



# eltic-Plus<sup>+</sup>

Smart Connected World



## WP 5A seminar

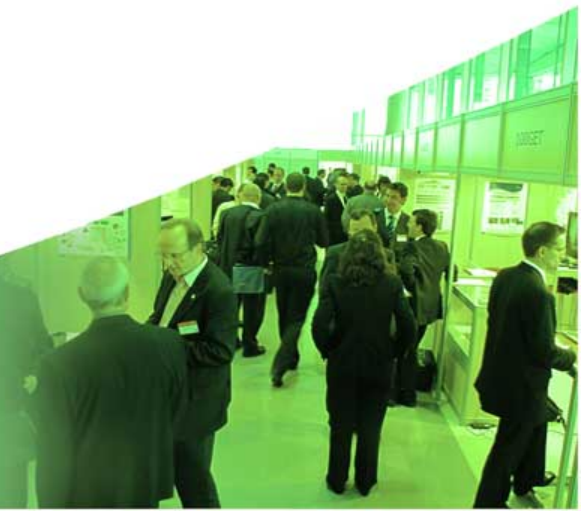
11/18/2013

*Presenter: Dominique Nussbaum (EURECOM)*

# SPECTRA



**Spectrum and energy efficiency in  
4G communication systems and  
beyond**



1. Overview of the SPECTRA project
2. Concrete achievements
3. Use of the results and next steps

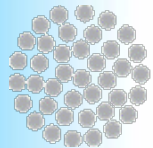


# 1. Overview of the SPECTRA project



- SPECTRA is a CELTIC project (Celtic is a European research and development programme, established as Eureka cluster, <http://www.celtic-initiative.org/>)
- Start Date: 1 September 2010
- Completion date: 31/08/2014

