http://www.ic1004.org

NEWSLETTER

Cooperative Radio Communications for Green Smart Environments

Number 3, November 2012

Newsletter Editor: Alain Sibille, Telecom ParisTech, France

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

Editorial

Dear readers,

Like many of you probably, I regularly receive some of these news posts that help follow what's going on around. Looking at the Sept. 28 "Rethink Wireless" Newsletter, my eye was caught by this announcement: "EU project boosts mobile capacity tenfold". And I read: "Alister Burr, professor of communications at the University of York, UK, said: the demonstration and the completion of the project mark a very significant step forward in the implementation of next generation wireless networks". It turns out that Alister has been a strong actor in the past COST Actions (231, 259, 273, 2100) and now in IC1004. What's more, the involved BuNGee european funded project has Université Catholique de Louvain in addition to York University as partner, both being very much involved in COST and certainly contributing by a large share to the project outputs. This just means that the COST "success story" indeed has a profound collaboration record and a genuine capacity of influencing technological research in the best sense. It's a real satisfaction to see this once more concretely demonstrated.

In this issue, we pursue the 2nd Newsletter initiative of a "special section", here in the form of an interview of Simon Fletcher, Senior Manager at NEC and Mobile VCE Director in UK. Simon speaks about green radio, a topic at the very heart of IC1004. We learn that while a hundredfold energy reduction of wireless networks is targeted, a factor of 10 is already appearing feasible with LTE-Advanced. What's more, there are many research opportunities in this direction, which should attract the interest of many laboratories active in "green wireless".

The other part of the NL is devoted to highlights of WG activities, mainly from the last Bristol meeting in September, and to a selection of summarized TDs that present a few recent results. We hope you will find the topics of this NL more than just "interesting".

Alain Sibille

Chairman's Address

Dear Colleagues,

Thank you for still reading our Newsletter. IC1004 is growing every day, both in the number of participants, institutions and companies at meetings, as well as in terms of the quality of technical outcomes. We are only one piece of the big family of COST, one of the networks of scientists who believe in the benefits of cooperation and coordination of our research activities. If it hadn't been this way for many years and in many successful previous Actions, COST would never have been one of the longest-running frameworks in Europe. That is why in my opinion, and I'm sure I share this view with many colleagues, COST has become a cornerstone of the EU Research Area.

The future of research in Europe is being discussed these days. Among others, but on the top of the preliminary documents keywords, cost reductions, budget cuts or research downsizing are easily found in the list of EU policy priorities. Let me use some lines of this Newsletter to claim that, if reductions were unfortunately to be applied, EU policy makers would show cleverness, selectivity and rationality if their priorities took into account the true price/performance ratio. COST is a very small percentage of the overall EU Research budget, but its effect on the integration of scientists, early stage researchers and companies from dozens of countries into a single network haven't until now been equaled by any other instrument, after 7 European Framework Programs. I do wish that the EU decision-makers will understand that COST Actions are one of the most efficient and inclusive ways to integrate research communities, and that the budget for keeping this key instrument running is really low compared to many other expenses in this Area. Be sure that if I had to find these days a new acronym for the *European Cooperation in Science and Technology* framework, I would never propose "COST"!

Enjoy the reading and be welcome to join IC1004, if you aren't with us yet.

Narcis Cardona

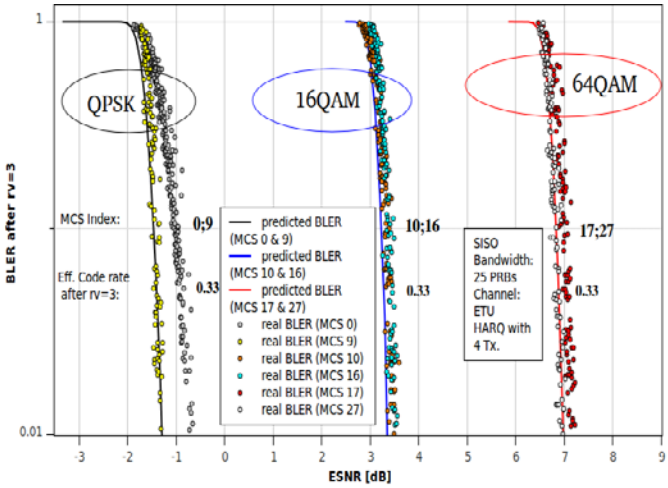
Highlights

This section mainly concentrates on the IC1004 working group activities and on results presented at the last Management Committee meeting, which took place in Bristol (Sept. 24-26, 2012).

