



WG2: CR/SDR Coexistence Studies Overview and Current Status

Marja Matinmikko, VTT, Finland
Fernando J. Velez, UBI, Portugal

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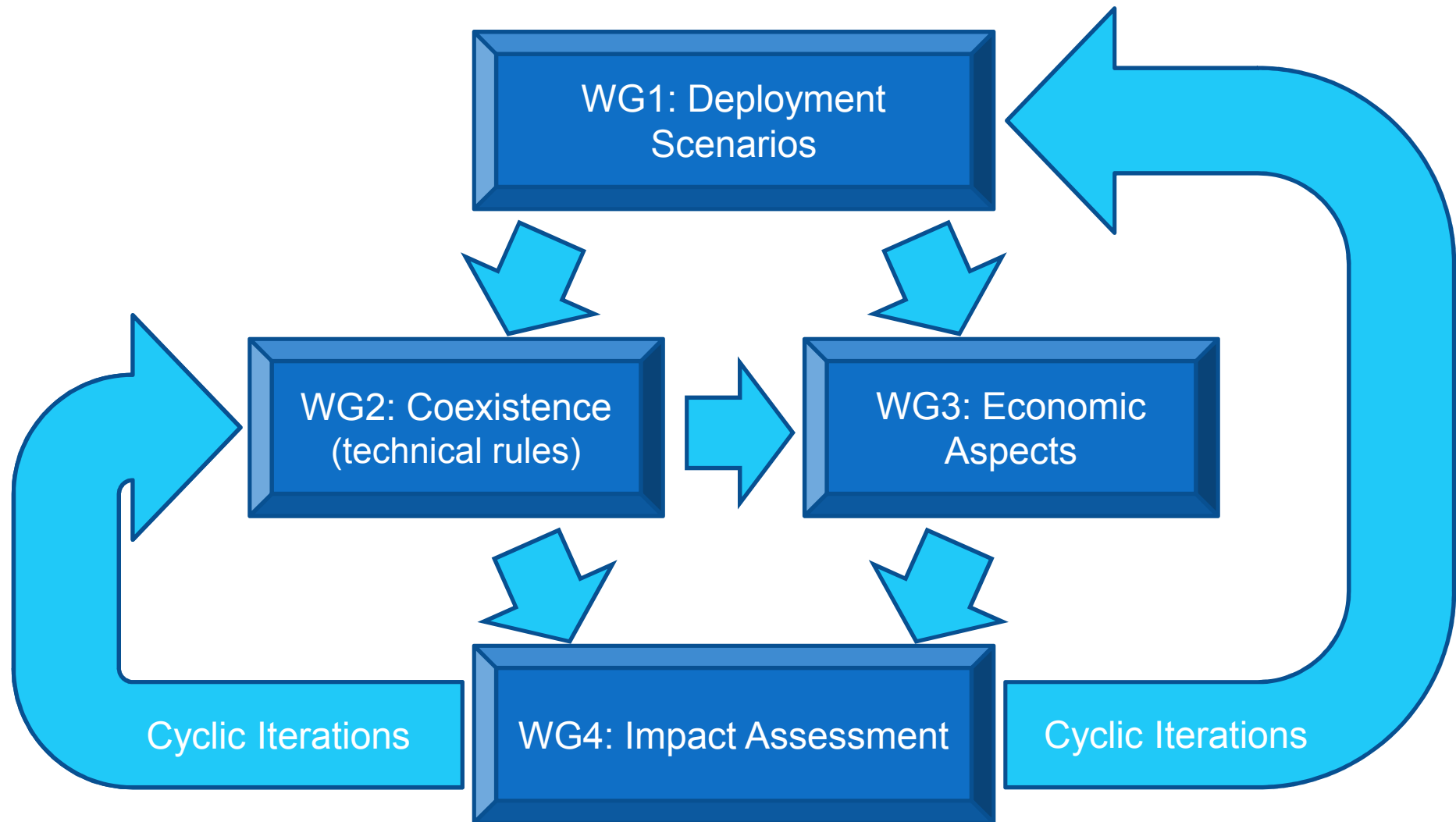
Outline

- WG2 Focus
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- WG2 Input to August 2010 Meeting
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WG2 Focus

- WG2 addresses "CR/SDR co-existence studies" and will consider the identified deployment scenarios from WG1 to devise and carry out the technical co-existence studies that would result in identification of essential technical rules/conditions for CR/SDR.

