

COST

Domain Committee "Information & Communication Technologies"

COST Action IC1004

Start Date 19 May 2011

Cooperative Radio Communications for Green and Smart Environments

MONITORING PROGRESS REPORT

Reporting Period: *from 19th May 2011 (start date of the Action)
to 9th May 2013 (reporting date)*

This Report is presented to the relevant Domain Committee.
It contains three parts:

- I. Management Report prepared by the COST Office/Grant Holder***
- II. Scientific Report prepared by the Chair of the Management Committee of the Action***
- III. Previous versions of the Scientific Report; i.e., part II of past reporting periods***

The report is a "cumulative" report, i.e. it is updated annually and covers the entire period of the Action.

Confidentiality: the documents will be made available to the public via the COST Action web page except for chapter *II.D. Self evaluation*.

Based on the monitoring results, the COST Office will decide on the following year's budget allocation.

Executive summary (max.250 words):

The scientific scope of IC1004 is on the Radio Communication Systems and Networks, within the framework of the Energy Efficiency and Smart Environments (SEs). The optimal exploitation of the radio channel through its study and modelling, through the development of cooperative transmission techniques and through the design of self-organizing and energy efficient protocols and algorithms, is the major goal of IC1004.

After almost two years of activities, IC1004 is approaching the end of its second year with already a stable participation, clear objectives in both Disciplinary (DWG) and Topical Working Groups (TWG), a well-established set of liaisons to external projects and bodies, and many completed training and dissemination activities. Some relevant results have been reached in the areas of implementation of a COST 2100-IC1004 multi-link channel model, definition of feasible MIMO OTA tests for (LTE) User Equipment, an energy consumption model for multi-RAT networks, the characterisation of the vehicular radio channel at the 5 GHz band, the simulation of complex radio wave propagation in enclosed spaces, robust passive indoor localization techniques, energy efficient radio resource management algorithms, models for body-centric applications, and the joint validation of scenarios and system level simulators for Radio Access Networks.

The Action accounts with a total of 427 individuals registered, from 129 research institutions and companies, 13 of them from non-COST Countries. IC1004 meetings are attended by an average of 120 experts, being the MC members only 1/3 of them. The fact that the majority of participants to COST IC1004 meetings cover the expenses by their own, clearly indicates that the activity in IC1004 is generating significant results, not only in terms of the meeting discussions with colleagues, but mainly on the scientific networking of methodologies, standards, references, techniques, models and tools.

The percentage of ESRs and the activities of the Action devoted to their inclusion and training have also increased, with four Training Schools organised so far, and 11 STSMs performed during the second year term. Those ESR have taken advantage of other IC1004 activities, apart from the 6 technical meetings celebrated so far: 4 tutorials; about 75 grants to attend our 4 Training Schools on Vehicular Connectivity, Body Communications, MIMO OTA Testing, Tools for Cooperative Communications; two workshops on Cooperative Small Cells and Self Organising Networks for Energy Efficiency, and 20 special sessions in international conferences like EuCAP, FuNeMS, ICC, PIMRC, European Wireless, URSI-ISSSE, IEEE VTS, CEMA and CAMAD, among others.

The Action IC1004 is publishing a Newsletter three times per year, with the technical and organisational highlights of its activities, and has published s Special Issue in the EURASIP Journal on Wireless Communications and Networking, as well as a White Paper on the Action views towards HORIZON-2020.

The IC1004 group is also reached a consolidated status in Scientific Networking. The natural synergies between participants in COST have made possible to reach 100 joint publications so far, and the joint participation of IC1004 members to FP7 and other framework research projects. After 23 months of live, COST IC1004 is already cited 281 times in the literature ([\\scholar.google.com](https://scholar.google.com))

I. Management Report prepared by the COST Office/Grant Holder



I.A. COST Action Fact Sheet

- **COST Action IC1004 - Cooperative Radio Communications for Green Smart Environments**
- **Domain ICT**

- **Action details:**

CSO Approval: 02/12/2010

End date: 18/05/2015

Entry into force: 17/01/2011

Extension: (day/month/year)

- **Objectives** Smart Environments (SEs), like the human body, energy efficient buildings, vehicular or urban environments, are populated by many devices connected by wireless networks. The radio channel is central to SEs, as it impacts the design of transmission techniques and communication protocols. Radio communications in SEs need to be green and based on cooperative paradigms to mitigate the effect of interference and improve efficiency. This Action addresses research issues in the field of cooperative radio communications to make our society cleaner, safer, and more energy efficient. The main goal of the Action is to increase knowledge of cooperative communications applied to Green SEs (GSEs), by exploring and developing new methods, models, techniques, strategies and tools, in a context enriched by deep industry-academia links. Training of young researchers is also one of its main objectives, to be pursued e.g. via annual training schools. Europe will benefit from the activities of this Action, as GSEs will be one of the key components of the broader field (and exploding market) of the Internet of Things, a domain of interest to many large and small companies in Europe. COST is the ideal framework, as it allows very efficient cooperation among industries and academia

- **Parties:** list of countries and date of acceptance (28)

Austria (25/01/2011)	Ireland (07/02/2011)	Spain (02/02/2011)
Belgium (09/03/2011)	Israel (17/01/2011)	Sweden (10/05/2011)
Bulgaria (17/01/2011)	Italy (17/01/2011)	Switzerland (05/07/2011)
Croatia (13/09/2011)	Luxembourg (24/05/2011)	United Kingdom (17/01/2011)
Cyprus (24/06/2011)	Netherlands (31/01/2011)	
Czech Rep. (27/04/2011)	Norway (18/01/2011)	
Denmark (08/06/2011)	Poland (04/03/2011)	
Finland (25/01/2011)	Portugal (18/01/2011)	
FYR of Macedonia (25/02/2011)	Romania (11/02/2011)	
France (01/03/2011)	Serbia (21/01/2011)	
Germany (20/01/2011)	Slovakia (10/03/2011)	
Greece (17/01/2011)	Slovenia (12/07/2011)	

- **Intentions to accept:** list of countries and date

- **Other participants:**

Academy of Broadcasting Planning	China
Beijing University of Posts and Telecommunications, Wireless Technology Innovation Institute	China
COMSEARCH	United States of America
La Trobe University	Australia
Motorola Mobility US	United States of America

National Institute of Information and Communications Technology	Japan
The Communications Research Centre	Canada
Tokyo Institute of Technology	Japan
Tongji University	China
Universidad Icesi	Colombia
University of Montenegro	Montenegro
National Institute of Standards and Technology	United States of America
Academy of Broadcasting and Planning	China

Chair: (*Narcis Cardona, iTEAM Research Institute, Universitat Politecnica de Valencia, Camino de Vera S/N 46022, Valencia, Spain, +34 963879580 (ncardona@iteam.upv.es)*)

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- **Action Web site:** <http://www.ic1004.org/>
- **Grant Holder Representative** (*Roberto Verdone, roberto.verdone@unibo.it*)