The research within WG1 of COST IC1004 builds on the work of COST 2100 Action. In this respect, researchers from 4 institutions within COST IC1004 (UCLouvain, Aalto University, Lund University and University of Brussels) have worked towards a scientific paper summarizing the main aspects of COST 2100 channel model. The paper, entitled **"The COST 2100 MIMO channel model"**, will soon appear in the IEEE Wireless Communications Magazine.

Two of the papers discussed at WG3 during the Bristol Meeting have been selected by the Chairman of COST-TERRA (Action IC0905), inviting the authors to give a talk at the November meeting. They are IC1004 TD(12)05044 "White Spaces potentially available in Italian scenarios based on the geo-location database approach" a joint work of the University of Bologna and the Fondazione Ugo Bordoni, and IC1004 TD(12)05058 "An Overview of the Cambridge White Spaces Trial" from the British Sky Broadcasting.

The work done by Eurecom and UPC after their Short Term Mission, was presented in a joint session of WG2 and WG3 through papers TD(12)046 "On the Use of Mutual Information at Bit Level for Accurate Link Abstraction in LTE with Incremental Redundancy H-ARQ" and TD(12)05060 "Low Complexity Link Abstraction for MIMO Transmission in LTE/LTE-Advanced with IR-HARQ". Joan Olmos and Florian Kaltenberger proposed a **novel link abstraction method to predict the BLER with good accuracy in multipath fading** including the effects of IR H-ARQ retransmissions for multiple MCS, working at bit level and without requiring any set of calibration constants (see the figure).



Predicted and simulated BLER after the fourth H-ARQ round in LTE (bandwidth of 25 PRBs)

A memorandum of understanding intended to promote SWG1.1 **as a platform for SAR** (Specific Absorption Rate) research has been drafted. Several SWG members have indicated interest to support this initiative in different ways, including a liaison with a new EU project on the subject (with several members being part of it), as well as giving a tutorial in one of the upcoming COST meetings on SAR issues.

TWGU discussions focused on the **harmonization of the system-level simulators** used and developed by the individual partners and the integration of the IC 1004 Hannover Scenario in these simulators. It is planned to compare and align the simulation results of different simulators using the same input data on a KPI level to assure comparability of future simulation results. To initiate this activity we intend to launch a short term mission. The concept of the IC 1004 Hannover Scenario was presented at the International Symposium on Signals, Systems and Electronics (ISSSE) in Potsdam. MIMO and outdoor relay propagation studies and scenarios are two other areas of interest to the group. The focus for MIMO is on developing a full wave propagation model linked to the reference scenario and a "feasible" MIMO model for system-level simulations.

TWGV sessions included eight excellent contributions that sampled the broad scope of the working group**: from propagation and antennas to medium access issues and radar systems**. Especially nice was to see the contributions from industry (BMW and ERICSSON), and the outcome of the Short-Term Scientific Mission (STSM) carried out between TU Braunschweig (Germany) and Lund University (Sweden), intended to compare channel measurements with ray tracing output. In the true COST IC1004 spirit, discussions were plentiful and fruitful.