Work Programme



Coexistence Issues in European Framework

- Coexistence studies in Europe are conducted in CEPT.
 - CRS coexistence is a complex topic in Europe as the spectrum use still varies between the countries.
- CRS brings new dimensions into coexistence issues
 - Coexistence between the primary service and the cognitive radio system (CRS).
 - CRS has to protect the primary service from interference.
 - CRS has no regulated protection from the primary service.
 - Coexistence between several secondary systems.
 - Development of rules for coexistence.

Coexistence Issues in COST TERRA

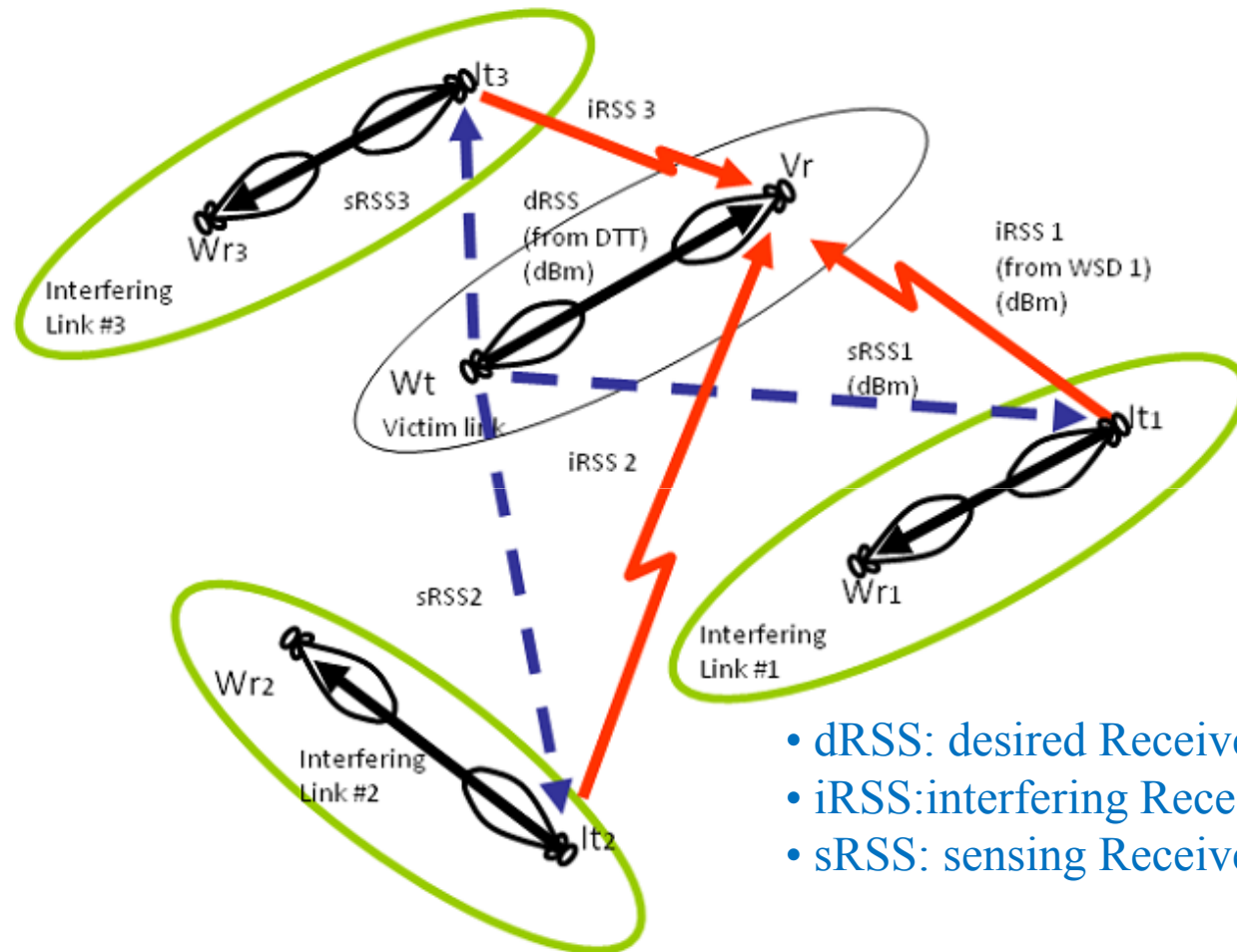
- Exploring the role of innovative techniques to facilitate co-existence.
 - Elements of existing solutions, or their combinations that would appear most suitable for the identified CR/SDR scenarios.
 - Development of toolbox of techniques to facilitate coexistence.
- Advanced coexistence modeling.
- Rethinking of the current coexistence criteria.
- Development of new rules for efficient coexistence.