• **Working Groups** (*list of WGs and names and affiliations of participants¹*)

- TWGB - Body Environment, chaired by Raffaele D'Errico (FR) and Kamyaz Yazdandoost (JP);
 - 97 participants
- TWGV - Vehicular Environment, chaired by Alexander Paier (AT) and Erik Strom (SE);
 - 129 participants
- [TWGI](#) - Indoor Environment, chaired by Pawel Kulakowski (PL) and Katsuyuki Haneda (FI)
 - 150 participants
- TWGU - Urban Environment, chaired by Thomas Jansen (DE) and Sana Salous (UK)
 - 131 participants
- [TWGO](#) - OTA (Over-the-air Testing), chaired by Gert Pedersen (DK) and Wim Kotterman (DE)
 - 36 participants
- [WG1](#) – Radio Channel, chaired by Claude Oestges, U.C.L. (BE)
 - 195 participants
- WG2 – Radio Signalling, chaired by Alister Burr, U.York (UK)
 - 107 participants
- WG3 – Radio Networks, chaired by Silvia Ruiz, U.P.C. (ES)
 - 145 participants
- [SWG 1.1](#) – Antennas, chaired by Buon Kiong Lau (SE)
 - 39 participants
- SWG 2.1 – PHY layer Cooperation and Relaying, chaired by Jan Sykora (CZ)
 - 35 participants

¹ The lists of participants to every Working Group can be found at www.ic1004.org under “minutes” of every meeting. Only number of participants is reported here.

I.B. Management Committee member list

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I.C. Overview activities and expenditure

BUDGET

2011 - 2012: 133.700 €
2012 - 2013: 177.675 €
Still to be spent: 76.886,61 €²

Meetings

Meeting Type	Date	Place	Cost	Total
2 nd MC Meeting	19-21 October 2011	Lisbon, Portugal		40.017,83 €
3 rd MC Meeting	8-10 February, 2012	Barcelona, Spain		26.631,65 €
4 th MC Meeting	2-4 May, 2012	Lyon, France		28.305,39 €
5 th MC Meeting	24-26 September, 2012	Bristol, UK		37.536,77 €
6 th MC Meeting	6-8 February, 2013	Malaga, Spain		34.716,94 €

STSM

Beneficiary	Date	Place	Cost	Total
Zoran Utkovski	19-29 January 2012	Chalmers University of Technology (SE)		1.000 €
Nikola Gvozdenovic	19-24 February 2012	University of Bristol, Bristol(UK)		690 €
Imran Latif	19-23 March 2012	UPC, Castelldefels (ES)		900 €
Wei Wang	19-23 March 2012	Aalborg University, Aalborg (DK)		1.000 €
Geoffrey Hilton	12-12 March 2012	Vienna University of Technology, Vienna (AT)		800 €
Thomas Jensen	21-30 May 2012	Universitat Politecnica de Valencia, Valencia (ES)		1.000 €
Joerg Nuckelt	01/08/2012 - 14/09/2012	Lund University, SE		1.200 €
Sato Telemi	20/08/2012 - 21/09/2012	University of Bristol, UK		1.800 €
Josep Colom Ikuno	02-08 December 2012	Technische Universitat Braunschweig, DE		800 €
Claude Oestges	20-26 January 2013	CEA-LETI, FR		500 €
Thomas Werthmann	18-22 February 2013	Vienna University of Technology, Vienna(AT)		700 €

² The 7th MCM, 4th TS and 2nd Workshop to take place on May 2013.

Thomas Jansen	18-22 February 2013	Vienna University of Technology, Vienna(AT)	600 €
Evangelos Mellios	11-15 March 2013	Ilmenau University of Technology, DE	840 €
Pawel Kulakowski	25/02/2013 - 7/04/2013	University of Castilla La Mancha, ES	2.500 €
Taimoor Abbas	15/03/2013 - 26/04/2013	Technische Universitat Braunschweig, DE	1.200 €
Enrico Maria Vitucci	21-26 April 2013	Université catholique de Louvain, BE	850 €
Francesco Mani	22-26 April 2013	Université catholique de Louvain, BE	650 €

Workshops

Title	Date	Place	Cost	Total
Small Cell Cooperative Communications	May 2 nd , 2012	Lyon, France		3.000 €

Schools

Title	Date	Place	Cost	Total
Training School Vehicular Connectivity	21-23 May 2012	Vienna, Austria		10.296,71 €
Wireless Body Area Networks	4-6 June 2012	Bologna, Italy		2.500 €
Propagation Measurement, Modelling, and OTA-Emulation	12-14 November 2012	Ilmenau, Germany		11.348,47 €

Dissemination

	Cost	Total
12 months web maintenance (first year)		1.500 €

Others

Bank fees (first year 11-12)		961,20 €
Bank fees (second year 12-13)		377,10 €

Secretariat

(first year 11-12)		16.698,44 €
(second year 12-13)		13.864,60 €

Action Total (9-May-2013) : 234.488,39 €

II. Scientific Report prepared by the Chair of the Management Committee of the Action, describing results achieved during the Action operation in this period, in no more than 3 pages (the report is “cumulative”). All items listed in Sections A, B, and C, below, must be addressed.

Additional documentation such as extended scientific reports, proceedings of workshops, seminars or conferences may be provided separately as an annex to this report, and should be referenced in the report.

II.A. Innovative networking

- *Innovative knowledge resulting from COST networking through the Action. (Specific examples of Results vs. Objectives)*
 - DWG 1 “Radio channel” has successfully implemented and made available the **COST 2100-IC1004 multi-link channel model**, which was published in IEEE Wireless Communications Magazine and made public on *googlecode*: (<http://code.google.com/p/cost2100model/>). This model, which tackles MIMO and multi-link aspects for beyond 4G networks is now ready for use by the community and for further extension within DWG1.
 - Also in the second year, much effort has been spent by members of the IC1004 TWGO to understand the actual **requirements for feasible MIMO OTA tests for (LTE) User Equipment**. Alignment and calibration of especially the anechoic chamber methods are not trivial and cause considerable overhead. Due to the spatial character of the MIMO channel, (angular) isotropy of components or methods became highly relevant. Seemingly obvious definitions like Signal-to-Noise ratio were giving rise to three different, but all reasonable, interpretations that lead to large spreads in results between laboratories
 - By combining competences from the IC1004 partners, across countries, institutions, and scientific disciplines, discussion in WGV has spawned ideas on how to model, characterize, and estimate the **vehicle-to-vehicle and vehicle-to-road side radio channel at the 5 GHz band**, currently allocated for traffic safety applications. Such knowledge is instrumental for designing efficient wireless systems to enable traffic safety and traffic efficiency applications, which, in turn, will make the road transport system safer (less accidents, injuries, and fatalities) and more efficient (less traffic jams, fuel consumption, and emissions), and thereby contributes to the Action’s objectives. The motivation of scientific work on the vehicular topic increased by an interesting Training School for Vehicular Connectivity with content ranging from information theory background, vehicular radio channel (characterization, modelling, simulation), IEEE 802.11p (PHY, MAC), architecture to standardization issues. Achieved results in the past period (May 2012 – May 2013) concerned the important topics: complementary communication technologies to short range communications (802.11p) like LTE, investigation of the outdoor to in-vehicle radio channel, vehicle antenna investigations/realizations (SISO as well as MIMO), and ETSI ITS-G5 MAC methods. Beside the focus on automotive V2X communication also the work on railway communication (radio propagation modelling) started.
 - Among other smart spaces, indoor scenarios are one of the most complicated to model and to manage. In IC1004 a very simple method to **simulate complex radio wave propagation in enclosed space**, such as indoor scenarios, by means of a room acoustics theory has been proposed. The method was originally brought by a group in the Aalborg University and is now widely verified and exploited by the participating institutions of COST IC1004.
 - IC1004 TWGI has worked on a robust passive **indoor localization technique** for security and safety measures. The method exploits polarization information of the electromagnetic field propagation to localize and classify an object of interests. The COST networking allows inter-institution activities for a feasibility study including experimental testing of the proposed technique.

