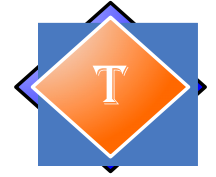




Ss. Cyril and Methodius University in Skopje

Faculty of Electrical Engineering and
Information Technologies (FEEIT)

Institute of Telecommunications (ITK)



Practice Cases in Network and Service Infrastructures – The Future Internet Research activities - **WiNGroup**

Prof. Liljana Gavrilovska

Faculty of Electrical Engineering and Information Technology

Workshop

“Promoting Western Balkan research excellence in the
fields of eHealth and Network & Service Infrastructures”



ICT – WEB PROMS Workshop 10.05.2010, Skopje

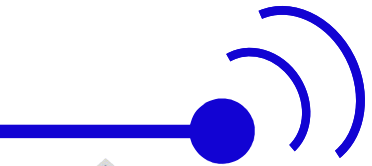
Outline



- About WiNGroup
- Participation in research projects
 - EU funded, NATO funded, domestic...
- The Future

About WiNGroup (1)

- Faculty of Electrical Engineering and Information Technologies (FEEIT)
 - Institute of Telecommunications (ITK)
 - **Center for Wireless and Mobile Communications (CWMC)**
 - **Wireless Networks Group**
Leader: Prof. Liljana Gavrilovska



About WiNGroup (2)



- Research oriented group specializing in wireless and mobile networking
 - **WiNGroup = Wireless Networks Group**
- Special attention on:
 - Reconfigurability in future heterogeneous wireless systems
 - Interoperability of different wireless systems
 - Cognitive radio and policing spectrum usage
 - Dynamic spectrum access
 - Cross-layer optimizations in wireless protocol stacks
 - Resource management in future heterogeneous wireless systems
 - Sensor networking and RFID
 - User personalization aspects
- Members
 - Prof. Liljana Gavrilovska, PhD
 - WiNGroup Leader
 - Assist. Vladimir Atanasovski, MSc
 - Assist. Pero Latkoski, MSc
 - Valentin Rakovic, BSc
 - Daniel Denkovski, BSc
 - Ognjen Ognenoski, BSc
 - Valentina Pavlovska, BSc
 - Aleksandra Mateska, BSc
 - Bisera Jankuloska, BSc
 - Milan Zahariev, BSc
 - Mihajlo Pavloski, BSc

Ongoing International Projects



- **ARAGORN**, FP7-ICT-2007-1, 216856
 - <http://www.ict-aragorn.eu/>



- **QUASAR**, FP7-ICT-2009-4, 248303
 - <http://www.quasarspectrum.eu>



- **FARAMIR**, FP7-ICT-2009-4, 248351
 - <http://www.ict-faramir.eu/>



- **ProSense**, FP7-REGPOT-2007-3, 205494
 - <http://www.prosense-project.eu/>



- **RIWCoS**, NATO Science for Peace (SfP) Programme, 982469
 - <http://riwcos.comm.pub.ro/>



FP7 ARAGORN Project (ICT-216856, STREP) (1)

Factsheet



- **The acronym = Adaptive Reconfigurable And Generic interfaces for Optimization in Radio Networks**
- **Partners**
 - RWTH Aachen University, Germany
 - ST Microelectronics, Italy
 - EMIC European Microsoft Innovations Center GmbH, Germany
 - Toshiba Research Europe Ltd., United Kingdom
 - University College London, United Kingdom
 - Consorzio Ferrara Ricerche, Italy
 - **University Ss. Cyril and Methodius, Skopje, Faculty of Electrical Engineering and Information Technologies, Macedonia**
 - Huawei Technologies Sweden AB, Sweden
- **Frame**
 - Duration: January 2008 – August 2010

FP7 ARAGORN Project (ICT-216856, STREP) (2)

Goals



- Study, propose and implement appropriate methods to provide cross-layer optimization for wireless communications
- Develop and implement a **Cognitive Resource Manager (CRM)** using machine learning and artificial intelligence algorithms
- **Design interfaces for CRM** to access the state information and update the parameter configuration in a cross-layer fashion
- Develop a **policy system** to constraint and prioritize spectrum and network resources usage, as well as determine user priorities
- Experimentally test and validate the system