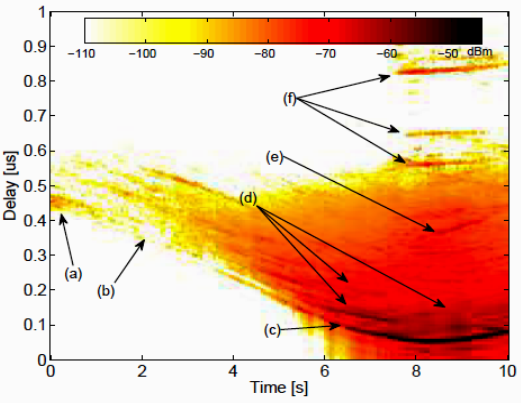


Fig. 3. Power delay profile based on channel sounder data averaged over all 4x4 MIMO links

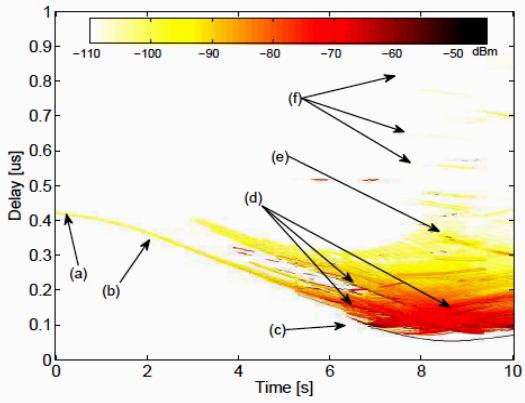


Fig. 4. Power delay profile obtained from the predicted CIRs using the ray-tracing channel model

(extracted from TD(12)05031"Comparison of Ray Tracing and Channel-Sounder Measurements for Vehicular Communications" by Jörg Nuckelt et al.)

Interview: Simon Fletcher, Senior Manager at NEC and Mobile VCE Director

[IC1004]: green, green, green, what isn't green today? Is it a new hype, the buzzword of the moment, the thing to do to get money? What profound future and in-depth issues do you see for greenness in wireless networks?

[Simon Fletcher]: The MVCE Green Radio **target was a 100x reduction is energy consumption**, and the research showed that on average a **~10x energy reduction** using a number of architectural and technique approaches is **feasible with LTE-Advanced** technologies. We can see there is not a one size fits all solution, but there is certainly a need to change the approach to system design to balance energy and spectral efficiency.

[IC1004]: well, let's take it. But isn't the big leap just achieved by using less power hungry amplifiers, avoiding air conditioners, having small access points plugged on internet? Is a big improvement really possible through a clever network engineering?

[Simon Fletcher]: It's certainly true that PA efficiency and avoiding wasteful cooling is a critical piece of the puzzle. However, by taking an integrated system view across a heterogeneous system **there are approaches across the protocol stack** taking into account architectures & cell deployments, sleeping techniques, interference management and distribution of antennas that will bring benefits.

[IC1004]: any job for antenna makers? You can't avoid antennas, some have poor efficiency, especially for wide bands.

[Simon Fletcher]: Although there are now a couple of solutions available that achieve high efficiency they are not so easy to come by and are in fact more expensive than standard efficiency antennas. Green Radio explored the possibility of airgap and other approaches. The challenge is for the industry to develop manufacturing techniques. Also we shouldn't overlook the trend to integrate amplifiers, beam forming, and beam steering into systems which presents yet another dimension to the optimization challenge at the RF and Antenna stages.

[IC1004]: in terms of research, is there any sense in trying to build sophisticated models? Any challenges there, or are the issues sufficiently well identified and easy to address that academic work has no strong relevance?

[Simon Fletcher]: Green Radio researchers are certainly interested in **deriving an information theoretic approach that encompasses energy efficiency**. Generally such pursuits may not have immediate industry impact; however, they can help with scoping the desirable direction of future systems. The view emerging as we see early HetNet deployments, that generally target capacity, is we need to ensure the system is much more dynamic and able to switch capacity based on traffic demand and energy efficiency constraints. The existing standardized protocols **do not support a cross layer optimal support for real-time sleep modes**, some thinking is necessary on this point. Networks have traditionally been deployed to meet the network traffic requirements but in some locations we may hit the limit of the energy density and need to ensure graceful and fair reduction in service provision and **supplement energy supply by the use of harvesting**.