WG2 Input to August 2010 Meeting

- In August meeting WG2 dealt with three key topics:
 1. On-going standardization efforts on coexistence (e.g. ETSI RRS and IEEE 802.19.1)
 2. Technical approaches for coexistence (e.g. filter bank multicarrier, spectrum aggregation, OFDM pulse shaping)
 3. SEAMCAT tool* developed by European Communications Office (ECO) that allows statistical modelling of different radio interference scenarios for performing sharing and compatibility studies between radiocommunications systems in the same or adjacent frequency bands.

*<http://www.ero.dk/SEAMCAT>

SEAMCAT CR Tool



- dRSS: desired Received Signal Strength
- iRSS: interfering Received Signal Strength
- sRSS: sensing Received Signal Strength

Source: Jean-Philippe Kermoal, European Communications Office (ECO),
“Modeling of Cognitive Radio (spectrum sensing)”

WG2 Input to August 2010 Meeting

- **Keynote presentation:** Jean-Philippe Kermoal, European Communications Office (ECO), “Modeling of Cognitive Radio (spectrum sensing)”, WG2(10)04
- Kari Kalliojärvi, Päivi Ruuska, Mikko A. Uusitalo and Carl Wijting, Nokia Research Center, “Contribution on coexistence”, WG2(10)05
- Maurice Bellanger, CNAM, “Opportunistic unsynchronized cognitive radio networks”, WG2(10)01
- Filippo Meucci, Orlando Cabral, Fernando J. Velez, Albena Mihovska and Neeli R. Prasad, “Spectrum Aggregation with Multi-Band User Allocation over Two Frequency Bands”, Universidade da Beira Interior, Instituto de Telecomunicações, WG2(10)03
- Keith Nolan, Baris Ozgul, Paul Sutton and Irene Macaluso, CTVR, University of Dublin, Trinity College Dublin, “Coexistence using orthogonal frequency division multiplexing (OFDM) sculpting, shaping, and intentional feature injection and analysis for rendezvous”, WG2(10)02

WG2 Input to January 2011 Meeting

- In January meeting WG2 dealt with four key topics:
 1. Experimental platforms (spectrum sensing and over the air testing)
 2. TV White space availability in Europe
 3. Cooperative spectrum sensing and techno-economical evaluation of spectrum sensing
 4. Radio resource management with spectrum aggregation