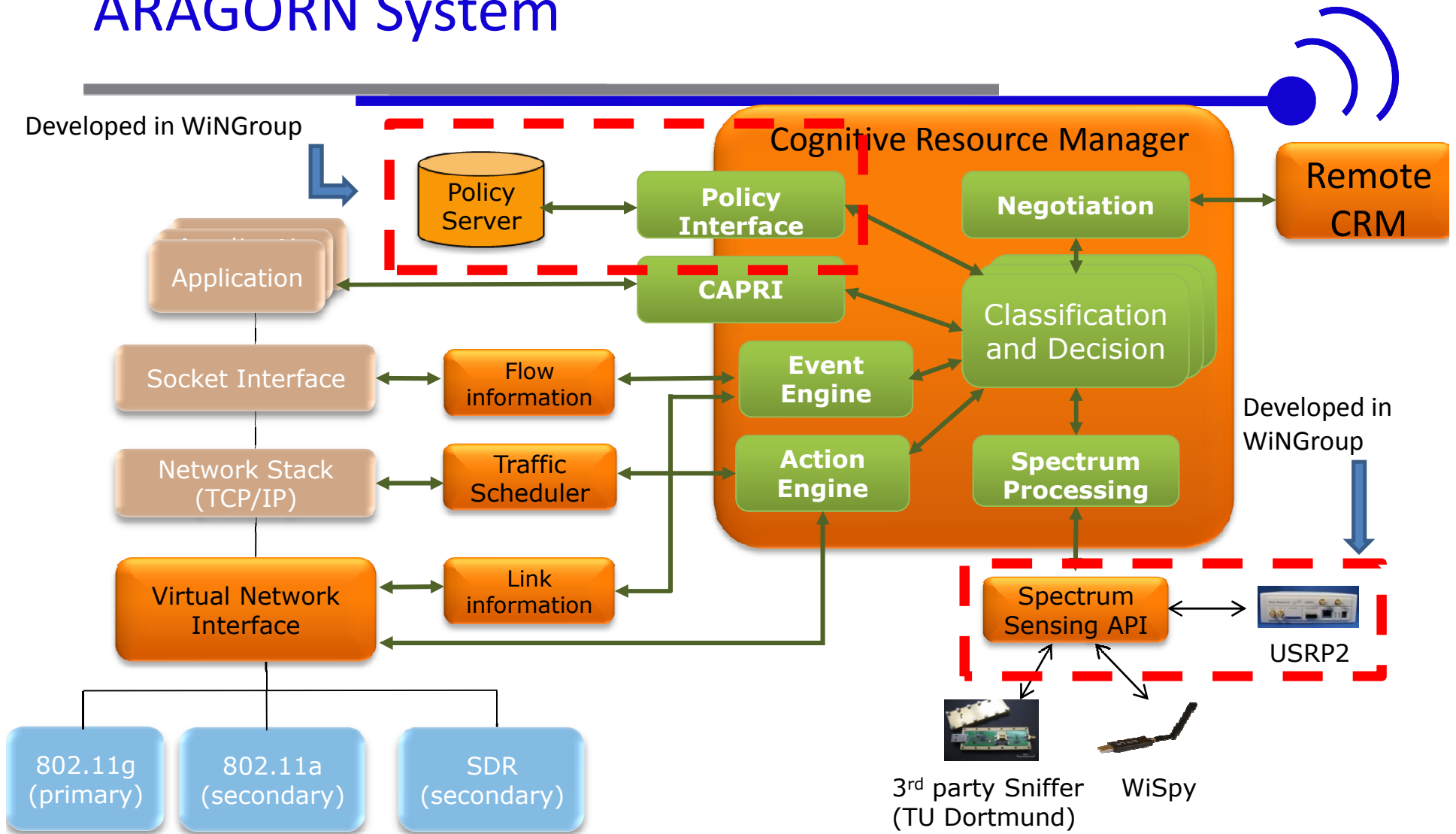
FP7 ARAGORN Project (ICT-216856, STREP) (3)