[IC1004]: it is widely considered that, by far, most of the energy consumption comes from the BST or the network core. What about terminals? They are many as well, and the terminals to BST number ratio increases, as cells reduce in size…

[Simon Fletcher]: In the network we still see the balance of power consumption is greater at the BST, the increase in the number of smaller cell platforms will ensure this balance remains the same. However, you are right that again **the handsets are becoming a significant issue**. We are now at the point where most users will have to charge their smart phone devices once a day, the truth is there has always been a complex optimization challenge for the handset designers, they have developed techniques to manage the power consumption, now the network side has gained a toolkit through projects like Green Radio to help tackle the network side issues.

[IC1004]: life teaches us that there is no free lunch. We can accept some lesser comfort in the use of wireless connections, but not that much. Do you expect that pushing consumption down will be compatible with a good user "quality of experience"?

[Simon Fletcher]: We constrained the researchers to assure QoS and QoE and they achieved x10 saving. Towards the end of the research we did allow some researchers to investigate what may be possible if we compromised QoE and some approaches do enable additional savings. By embedding intelligence in the network nodes so that there is awareness of the application will enable smart decisions about optimization that shouldn't compromise QoE. However, it is quite possible that some users will accept some QoE compromise to feel that they are saving the planet.

[IC1004]: in terms of time line, LTE networks are on the verge of being deployed, they will require heavy investments from operators. Is the research on advanced consumption reduction techniques not too late already, to have an impact there?

[Simon Fletcher]: We are still only at the early stages of the paradigm shift that will be necessary to sustain the industry in the long term. **5G Systems in the 2020s** is likely to be the point at which we can say there are systems that truly deliver the **optimal balance between Energy and Spectral Efficiency**. The Network Operator challenge to drive up Operational Efficiency against a backdrop of flat lining ARPU will not go away anytime soon.

[IC1004]: thank you !

Simon Fletcher has responsibility for the development of technology strategy and emerging communications infrastructure platforms for the NEC Global Market product portfolio. With a primary interest in 3GPP Radio access technologies, the management of standardisation processes, and Sustainability. Simon represents NEC in CPRI (Common Public Radio Interface), NGMN Ltd., and steered NEC engagement in the LTE SAE Trials Initiative (LSTI) as NECs Board member. Simon is the Industrial Chairman for the MVCE Green Radio Programme, a Director of the Mobile VCE and the ICT-KTN. In the past Simon has worked on behalf of NEC in various project management and consultant roles within NEC joint venture activities, and led core technology development projects. (see invited presentation at Bristol MCM here)

Selected scientific topic: "An efficient co-located MIMO antenna for compact terminals", *by Hui Li, Buon Kiong Lau, Zhinong Ying, and Sailing He* (TD(12)05043)

Proper design of multiple antennas for compact mobile terminals is critical to achieve high MIMO transmission rates. However, antenna elements that are implemented on a mobile terminal tend to share the chassis as a common radiator, which severely increases mutual coupling among the antennas and significantly degrades MIMO performance. This phenomenon occurs especially for frequency bands that are lower than 1 GHz. In this work, a co-located dual-antenna system is designed on a mobile chassis for the GSM900 band. One antenna is a folded monopole, which excites the chassis and radiates like a flat dipole. The other antenna is a coupled-fed loop antenna, whose radiation pattern is similar to that of a magnetic dipole. Thus, angle and polarization diversities are achieved. To further reduce the mutual coupling induced by the proximity of the feed points of the two antennas, the feed location of the folded monopole is optimised. Compared with a conventional dual-antenna prototype (i.e., reference prototype) with antennas positioned at two edges of the chassis, the proposed antenna system gives significantly better performance in terms of capacity and multiplexing efficiency, with the latter being a generalised efficiency measure to include total antenna efficiency, efficiency imbalance and correlation.