**THALES**



**indra**

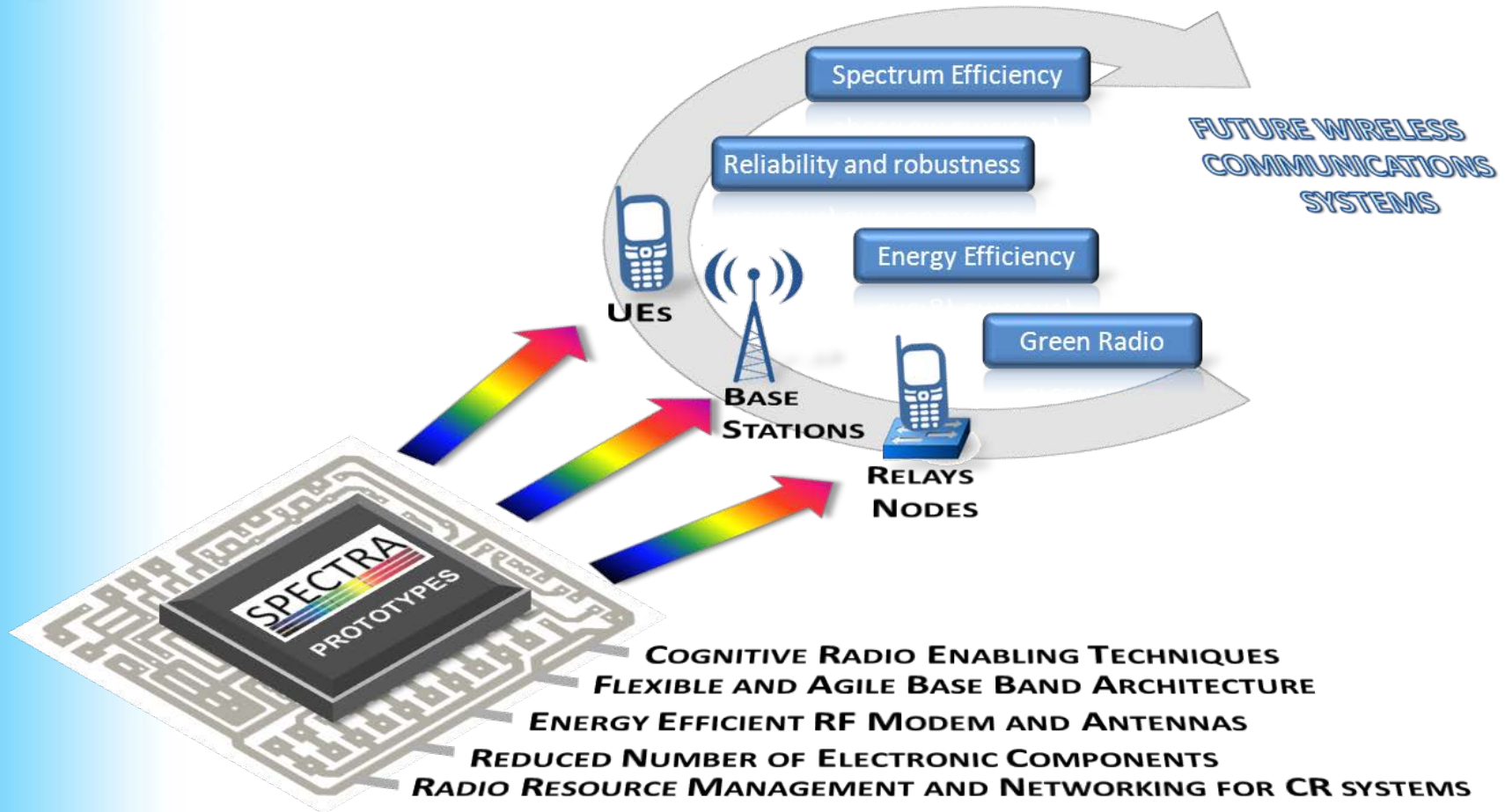


TELLEMENT MONACO

**TeamCast**



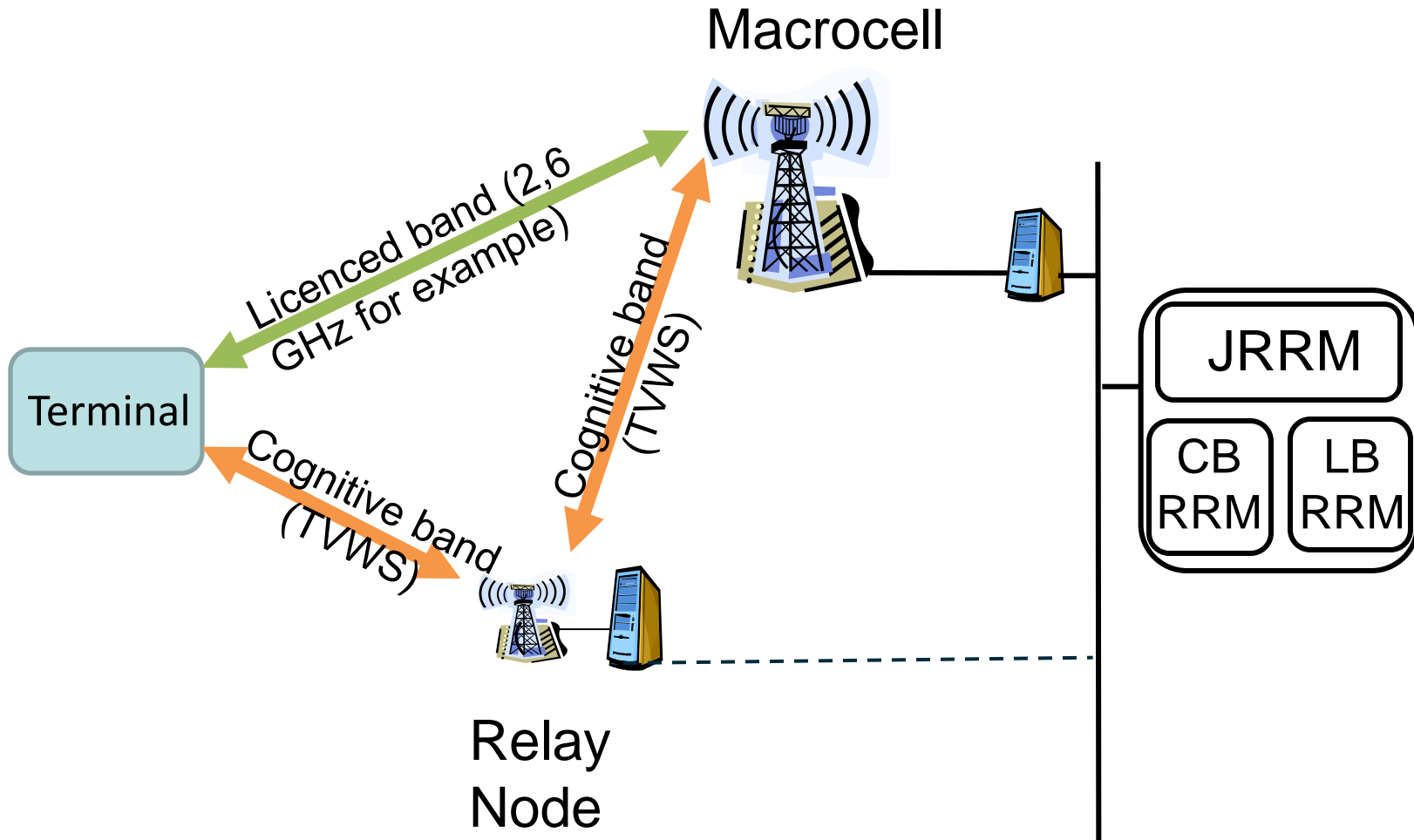
# 1. Overview of the SPECTRA project



## Five major research topics are investigated:

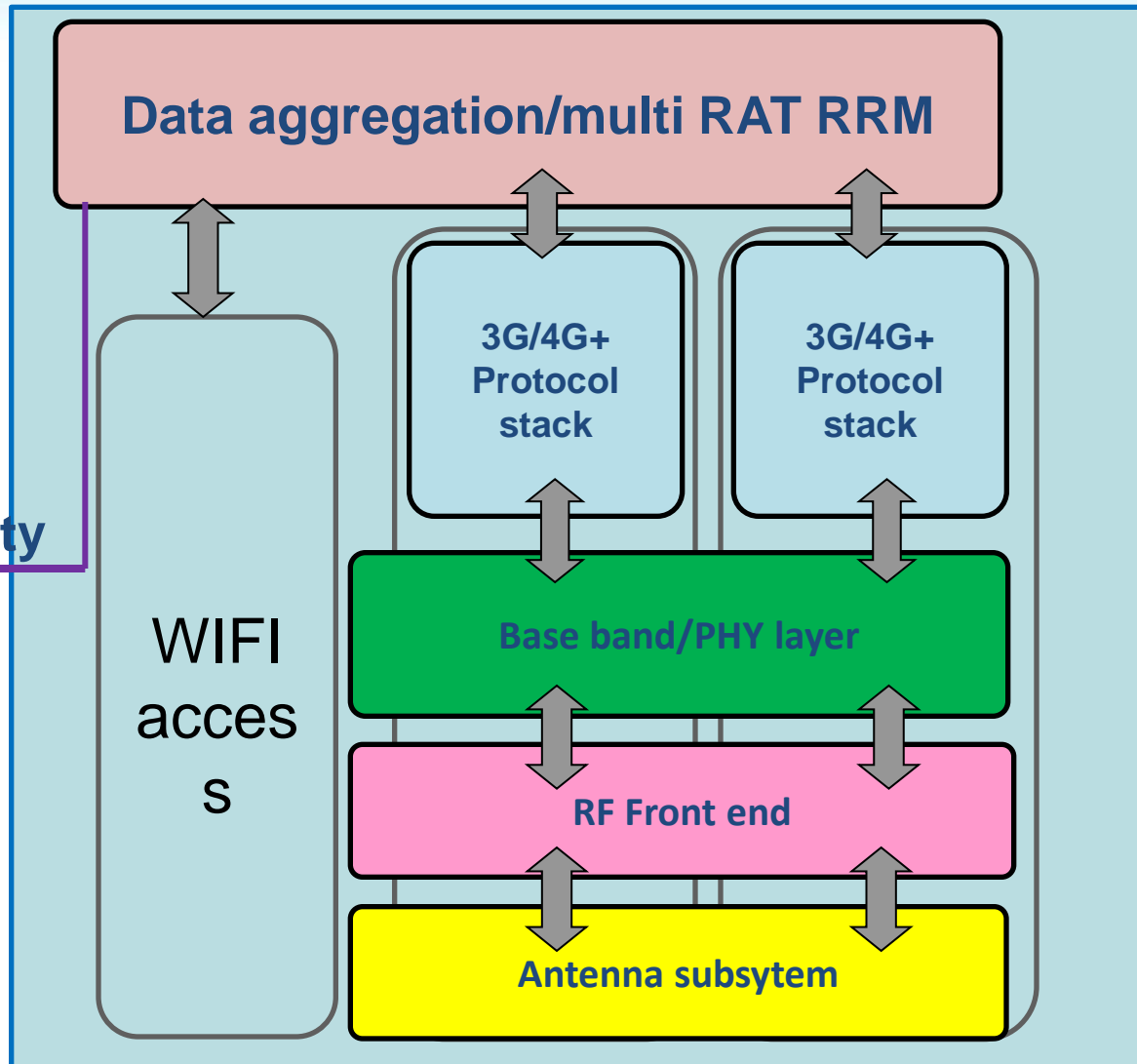
- Spectrum efficiency thanks to the use of cognitive radio techniques in wireless systems.
- Minimization of the number of electronic components thanks to agile RF architecture, versatile analogue/digital conversion and flexible base band architecture.
- Energy optimisation for wireless communication terminals by optimizing architecture design and algorithms implementation.
- Minimization of the generated interference in the environment by selecting the adequate band which will guarantee the shortest transmission distance and the minimum power while preserving the Quality of Service.