WiNGroup's Contribution

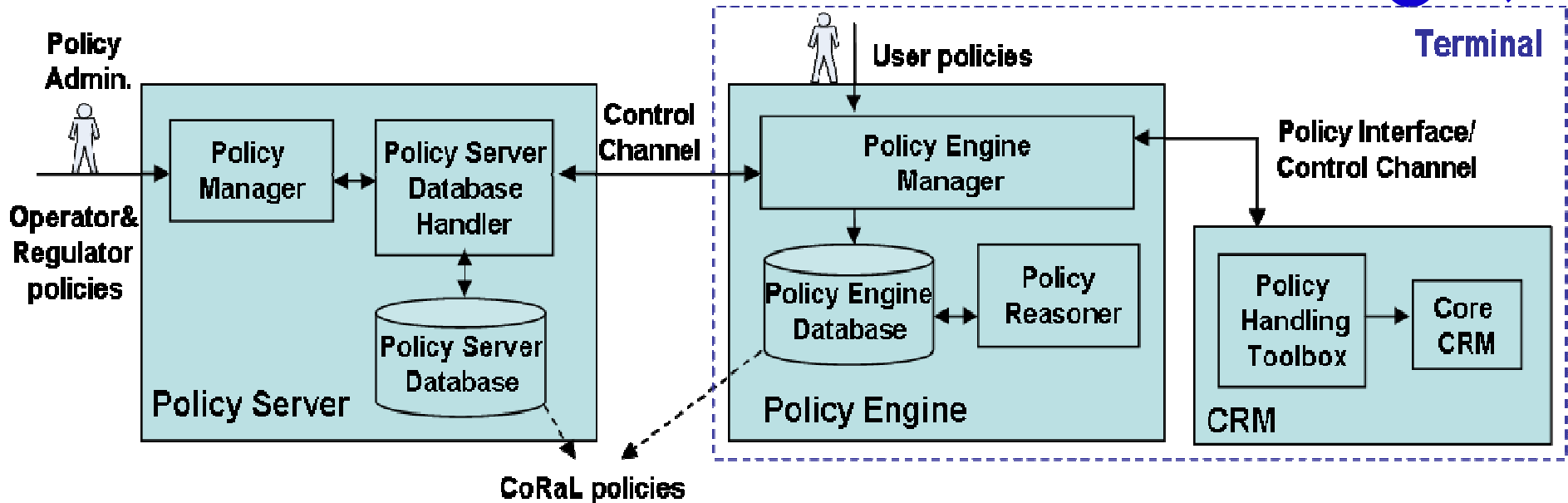
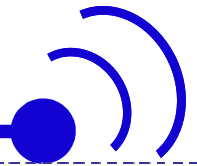


- Definition of a policy system (server, reasoner, protocol) for cognitive environments
- Design of cooperative spectrum resource management techniques in ISM-bands using USRP2s
- Prototyping and scenarios
- Dissemination and exploitation