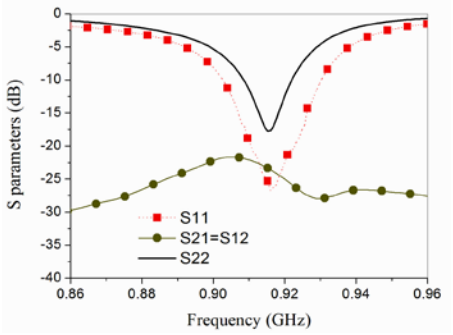
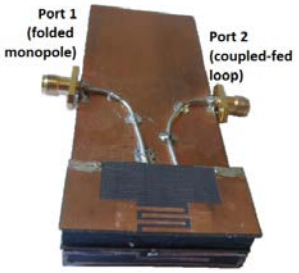


Fig. 1: Measured scattering parameters of the proposed co-located antennas.



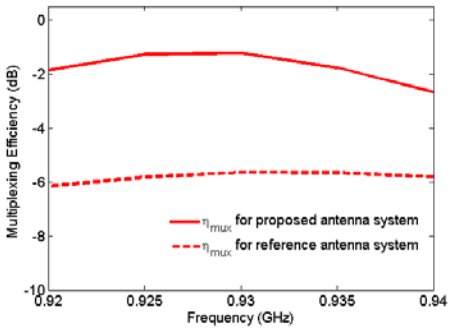


Fig. 2: Multiplexing efficiencies of the proposed co-located prototype and the reference prototype

For more details please contact: Hui.Li@eit.lth.se

Selected scientific topic: "Power Consumption Model for GMS, UMTS and LTE Macro Cells", *by Johannes Baumgarten, Thomas Jansen, Dennis M. Rose and Thomas Kürner* (TD(12)05052)

The increasing awareness for energy efficiency in the area of mobile communications leads to a wide range of different approaches to reduce the power consumption of equipment and networks. To evaluate the impact of hardware improvements or intelligent network management, which adapts the amount of active equipment to the required capacity, a power consumption model for base stations of cellular networks has been developed as part of the FP 7 project GreenNets. The model allows the load - and hardware - dependent estimation of the power consumption for GSM, UMTS or LTE base stations. It incorporates the power consumption of auxiliary site-support hardware like climate control or power supply and supports optional equipment, such as microwave transmitters for the backhaul connection. As shown in Figure 1, a base station consumes power even if it does not serve any traffic. When taking into consideration the idle power consumption and the load due to mandatory signalling, plausible consumption values can be obtained even for low load situations. Thus the model can be used to monitor the power consumption of a network (see Figure 2) as well as to estimate possible savings through intelligent network management approaches or hardware modifications.

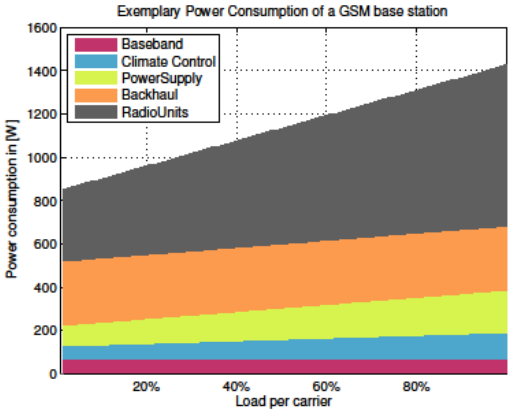


Figure 1: Load-dependent power consumption of the different subsystems for a three sector GSM base station with two carriers per sector and dual transmit/receive radio units (DTRU) using microwave transmitters for backhaul.

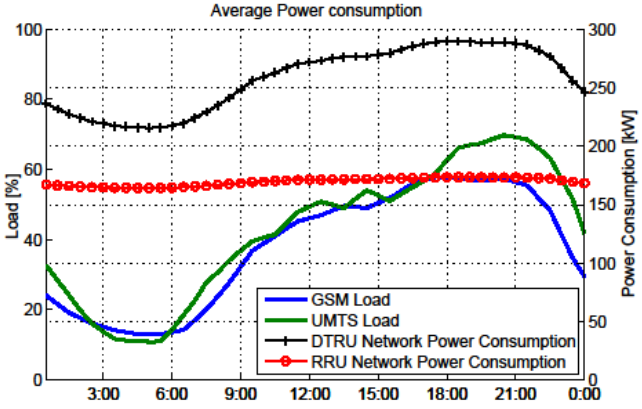


Figure 2: Average power consumption and load of an artificial mixed GSM/UMTS network with 72 network sites for two different hardware types of radio units.

