http://www.ic1004.org

NEWSLETTER

Cooperative Radio Communications for Green Smart Environments

Number 4, March 2013

Newsletter Editor: Alain Sibille, Telecom ParisTech, France

COST IC1004 Chairman: Narcis Cardona, Univ. Politecnica Valencia, Spain

Editorial

Dear readers,

As you will see below, IC1004 is a "boiling pot" of initiatives and activities, with the Action now running at full speed. I invite you to browse WG highlights, selected TD summaries from the last meeting in Malaga, ads on training schools, call for special issue papers, sessions, white paper... all this cheerfully supported by Action participants.

Let me now focus on a few important topics, extracted from the talks of invited speakers at the Malaga's meeting plenary session. MONOLOC is a spanish project supported by European funds, which addressed an advanced management platform for mobile and next-generation heterogeneous networks with user indoors location. The achieved results are very encouraging and will contribute to the provisioning of in-building user location for many future wireless services. METIS is a starting FP7 IP project intended to deal with the avalanche of traffic, the explosion of the number of connected devices and the diversity of use cases in the coming years. It will investigate 5G concepts and technologies towards these goals. LEXNET is also a starting FP7 IP project, addressing the reduction of the exposure to electro magnetic fields from wireless networks, through the definition of an "index of exposure" and techical developments at terminals and at various levels of the network architecture and protocol stack.

These three projects involve a participation, sometimes a major one, from IC1004 participants. This has two virtues :

1. the Action feeds from R&D carried out in projects and help disseminating and further scientifically exploiting the results, towards future prospects
2. the projects feed from the deep exchanges carried out during our meetings and benefit from the massive inputs provided by participants

In short this is an example of an excellent mix of objectives and I am very happy to transfer it to you !

Alain Sibille

Chairman's Address

Dear Colleagues,

Welcome to the 4th issue of the Newsletter. 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.

COST IC1004 started in 2011 with the first LTE trials running and the mobile “data tsunami” still in infancy. It seems that the wave is still on and more is nowadays foreseen by market players to expand to new wireless scenarios, mainly of them analyzed in our TWGs: not only about devices hold 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. Our Action will finish right before WRC (2015), with additional spectrum expected to be allocated to Mobile Networks. There is and will be a lot to do in developing new infrastructures, improve access technologies and network efficiency to cope with the needs. 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.

Let me close this address by stressing the commitment of companies, 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, equipments and networks. Many liaisons to standardization bodies come from companies. I wish that, for the two years ahead, companies keep finding in IC1004 a profitable source of exchanges on analysis, modeling, testing and optimization of future communication systems.

Enjoy the reading,

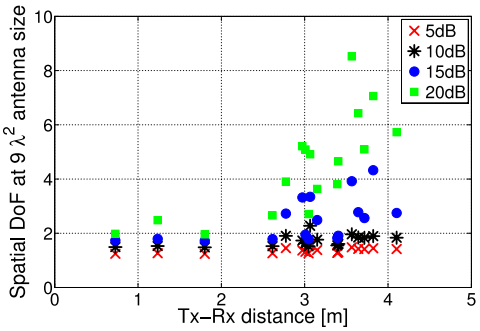
Narcis Cardona

Highlights

This section mainly concentrates on the IC1004 working group activities and on results presented at the 6th Management Committee meeting, which took place in Malaga (Feb. 6-8, 2013).

As part of **ongoing efforts to promote the setting up of a technical platform for SAR** (Specific Absorption Rate) research, WG1.1 organized a tutorial on "Biological Effect of Electromagnetic Radiation", presented by Kamya Yekeh Yazdandoost from NICT, Japan. The memorandum of understanding devised to invite participation to the platform has been finalized and circulated. SWG1.1 also discussed the details of the upcoming joint workshop with VISTA in Ghent on 25 Sep 2013.