ARAGORN System



Policy System Within



```

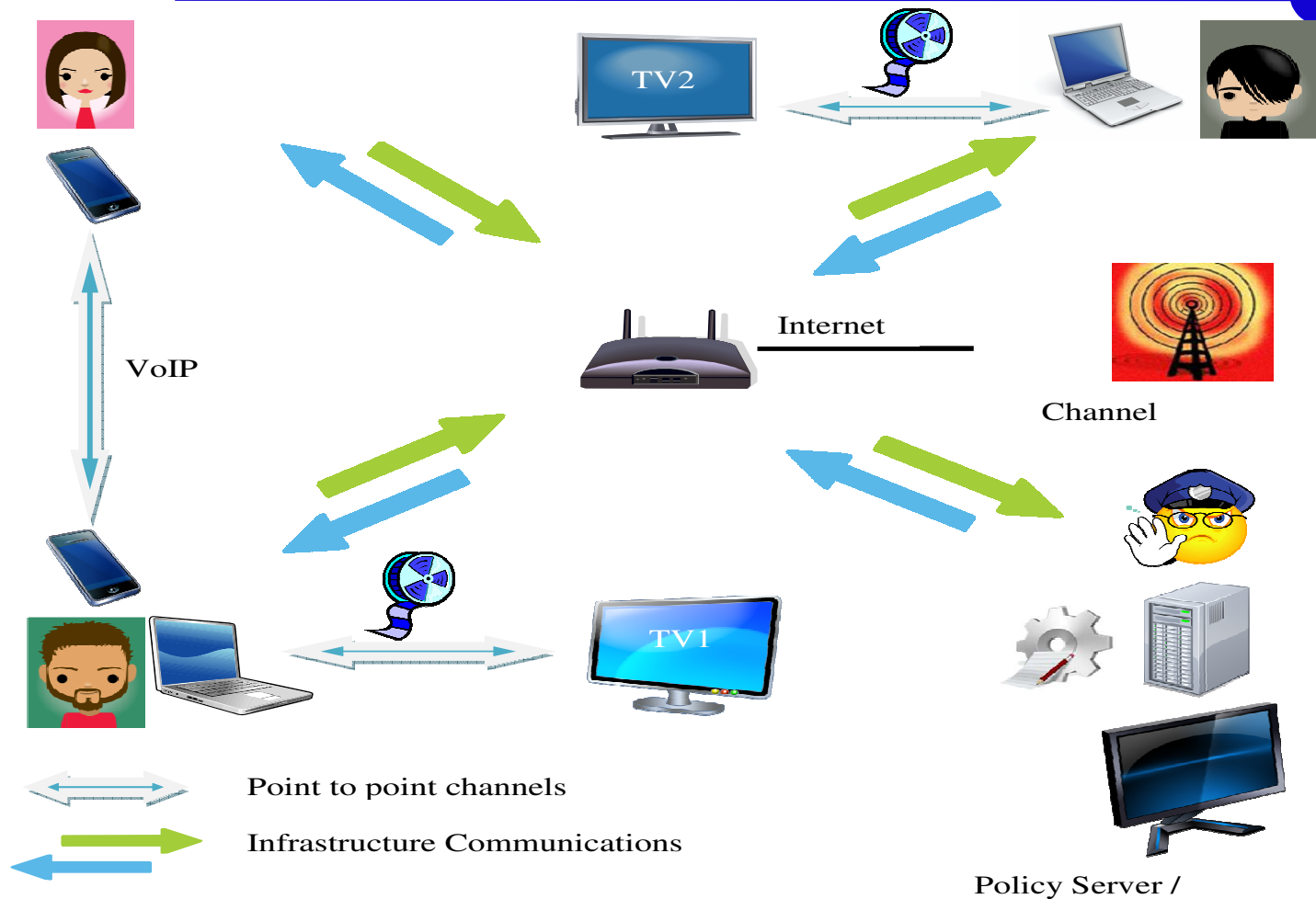
policy policy1WiFi is
  use request_params;
  allow if
    centerFreq(req_transmission) in [2412000,2432000] and
    bandwidth(req_transmission) =< 20000 and
    meanEIRP(req_transmission) =<30 and
    rat(req_transmission) in [ieee80211b, ieee80211g] and
    hourOfUsage(req_transmission) in {23..7}
end;
    
```

```

policy appVideo is
  use request_params;
  allow if
    application(req_transmission) = video
  and
    priority(req_transmission) = 4;
end;
    
```

ARAGORN for Home Networking (1)

IEEE DySPAN 2010 (Singapore)



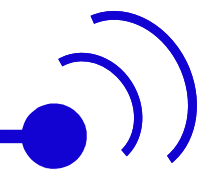
ARAGORN for Home Networking (2)