For more details please contact: baumgarten@ifn-ing.tu-bs.de

Selected scientific topic: "LTE MIMO Performance Evaluation of Automotive Qualified Antennas ", by Levent Ekiz, Oliver Klemp and Christoph Mecklenbräuker (TD(12)05071)

Future vehicles are targeted to integrate multiple radio access technologies differing in their properties such as latency, throughput, mobility or coverage in order to choose the most suited network for an application. 3GPP Long Term Evolution (LTE), being one of the aforementioned access networks, is able to cover safety and traffic information services as well as infotainment applications. In this investigation, the performance of a multi-standard automotive qualified antenna is evaluated.

The measurement results were obtained in the spectrum at 800 MHz, where LTE is deployed in Germany. At such low frequencies especially, multiple-input-multiple-output (MIMO) transmission using two antennas poses the greatest challenges with regards to the antenna design. In Figure 1, the throughput histogram is presented for the two measurement routes. A section of the routes is shown in Figure 2. Although the mean value is similar for both directions, 25.6 Mbit/s for 'Direction I' and 26.3 Mbit/s for 'Direction II', the data rates are less spread for 'Direction I' and the variance is 4 Mbit/s lower. Further analysis showed that for 'Direction II' a rank indicator of one was predominately registered close to the base station, see Figure 2, implying that just one of the two antennas was effectively used for the transmission.

The paper illustrates that the MIMO performance deterioration is resulting from the antenna gain difference of the two antenna system. Moreover it is shown that the signal-to-noise-plus-interference ratio (SINR), as opposed to power parameters such as the received signal strength indicator (RSSI), is better suited to determine the performance of the LTE link.

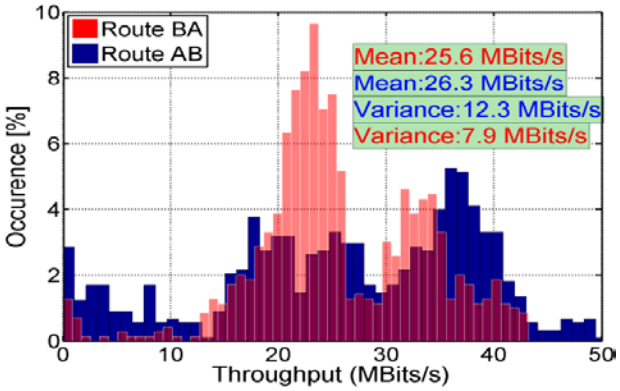


Fig. 1: Throughput histogram for the entire measurement track. Both directions are displayed.

a.) Measurement Route: 'Direction I'.

b.) Measurement Route: 'Direction II'.

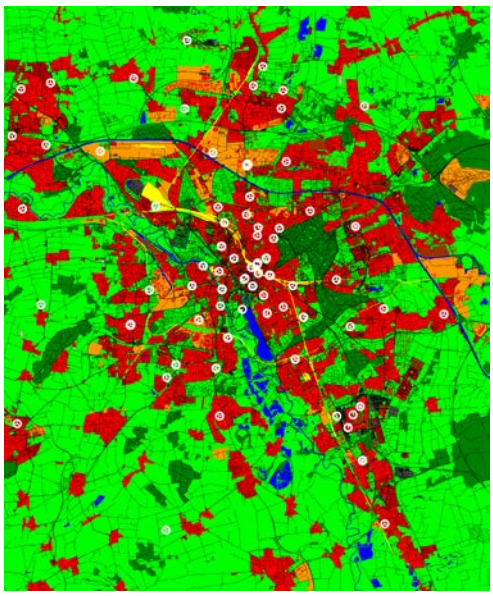
Fig. 2: Rank indicator results for a section of the measurement track close to the base station.

