23-26, 2014.
- Participation in the EC Stakeholders Consultation Workshop - Network Technologies Work Programme 2016-2017, held in Brussels on 29-30 September, 2014.
- Participation and presentation in the Concertation Meeting held in Brussels on October 20, 2014.
- Presentation of NEWCOM# activities towards 5G at the EC Stakeholders Consultation Workshop - Network Technologies Work Programme 2016-2017, held in Brussels 29-30 September 2014 (in Annex II)

5. Conclusions and Prospects

Some concluding remarks after the body of the work presented in the previous sections are in order.

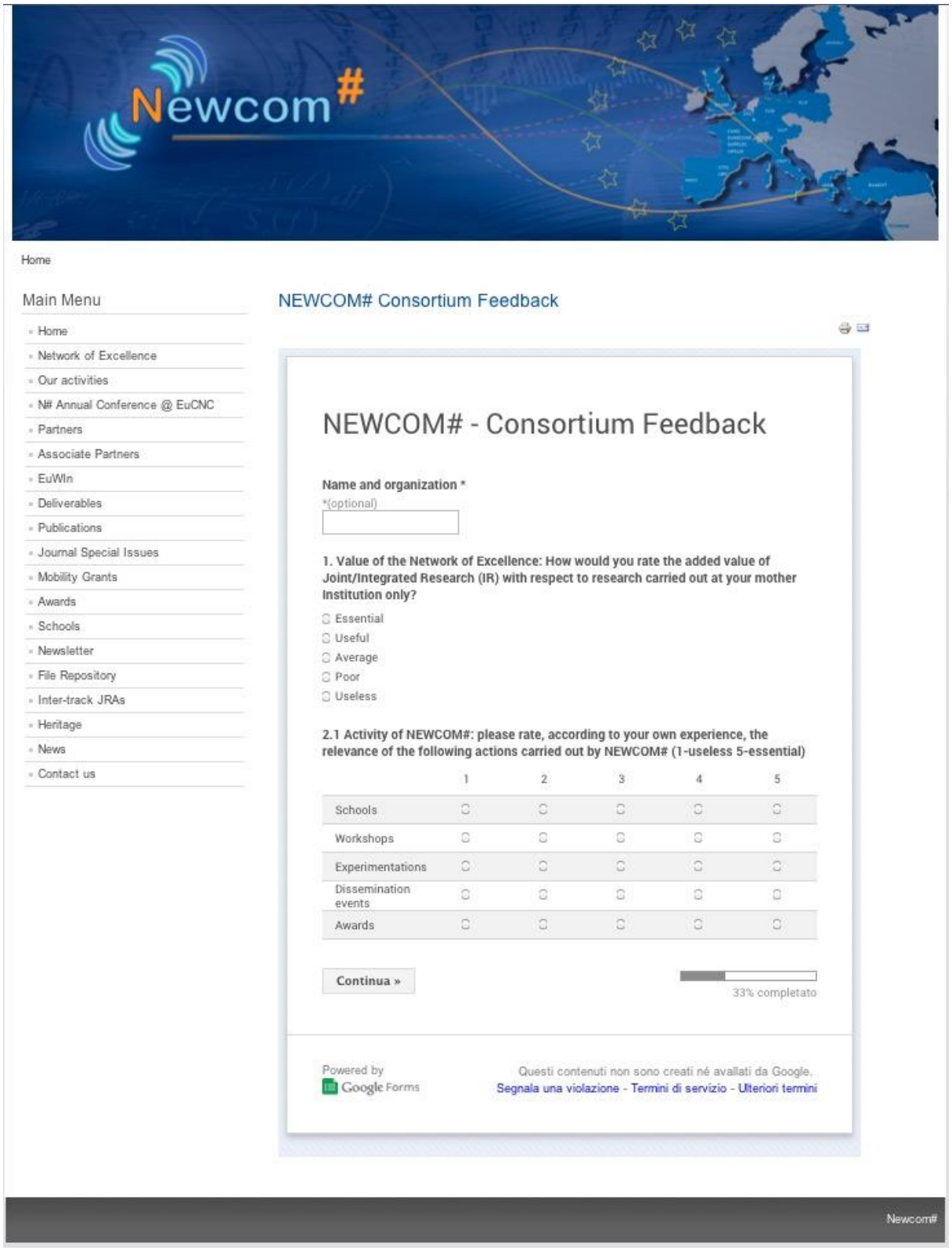
In terms of scientific joint activity, the NoE has fulfilled its expectations, improving on Y1 in terms of quality and quantity of the results that are being produced. Partners active in Track 1 still proves to be more integrated than Track 2, but the latter is advancing at a fast pace in terms of number of JRAs an external recognition.

Concerning dissemination and training (Track 3), the results are very good in general as well. Dissemination events at companies are still of varying degree of effectiveness, this "variance" owing to the different nature of the companies that host such events (very good acceptance from manufacturers, less recognition form service providers). Schools, workshops, special sessions, special issues in journals are good in quality and quantity – especially schools attract a large number of early stage researchers from outside the NoE.

In addition to going on with the "standard" activities as above, we see two special challenges in Y3 of the NoE: the first is the organization of the final, autonomous event (after the second annual event # EuCNC 2015 in Paris), and the second is the actual implementation of actions for survival. In this respect, a "survival session" is being planned for the joint Track1/Track 2 meeting to be held in Athens in Jan. 2015. The main assets for survival will be, as mentioned several times, EuWIn and EURACON.

6. Annexes

6.1 Annex I: The NEWCOM# Consortium Feedback



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NEWCOM# Consortium Feedback

NEWCOM# - Consortium Feedback

2.2. Activity of NEWCOM#: please rate, according to your own experience, the achieved success of the following actions carried out by NEWCOM# (1-useless 5-essential)

	1	2	3	4	5
Schools	○	○	○	○	○
Workshops	○	○	○	○	○
Experimentations	○	○	○	○	○
Dissemination events	○	○	○	○	○
Awards	○	○	○	○	○

3. Value of EUWIN: How would you rate the experimental approach to fundamentale research carried out at EuWIN wrt a more theoretical-oriented aqpproach?