Demonstrated features

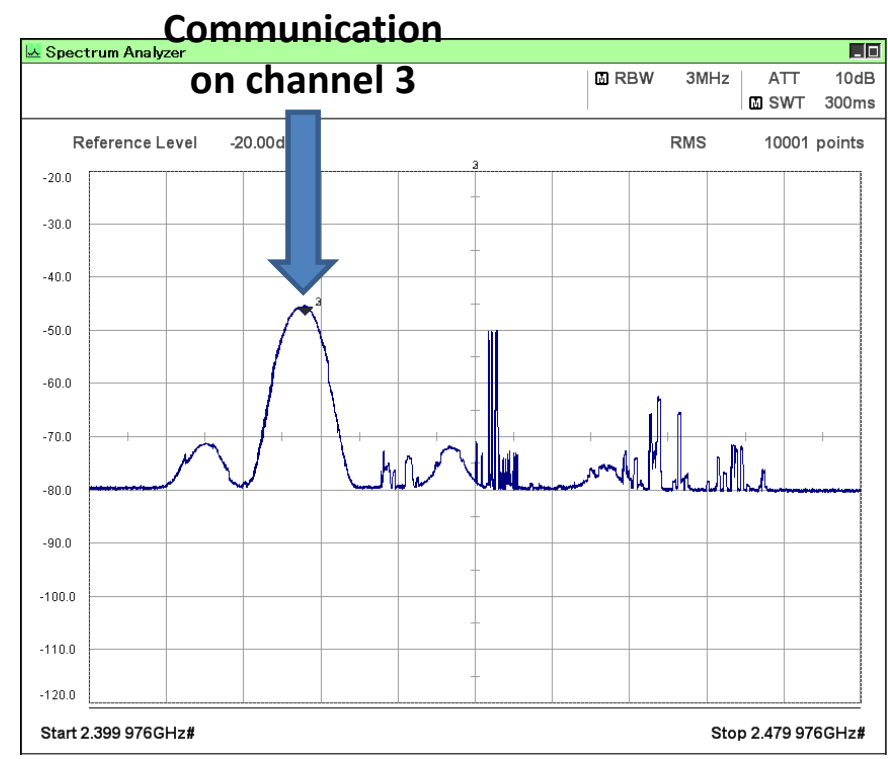
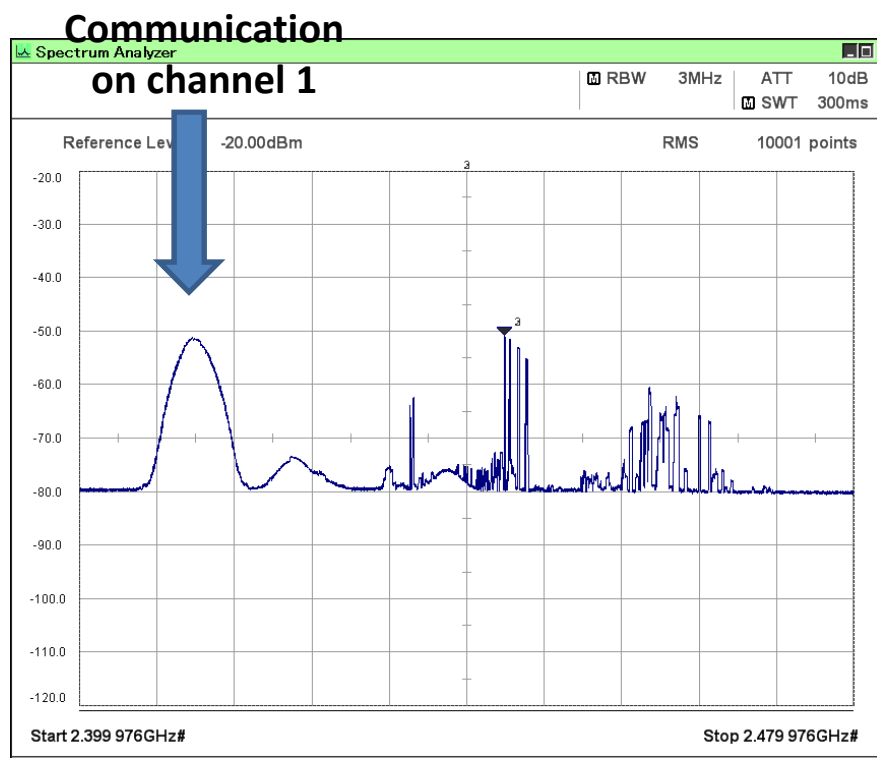


- Cognitive Resource Management architecture
- Cross-layer optimization and interference management
- Policy management and application priorities through hierarchical policy servers

Snapshots



- Policy regulated spectrum management
- Opportunistic usage of available WiFi channels and spectrum handover whenever necessary