CR Solutions for Industrial Scenario

15 Assembly lines

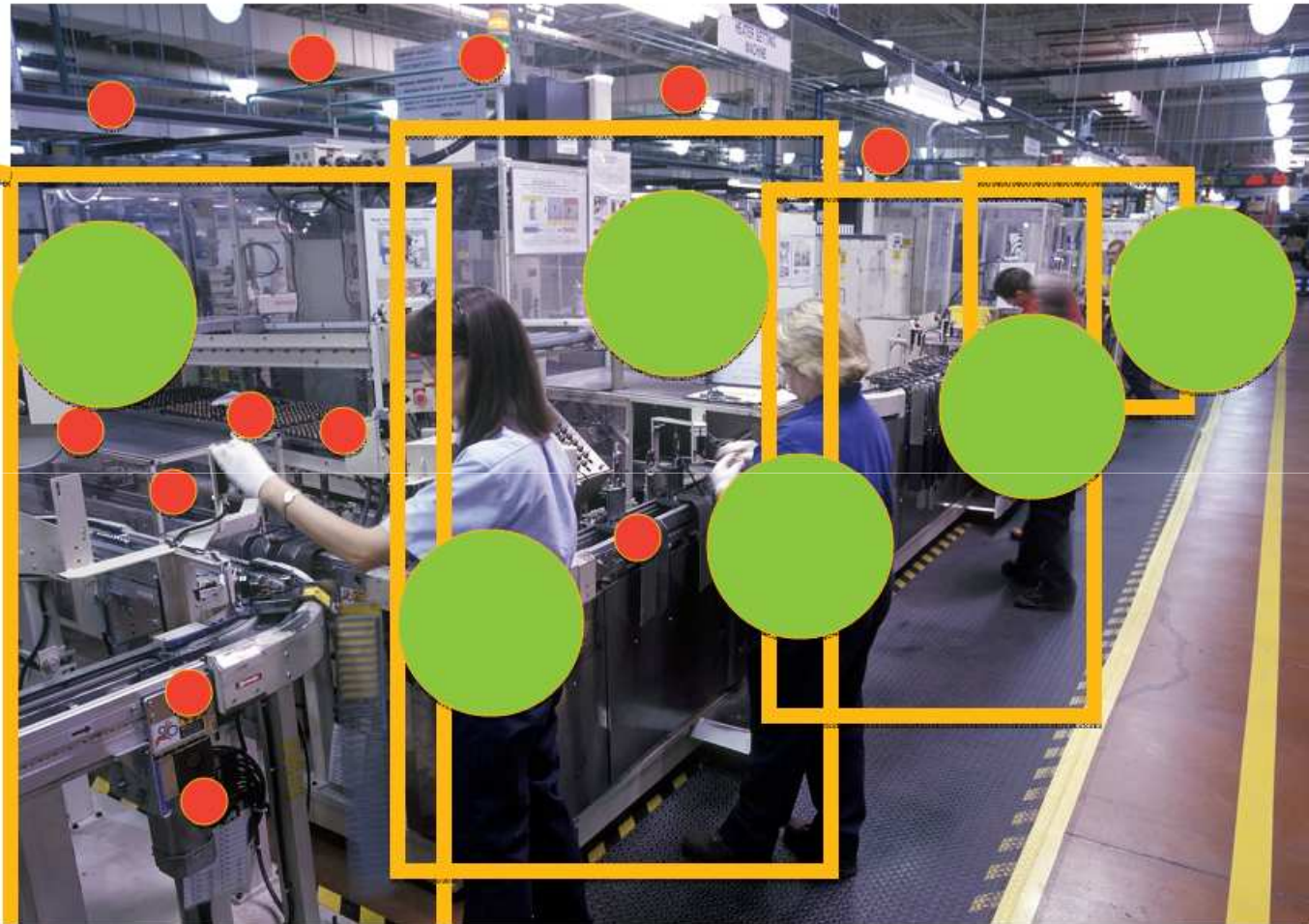
3-4 robots
1 oven
2 human operators

600 ZigBee nodes

6-7 per robot
10 per oven

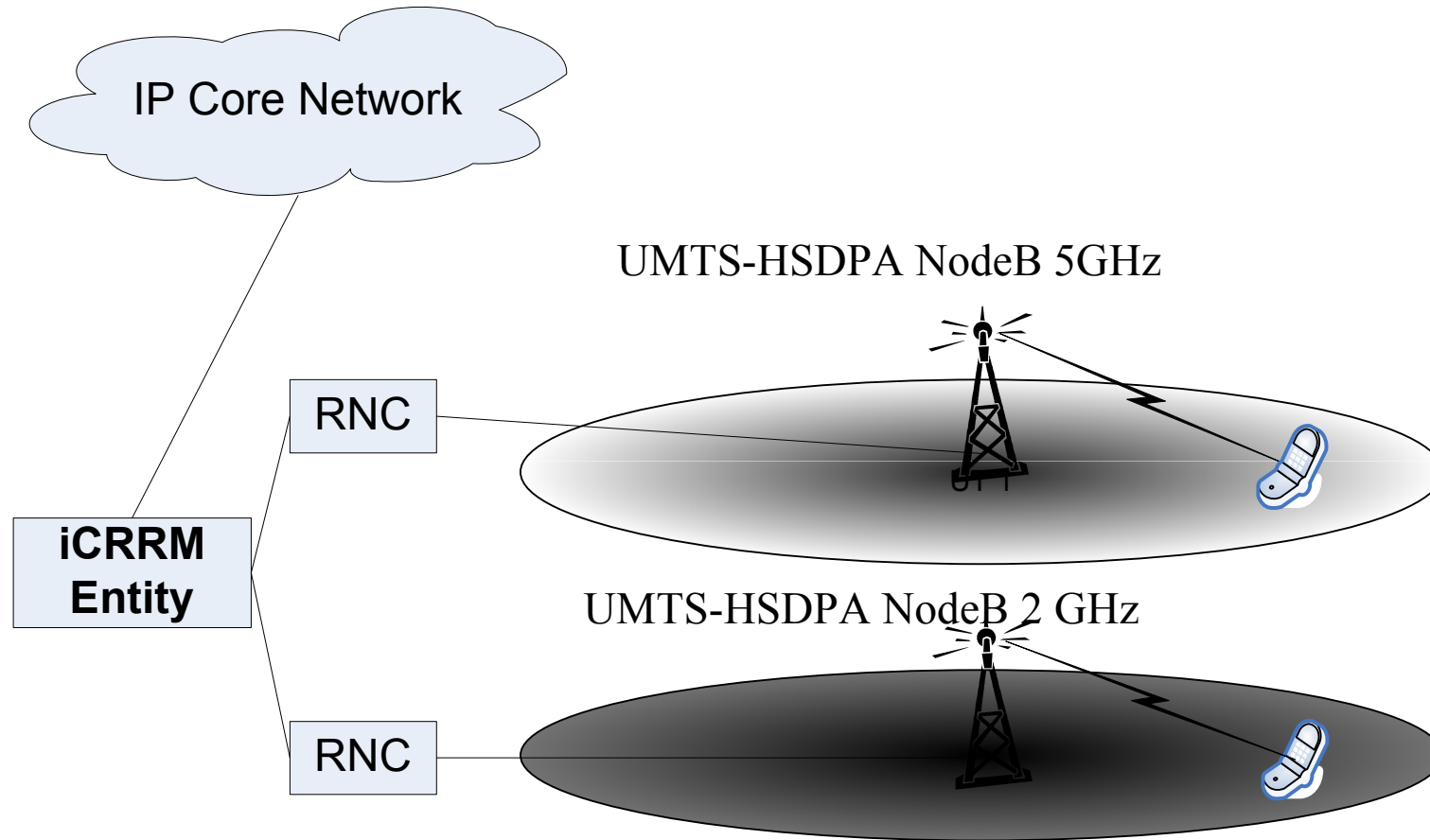
100 WiFi devices