- ○ Essential
- ○ Useful
- ○ Average
- ○ Poor
- ○ Useless

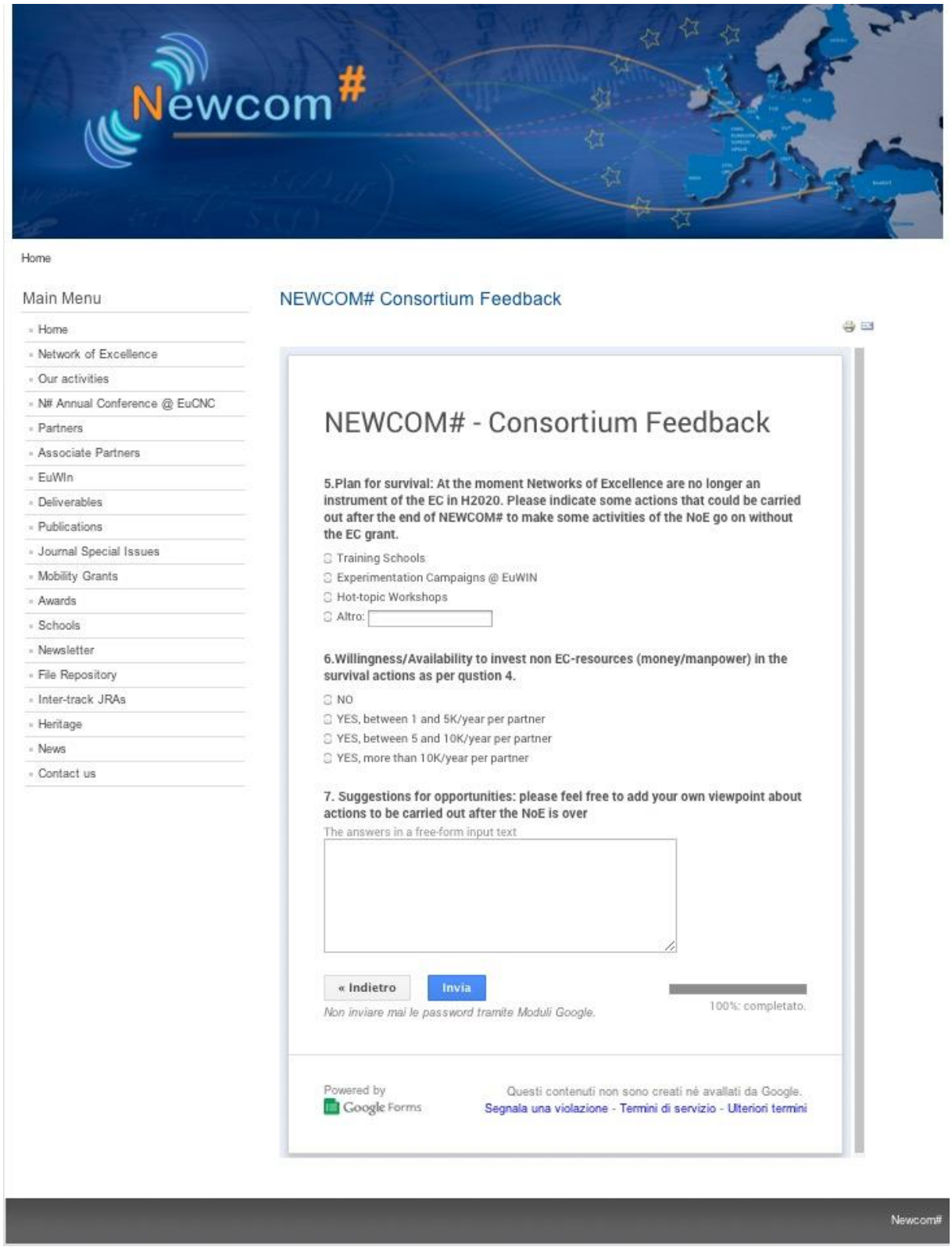
4.Value of EURACON: What are the three most relevant aspects you would like developed by the Association?

- ☐ Organization of Schools
- ☐ Organization of Conferences/Workshop
- ☐ Publication of an online Journal
- ☐ Preparation of white books/papers on hot topics in research/standardization
- ☐ Help in the preaparation of research proposals
- ☐ Altro:

« Indietro Continua »

66% completato

Newcom#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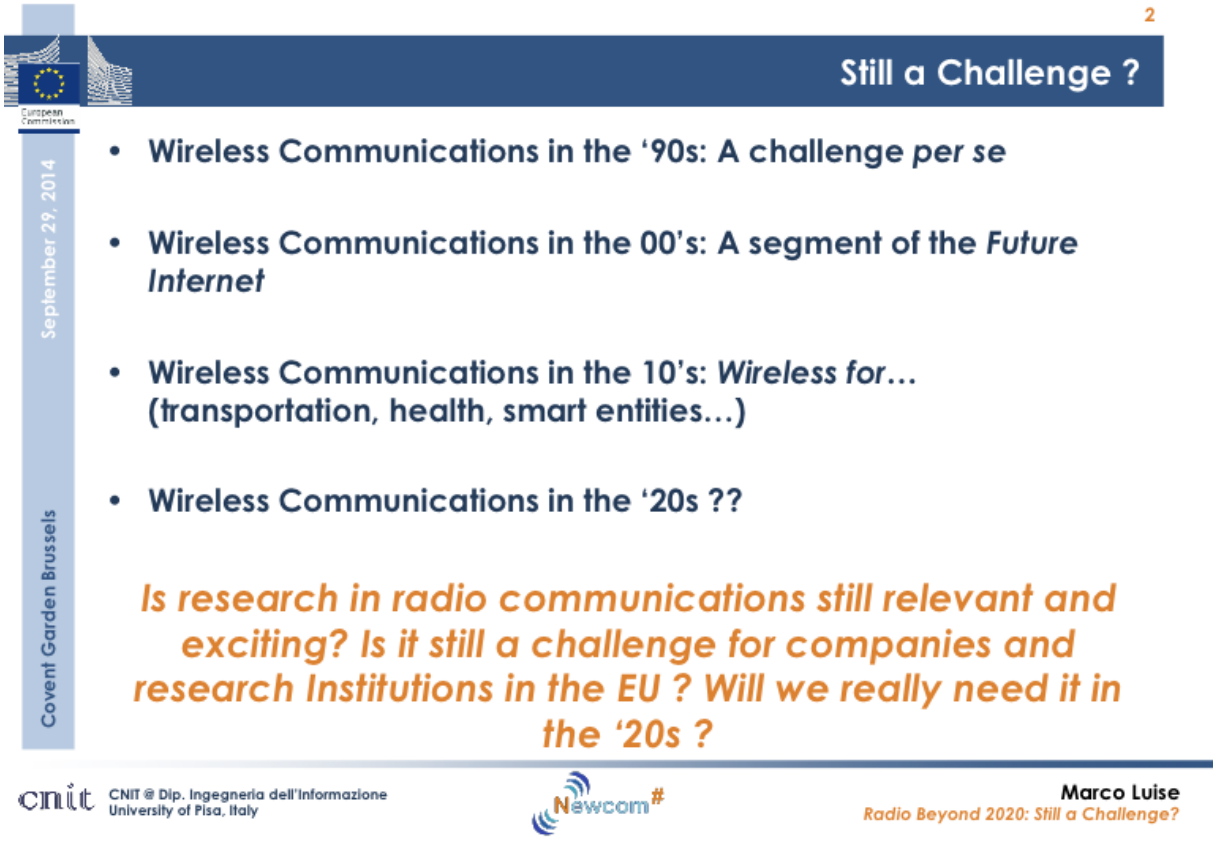
NEWCOM# Consortium Feedback
NEWCOM# - Consortium Feedback
5.Plan for survival: At the moment Networks of Excellence are no longer an instrument of the EC in H2020. Please indicate some actions that could be carried out after the end of NEWCOM# to make some activities of the NoE go on without the EC grant.
Training Schools
Experimentation Campaigns @ EuWIN
Hot-topic Workshops
Altro:
6.Willingness/Availability to invest non EC-resources (money/manpower) in the survival actions as per qustion 4.
NO
YES, between 1 and 5K/year per partner
YES, between 5 and 10K/year per partner
YES, more than 10K/year per partner
7. Suggestions for opportunities: please feel free to add your own viewpoint about actions to be carried out after the NoE is over
The answers in a free-form input text
« Indietro
Invia
100%: completato.
Non inviare mai le password tramite Moduli Google.
Powered by
Google Forms
Questi contenuti non sono creati né avallati da Google.
Segnala una violazione - Termini di servizio - Ulteriori termini
Newcom#