One of the active topics in TWG-I is **millimeter-wave indoor channel modeling and radio link design based on measurements**. In the Malaga MCM, 4 TDs covered this topic, ranging from double-directional channel modeling, spatial degrees-of-freedom estimation, comparison of channel parameters such as delay spread and pathloss with microwave UWB channels, and antenna height optimization for in-hospital radio links. Among them, the work by Aalto, Lund, and COMSATS revealed the potential of spatial multiplexing in mm-wave channels, showing that the spatial degrees-of-freedom (DoF) can be larger than one, even in line-of-sight channels. The spatial DoF is the number of eigenmodes that depends only on multipath richness and antenna aperture size, but otherwise is independent of configuration of antenna elements on the aperture



spatial DoF of mm-wave single-polarized channels

TWGU discussions focused on the objectives for the second period of the action. Following the idea of comparing our system-level simulators using common input data on KPI level we intend **to compare the ray-tracing prediction tools used by different groups**. The development of indoor-to-outdoor and outdoor-to-indoor prediction tools will be in the focus of the TWGU. Furthermore we plan to develop a model that allows the integration of MIMO in system level simulations. The work on defining a IC1004 reference simulation environment will continue and we will strengthen our activities in optimization of heterogeneous networks and the development of base station power consumption models.

TWGV very warmly welcomed a new participant in COST IC1004, the Beijing Jiaotong University, which presented two contributions (in cooperation with TU Braunschweig) on propagation modeling for high-speed railways. **This is a nice extension of TWGV work**, which is currently focused on automotive communications. Important to mention is the contribution about Decentralized Congestion Control (DCC) for ITS-G5 (based on IEEE 802.11p) in high channel load scenarios, which is currently a very hot topic in the standardization group ETSI ITS. TU Vienna and Kapsch TrafficCom AG, the authors of this TD, are in direct cooperation with the Special Task Force of ETSI ITS.

The Topical Working Group on MIMO OTA commits itself to **developing Over-the-Air testing techniques for reproducibly and reliably assessing the performance of (small) MIMO user equipment**. During the Malaga meeting some contrasting views were expressed: Up to now, OTA set-ups in the anechoic chamber primarily feature 2D annular antennas arrays, although it is well-known that mobile channels show 3D propagation. However, as every OTA antenna has to be driven by a separate, expensive, channel emulator, the required number of antennas in 3D array configurations seems to be prohibitive. In one paper, the extension of this typical annular array to a 3D configuration with a more or less random arrangement was presented. The achievable measurement volume, over which a field of certain quality can be guaranteed, was discussed for some, still affordable, array configurations, see TD(13)06041. However, another contribution determined the loss of realism when reducing 3D full-polarimetric measured channel data (Ilmenau Reference Scenario) to 2D full polarimetric or even to 2D single polarized (vertical), both being realizable with annular arrays. The first option requires doubling the number of generators of the second. Using throughput as performance metric, simulations showed that the first reduction could be justified for small MIMO systems with perfect power control, whereas the latter reduction produced "significant" performance deviations, see TD(13)06057. Where contributions discussed "absolute throughput" as performance metric TD(13)06086, channel fading specifics TD(13)06075, and optimal choice of noise injection points TD(13)06076, it was argued too, as an opposing opinion, that the telling differences between UE of different brands logically can only be in antenna and LNA performance, see TD(13)06072. For quantifying these, applying fading simply complicates matters and noise-injection for reaching a specified SNR/SNI at high input powers obscures possible effects. Average throughput, as a performance metric, is purported not to relate to any operational condition of 4G mobile systems. Besides discussing progress in the world-wide testing program, also typical effects of gaining experience with a new technology were presented. For instance, in hindsight, some test conditions are specified too harsh to produce usable results, see TD(13)06086. As another example, fine-tuning large MIMO OTA installations revealed unknown behaviour for which no explanation could be found yet, see TD(13)06047.

newcomers at the 6th Malaga Management Committee Meeting (MCM)

Selected scientific topic: "Improved Scheduling Decisions for LTE-A Uplink Based on MPR Information", *by María Lema, Mario García-Lozano, Silvia Ruiz, Joan Olmos* (TD(13)06070)

Long Term Evolution - Advanced (LTE-A) allows for non-contiguous resource allocation in the uplink. The aim is to increase the spectral efficiency by exploiting users' frequency diversity gain. This feature implies that clustered-DFT-S-OFDM must be used in the uplink, no longer preserving the single carrier property of previous releases. Multi-cluster transmission brings an increase in the signal's Peak-to-Average Power Ratio (PAPR) and so power de-rating must be introduced to control out-of-band emissions. Maximum power Reduction (MPR) can counteract the frequency gain and bring losses to the users' performance.