For more details please contact: Levent.Ekiz@bmw.de

Selected scientific topic: "The IC 1004 Urban Hannover Scenario - 3D Pathloss Predictions and Realistic Traffic and Mobility Patterns", *by Thomas Jansen, Ulrich Tuerke, Christian M. Mueller and Thomas Werthmann* (TD(12)05059)

The demand for mobile broadband access has significantly increased in the last years. On the one hand smartphones and the huge amount of applications that are developed by companies and private people introduce new services to mobile radio networks. On the other hand mobile network operators launch new network technologies and new network layers like femtocells to encounter the increasing data traffic. The outcome of this is a huge increase in complexity in nowadays networks, which imposes a strong demand for automation and optimization. The latter enforces a more realistic modeling of radio networks in system analysis and simulation. The often used homogeneous network models do not capture all relevant effects.

One of the challenges for scientific research in radio network simulations is to properly model the important parts of a mobile communication system. This is both time consuming and error-prone. In this paper the simulation environment "IC 1004 Hannover Scenario" is introduced including the scenario layout, propagation model, radio network design, user mobility and a traffic model. The user traces can be accessed on demand from one of the authors. A web page will be built allowing the flawless download of the scenario files. Ahead of its completion the data can be provided by the authors on individual request.



Network layout of the IC 1004 Hannover Scenario including land-use classes and site positions.

For more details please contact: jansen@ifn-ing.tu-bs.de

Training Schools (open to anyone, see http://www.ic1004.org for updated information)

"PROPAGATION MEASUREMENT, MODELLING, AND OTA-EMULATION" (ILMENAU, GERMANY, NOVEMBER 14-18, 2012)

General outline:

- Multidimensional channel sounding
- Performance Evaluation based on measured data
- High resolution parameter estimation
- Processing of measured data
- State-of-the-Art channel modelling
- Real-time UWB MIMO channel sounding and applications
- 60 GHz channel sounding and applications
- Polarimetric MIMO radar and MIMO sensing at mm-waves
- Practical aspects of OTA
- Calibration of OTA installations
- Wave Field Synthesis

Organizer: Prof. Wim Kotterman (Ilmenau University of Technology)

Registration: by October 28, here

Next Management Committee meeting:

the next MC meeting and presentation of technical Documents (TD) will take place in Malaga, Spain (February 6-8, 2013). Only registered COST IC1004 members can participate. Information on our to join can be found on the web site here.

A glimpse of IC1004 at the Bristol last MC meeting social event

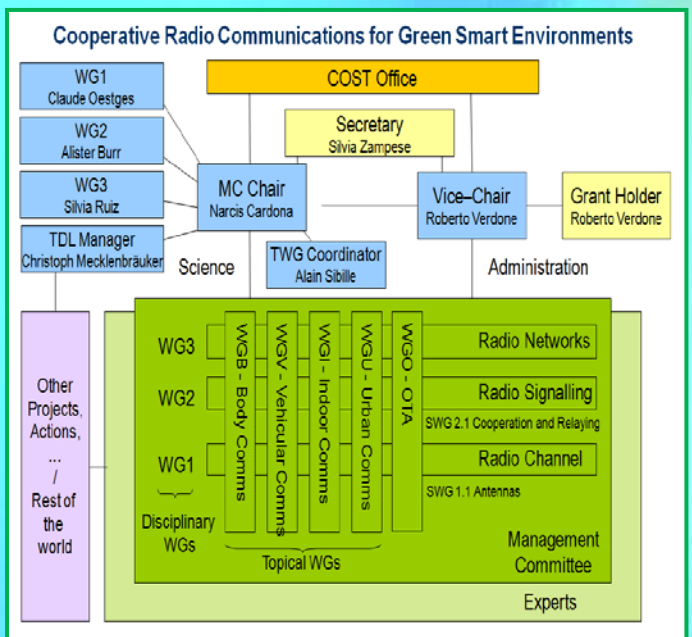
About COST IC1004

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: **105**

Number of non-COST entities (institutes, etc.) currently participating: 11

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

Number of registered experts: **380**

Number of meetings / year: **3**

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

Number of presented TD/workshop papers: **360**

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