Base stations
Smartphones
Cameras
Laptops



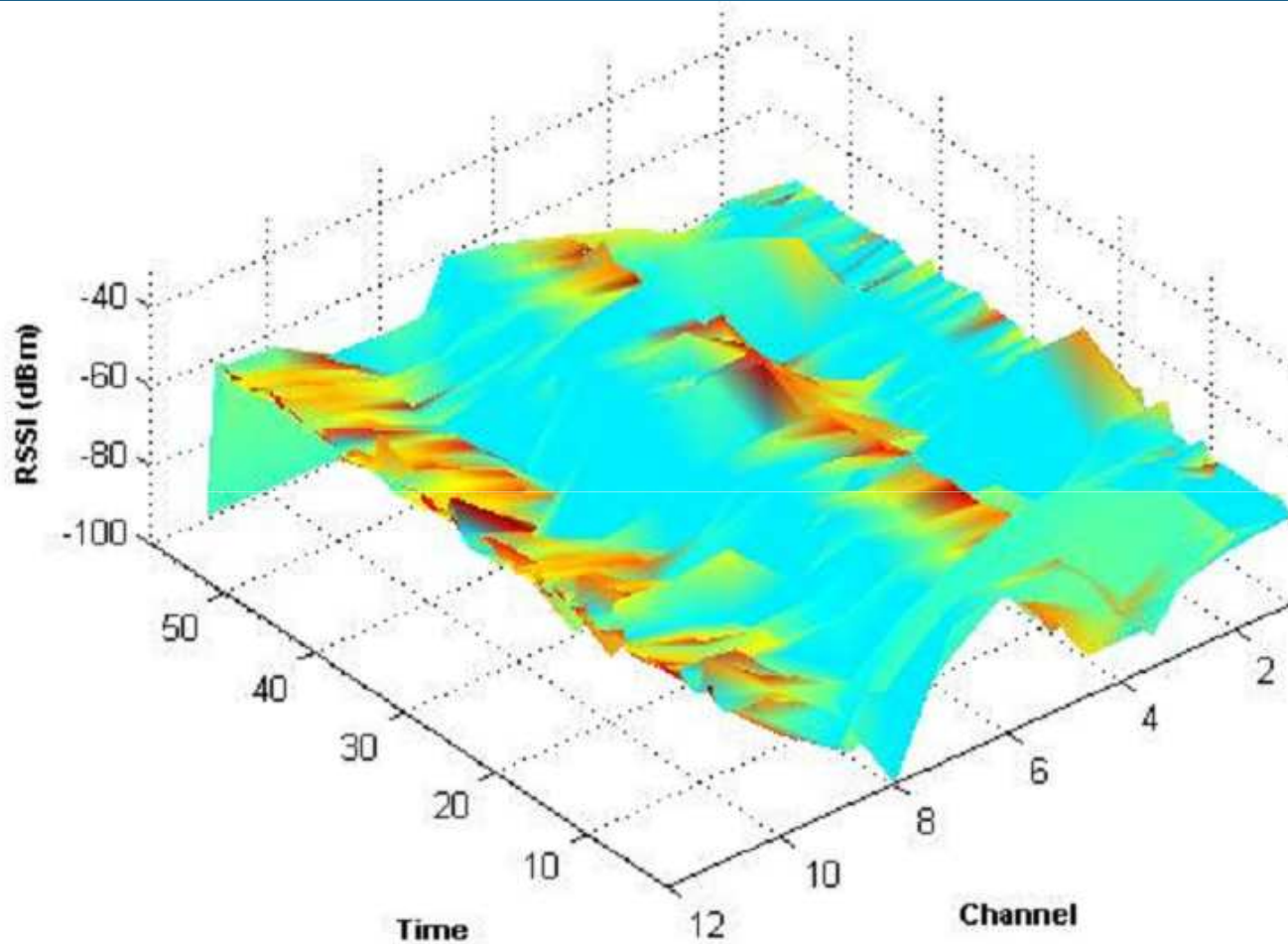
Source: Matthias Barrie, Vânia Gonçalves, *Vrije Universiteit Brussel, Belgium*,
“Techno-economical Viability of Cognitive Solutions for a Factory Scenario”