This work proposes a novel scheduler that considers the MPR information. The packet scheduler's main task is to evaluate the gain or loss in throughput of the multi-cluster transmission over a conventional contiguous one. Based on the Sounding Reference Signals (SRSs) channel estimation, the eNB can predict the multi-cluster transmission's performance. In order to assess the performance of considering MPR wise scheduling decisions, it has been compared to other three benchmarks: MC, pure multi-cluster transmission; Cont, contiguous allocation; and MC-Thr, in which multi-cluster transmission is ruled by a given threshold. Also different cluster sizes have been tested as the MPR to be applied strongly depends on this parameter. In all cases MC-MPR has presented throughput increases. Enabling the MPR information in the scheduler adapts the transmission mode to each particular case, enhancing 30% cell edge throughput compared to MC. Average throughput is increased almost 18% when compared to Cont.

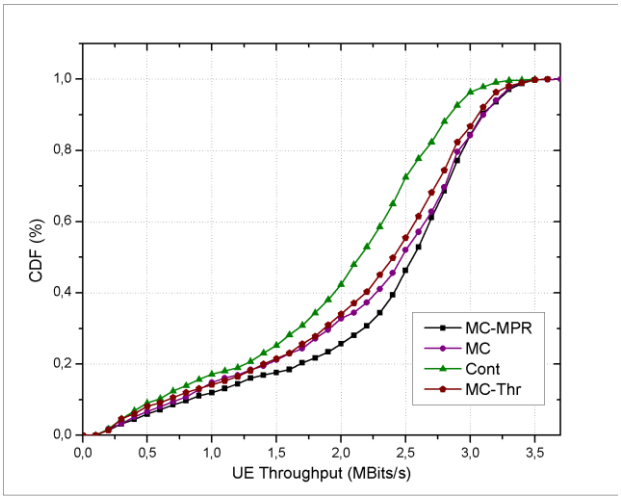


Fig. 1: User throughput for the four scheduler algorithms. Cluster Size = 4 PRBs; SRS BW= 4RBG

For more details please contact:
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Selected scientific topic: "Channel Modeling for the Stationary UE Scenario ", *by Jonas Medbo and Fredrik Harrysson* (TD(13)06077)

None of the established standard channel models like 3GPP-SCM and ITU-IMT-Advanced account for the increasingly important scenario where the user equipment (UE) is stationary. This is not satisfactory as the mobile broadband usage is exploding bringing about that the typical user scenarios are radically less mobile and commonly even stationary. Optimizing current and future radio access technologies based on standard channel modeling, which does not account for the stationary UE scenario, could result in substantial suboptimal performance. The current standard way of modeling the stationary UE scenario is to set the UE speed to some low value at the order of one meter per second. The corresponding channel characteristics are however fundamentally different from those of a realistic channel in which the UE is stationary. The basic difference is that the temporal fading is dramatically larger for the moving UE than for the stationary UE. Typically the channel of a moving UE follows Rayleigh statistics in contrast to a stationary UE for which the fading typically is very small following Rice statistics. The Doppler characteristics of a stationary UE are, in contrast to a mobile UE, strongly peaked at zero Doppler frequency.

In this work realistic modeling of a stationary UE in proximity to a moving shadowing and scattering user has been elaborated, which conveniently may be added as an extension to any standard ray based channel model. The stationary UE scenario is herein demonstrated and the model has been verified by channel simulations and measurements.