6.2 Annex II: Presentation for Stakeholder Meeting



3

Our Roots 1/2

September 29, 2014
Covent Garden Brussels

- NEWCOM : 2004-2007, 60 partners
- NEWCOM++ : 2008-2010, 17 partners
- NEWCOM# : 2012-2014, 14 partners
- Overall financing by the European Commission close to 16 Million €
- Overall effort of 3400 person-months

4

Our Roots 2/2: Objectives of NEWCOM#

September 29, 2014
Covent Garden Brussels

- To produce medium to long term results in the area of design and performance evaluation of wireless networks
- To strengthen the integration of partners' research activities and agendas, both at the theoretical *and* experimental levels
- To foster Industry-Academia cooperation and, by doing so, make academic research closer to industrial interests
- To train a new generation of researchers in the field of wireless communications with solid theoretical and experimental skills
- To contribute to the long-term sustainability of the NoE by creating a *permanent* environment for cooperative research: the EuWIn lab

5

Outline

- **Some ideas for medium-to-long-term research in wireless**
  - 5G is almost here, with fundamental research we should already start thinking of B5G…
- **Our view of European Leadership**
  - Are there any capacities that are missing to keep it?
- **Lessons learnt & Way forward**
  - Metcalfe's law and cooperative/integrated research
  - Let's not waste our capitals

September 29, 2014
Covent Garden Brussels

6

Some ideas for medium-to-long-term research in wireless

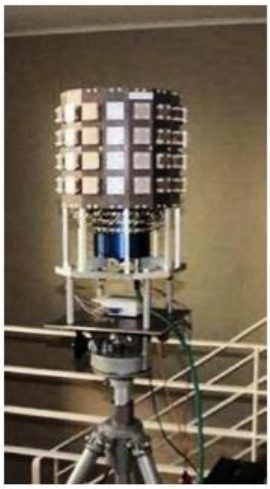
September 29, 2014
Covent Garden Brussels
CNIT @ Dip. Ingegneria dell'Informazione
University of Pisa, Italy
Marco Luise
Radio Beyond 2020: Still a Challenge?

7

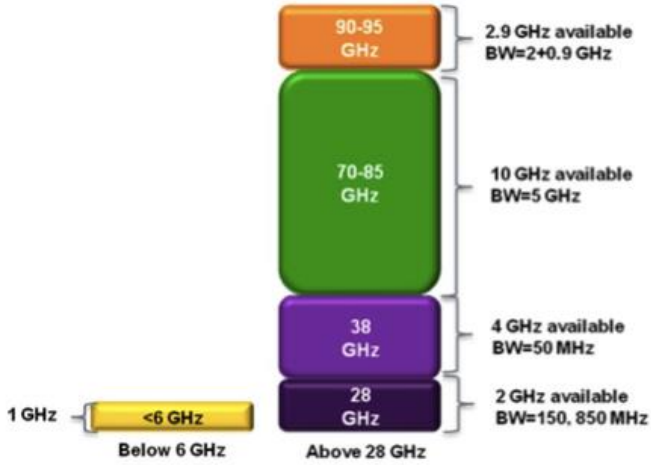
Main trends for 5G towards the 1000-fold capacity increase

September 29, 2014
Covent Garden Brussels

Massive MIMO



mm-waves



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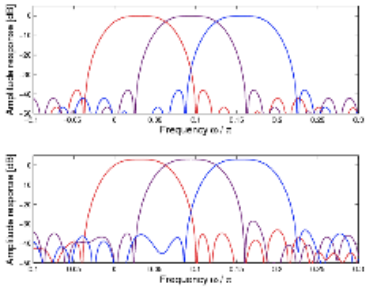
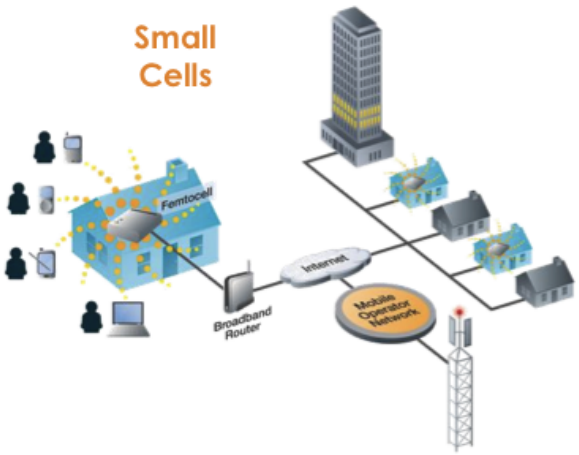
Main trends for 5G towards the 1000-fold capacity increase