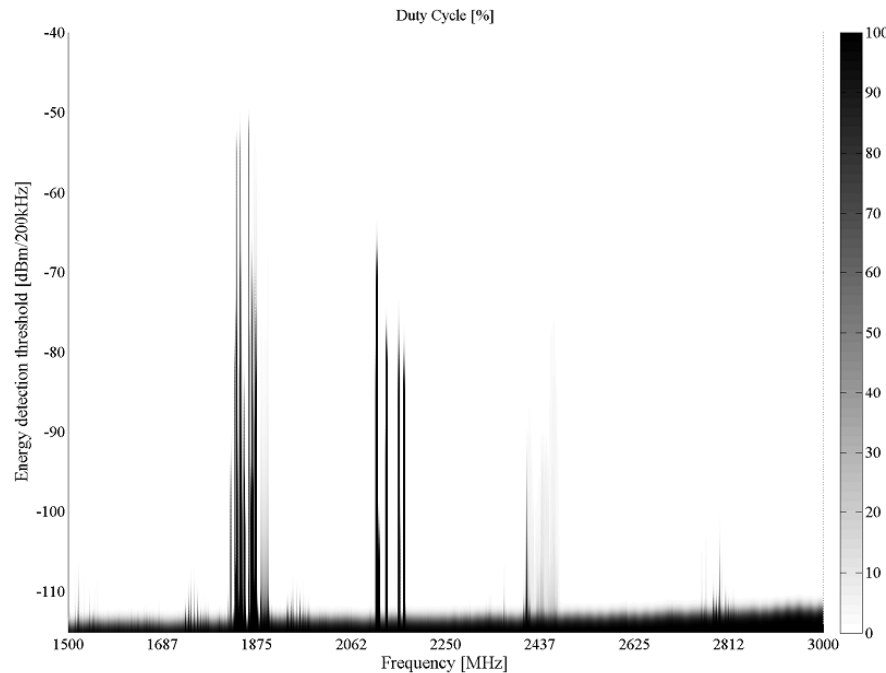
FP7 QUASAR Project (ICT -248303, STREP) (1)

Factsheet



- **The acronym = QU**antitative **A**ssessment of **S**econdary Spectrum **A**ccess
- **Partners**
 - Royal Institute of Technology (KTH), Sweden
 - Ericsson AB, Sweden
 - RWTH Aachen University, Germany
 - Aalto University, Finland
 - Yonsei University, Republic of Korea
 - British Telecommunications PLC (BT), UK
 - Bundesnetzagentur, Germany
 - **Ss. Cyril and Methodius University in Skopje (UKIM), Macedonia**
 - Post & Telestyrelsen (PTS), Sweden
 - Office of Communications (OFCOM), UK
 - Finish Comm. Reg. Authority (FICORA), Finland
- **Frame**
 - Duration: January 2010 – June 2012

Low spectrum occupancy?



- QUASAR aims to:
- Remove the hype about the CR and DSA discussion
- Justify and quantify the spectrum opportunity models
- Enable real business and deployment decision

FP7 QUASAR Project (ICT -248303, STREP) (2)

Goals



- Assess and quantify the “real-world” **benefits of secondary (opportunistic)** access to primary (licensed) spectrum
 - => Investigation of the impact of opportunistic spectrum access on primary system performance
- **Spectrum discovery** (detect the spectrum holes, and discover real spectrum opportunities)
- Developing detailed **methods to assess the impact** of multiple secondary users
- Multi-parameter and **utility based assessment of spectrum value (opportunities)**
- Detailed roadmaps and guidelines on how to apply and analyze **new opportunistic spectrum access business models**

FP7 QUASAR Project (ICT -248303, STREP) (3)

WiNGroup's Contribution



- Performance of opportunity discovery schemes
 - Define performance measures/metrics for spectrum opportunity discovery schemes
 - Validate the developed methodology/metrics via laboratory tests
- Secondary users spectrum sharing
 - Develop models for the combined interference from multiple secondary system users under different sharing policies
 - Investigate and develop secondary usage strategies and mechanisms for multiple secondary system users
 - Develop cooperation strategies for secondary users
- Spectrum availability assessment
 - Develop models for spectrum usage
 - Develop methods and tools to estimate the availability of spectrum for secondary use
- Dissemination and exploitation

FP7 FARAMIR Project (ICT -248351, STREP) (1)

Factsheet



- **The acronym = Flexible and spectrum-Aware Radio Access through Measurements and modeling In cognitive Radio systems**
- **Partners**
 - RWTH Aachen University, Germany
 - Interuniversitair Micro-Electronica Centrum VZW, Belgium
 - Universitat Politecnica de Catalunya, Spain
 - Huawei Technologies Sweden AB, Sweden
 - Toshiba Research Europe Limited, UK
 - Institute of Accelerating Systems and Applications, Greece
 - Thales Communications SA, France
 - **Ss. Cyril and Methodius University in Skopje (UKIM), Macedonia**
 - France Telecom, France
 - Bundesnetzagentur für Elektrizität, Gas, Telekommunikation, Post und Eisenbahnen, Germany
- **Frame**
 - Duration: January 2010 – June 2012