- After deployment of LTE first commercial Networks, many issues remain open on the optimum configuration and tuning of the Radio Access elements. In IC1004 different LTE and LTE Advance simulation platforms have been compared for both, DL and UL, at physical layer and system level, testing different **scheduling algorithms**, as well as analysing ways to **reduce interference through coordination**. Discussions have arisen inside WG3 sessions that have been extended outside the meetings. Examples of this are: the STM of EURECOM (Sofia Antipolis, France) visiting UPC (Barcelona, Spain) in March 2012 and working now in a joint paper, and the TUWien (Vienna, Austria) visit to UPC (Spain) at the end of May 2012 to compare simulation platforms, being also invited to act as joint PhD supervisors.
- Femtocells are becoming crucial in the current development of Access Networks. In IC1004, several simulation analysis in synthetic and real scenarios, as well as measurements, coming from different research teams, have allowed a detailed comparison and discussion among partners: Braunschweig University (Braunschweig, Germany), UM (Malaga, Spain) and UPV (Valencia, Spain). Specific tools to **model indoor to indoor and indoor to outdoor interference effects on capacity** are being investigated. A workshop on this subject has been organised on May 2012 by IC1004 in cooperation with iPLAN FP7 project.
- **Smart city** technologies and applications have been discussed by university research teams UB (Bologna, Italy), IST (Lisbon, Portugal) to City responsible institutions (IMI, Barcelona, Spain), mainly about how research works addressing **sensor networks and ad-hoc networks configuration** can be deployed in real scenarios. It is expected that urban networks, as well as advanced resource management for heterogeneous networks and applications, will become one of the key research activities of the IC1004 WG3.
- In the scope of TWGB “Body Environment” a number of strong collaborations have been established. In particular the knowledge sharing between different IC1004 participants, such as CEA-LETI (Fr), NICT (Jp), IST-UL (P), UCL (B), UPV (Es) is contributing to the creation of a **new channel model for body-centric applications**. Further collaborations between different research institutes, e.g. between UniBO (It) and CEA-LETI (Fr), have been producing significant results on cross-layer network design from channel modeling to PHY-MAC protocol performance evaluation, thanks to the participants’ knowledge sharing in different fields.
- The **impact of vegetation on the wave propagation** and hence the signal quality in mobile communication systems is an important factor for the planning of the networks. State of the art propagation models like e.g. empiric models (Okumura-Hata, COST 231, etc.) or ray-optical models (Ray-Tracing, Ray-Launching, etc.) neglect the vegetation so far. Recent activities in the urban environment group of IC1004 extended the existing models and reached significant higher prediction accuracy by integrating the impact of vegetation into the models. This is of high interest for system simulations in urban and even more in sub-urban scenarios.
- In the development and optimization of mobile communication networks, system-level simulations play an important role in reducing deployment costs in real networks. In the research community many platforms and simulators have been developed in recent years to perform system-level simulations. In order to increase the understanding of the simulation results of other research groups and to ensure the comparative assessment, validation and alignment of these simulation tools is beneficial. In a joint work of three partners of the **urban environments working group**; the Institute of Telecommunications (Vienna, Austria), the Institut für Nachrichtentechnik (Braunschweig, Germany) and the Institute for Communication Networks and Computer Engineering (Stuttgart, Germany), a **validation of different system-level simulators** has been performed. The simulation results have been published to allow calibration of other simulation tools for three different simulation scenario types, which included a single cell scenario, a hexagon scenario and a realistic scenario using ray-tracing propagation models. The comparability of research results in the COST IC1004 will increase significantly using harmonized platforms.

- The work on the development of **realistic simulation scenarios for urban environments** has been continued in TWG-U. In order to cope with the needs for higher levels of detail for smaller cell sizes and higher user density, the simulation scenarios have been extended by more detailed ray-tracing pathloss predictions and user mobility types. Moreover a joint publication on this topic has been released at the International Symposium on Signals, Systems and Electronics (ISSSE) in Potsdam in October 2012.
- In cooperation with the 7th framework program GreenNets an **energy consumption model for multi-RAT networks** based on hardware information, configuration (CM) data and performance measurement (PM) from a real network has been developed. This is a hot research topic since the energy costs can be up to 50% of a mobile network operator's operational expenditures. As up to 60% of this can be attributed to the access network, there is a strong incentive to reduce that share of the power consumption. In the GreenNets project and in the COST IC1004 urban environments group, solutions to save energy by adapting the networks configuration to the expected traffic have been investigated. The model takes into account the actual radio transmission hardware as well as the required auxiliary power consumers, such as cooling, backhaul connections and inevitable losses by power conversion.
- *Significant scientific breakthroughs as part of the COST Action. (Specific examples)*
 - COST IC1004 is also a pioneer in the modelling of the so-called **dense or diffuse multipath component** which can represent a large part of the radiated energy in a wireless network. By combining competences in channel modelling, measurement and characterization, an original and experimentally validated model is emerging.
 - The introduction of femtocells in mobile communication networks is significantly impacting the architecture and management of the radio access networks. Femtocells are not part of the planning process of a network but will influence the planned network. First research results in the area of **femtocells interference management and mobility optimization** show that special attention has to be given to these cells. In the urban environment group the impact of femtocells to the network is one of the main research topics.
 - IC1004 has progressed in the modelling, design and evaluation of **MIMO antenna terminals**, including the adaptive impedance matching for MIMO (e.g. LTE) antenna, focusing on achievable gains and practical aspects and the efficient design techniques in the presence of chassis radiation. Study of the coverage of cellular systems (in Denmark) reveals very poor over-the-air performance of many new smartphones, highlighting important role of antenna design
 - Channel characterization and **modelling for on-body**, off-body and body-to-body communications
 - Antenna design and statistical **antenna modelling for BANs**
 - MAC protocol and relay techniques for **cooperative BANs**
 - Method to model **shadowing fading phenomena due to vehicles** obstructing the direct propagation path between the transmitter and receiver. This is major step towards understanding this important propagation mechanism in the vehicle-to-vehicle radio channel.
 - Real-time ultrawideband multi-antenna **channel sounder at 60 GHz** band, providing significant capability to analyze the effectiveness of multiple antenna systems in the millimeter-frequency range that can offer very high data rate transmission.
 - Detailed study of **measurement tolerance** for an antenna pattern measurement system at **60 GHz**
 - UWB passive and RSS-based localization techniques for **indoor environments**
 - Statistical radio channel models for surgery rooms in a hospital at 60 GHz frequency band developed by three Universities and research institutes in Finland and in Japan. The channel model serves as a fundamental tool for the feasibility study and the design of radio systems to realize a **smart hospital**.