September 29, 2014
Covent Garden Brussels



Efficient Waveform Design

Small Cells



9

Going further: B5G for the '20s 1/2

September 29, 2014 Covent Garden Brussels

- **Cooperative networking**
  - Nothing to do with Massive or Distributed MIMO: massive relaying of messages in a dense (peer-to-peer) network
- **Noisy Networks**
  - Strategies for network coding and its interplay with routing
- **Cooperative Robust Interference Alignment**
  - Overcomes the notion of resource allocation/sharing and interference cancellation
- **Physical-layer security**
  - Encryption-less enhanced security of radio access with adaptive features of the radio interface

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Going further: B5G for the '20s 2/2

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- **Distributed Caching/Storage and Social networking**
  - Information Flow and Information Storage goes hand-in-hand. It pairs the issue of cooperative communications and exploits the spatial correlation of information in population of users
- **D2D with non-cellular architecture**
  - Internet of Things 2.0 – it is again configured as a peer-to-peer low bit-rate, very high density network with possible cooperation
- **Integration with broadcast**
  - Unique radio interface with cellular and D2D ? Integration of all networks (see the issue with D2D above)
- **Network *robustification***
  - No increase of bit-rate, a huge improvement of user experience, indistinguishable in mobility from that on the fixed network

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Our view of European Leadership
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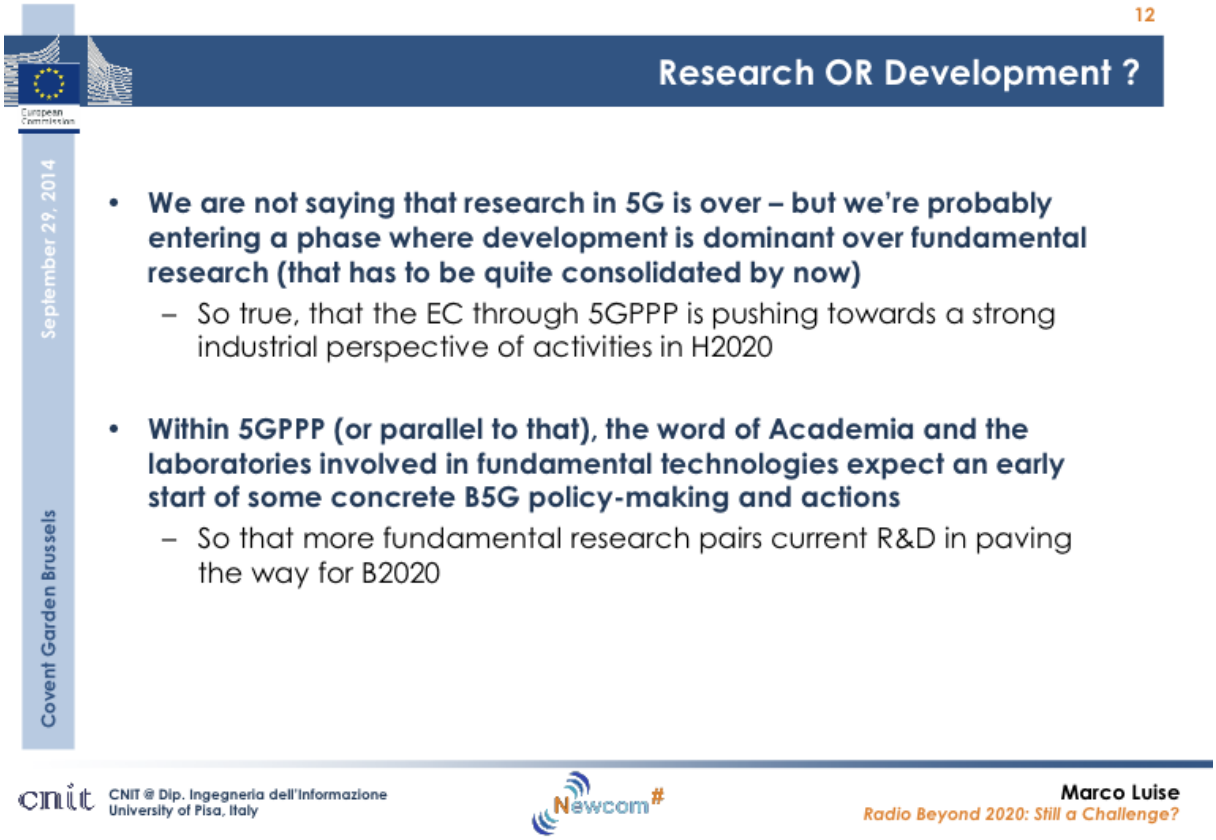
Radio Beyond 2020: Still a Challenge?


12
Research OR Development ?
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• We are not saying that research in 5G is over – but we're probably entering a phase where development is dominant over fundamental research (that has to be quite consolidated by now)
– So true, that the EC through 5GPPP is pushing towards a strong industrial perspective of activities in H2020
• Within 5GPPP (or parallel to that), the word of Academia and the laboratories involved in fundamental technologies expect an early start of some concrete B5G policy-making and actions
– So that more fundamental research pairs current R&D in paving the way for B2020
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Marco Luise
Radio Beyond 2020: Still a Challenge?

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A Place for Europe

- **Europe has the lead in the field of cooperative research**
  - It is something whose value comes from the "pooling" of knowledge and resource that has to be pursued further and further in future programs
- **If Europe has to keep the lead, in spite of the many changes involving the main players in the field, the only way is to think forward and try to anticipate the new technologies as much as possible**
  - In the past, it worked in many areas: 2G, (to some extent)3G, 4G, DVB for broadcasting etc.
- **Even non-European players will welcome advances in European fundamental research**
  - This has already happened – many of the features embedded into 4G, and from which worldwide providers are benefiting, are a results of fundamental technologies devised in Europe

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Lessons Learnt & Way Forward

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What is Missing under the European Sun ?

- **All of the previous statements about leadership are easier said than done**
  - SMEs are often at the forefront, but their research fails to achieve a critical mass
  - The same is true for Academia, whose relation with large companies is at times too weak – we're even witnessing cases of diaspora of researchers from University to companies
  - At times, large companies may be medium-term oriented with lesser attention to fundamental aspects
- **The times of large National laboratories (like CSELT…) are well over and unfortunately we do not have a CERN for wireless communications to steer and implement research at the continental level**
  - Federative actions are needed to make available to the community some large shared facilities for fundamental theoretical and experimental research

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Summary and Conclusions 1/2

- **There is a lot (still) to be done in the area of radio access, especially in the fields of cooperative and non-cellular communications**
  - Something that we may start qualifying as "Beyond 5G"
- **5GPPP has already identified the main trends and projects that are needed to come to successful architecting of 5G**
  - It will smoothly hand over to standardization bodies (or will be directly turned into one?)
  - Fundamental research risks having (only) an indirect role into the different projects that are envisaged
- **Other opportunities for fundamental research like ERC's grants are a bit too far from the Wireless Communications community**
  - We're not saying there are no examples of success with ERC grants, but we've also seen many top-level proposals from the best European scientists in our field that did not go through – perhaps they were a bit mismatched to the panels' skills.