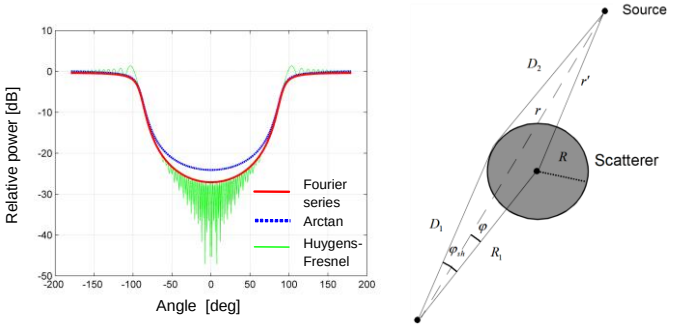

Fig. 1: Shadowing and scattering model. Comparison between proposed model (Fourier series), a previously proposed model (Arctan), and the exact Huygens-Fresnel model.

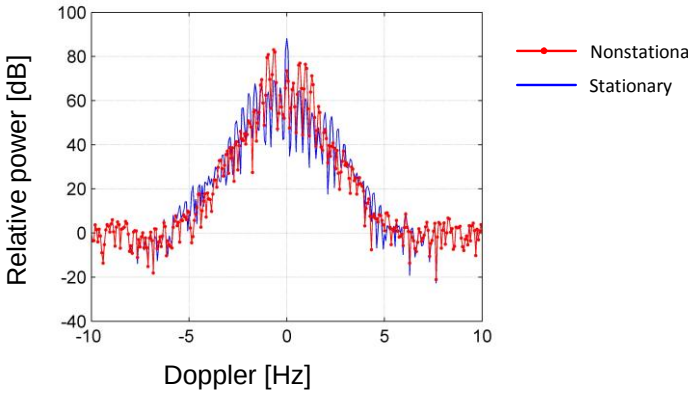

Fig. 2: Comparison of the Doppler spectrum for stationary and non-stationary scenarios.

For more details please contact: *Fredrik.Harrysson@ericsson.com*

Selected scientific topic: "Characterization of UE Antenna Systems by Means of the Two-Antenna MIMO OTA Measurement Method", *by Werner L. Schroeder, Adam Tankielun, Yifei Feng and Christoph von Gagern* (TD(13)06072)

The paper poses some thought provoking questions as to the essence of MIMO OTA testing and concepts followed therein. Throughput measurement is addressed first. The authors remind us that LTE is an adaptive system. In a real network the Modulation and Coding Scheme (MCS) is adaptively switched to maintain a relative throughput target of roughly 90 % of the current MCS. In a MIMO OTA measurement with Fixed Reference Channel, however, MCS is fixed. Below the outage power level of the MCS throughput rapidly drops to 0 % and above rapidly rises to 100 %. Averages taken over a spread of effective SNR can therefore not describe UE performance. Information about UE performance can only be deduced from the observed value of outage power level itself.

The meaningfulness of other intentional channel impairments in MIMO OTA measurements is questioned as well. Pre-fading for instance, i.e. the application of Multi-Tap Delay Lines to downlink signals before radiating them via the test antennas is one such issue. The authors argue that small scale fading, i.e. the superposition of signals arriving via different paths, is physically realized in the UE antenna system. A fading emulator therefore emulates properties of the antenna system under test. It is shown that other artificial channel impairments like AWGN and basestation antenna correlation as well obscure UE properties.

The authors recommend a combination of conducted tests and OTA tests without artificial channel impairments. It is pointed out that the impact of the UE antenna system on first and second order channel statistics, which governs MIMO performance, can be characterized by recording outage power levels over suitable sets of constellations of only two measurement antennas.

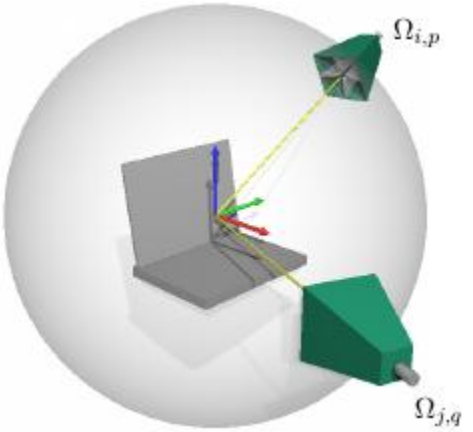

Fig. 1: Sampling over constellations of 2 antennas.