- *Tangible medium term socio-economic impacts achieved or expected. (Specific examples)*
 - IC1004 is a good example of industrial involvement in COST, with the necessary mix between **Industry and Academia**, in the best sense. There is no other benefit for companies to come than grasping what's going on in academia and transfer some of their own needs. It's probably a purer way than in projects, where funding creates some bias. 36% of the participant institutions to COST IC1004 are Companies.
 - The knowledge produced as the result of the Vehicular Communications WG work is expected to impact **ETSI standardization** work on intelligent transport systems, and hence will impact the safety, comfort, and environmental impact of the road transport system in the future. One important scientific result in the past period (May 2012 – May 2013) was the outcome of a STSM (TU-Braunschweig, Germany visited LUND, Sweden) – a comparison between vehicular radio channel measurements and ray-tracing simulation results. A well parameterised simulation model (consistent with the channel measurement) has the advantage omitting time- and money extensive radio channel measurements on the road.
 - For the first time in this COST Action a **City is participating** as full member, with the added value of being the final responsible of the deployment and monitoring of different open and private networks (based on WiMax, Zigbee, WLAN technologies among others) as well as closely involved in the design and coordination of new applications oriented to improve quality of service in green environments and citizens' life.
 - Efforts will be done in obtaining **reference scenarios** based on real heterogeneous networks where the different research teams could test their applications and ideas, sharing the results at next meetings.
 - A **database** of actually measured **antenna patterns** of small terminals for use in the TWG was created, to be used in systems simulations.
 - Simulation activities to **support the choice of MIMO** OTA technology by 3GPP and CTIA at the end of this year has started in IC1004. To this end, Agilent licensed TWG MIMO OTA members to use its system simulator Systemvue.
 - An important item was the participation of many COST institutions in the official LTE Round Robin for **ETSI 3GPP RAN4**, organised by Vodafone, which was held to reveal similarities and differences between the several proposed OTA technologies.
 - A liaison with the **North-American CTIA MOSG** (MIMO OTA Sub Group) was established, meaning bilateral information exchange. In the second year, several members of TWGO participated in CTIA's efforts to arrive at a feasible MIMO OTA test set-up for MIMO UE (Inter-Lab/Inter-Technique OTA Performance Comparison Testing for MIMO Devices). A successful standardisation will result in objective measures that will allow customers to judge UE product quality with respect to communication performance.

- *Spin off of new EC RTD Framework Programme proposals/projects. (List)*

(See Annex 1)

- *Spin off of new National Programme proposals/projects. (List)*

(See Annex 1)

II.B. Inter-disciplinary networking

- *Additional knowledge obtained from working with other disciplines within the COST framework. (Specific examples)*

Traditionally, the antennas and propagation community, the signal processing community and the networking community interact in a limited manner, which stems from the differences in the concepts involved and in the baseline scientific culture.

IC1004 is in itself basically inter-disciplinary, in that several working groups have been built in order to favour interactions between these communities. This is specially the "DNA" of most Topical Working Groups, for which the challenges that are addressed require progress on multiple aspects jointly, as highlighted below.

COST IC1004 has established liaisons with several regulatory bodies, PF7 projects, International Organisations and other COST Actions. The objective of such liaisons is first to get from the other groups a wider view on some of the topics the Action is dealing with. In particular, we are interested in knowing about the energy consumption aspects of the radiocommunications equipment and the backhaul transport networks, as well as to find the way to increase the energy efficiency of the RANs. In this sense we have invited to participate to the Action to representatives from **Greentouch, EARTH, Greenet, Mobile VCE, LEXNET, METIS 2020**, and the COST actions **VISTA** and **TERRA**. Among other activities, we are establishing links to COST VISTA, with some plans to create an inter-Actions Working Group. We have invited an expert from COST VISTA to our Bristol meeting (Sep 2012) to speak on antennas and propagation for body area networks, and we also sent an expert to COST VISTA's Istanbul meeting (Sep 2012) to speak on terminal antenna issues. We will also organize a joint workshop with COST VISTA in Ghent during Sep 2013.

A second and very important aspect of our relations to outer fora is to make our results be known outside the Action. In this sense, we have invited to participate to our meetings to representatives from **ETSI, 3GPP, CTIA, URSI, IEC**, and start providing inputs to such standardisation and regulatory bodies. Some initial efforts have been made to foster closer contact with the IEC, dealing with standardisation of exposure limits of mobile devices and base stations. In addition, in conjunction with the joint workshop with COST VISTA in Sep 2013, we also plan for a joint special cluster in the IEEE Antennas and Wireless Propagation Letters, to disseminate results relating to our antenna activities.

Finally, the commitment of companies to our Action, representing 1/3 of IC1004 institutions, provide the participants their views on market evolution, on gaps before putting results to practice and on their experience in R&D of terminals, equipment and networks. Many liaisons to standardization bodies come from companies, and the way IC1004 is attracting the Industries to the Action is either through the relations that the Academia participants have to the Industry in research projects, and by inviting representative persons from the R&D Departments of some Companies and Bodies to participate with talks in our meetings. During the second year term, we had invited speakers from **Ericsson, Alcatel, OFCOM, NEC Telecom ICT-KTN, France Telecom, Field Imaging, SistelNetworks and ETSI-ITS**. Many of those companies have joined the Action and continue participating to IC1004 Technical meetings. The MC of IC1004 expects that, for the two years ahead, companies keep finding in IC1004 a profitable source of exchanges on analysis, modelling, testing and optimization of future communication systems.