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Summary and Conclusions 2/2

- **Together with short-to medium term activities, the EC should find a direct way to support fundamental research to help European companies and Institutions keep the edge**
  - *Fundamental* does not only mean *theoretical*. In engineering, fundamental can have both a theoretical and an experimental flavor
  - The instruments to do this has probably to be refined (including NoEs…)
- **A series of focused actions on selected long-term topics might be the solutions to this**
  - Something in-between 5GPPP and ERC, managed by a special task force by the DG
- **Creation of a reference experimental facility to be shared at the continental level would help very much**
  - Again, to combat fragmentation

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Newcom#

We do believe that research in radio access is still a challenge for our community, and a source of opportunities for companies and research Institutions

Thank You

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6.3 Annex III: Publications in Year 2

Nr	Journal Papers - Joint	WP
1	A. Kliks, P. Kryszkiewicz, K. Cichoń, A. Umbert, J. Prez-Romero, F. Casadevall,, DVB-T channels measurements for the deployment of outdoor REM databases, Journal of Telecommunications and Information Technology, no. 3/2014, pp. 42-52	2.1
2	A. Kliks, P. Kryszkiewicz, Jordi Perez-Romero, Anna Umbert,, DVB-T signal detection for indoor environments in low-SNR regime Przegląd Telekomunikacyjny i Wiadomości Telekomunikacyjne, rocznik LXXXVII, nr 8-9/2014, str. 1196-1201	2.1
3	O. Font Bach, N. Bartzoudis, A. Pascual Iserte, M. Payaro, L. Blanco, D. Lopez Bueno and M. Molina, Interference Management in LTE-based HetNets: a Practical Approach, Transactions on Emerging Telecommunications Technologies (Wiley), April 2014 (available on-line, DOI: 10.1002/ett.2833)	2.1
4	M. Luise, C. Fernández-Prades, S. Gezici, H. Wymeersch, Signal processing techniques for anywhere, anytime positioning, EURASIP Journal on Advances in Signal Processing, Vol. 2014, No. 93, June 2014.	2.1
5	Achraf Mallat, Sinan Gezici, Davide Dardari, Christophe Craeye, Luc Vandendorpe, Statistics of the MLE and Approximate Upper and Lower Bounds—Part I: Application to TOA Estimation, IEEE Transactions on Signal Processing, vol.62, no.21, pp.5663,5676, Nov.1, 2014	2.1
6	Achraf Mallat, Sinan Gezici, Davide Dardari, Luc Vandendorpe, Statistics of the MLE and Approximate Upper and Lower Bounds–Part II: Threshold Computation and Optimal Pulse Design for TOA Estimation," IEEE Transactions on Signal Processing, vol.62, no.21, pp.5677,5689, Nov.1, 2014	2.1
7	A. Mallat, S. Gezici, D. Dardari, C. Craeye and L. Vandendorpe, Statistics of the MLE and Approximate Upper and Lower Bounds – Part 1: Application to TOA Estimation, IEEE Transactions on Signal Processing, vol. 62, no. 21, pp. 5663-5676, Nov. 2014	2.1
8	A. Mallat, S. Gezici, D. Dardari, and L. Vandendorpe, Statistics of the MLE and Approximate Upper and Lower Bounds – Part 2: Threshold Computation and Optimal Signal Design, IEEE Transactions on Signal Processing, vol. 62, no. 21, pp. 5677-5689, Nov. 2014	2.1
9	Marius Caus, Ana I. Perez Neira and Adrian Kliks, Characterization of the effects ofmulti-tap filtering on FBMC/OQAM systems. EURASIP Journal on Advances in Signal Processing	1.3
10	S. D'Oro, L. Galluccio, G. Morabito, S. Palazzo, L. Chen, F. Martignon, Defeating jamming with the power of silence: a game-theoretic analysis, IEEE Trans. On Wireless Communications, June 2014.	1.2
11	X. Vilajosana-Guillen, P. Tuset-Peiro, F. Vazquez-Gallego, J. Alonso-Zarate, L. Alonso,, Standardized low-power wireless communication technologies for distributed sensing applications,, MDPI Sensors	1.2
12	K. Wang, A. Laya, J. Alonso-Zarate, L. Alonso, M. Dohler, Green Machine-Type Communications, Machine-to-Machine Communications and the Internet of Things,, Green Communication, Wiley Science,	1.2
13	T. Predojev, J. Alonso-Zarate, M. Dohler, L. Alonso, Energy Consumption Optimisation for Duty-Cycled Schemes in Shadowed Environments, EURASIP International Journal of Distributed Sensor Networks, Special Issue Protocols and Architectures for Next-Generation Wireless Sensor Networks, vol. 2014 (May),	1.2
14	A. Laya, K. Wang, A. Widaa, J. Alonso-Zarate, J. Markendahl, and Luis Alonso, Device-to-Device Communications and Small Cells: Enabling Spectrum Reuse for Dense Networks, IEEE Wireless Communications Magazine, vol. 21, issue 4, August 2014, PP. 98-105	1.2
15	P. Tuset-Peiro, F. Vazquez-Gallego, J. Alonso-Zarate, L. Alonso, X. Vilajosana, , Experimental energy consumption of Frame Slotted ALOHA and Distributed Queuing for data collection scenarios,, Sensors 2014, 14(8), 13416-13436; doi:10.3390/s140813416,	1.2
16	P. Tuset-Peiro, F. Vazquez-Gallego, J. Alonso-Zarate, L. Alonso, X. Vilajosana,, LPDQ: a self-scheduled TDMA MAC protocol for one-hop dynamic low-power wireless networks, Accepted for publication at ELSEVIER Journal on Pervasive and Mobile Computing, Special Issue on the Internet of Things	1.2