Integrated Common RRM



Source: O. Cabral, Fernando J. Velez et al., *Instituto de Telecomunicações - UBI*,
“Integrated Common Radio Resource Management with Spectrum
Aggregation over Non-Contiguous Frequency Bands”

ISM Band Interference Measurement



Source: John Sydor, *CRC Canada*, “CORAL Cognitive Radio Development platform for ISM bands. CRC's work on ISM Band Interference Measurement”

WG2 Input to January 2011 Meeting

- John Sydor, *CRC Canada*, “CORAL Cognitive Radio Development platform for ISM bands. CRC's work on ISM Band Interference Measurement”
- Jens Zander, *KTH*, “QUASAR Secondary Spectrum Assessment Methodology”
- Matthias Barrie, Vânia Gonçalves, *Vrije Universiteit Brussel, Belgium*, “Techno-economical Viability of Cognitive Solutions for a Factory Scenario”
- Jiangzhou Wang, *University of Kent, UK*, “Cooperative spectrum detection in cognitive radio based distributed antenna systems”
- Yan Zhang, *Simula, Norway*, “Cooperative spectrum sensing”
- Wim Kotterman, *Fraunhofer IIS*, “Over-The-Air Test Vision for CR Nodes”
- O. Cabral, Fernando J. Velez et al., *Instituto de Telecomunicações - UBI*, “Integrated Common Radio Resource Management with Spectrum Aggregation over Non-Contiguous Frequency Bands”