- *Evaluation of whether the level of inter-disciplinarity is sufficient to potentially provide **scientific impacts** (Specific examples) and **socio-economic impacts** (Specific examples)*

Some working groups of IC1004 are already taking advantage of the interdisciplinary discussions with some invited experts and colleagues, with results on mid term scientific results and long term socioeconomic impacts:

- Vehicular communications group, by discussions with manufacturers and ETSI standardisation experts, has developed some knowledge which is instrumental for designing efficient wireless systems to enable traffic safety and traffic efficiency applications, which, in turn, will make the **road transport system safer** (less accidents, injuries, and fatalities) **and more efficient** (less traffic jams, fuel consumption, and emissions). The **cooperation with ETSI TC ITS** got more intensive in the past period (May 2012 – May 2013) started by an invited talk of an expert from ETSI TC ITS. The work focused on high loaded traffic scenarios, so called decentralized congestion control (DCC) on the MAC layer. This work yields important input for the ETSI standardization that shall be finalized 2013.
- Urban networks working group has involved in IC1004 the Information System of the City of Barcelona, getting a complementary knowledge of the requirements for the design and coordination of wireless sensor networks aimed to improve the quality of services and **citizens' life in green and smart city** environments.
- In the scope of TWGO "Over the Air Testing", several strong collaborations have been established. AAU (Denmark) and IMC (Denmark) have been working closely in the OTA project. AAU and IMC jointly built a **MIMO OTA testing setup** in Aalborg University, and they have been actively **contributing to the 3GPP, CITA**. They also co-authored several scientific papers in the MIMO OTA field. Strong cooperation with Motorola (US), ETS (US) and Anite has been established as well. Examples of this are a PhD student from AAU visiting Motorola and ETS in May, 2013, similar setup built in Motorola with probes designed by AAU, a joint publication with Anite. Also **Inter-Lab/Inter-technique measurement campaigns** have been performed in different labs, which allowed detailed comparisons and discussions among partners.
- Some experts in implanted systems are joining the discussions with Body Communications WG participants at IC1004. In the mid- and long-term, the wireless body environment (WBE) is supposed to **revolutionize health monitoring**, with its huge number of possible applications in home, hospital, elderly care and emergency cases. As this service permits remote monitoring of several patients simultaneously, it could also potentially decrease health care costs. Moreover Wireless Body Area Networks are expected to provide new functionalities of applications in people's every-day life such as sport, leisure, gaming and social networks.

II.C. New networking

- Additional new members joining the Action during its life, and
- Total number of individual participants involved in the Action work. (Number of participants. Give % of female and of Early Stage Researcher participants)

The Action started on May 19th, 2011, the MC meeting was attended by 28 of the National Delegates. The Action has organised six technical meetings so far, with the following progress:

	Institutions	Individuals ³	ESR	Women
Lund, June 2011	62	94	38 (40%)	10 (11%)
Lisbon, October 2011	78	190	72 (38%)	22 (12%)
Barcelona, Jan 2012	94	230	124 (54%)	29 (13%)
Lyon, May 2012	112	342	200 (59%)	49 (15%)
Bristol, September 2012	121	380	216 (57%)	61 (16%)
Malaga, February 2013	129	427	232 (55%)	65 (16%)

An average of 120 persons is regularly attending every Technical Meeting. The percentage of **Industry vs. Academia** is also relevant: 42 over 129 registered institutions are companies, so the **33%** of the total.

- *Involvement of Early Stage Researchers in the Action, in particular with respect to STSMs, networking activities, and Training Schools. In addition, justification should be provided if less than 4 STSMs were carried out during the year.*

From the very beginning of the Action, ESRs have been in the centre of IC1004 strategy. One of the first decisions the Steering Committee took was to promote the participation to ESRs in leading activities in IC1004, to the point that

- 5 of the Topical **Working Group Chairs** are ESRs: Katsuyuki Haneda, Pawel Kulakowski, Thomas Jansen, Raffaele D'Errico, Alexander Paier

At the end of the second year period, ESRs have also been supported by COST IC1004 in:

- **17 STSMs** have been granted to ESRs among those participating to the Action, 11 during the second year term
- **22 ESRs** have **granted** to participate to the first IC1004 Training School (May 2012)
- **26 ESRs** have been **granted** to participate to the 3rd Training School (November 2012)
- **25 ESRs** are **granted** to attend the coming 4th Training School (May 2013)

Additionally, in three of the meetings (those not co-located with Workshops), the Action has organised **four Tutorials**, free of charge for any COST IC1004 participant, attended by an average of 45 people, most of them PhDs and ESRs:

- 4 Tutorials from Prof. Tadashi Matusumoto, Dr. Misha Dohler, Prof. Jose Monserrat and Dr. Kamy Y. Yazdandoost

Finally, there are other **non-tangible outcomes** in COST for ESR to take advantage of IC1004 like in any other forum in the European Research Area. ESRs find in COST those colleagues who are working in the same topics, both senior researchers from other institutions and young people in their same situation, who in some years will take responsibilities and could propose joint participation to future projects. When a young researcher comes to a COST meeting to show the results of a research work, what can be expected is to have long and constructive discussions about it, taking back after the meeting some new ideas on how to improve the investigations. This is radically different if the young researcher attends a big conference, where a very limited time slot is assigned for the presentation, very few questions are expected and the audience is usually of wider scope.

³ Number of registered individuals who have participated to at least one technical meeting

- *Involvement of researchers from outside of COST Countries. (Number of participants from non-COST Countries approved by the CSO. Give % of such participants from countries with reciprocal agreements. Specify their contribution)*

COST IC1004 has received numerous expressions of interest from non-COST institutions to participate. At the current stage, and apart of some applications in progress, the **13 non-COST institutions** accepted are:

- ComSearch, a global company based in the USA, global provider of spectrum management and wireless engineering products and services. Their contribution to COST IC1004 is in the propagation modelling in forest and urban areas, to the Working Groups 1 and U
- Motorola Mobility, the recently created company from the former Motorola, is developing smartphones, tablets, wireless accessories, end-to-end video and data delivery, and management solutions, including set-tops and data-access devices. In IC1004 the participation of Motorola is twofold: on the technical contributions and discussions about Over-the-Air testing (OTA) and as one of the major liaisons to CTIA, the North American association of wireless carriers and their suppliers, as well as providers and manufacturers of wireless data services and products.
- NIST, National Institute of Standards and Technology is a research laboratory of the US Department of Commerce, which aims to promote innovation by advancing measurement science, standards, and technology through research and development in information technology, mathematics, and statistics. This Institution is mainly participating to TWGB of IC1004 on channel modelling and interference analysis & mitigation, and they contribute to the IEEE802.15 task group 6, on international standards for on-body area networks.
- NICT, the National Institution of Information and Communication Technology is the Administrative Agency which supports Communication Technology Development in Japan. They role in IC1004 is providing research results for technical discussion on antennas and propagation models for Body Area Networks. One representative from NICT is co-chairing the Topical Working Group B.
- Tokio Institute of Technology, the largest institution for higher education in Japan dedicated to science and technology, is providing to COST IC1004 their results mainly on antenna technologies, and also to radio channel modelling (WG1) and Body Area Communications (WGB)
- JAIST, Japan Advanced Institute of Science and Technology (JAIST) is one of the leading research-oriented universities in Japan. The participation to IC1004 is enriching the Action discussions in the area of Cooperative Transmission Systems, with the valuable inputs from Prof. Tadashi Matsumoto on point-to-point to multi-point to multi-point communications, including cooperative wireless communications, based on the iterative detection and decoding techniques, included in our Working Group 2.
- Tongji University; in China, and in particular its School of Electronics and Information Engineering, is contributing to COST IC1004 in the area of Radio Channel Modelling (WG1) and some results to Energy Efficiency in Mobile Networks (WG3)
- BUPT; Beijing University of Posts and Telecommunications, is contributing to radio channel sounding for relay, coordinated communication and multi-user MIMO systems, with technical inputs to WG1, 3 and TWG-O