17	Marius Caus, Ana I. Perez Neira and Adrian Kliks, Characterization of the effects ofmulti-tap filtering on FBMC/OQAM systems. EURASIP Journal on Advances in Signal Processing June 2014, 2014:84,	1.2
18	A. Laya, K. Wang, L. Alonso, J. Alonso-Zarate, Supporting machine-to-machine (M2M) communications in long-term evolution (LTE) networks, Machine-to-machine (M2M) communications, architecture, performance and applications, Woodhead Publishing.	1.2
19	A. Laya, L. Alonso, J. Alonso-Zarate, Is the Random Access Channel of LTE and LTE-A Suitable for M2M Communications? A Survey of Alternatives, IEEE Tutorials and Surveys Communications Magazine, January 2014.	1.2
20	Mohieddine El Soussi, Abdellatif Zaidi, Luc Vandendorpe, Compute-and-Forward on a Multiaccess Relay Channel: Coding and Symmetric-Rate Optimization, IEEE Transactions on Wireless Communications, vol.13, no.4, pp.1932,1947, April 2014	1.2
21	Mohieddine El Soussi, Abdellatif Zaidi, Luc Vandendorpe, Compute-and-Forward on a Multi-User Multi-Relay Channel, To appear in IEEE Wireless Communications Letters	1.2
22	A. Zaidi and S. Shamai (Shitz), On Cooperative Multiple Access Channels With Delayed CSI at Transmitters, Information Theory, IEEE Transactions on , vol.60, no.10, pp.6204,6230, Oct. 2014	1.1
23	A. Zaidi, P. Piantanida and S. Shamai (Shitz), Capacity Region of Cooperative Multiple-Access Channel With States, Information Theory, IEEE Transactions on , vol.59, no.10, pp.6153,6174, Oct. 2013	1.1
24	M. El Soussi and A. Zaidi and L. Vandendorpe,, Compute-and-Forward on a Multiaccess Relay Channel: Coding and Symmetric-Rate Optimization, Wireless Communications, IEEE Transactions on , vol.13, no.4, pp.1932,1947, April 2014	1.1
25	A. Zaidi, Z. H. Awan, S. Shamai (Shitz) and L. Vandendorpe,, Secure degrees of freedom of MIMO X-channels with output feedback and delayed CSI, Information Theory Workshop (ITW), 2013 IEEE , vol., no., pp.1,5, 9-13 Sept. 2013	1.1
26	Lejosne, Yohan; Bashar, Manijeh; Slock, Dirk TM; Yuan-Wu, Yi, From MU massive MISO to pathwise MU massive MIMO SPAWC 2014, 15th IEEE Int'l Workshop on Signal Processing Advances in Wireless Communications, 22-25 June 2014, Toronto, Canada.	1.1
27	Bashar, Manijeh; Slock, Dirk TM, Cognitive multi-User MIMO downlink with mixed feedback/location based Gaussian CSIT SPAWC 2014, 15th IEEE Int'l Workshop on Signal Processing Advances in Wireless Communications, 22-25 June 2014, Toronto, Canada.	1.1
28	Lejosne, Yohan; Bashar, Manijeh; Slock, Dirk TM; Yuan-Wu, Yi, Decoupled, rank reduced, massive and frequency-selective aspects in MIMO interfering broadcast channels ISCCSP 2014, 6th Int'l Symp. on Communications, Control, and Signal Processing, May 21-23, 2014, Athens, Greece.	1.1
29	Lejosne, Yohan; Bashar, Manijeh; Slock, Dirk TM; Yuan-Wu, Yi, MIMO interfering broadcast channels based on Local CSIT EW 2014, 20th European Wireless Conference, May 14-16, 2014, Barcelona, Spain.	1.1
30	M. Benammar, P. Piantanida, and S. Shamai (Shitz), On the Compound Broadcast Channel: Multiple Description Coding and Interference Decoding, Information Theory, IEEE Trans. on, September 2014, (Submitted)	1.1
31	S. Pfletschinger, D. Declercq, M. Navarro, Adaptive HARQ with non-binary repetition coding, IEEE Transactions on Wireless Communications, accepted March 2014.	1.1
32	V. Suryaprakash, J. Møller, and G. Fettweis, On the Modeling and Analysis of Heterogeneous Radio Access Networks using a Poisson Cluster Process, To appear in IEEE Transactions on Wireless Communications	1.1

Nr	Conference Papers - Joint	WP
1	Dimitrova, Desislava; Alfayawi, Islam; Ferreira, Lucio S.; Gomes, André; Nikaein, Navid; Georgiev, Alexander; Pizzinat , Anna, , Challenges ahead of RAN virtualization in LTE, in Proc. European Conference on Networks and Communications (EuCNC), Bologna (Italy), June 2014.	2.3