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Selected scientific topic: "Joint RSS-DOA Factor Graphs based Geo-location Technique," by Muhammad Reza Kahar Aziz, Khoirul Anwar, and Tad Matsumoto (TD(13)06084)

Wireless geo-location has been recognized as a key of technology with significant importance for recent and future location based service applications, e.g., location-sensitive billing, Enhanced-911, vehicle navigation, fraud detection, people tracking, and social safety systems. A geo-location technique that achieves accurate and reliable location identification is to make efficient use of factor graph representation of the measurement data distributions, where global function is factorized into a product of some local functions, with the aim of reducing the computational complexity and hence power consumption for computation.

With the factor graph representation, the input can be in arbitrary form of measurements that is convertible to geo-location coordinate *(x,y)*. It can be Received Signal Strength (RSS), Direction of Arrival (DOA), Time of Arrival (TOA), and Time Difference of Arrival (TDOA). We propose a new low complexity technique to consider the both RSS and DOA as the input measurement to the factor graph.

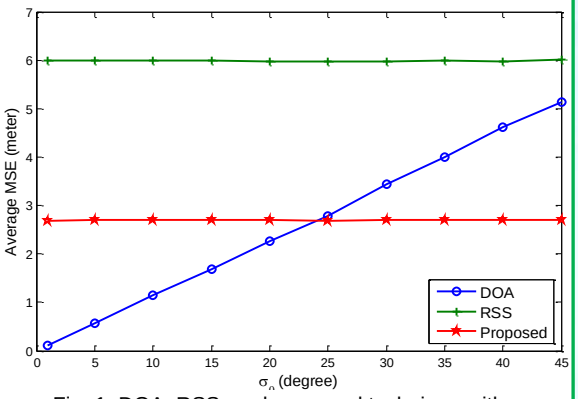


Fig. 1: DOA, RSS, and proposed technique with fixed σ_p of 1.10^{-6} watt.

Fig. 1 shows mean square error (MSE), defined by $\mathrm{MSE} = \sqrt{(x-\hat{x})^2 + (y-\hat{y})^2}$, vs. standard deviation (σ_p) of the received signal power, where $(\hat{x}, \hat{y})$ is the detected position. As shown in Fig. 1, the proposed technique provides stable and accurate detection with significant improvement at angle standard deviation (σ_θ) of more than 30^o and fixed σ_p at 1.10^{-6} watt. The accuracy is improved by the proposed new additional algorithm in the DOA part. Fig. 2 shows that with fixed σ_θ being 30^o, the proposed technique provides the best performance compared with the cases where either RSS or DOA alone is used. The results described in this COST IC 1004 technical document (TD) is robust against the channel conditions, especially for channel with varying angles and received powers. The computational complexity with the proposed technique can be minimized, because only mean and variance are to be exchanged between the factor nodes. Given the presented results, it is expected that the proposed technique is suitable for future geo-location where multipoint communications are the main part of the network.

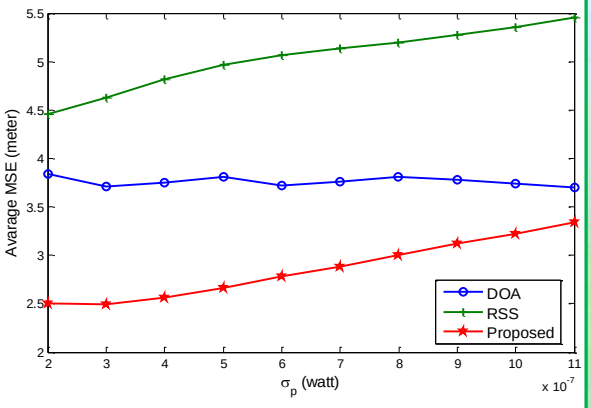


Fig. 2: DOA, RSS, and proposed technique with fixed σ_θ of 30^o.