- ABP, Academy of Broadcasting and Planning (China), is an academic institute whose research focus mainly on the progress of Radio & TV broadcasting techniques. The participation of ABP to COST IC1004 is mainly in the MIMO-OTA testing, providing their expertise in Broadcast systems, and also on the mutual influence between broadcast and mobile networks systems, like LTE vs DVB-T2 coexistence
- ICESI; a Colombian University, is taking to IC1004 the view of the mobile telecommunications networks in special scenarios like the Andean area, and contributes mainly to Radio Networks (WG3) and Urban Environment (WG-U) on Radio Resource Management and Cognitive Radio
- Communications Research Centre Canada (CRC) is a Canadian Government institution that operates as part of the Canadian Government Department known as “Industry Canada” and conducts independent research on topics associated with radio communications, and radio broadcasting. CRC is participating to the WG1 in IC1004 in the area of Radio Propagation and Channel Modelling.
- University of Montenegro; COST Neighbour Country. The initial proposal was to contribute to OFDM based cooperative systems, but up to date they have not attended any meeting.
- La Trobe University; Australia, entered the action under the condition of “**Reciprocal Agreement**” Country. The intention was to contribute with their experience on green computing, but up to date they have not attended any meeting.

To summarise, the 13 non-COST institutions which are part of the IC1004 members are:

- 2 are no active by now (Montenegro and La Trobe)
- 11 are very active, among which
 - o 2 are Companies (Motorola and Comsearch)
 - o 3 are Governmental Agencies (NIST, NICT and CRC)
 - o 6 are Universities (JAIST, BUPT, Tokio, ABP, Tongji and ICESI)
- 8% (1/13) of the non-COST Institutions is from a reciprocal agreement country.

- *Advancement and promotion of scientific knowledge through publications and other outreach activities. (Number of publications and other outreach activities that resulted from COST networking through the Action. Complete list should be given in an annex)*

Participants to COST IC1004 meetings have produced and discussed 413 **technical documents** in 6 technical meetings so far. An increasing percentage of them are joint works among two or more Action participants. The complete list of documents can be found at www.ic1004.org under “meetings”.

Some of such **joint results** have already produced papers to conferences and journals, and after 23 months of live, COST IC1004 is already cited 281 times in the literature ([\\scholar.google.com](http://scholar.google.com)). The full list still of the current 100 joint publications is listed in Annex 2.

The Action is also producing a **Newsletter**, three times per year, in which a selection of the recent results discussed in technical meetings are summarised, as well as the news on the Action ongoing activities: <http://www.ic1004.org/index.php?page=newsletter>

COST IC1004 has edited a **Special Issue** on Small Cell Cooperative Communications published by Springer in the **EURASIP Journal** on Wireless Communications and Networking (<http://jwcn.eurasipjournals.com/series/sccc>), and is now editing a **Special issue for "Radio Science"** (http://onlinelibrary.wiley.com/journal/10.1002/%28ISSN%291944-799X/homepage/call_for_papers.htm)

In addition, IC1004 has organised **Special Sessions** at several conferences for 2012 and 2013:

- EuCAP, Special Sessions on "Joint antenna-channel issues in Body Area Networks" and "Novel methods in radio channel modelling for smart environments", Prague (Czech R.) 26-30 March, <http://www.eucap2012.org/>
 - European Wireless, Special Sessions on "Wireless Body Area Networks", 18-20 April, Poznan (PL)
 - ICC, participation at Special sessions on "Cognitive and Cooperation for Green Networking" (in coop. with C2POWER), and "Cooperative and Cognitive Mobile Networks (in coop. With COcONET); Ottawa (Canada) 10-15 June <http://www.ieee-icc.org/>
 - IC1004 Special Session (Workshop) on "Cooperative Radio Communications" at Future Network & Mobile Summit 2012, Berlin (Germany) 4 - 6 July ; <http://www.futurenetworksummit.eu/2012/>
 - IC1004 Special Sessions at IEEE ComSoc CAMAD 2012, Barcelona (Spain) 17-19 Sept; <http://camad2012.av.it.pt/>
 - IC1004 Special Session to URSI-ISSSE'2012 Conference, Potsdam (Germany) 3 - 6 Oct; <http://www.issse2012.org/>
 - IC1004 Special session on "Body Environment Communications" to CEMA'12 Conference, Athens (Greece) 8 -10 Nov <http://tu-sofia.bg/ENG/fktt/cema12>
 - The Second Ultra Wideband for Body Area Networking Workshop (UWBAN-2013); Co-located with the 8th International Conference on Body Area Networks (BodyNets-2013); September 30 - October 2, 2013, Boston, MA, USA <http://uwban.bodynets.org/show/home>
 - The 19th European Wireless Conference (EW2013) Guildford, UK, 16-18 April 2013 <http://www.ew2013.org/>
 - PWSN 2013 - 5th International Workshop on Performance Control in Wireless Sensor Networks <http://www.netrl.cs.ucy.ac.cy/pwsn2013/> May 23, 2013 - Boston (Cambridge), Massachusetts, USA
 - Future Network & Mobile Summit 2013 Conference and Exhibition; 03 - 05 July 2013, Lisbon, Portugal; <http://www.futurenetworksummit.eu/2013/>
 - IEEE International Conference on Ultra-Wideband (ICUWB 2013); Sydney Australia from 15 - 18 September 2013; <http://www.icuwb2013.org/index.php>
 - VTC2013-Spring - 77th IEEE Vehicular Technology Conference; 2-5 June 2013 Dresden, Germany; <http://www.ieeevtc.org/vtc2013spring/>
 - IEEE International Workshop on Advances in Network Localization and Navigation (ANLN) 9-13 June 2013, Budapest – Hungary
 - ICT 2013 - The 20th International Conference on Telecommunications 6-8 May 2013, Casablanca – Marocco
 - IC1004 Special Session at 7th International Symposium on Medical Information and Communication Technology (ISMICT); 6-8 Mar 2013 - Tokyo, Japan; (<http://www.ismict2013.org/>)
- *Activities and projects with COST network colleagues.*

(See Annex 1)

- *The capacity of the Action members to raise research funds.*

In IC1004 we understand that the philosophy of COST Actions is to serve as a networking activity, assuming that the individual participants are getting funds from other public or private programs. Inside IC1004 the results of research projects are shown, being COST meetings a way for dissemination of such results, but also a framework where to discuss the ongoing work, with colleagues who are not partners to those same funded projects. COST IC1004 has also played a match-making role among their participants, resulting in consortiums that obtain large research grants, including those from EU framework programs. Up to date, COST Actions contracts have been not related to other FP7 instruments, but our proposal, as mentioned in the Position Paper sent to Horizon2020 consultancy in 2012, is that some budget at such projects can be eligible for partners to participate into COST Actions.