- Scientific results on cognitive radio:
  - Sensing, signal classification and MIMO : more than 20 international publications
  - Antennas, digital corrections of amplifiers
  - RRM and mobility management





Wired IP  
connectivity





- **Real time**, with processing split between the SPARTAN6 and the PC
- MIMO 4\*4 : LTE-A compliant
- **FDD and TDD**
- Frequency range : **300 MHz to 6.5 GHz**
- Noise Frequency RX : 7 dB
- Power : + 23 dBm
- Max bandwidth 28 MHz
- The transceivers are controlled individually => MIMO 4\*4, MIMO 2\*2 on one band and MIMO 2\*2 on another band, ...
- The system has to support a feedback loop in order to support Dirty RF mechanisms (DPD, IQ balance, LO leakage compensation)

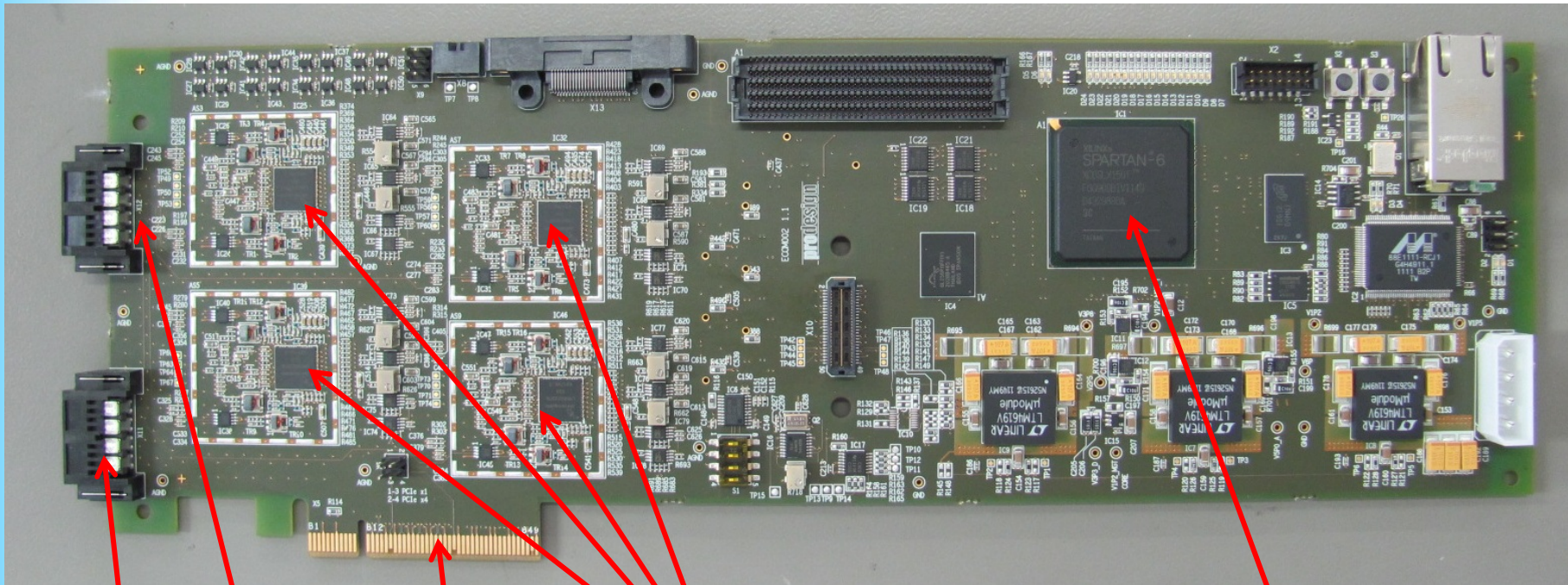


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## 2. Concrete achievements



- EXPRESSMIMO2



RF RX  
(4 ways)

RF TX  
(4 ways)

PCIe  
connector

RF transceivers  
LIME 6002D

FPGA



# 3. Use of the results and next steps



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- Use of the SPECTRA solution for an experimental network
- SPECTRA concepts will be illustrated publically during the CELTIC event in Monaco, 23-24 April 2014 at [Grimaldi Forum](#).
- The demonstrations will include:
  - Real field trials, with a SPECTRA experimental cellular network. Those trials will be feasible thanks to the support of Monaco Telecom and the regulator of Monaco (Direction des Communications Électroniques, Monaco gouvernement)
  - Interoperability with a commercial equipment (real-time over-the-air operation between the SPECTRA relay and a commercial LTE equipment)
  - MBMS service demonstration in the TVWS band
  - Specific scientific results such as Digital Predistortion, advanced antenna designs and more.





SPECTRA has an impact even outside Europe. Indeed, the hardware and software developed in the project are used in China by 2 major industrial companies:

- Orange China, Beijing, has connected [our](#) code on a [USRP](#) platform, in real-time, running at 6.25 MS/s. **This achievement illustrates the validity of our Software Defined Radio approach in SPECTRA since the code has been ported successfully on a totally different hardware target.** To the best of our knowledge, it is a world first.
- Agilent China has used ExpressMIMO2 as a base station and set up a connexion with a commercial UE (Huawei [E392U](#)-12, FDD and TDD mode). Now the attachment process has been passed and the UE can get an IP address. **The work performed shows that our platform is mature enough for industrial applications/deployment.**

- In the future :
  - Use of SPECTRA solution in commercial SDR deployment
  - Advantages : flexibility, evolutivity, low-cost solutions
  - Exemple of this flexibility: the use of a wideband transceiver, from 300 Mhz to 3,8 Ghz and soon for several MHz to 6 GHz (information from LIME Microsystems)

- General information on SPECTRA :
- information on demonstrators :
- And come to see us during the CELTIC event in Monaco, 23-24 April 2014