2	A. Kliks, P. Kryszkiewicz, A. Umbert, J. Pérez-Romero, F. Casadevall , TVWS Indoor measurements for HetNets, FutureHetNets workshop at IEEE Wireless Communications and Networking Conference (WCNC) 2014, Istanbul, Turkey, 6-9 April 2014	2.1
3	A. Kliks, P. Kryszkiewicz, K. Cichoń, J. Perez-Romero, F. Casadevall, , DVB-T channels power measurements in indoor/outdoor cases, IEICE Information and Communication Technology Forum 2014, 28-30 May, 2014, Poznań, Poland	2.1
4	David Lopez, Pere Gilabert, Gabriel Montoro, Nikolaos Bartzoudis, Peak Cancellation and Digital Predistortion of High-Order QAM Wideband Signals for Next Generation Wireless Backhaul Equipment, in the Proceedings of the IEEE International workshop on Integrated Nonlinear Microwave and Millimetre-wave Circuits (INMMIC'14), 2-4 April 2014, Leuven, BE (EU).	2.1
5	Nikolaos Bartzoudis, Oriol Font-Bach, Miquel Payaró, Antonio Pascual-Iserte, Javier Rubio, Juan José García Fernández, Ana García Armada, Energy Profiling of FPGA-based PHY-layer Building Blocks Encountered in Modern Wireless Communication Systems, Proceedings of 2014 IEEE 8th Sensor Array and Multichannel Signal Processing Workshop (SAM), A Corunya, Spain, June 2014.	2.1
6	O. Font Bach, N. Bartzoudis, A. Pascual Iserte, M. Payaro, Measuring the performance of a distributed interference management scheme in a LTE-based HetNet deployment, Proceedings of 2014 IEEE 8th Sensor Array and Multichannel Signal Processing Workshop (SAM), A Corunya, Spain, June 2014.	2.1
7	J. Vilà-Valls, Q. Wei, P. Closas, C. Fernández-Prades, Robust Gaussian Sum Filtering with Unknown Noise Statistics: Application to Target Tracking, In Proc. of the IEEE Statistical Signal Processing Workshop (SSP'14), June 29 - July 2 2014, Gold Coast (Australia).	2.1
8	Marius Caus, Ana I. Perez Neira, Marco Moretti and Adrian Kliks, A margin adaptive scheduling algorithm for FBMC/OQAM systems, in Proceedings of the 11th International Symposium on Wireless Communication Systems (ISWCS 2014), 26-29 August 2014, Barcelona (Spain)	2.1
9	J. M. Castro-Arvizu, P. Closas, J. Vilà-Valls, J. A. Fernández-Rubio, Simultaneous Tracking and RSS model Calibration by Robust Filtering, in Proc. of the Asilomar Conference on Signals, Systems, and Computers (ASILOMAR'14), 2-5 November 2014, Pacific Grove, CA (USA).	2.1
10	J. M. Castro-Arvizu, P. Closas, J. A. Fernández-Rubio, Cramér-Rao lower bound for breakpoint distance estimation in a path-loss model, in Proc. Of the IEEE International Conference on Communications (ICC 2014), 10-14 June 2014, Sidney (Australia).	2.1
11	Javier Rubio and Antonio Pascual Iserte, Simultaneous Wireless Information and Power Transfer in Multiuser MIMO Systems. Globecom 2013 (IEEE Global Communications Conference). Atlanta (USA), December 2013.	2.1
12	Adria Gusi Amigo, Pau Closas, Achraf Mallat, Luc Vandendorpe , Ziv-Zakai lower bound for UWB based TOA estimation with unknown interference, 2014 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), pp.6504,6508, 4-9 May 2014	2.1
13	Evgenii Vinogradov, Wout Joseph, Claude Oestges, Modeling and simulation of fast fading channels in indoor peer-to-peer scenarios," 2014 8th European Conference on Antennas and Propagation (EuCAP), pp.433,434, 6-11 April 2014	2.1
14	Enrico M. Vitucci, Francesco Mani, Vittorio Degli-Esposti,Claude Oestges, Dense multipath depolarization in outdoor and indoor radio transmissions," 2014 XXXIth URSI General Assembly and Scientific Symposium (URSI GASS), pp.1,4, 16-23 Aug. 2014	2.1
15	H. Bogucka, J. Perez-Romero,, Small cells deployment in TV White Spaces with neighborhood cooperation, URSI General Assembly and Scientific Conference, 16-23 Aug. 2014, Beijing, China	1.3
16	Giacomo Bacci (CNIT-PI), E. Veronica Belmega (CNRS), Luca Sanguinetti (CNIT-PI), DISTRIBUTED ENERGY-EFFICIENT POWER OPTIMIZATION IN CELLULAR RELAY NETWORKS WITH MINIMUM RATE CONSTRAINTS, Acoustics, Speech and Signal Processing (ICASSP), 2014 IEEE International Conference on , vol., no., pp.7014,7018, 4-9 May 2014.	1.3

17	Giacomo Bacci (CNIT-PI), E. Veronica Belmega (CNRS), Luca Sanguinetti (CNIT-PI), Distributed Energy-Efficient Power and Subcarrier Allocation for OFDMA-Based Small Cells, Communications Workshops (ICC), 2014 IEEE International Conference on , vol., no., pp.647,652, 10-14 June 2014	1.3
18	Giacomo Bacci (CNIT-PI), E. Veronica Belmega (CNRS), Panayotis Mertikopoulos (CNRS), Luca Sanguinetti (CNIT-PI), Energy-Aware Competitive Link Adaptation in Small-Cell Networks, The 10th International Workshop on Resource Allocation in Wireless Networks (RAWNET), WiOpt 2014, invited paper, Hammamet, Tunisia, May 2014.	1.3
19	P. Del Fiorentino (CNIT-PI), R. Andreotti (CNIT-PI), V. Lottici (CNIT-PI), F. Giannetti (CNIT-PI), I. Stupia (UCL), L. Vandendorpe (UCL), Distributed Power Allocation Based On PER Minimization for Noncooperative Multicarrier Systems Under Interference Constraints, in Proc. European Conference on Networks and Communications (EuCNC), Bologna (Italy), June 2014.	1.3
20	Paolo Del Fiorentino (CNIT-PI), Riccardo Andreotti (CNIT-PI), Filippo Giannetti (CNIT-PI), Vincenzo Lottici (CNIT-PI), Jeroen Van Hecke (UGent), Marc Moeneclaey (UGent), Link Resource Adaptation for BIC-OFDM Systems with Outdated Channel State Information, European Wireless 2014; 20th European Wireless Conference; Proceedings of , vol., no., pp.1,6, 14-16 May 2014.	1.3
21	Paolo Del Fiorentino (CNIT-PI), Riccardo Andreotti (CNIT-PI), Filippo Giannetti (CNIT-PI), Vincenzo Lottici (CNIT-PI), Ivan Stupia (UCL), Distributed Power Allocation for Cognitive Noncooperative BIC-OFDM Systems, Wireless Communications Systems (ISWCS), 2014 11th International Symposium on , vol., no., pp.475,479, 26-29 Aug. 2014.	1.3
22	Riccardo Andreotti (CNIT-PI), Leonardo Marchetti (CNIT-PI), Luca Sanguinetti (CNIT-PI), Merouane Debbah (SUPELEC), Distributed power control over interference channels using ACK/NACK feedback, IEEE Global Communications Conference (GLOBECOM), Austin, Texas, Dec. 2014.	1.3
23	Jeroen Van Hecke (UGent), Paolo Del Fiorentino (CNIT-PI), Filippo Giannetti (CNIT-PI), Vincenzo Lottici (CNIT-PI), Luc Vandendorpe (UCL), Marc Moeneclaey (UGent), Resource Allocation for Multicarrier Cooperative Cognitive Radio Networks with Imperfect Channel State Information, PIMRC 2014, Washington, USA.	1.3
24	M. D. Abrignani, L. Giupponi, A. Lodi, R. Verdone, Mixed-Integer Linear Programming approaches for the LTE Uplink Radio Resource Assignment Model, European Conference on Communications and Networking (EUCNC), Bologna (Italy), June 2014.	1.3
25	M. D. Abrignani, L. Giupponi, R. Verdone, Evaluation of M2M Scheduling Opportunities in a LTE Small Cell Network for Smart City Applications, COST Meeting - IC1004 TD(14)09040 - Ferrara, Italy, 5-7 February 2014	1.3
26	Javier Rubio, Antonio Pascual Iserte, Jaume Del Olmo and Josep Vidal, Dynamic Base Station Switch On/Off Strategies for Sustainable Wireless Networks, IEEE International Workshop on Signal Processing Advances for Wireless Communications, Toronto, Canada, June 2014.	1.3
27	Nikos Dimitriou, Andreas Zalonis, Andreas Polydoros, Adrian Kliks, Oliver Holland, Context-Aware Radio Resource Management in HetNets, WCNC 2014, FutureHetNets workshop, April, 2014	1.3
28	Michal Mackowiak, Luis M. Correia, Adrian Kliks, Paweł Kryszkiewicz, MIMO channel analysis in the context of body area networks, Wireless Communications Systems (ISWCS), 2014 11th International Symposium on , vol., no., pp.470,474, 26-29 Aug. 2014	1.3
29	Ivan Stupia, Luca Sanguinetti, Giacomo Bacci, Luc Vandendorpe, Distributed energy-efficient power optimization for relay-aided heterogeneous networks, 12th International Symposium on Modeling and Optimization in Mobile, Ad Hoc, and Wireless Networks (WiOpt), pp.563,568, 12-16 May 2014	1.3
30	K. Cichoń, A. Kliks, , The Impact of Hardware Implementation on the Performance of Spectrum Sensing Algorithms, International Symposium on Wireless Communication Systems, ISWCS 2014, August 26-29, 2014, Barcelona, Spain	1.2
31	Vincenzo Zambianchi, Michel Kieffer, Francesca Bassi,Gianni Pasolini, Davide Dardari, Distributed SPS Algorithms for Non-Asymptotic Confidence Region Evaluation, in Proc. European Conference on Networks and Communications (EuCNC), Bologna (Italy),	1.2