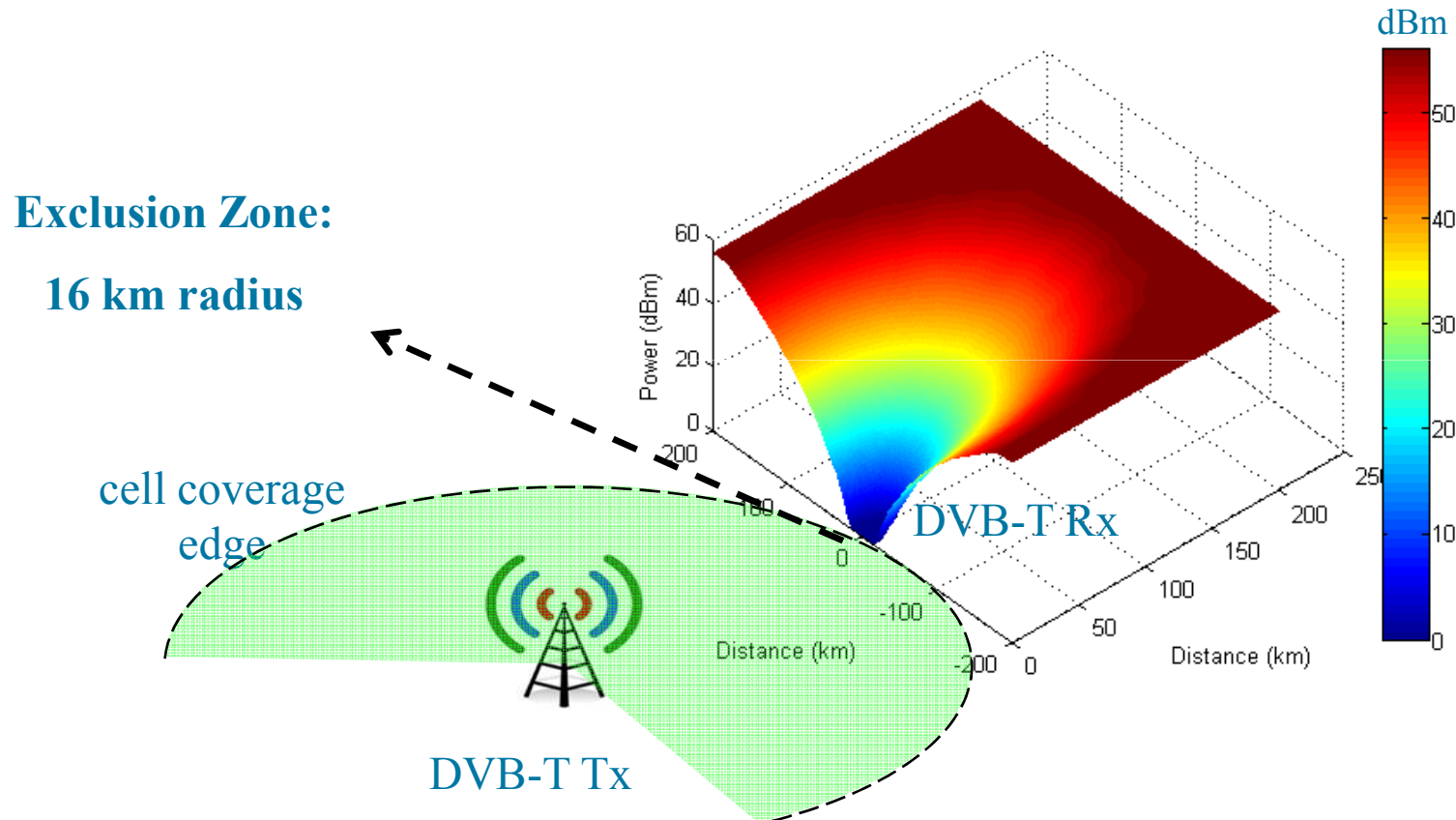
WG2 Input to June 2011 Meeting

- In June meeting WG2 dealt with 3 key topics:
 1. Coexistence studies on TV band and Digital Dividend (exclusion area computations, interference analysis)
 2. Experimental studies and application areas of CRS (radio environment maps, smart grids)
 3. Techniques for coexistence (beamforming and load balancing over networks/bands for greener communications)

1st scenario: DVB-T vs LTE BS

(DVB-T & Wireless Microphone Exclusion Area)

➤ Results for 1% of probability of interference $C/N = 21$ dB



Source: Rogério Dionisio, Instituto de Telecomunicações, Portugal & COGEU.
DVB-T and Wireless Microphone Exclusion Area Computation