Annex 1 includes the list of all the projects prepared during the reporting period (June 2011-April 2013) by COST IC1004 participants, many of them being joint proposals to EU FP7 Calls 8 to 11

II.D. Self evaluation

As listed in previous sections, the scientific, networking and dissemination initial **objectives of COST IC1004 for the second year term have been reached**. Our Action is approaching the end of its second year with already a stable participation, clear objectives in both Disciplinary (DWG) and Topical Working Groups (TWG), a well-established set of liaisons to external projects and bodies, and many completed training and dissemination activities.

It is also worth noting the commitment of **Industry**, representing 1/3 of IC1004 institutions. They bring us their views on market evolution, on gaps before putting results to practice and on their experience in R&D of terminals, equipment and networks. Many liaisons to standardization bodies come from companies. The MC of IC1004 expects that, for the two years ahead, companies keep finding in IC1004 a profitable source of exchanges on analysis, modelling, testing and optimization of future communication systems

From the technical point of view, the initial assumptions of which the current problems on broadband mobile communications would be are being confirmed. COST IC1004 started in 2011 with the first LTE trials running and the mobile “data tsunami” still in infancy. This tendency is still on and more is nowadays foreseen by market players to expand to **new wireless scenarios**, mainly of them analysed in our TWGs: not only about devices held by humans but also **machines, vehicles, smart cities and health sensors**. An annual growth rate (CAGR) of about 66% on data traffic is foreseen, creating the need for more resources and efficiency to deal with 20 times more mobile data traffic in the next 5 years and over 100 in 2020. This means that there is, and will be, a lot to do in **improving the access technologies and the network efficiency** to cope with the current and future needs for mobile broadband connectivity..

As for the statistics, COST IC1004 is at the end of its second year period (formally on 18th May 2013) a large Action in terms of participants, with a total of above 400 individuals from **87 research institutions and 42 companies**. IC1004 meetings are attended by 120 experts on average, being MC members only 1/3 of them. This makes the activity of this action being funded by COST only in a small percentage of the direct costs incurred by the participants, in the range of 25%, while results obtained from the COST Action activities are reported as a global outcome, making the effectiveness of the funding be artificially higher, since 75% of the total cost of the Action is masked by the volunteer participation of companies, universities and research centres not reimbursed by COST Administration. But on the other hand, the fact that the majority of participants to COST IC1004 meetings cover the expenses by their own, clearly indicates that **the activity in IC1004 is generating significant results and interest**, not only in terms of the meeting discussions with colleagues, but mainly on the scientific networking of methodologies, standards, references, techniques, models and tools.

Early Stage Researchers (ESRs) are taking advantage of COST IC1004 like in any other forum in the European Research Area. ESRs find in COST those colleagues who are working in the same topics, both senior researchers from other institutions and young people in their same situation, who in some years will take responsibilities and could propose joint participation to future projects. In IC1004 we understand that the philosophy of COST Actions is to serve as a **networking** activity, assuming that the individual participants are getting funds from other public or private programs. Inside IC1004 the results of research projects are shown, being COST meetings a way for dissemination of such results, but also a framework where to discuss the ongoing work, with colleagues who are not partners to those same funded projects. COST IC1004 has also played a **match-making role among their participants**, resulting in consortiums that obtain large research grants, including those from EU framework programs.

Hopefully, at the end of IC1004 we will have contributed to **fostering European scientific excellence in ICT**, early career investigators who join IC1004 every meeting will have found the best networking opportunities, and our results, models and proposals will impact regulatory bodies/decision makers.

III. Previous scientific report(s)

Part II of past periods' reports are to be found here.

(Available at <http://www.ic1004.org/index.php?page=official-documents>)

ANNEX 1. List of Joint Projects and Proposals

EU FP7 Calls

Status	Acronym	Type	COST Institutions Involved
Funded	METIS	IP	iTEAM-UPV Valencia, Chalmers Univ., Aalto University, Ericsson, U.Oulu, U. Karlsruhe, KTH
Funded	SEMAFOUR	IP	Braunschweig Univ, Ericsson, TNO
Funded	LexNET	IP	LexNET "Low EMF Exposure Pure Networks", France Telecom,, SIRADEL, KIT (Karlsruhe IT), UNIS (Surrey), Telecom-Paris-Tech, CEA-LETI, IST-TUL and IBBT (UGent/IBBT)
evaluation	ABSOLUTE	IP	University of York and University Duisburg-Essen
Funded	BUTLER	IP	UOULU, K.U.Leuven, CEA-LETI
Funded	(NEWCOM#)	NoE	Vienna University of Technology, Université Catholique de Louvain, Eurecom, Aalborg University, Univ Bologna, IST Lisbon, UOULU
Not funded	VIA VIRIDIS	STREP	Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V. Heinrich-Hertz-Institut, FTW Telecommunications Research Center Vienna, IMST GmbH, Kungliga Tekniska högskolan
evaluation	MEDAL	STREP	Lund University, Ericsson AB, Aalto University, University of Bologna, IMST GmbH
Evaluation	SHADOWS	STREP	Toshiba Research Labs. (UK), iTEAM-UPV (ES), Telefonica I+D (ES)
Funded	WISERBAN	STREP	CEA-LETI, Univ. Bologna
Funded	DIWINE	STREP	Toshiba Research UK, Czech Technical University, Univ. York
Funded	BuNGee	STREP	U.C. Louvain and Univ. York
not funded	DANCER	STREP	CTTC and Univ York
not funded	GREENCELL	STREP	Universidad Carlos III de Madrid (UC3M), King's College London (KCL), IST (UBI, Portugal)
not funded	NEMO	STREP	Eurecom (FR), Alcatel-Lucent Bell Labs (FR), ftw. (AT), UCL (BE), TU Berlin (DE)
Funded	GREENNETS	STREP	ATESIO, Univ. Braunschweig
Evaluation	BEACON	STREP	University Goce Delcev Stip (UGD), Chalmers University of Technology (CHALMERS), Technical University Wien (TU WIEN)
Evaluation	NatNet	STREP	University of Ulm (UUlm), Aalborg University (AAU)
not funded	Awareness	STREP	Lund University, Ericsson AB, Aalto University, Università di Bologna
not funded	SIMPLICITY	STREP	CTTC, University of Edinburgh, Toshiba Research Europe Limited TREL UK, Centre National de la Recherche Scientifique CNRS, Univ. of Bristol UNIVBRIS UK, SIRADEL SIR France
Funded	PHYLAWS	STREP	Telecom ParisTech, VTT Finland
Funded	WHERE2	STREP	Siradel, University of Rennes 1, Eurecom, Aalborg University, German Aerospace Center (DLR)
Funded	SELECT	STREP	CEA-LETI, Univ. Bologna, ENSTA-ParisTech
Not funded	ETNAtv	STREP	UPV (Spain - coordinator), FUB (Italy) and ICESI (Colombia)
not funded	SAFARI	STREP	Call 7, Univ. Bristol, VTT Finland