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32	Stefan Mijovic, Chiara Buratti, Alberto Zanella, Roberto Verdone, Cooperative Beamforming and Scheduling Strategies for Body Area Networks, in Proc. European Conference on Networks and Communications (EuCNC), Bologna (Italy), June 2014.	1.2
33	R. Andreotti (CNIT-PI), S. Mijovic (CNIT-BO), I. Stupia (UCL), C. Buratti (CNIT-BO), A. Zanella, F. Giannetti (CNIT-PI), VAA Formation Game for Cooperative Wireless Sensor Networks, in Proc. European Conference on Networks and Communications (EuCNC), Bologna (Italy), June 2014.	1.2
34	S D'Oro, P Mertikopoulos, AL Moustakas, S Palazzo, Adaptive transmit policies for cost-efficient power allocation in multi-carrier systems, Modeling and Optimization in Mobile, Ad Hoc, and Wireless Networks (WiOpt), 2014 12th International Symposium on , vol., no., pp.1,7, 12-16 May 2014	1.2
35	B. Lorenzo-Veiga, S. Glisic, L. Galluccio, Y. Fang., Adaptive infection recovery schemes for multicast Delay Tolerant Networks, Globecom Workshops (GC Wkshps), 2013 IEEE , vol., no., pp.4420,4426, 9-13 Dec. 2013	1.2
36	Fosson, S.M., Matamoros, J., Antón-Haro, C., Magli, E., Distributed support detection of jointly sparse signals, Acoustics, Speech and Signal Processing (ICASSP), 2014 IEEE International Conference on , vol., no., pp.6434,6438, 4-9 May 2014	1.2
37	Nafkha, A.; Naoues, M.; Cichon, K.; Kliks, A., Experimental spectrum sensing measurements using USRP Software Radio platform and GNU-radio	1.2
38	Nafkha, A.; Naoues, M.; Cichon, K.; Kliks, A., Experimental spectrum sensing measurements using USRP Software Radio platform and GNU-radio	1.2
39	W. Li, F. Bassi, D. Dardari, M. Kieffer, and G. Pasolini, Low complexity distributed outlier identification for wireless sensor networks, in Proc. European Conference on Networks and Communications (EuCNC), Bologna (Italy), June 2014.	1.2
40	J. Matamoros, S. M. Fosson, E. Magli, C. Antón-Haro, Distributed ADMM for in-network reconstruction of correlated sparse signals, To appear in IEEE Global Conference on Signal and Information Processing conference (GLOBALSIP14), December 3-5, 2014. Atlanta, Georgia, USA.	1.2
41	F. Vazquez-Gallego, J. Bas, J. Alonso-Zarate, M. Rietti, L. Alonso, Performance Evaluation of Frame Slotted-ALOHA with Successive Interference Cancellation in Machine-to-Machine Networks, in proc. Of European Wireless 2014.	1.2
42	F. Vazquez-Gallego, J. Alonso-Zarate, P. Tuset-Peiro, and L. Alonso,, Energy Analysis of a Contention Tree-based Access Protocol for Machine-to-Machine Networks with Idle-to-Saturation Traffic Transitions, in proc. Of IEEE ICC 2014	1.2
43	X. Mestre, P. Vallet, W. Hachem, Correlation Test for High Dimensional Data with Application to Signal Detection in Sensor Networks	1.2
44	Luis Blanco, Montse Nájar, Multiple relay selection in underlay cognitivenetworks with per-relay constraints, EUCNC 2014, Bologna, June 2014	1.2
45	F. Vazquez-Gallego, J. Alonso-Zarate∗, P. Tuset-Peio, and L. Alonso, Energy Performance of Distributed Queuing Access in Machine-to-Machine Networks with Idle-to-Saturation Transitions. Globecom, Dec. 2013.	1.2
46	E. Lagunas, M. Nájar, Compressed Spectrum Sensing in the presence of interference comparison of Sparse recovery strategies, European Signal Conference, 1-5 September	1.2
47	Mihai-A. Badiu, Maxime Guillaud, Bernard Fleury, Interference alignment using variational mean field annealing, 2014 12th International Symposium on Modeling and Optimization in Mobile, Ad Hoc, and Wireless Networks (WiOpt),pp.585,590, 12-16 May 2014	1.2
48	Luca Sanguinetti (CNIT-PI), Emil Bjornson (SUPELEC), Merouane Debbah (SUPELEC), Aris L. Moustakas (SUPELEC), Optimal Linear Precoding in Multi-User MIMO Systems: A Large System Analysis, IEEE Global Communications Conference (GLOBECOM), Austin, Texas, Dec. 2014.	1.1

49	L. Sanguinetti (CNIT-PI), A.L. Moustakas (SUPELEC), M. Debbah (SUPELEC), Analysis and Management of Interference in 5G Reverse TDD HetNets, 1st International Conference on 5G for Ubiquitous Connectivity (5GU), Levi, Finland (2014).	1.1
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