White Space estimation in TV bands

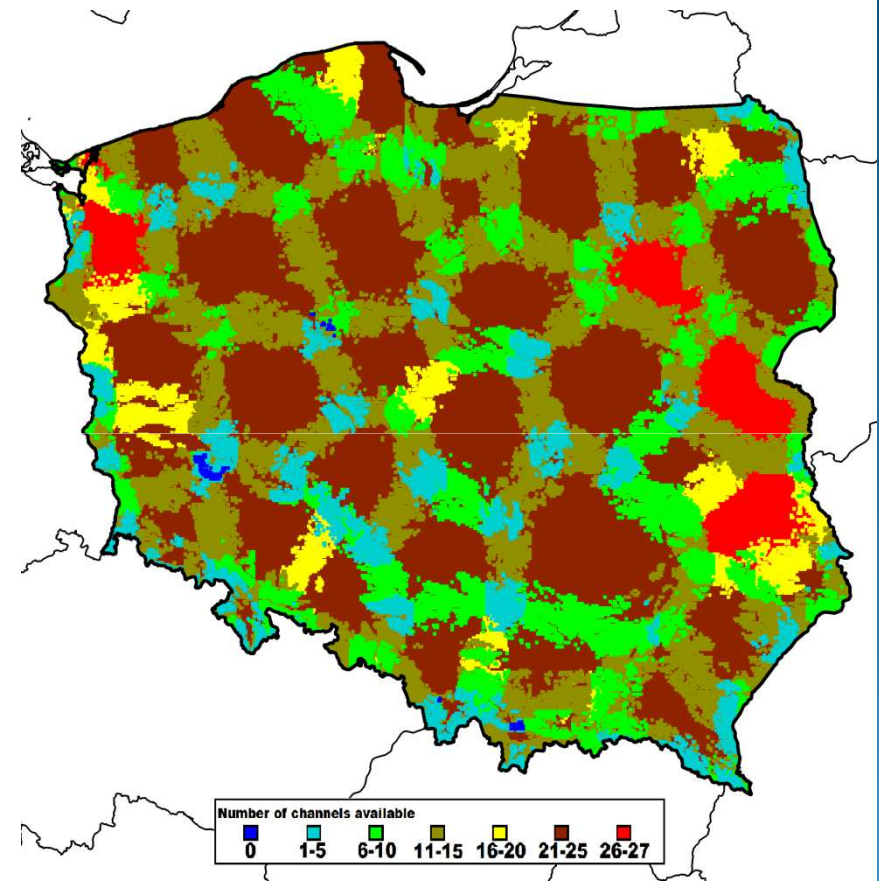
Main conclusions:

It is possible to establish methodology based on current interference levels in TV bands which can result in much more TV channels availability assuring protection to the GE06 Plan entries

Based on such methodology it can be expected an average around **10-15 channels available in each country** areas depending on local conditions

Such **method** may be used **internally** by the **Administrations** for establishing country geolocation database providing necessary separation distances from the borders or may be internationally accepted and then widely used.

Source: Dariusz Wiecek, National Institute of Telecommunications, Poland.
Methodology of White Space in TV bands estimation based on ITU GE06 rules.



WG2 Input to June 2011 Meeting

- Dariusz Wiecek, National Institute of Telecommunications, Poland. Methodology of White Space in TV bands estimation based on ITU GEo6 rules.
- Auon Akhtar, Oliver Holland, King's College London, UK. Cooperative Cognitive Radio Beamforming in the Presence of Location Errors.
- Rogério Dionisio, Instituto de Telecomunicações, Portugal & COGEU. DVB-T and Wireless Microphone Exclusion Area Computation.
- Roel Schiphorst, University of Twente, The Netherlands. Analysis of interference to CaTV due to mobile usage in the Digital Dividend.
- Oliver Holland, KCL UK; Fernando Velez & O. Cabral, UBI Portugal. Opportunistic Load and Spectrum Management for Mobile Communications Energy Efficiency.
- John Sydor, Salim Hanna, Bernard Doray and Li Pan, CRC Canada. Extracting Radio Environment Information from an ISM Band CR Network.
- Yan ZHANG, Simula Research Lab & University of Oslo, Norway. CR-based Smart Grid: Communications Architecture and Joint Spectrum Management.

Main Areas for Future Work

- Close cooperation with WG1 on the identified CR/SDR deployment scenarios to devise and carry out the technical co-existence studies that would result in identification of essential technical rules/conditions for CR/SDR:
 - TV white spaces;
 - ISM bands;
 - Cellular communication bands, e.g., spectrum aggregation;
 - (...)
- Techniques and rules for coexistence.
- Simulation/experimental studies for coexistence.
- Coexistence activities in different standardization and regulation bodies.
- Feeding some of the ideas/findings into various organisations.



Questions?

Marja.Matinmikko@vtt.fi
fjv@ubi.pt