Other FP7 Calls

Status	Acronym	Type	COST Institutions Involved
Funded	Greenet	ITN	Universitat Politècnica de Catalunya (UPC), Centre Tecnologic de Telecomunicacions de Catalunya (CTTC), University Degli Studi di Trento, Instituto de Telecomunicações (IT).
Evaluation	ETNAtv	Supporting	Univ. Cartagena, Univ. Bologna, AGH University of Science and Technology
Funded	BalkanGEONet	Cooperation	University of Novi Sad, Serbia, Institute Jozef Stefan, Ljubljana, Slovenia

Other joint projects

Status	Founder	Title	COST Institutions Involved
Funded	The German Israeli Foundation for Scientific Research and Development (G.I.F)	Cognitive broadband wireless mesh networks	Universitaet Duisburg-Essen and Ruppin Academic Center
Funded	Program Tournesol (Hubert Curien Partnerships)	" Wireless channel in industrial environment: Characterization and minimization of EM exposure".	Univ Lille/ Univ Gent(Belgium)
Funded	Campus International sur la sécurité dans les transports (CISIT)	" Optimization of ground to train communication in tunnel"	Univ Lille/UPCT
Funded	Bilateral	"Advanced technologies for next generations of mobile broadband communication systems"	Jozef Stefan Institute Ljubljana, (Slovenia) and University of Montenegro
Funded	Swedish Research Council	Coding for Future Wireless Communication Networks	University Goce Delcev Stip (UGD), Chalmers University of Technology (CHALMERS)
Funded	German Science Foundation	Non-coherent communication for future wireless networks	University Goce Delcev2000 Stip, Macedonia and Ulm University
Funded	FP7-ENV-2010. Cooperation	Balkan GEO Network - Towards Inclusion of Balkan Countries into Global Earth Observation Initiatives	University of Novi Sad, Serbia and Institute of Jozef Stefan, Ljubljana, Slovenia
Funded	CELTIC-Plus	SIGMONA - SDN Concept in Generalized Mobile Network Architectures	UOULU, Aalto, VTT, CEA, iTEAM-UPV
Funded	CELTIC-Plus	SHARING - Self-organized Heterogeneous Advanced Radlo Networks Generation	UOULU, CEA-Leti, CTTC, Eurecom, OLABS

Funded	Christian Doppler Gesellschaft	Christian Doppler Laboratory: Wireless technologies for sustainable mobility	Vienna University of Technology Kapsch TrafficCom BMW Forschung und Technik GmbH
Funded	COMET	ITS-Evolution	Vienna University of Technology FTW Kapsch TrafficCom

Joint National Projects

Status	Country	Title	COST Institutions Involved
Funded	Finland	MIMOTA	University of Oulu, Aalto University, Nokia, Pulse Finland, Elektrobit, ETS - Lingren
Funded	Spain	GEOCOM	iTEAM-UPV Valencia and U.P. Catalunya
Funded	France	Localization system for mobile phones	Univ. Lille and Siradel
Funded	Spain	Cognitive Radio Generation+	UPCT and U.P. Valencia iTEAM
Funded	Sweden	High Speed Wireless Center - HSWC	Lund University, Chalmers Univ. of Technology
Funded	Sweden	Antenna-channel harmonization for throughput enhancement in advanced mobile terminals	Lund University and Sony Mobile Communications AB
Funded	Finland	COIN - Cognitive and Intelligent Solutions for Testing and Monitoring of Future Access Technologies	UOULU, Elektrobit, VTT
Funded	German Science Foundation	Ultra High Speed Mobile Information and Communication (UMIC) – Channel Models	TU Ilmenau / RWTH Aachen University

Other National Projects related to IC1004 scope

Status	Country	Title	COST Institutions Involved
Funded	Czech Republic	Channels and energy efficient concepts for low power green smart devices	Brno University of Technology
Funded	Denmark	4th Generation Mobile Communication and Test Platform Platform	Aalborg University
Funded	Denmark	Mobility Stipends – Information and Communication Technology	Aalborg University
Funded	Spain	Self-optimising heterogeneous mobile radio access networks	Univ. of Málaga
Funded	Spain	Adaptive techniques of radio resource management in B3G networks	Univ. of Málaga
Funded	Serbia	Multivariable methods for biomedical analytical support	University of Novi Sad
Funded	Portugal	CREaTION (Cognitive Radio Transceiver Design for Energy Efficient Data	IT (Univ. Beira Interior)

		Transmission, EXCL/EEI-TEL/0067/2012).	
Funded	Switzerland	Full wave time domain methods for "simple but not simpler" propagation modelling	Fribourg University of Applied Sciences
Funded	Serbia	Development and modeling of energy-efficient, adaptable, multisensor and multiprocessor low-power electronic systems	Institute Mihajlo Pupin
Funded	Finland	Joint Advanced Development Enabling Next Generation Energy Efficient Wireless Networks	VTT Finland
Funded	German Science Foundation	Advanced Analog Signal Processing	Ulm University
Funded	Portugal	Opportunistic Aggregation of Spectrum and Cognitive Radios: Consequences on Public Policies	IT-U Beira Interior
Funded	Portugal	Cross-Layer Optimization in Multiple Mesh Ubiquitous Networks	IT-U Beira Interior
Funded	Portugal	Prototypes for Efficient Energy Self-sustainable Wireless Sensor Networks	IT-U Beira Interior
Funded	Portugal	LTE-Advanced Enhancements using Femtocells	IT-U Beira Interior
Funded	Luxembourg	Cooperative and Cognitive Architectures for Satellite Networks	University of Luxembourg
Funded	Spain	General radio concepts for energy efficient mobile communications	Univ. Carlos III
Funded	Austria	Signal and Information Processing in Science and Engineering	T. U. Graz
Funded	Austria	LOBSTER	T.U. Graz
Funded	Sweden	Distributed antenna systems for efficient wireless systems	Lund University
Funded	Sweden	Excellence center at Linköping Lund in information Technology	Lund University
Funded	France	Réseau de Communication haut-débit pour les Services de Sécurité	Telecom ParisTech
Funded	Montenegro	Advanced Solutions for Improving Performance of Wireless Cooperative Infrastructures	University of Montenegro

Annex 2. Joint Publications between COST IC1004 partners

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