For more details please contact:: *azizmrk@jaist.ac.jp*

Next Training School (open to anyone, see here for updated information)

"TOOLS FOR COOPERATIVE COMMUNICATIONS" (PRAGUE, CZECH REPUBLIC, MAY 20-22, 2013)

Organized jointly with the DIWINE project

General outline:

Cooperative communications, as well as being a major theme of COST IC1004, is increasingly the focus of much research in wireless communications, since wireless networks increasingly involve interactions between larger and larger numbers of nodes, which must cooperate to enable efficient communication. In conjuction with the FP7 DIWINE project, COST IC1004 is organising a Training School on 'Tools for Cooperative Communications', which will consider a whole range of techniques for designing and optimising cooperative wireless networks, including Wireless Network Coding, distributed signal processing and interference management, and will be introduced by Frank Fitzek who will discuss how cooperation and wireless network coding can also increase energy efficiency. More details can be found here and here (program).

Organizers: Prof. Jan Sykora (Czech Technical University)

Prof. Alister Burr (University of York, UK),

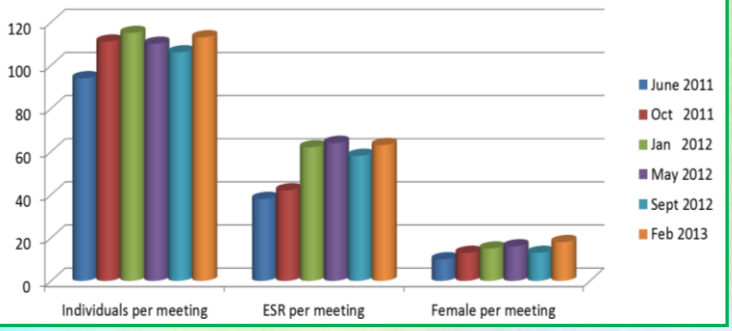
Prof. Silvia Ruiz (Polytechnic University of Catalunya, Spain)

Next Management Committee meeting: the 7th MC meeting and presentation of technical Documents (TD) will take place in Ilmenau, Germany (May 28-31, 2013). Only registered COST IC1004 members can participate. Information on our to join can be found on the web site here.

The 7th MCM will be accompanied by a joint Workshop with the FP7 GREENETS project on "Self Organising Networks for Efficient Networks".

8th Management Committee meeting and workshop: the 8th MC meeting (Sept 25-27, 2013, Ghent, Belgium) will be accompanied on Sept. 25 by a joint Workshop with the IC1102 VISTA COST Action. The topic will be "Terminal Antenna Systems for 4G and Beyond".

9th Management Committee meeting: the 9th MC meeting will take place in Ferrara, Italy (Feb. 2014).



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EURASIP Journal on Wireless Communications and Networking

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RADIO SCIENCE

Journal on Wireless Communications and Networking - Published Special Issue:

Small Cells Cooperative Communications

Edited by: Prof Narcis Cardona

This Special Issue is intended to serve as a dissemination platform on the current advances on smalls cells technologies, including not only indoor residential femtocells but also rural, enterprise and picocell systems.

Collection published: 22 January 2013 (EURASIP)

Last updated: 2 March 2013

The special issue was organized in conjunction with the 2nd IC1004 workshop, which took place in Lyon, France on May 2, 2012 (Chair: Jean-Marie Gorce)

COST IC1004 Position Paper to H2020:

This "position paper" was presented during the Workshop "Future Network Technologies Research and Innovation in HORIZON2020", organised by the EU Commission, Brussels on June 29, 2012. It can be downloaded from the IC1004 web site.

Radio Science Opened Special Issue:

Green Radio Communications

Associate Editor: Sana Salous

Guest Editor: Alain Sibille

Papers accepted from May 1, 2013

Submission deadline: July 31, 2013

See the Radio Science Web Site for further details and access to the CFP

A special section on, "Green Radio Communications", to be published in the Journal of Radio Science, has been approved. The Special Section will open for submissions in GEMS on May 1, 2013 and close to submissions on July 31, 2013. The special section will include invited papers and we are pleased to announce that three invited authors have already accepted our invitation to submit review papers. The special section is also open to all members of the COST IC1004 Action and to radio scientists. Please submit your contribution after the 1st of May to ensure that it is included in the special section and we look forward to a successful issue on Green Radio Communication.

Future Network & Mobile Summit 2013

3 - 5 July 2013, Lisbon, Portugal

An **invited session organized by IC1004 will take place** in the Future Networks & Mobile Summit (FUNEMS 2013), in Lisbon. It will deal with the key aspects of Cooperative Radio Communications Networks.

Training School on "Propagation Measurement, Modelling, and OTA-Emulation"

The third Training School on „Propagation Measurement, Modelling, and OTA-Emulation“, took place between 12 and 14 November 2012 at the campus of Technische Universität Ilmenau, Germany, with 30 Ph. D. students and 1 ESR. The topics were:

1. State-of-the-art channel sounding and measurement processing, giving a best-practice overview and a demonstration of operating high-resolution sounding equipment. Common pitfalls in measurement analysis were discussed and how to select and pre-process measurements for radio performance simulations. One keynote speaker addressed the similarities and differences between the WINNER and the COST2100 model.
2. Over-the-Air testing, explaining what this comprises and which advantages it has over connected testing. Common threads were the fast developments in standardisation. The second keynote speaker addressed solutions of remaining conceptual problems. OTA set-ups were demonstrated, discussing calibration issues.

3. UWB and mm-wave sounding (60 GHz), discussing topologies and implementation issues, calibration, and applications like imaging with their specific pre-processing. Demonstrations of operational 60 GHz equipment concluded the Training School.

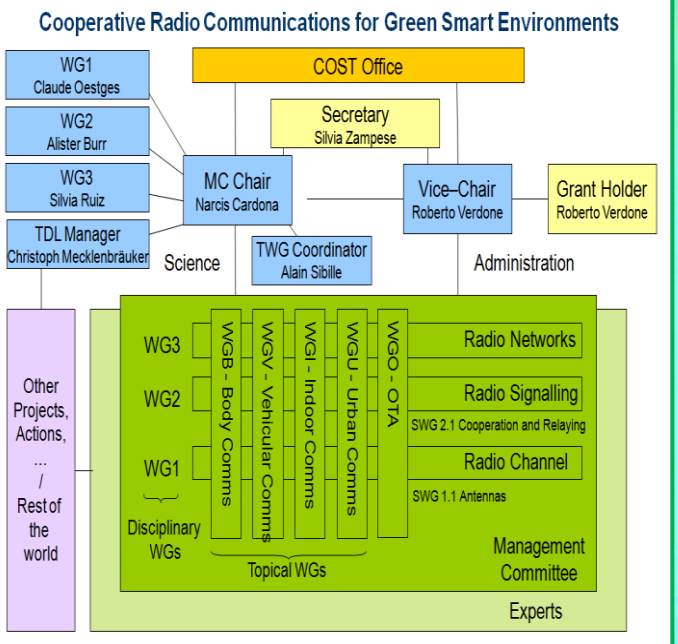
About COST IC1004

COST IC1004 is the Action on **“Cooperative Radio Communications for Green Smart Environments”**, belonging to the ICT Domain of the COST framework (see www.cost.eu). This Action addresses research issues in the field of cooperative radio communications to make our society cleaner, safer and more energy efficient. It started on January 2011 and will end on May 2015. Among many activities, 3 meetings and at least one training school are organized per year.

The Action goals are:

- 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
- to play a supporting role to European industry through the focused interest of Working Groups
- to train young researchers in the field of cooperative radio communications for GSEs

The MoU and all information can be found at http://www.ic1004.org or by contacting the secretariat at secretary@ic1004.org



Facts & Figures

Number of signatory countries: **28**
Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Israel, Italy, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, United Kingdom.

Number of non-COST countries: **7**
Australia, Canada, China, Colombia, Japan, Montenegro, USA

Number of COST country entities (institutes, etc.) currently participating: **116**

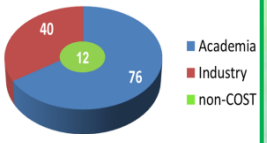
Number of non-COST entities (institutes, etc.) currently participating: **12**

Number of MC Members: **51** (+ Chair)

Number of registered experts: **427**

Number of meetings / year: **3**

Number of training schools / year: **≥1**



Number of completed STSM: **12**

Number of presented TD/workshop papers: **413**

Average number of participants / meeting: **120**