FP7 FARAMIR Project (ICT -248351, STREP) (2)

Topic



- **Cognitive radio** and **cognitive wireless networks** as a new paradigm to reduce complexity of wireless systems
- Cognitive radio research is still conceptual, with not well understood potential
- FARAMIR aims to bring the SoA in cognitive radio to factual engineering science and business
- Enablers: **increased radio environmental and spectral awareness** for cognitive radios

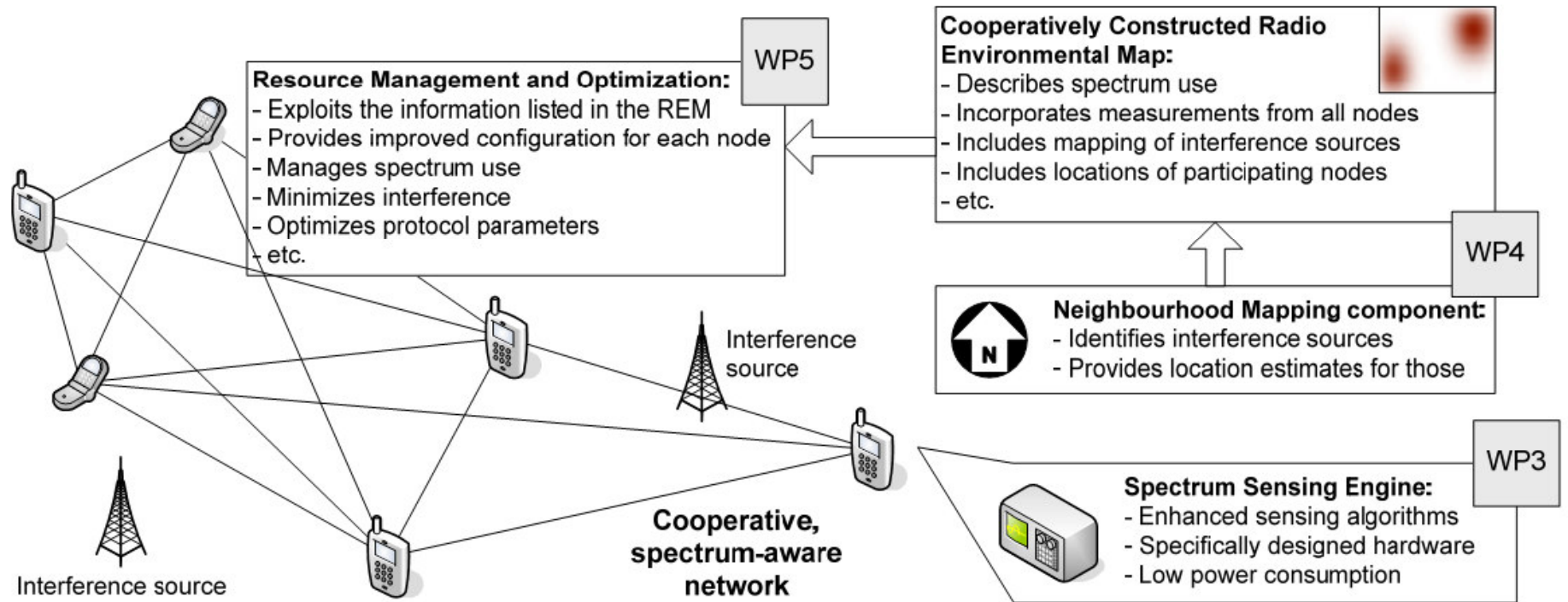
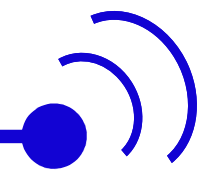
FP7 FARAMIR Project (ICT -248351, STREP) (3)

Goals



- Develop a comprehensive technology chain and show how radio environmental information can be measured, collected and represented efficiently
 - Usage of **Radio Environmental Map (REM)** techniques
- Conduct **spectrum occupancy measurements** in several European sites with different equipment and frequency bands
- Develop necessary data models, software and protocol frameworks for exchanging spectrum data
- Develop new empirical spectrum occupancy models
- Develop CMOS Spectrum Sensing Prototype (SSE)
- Develop novel “neighborhood and direction of interference source” concept
- Develop radio resource management concepts
- Evaluate developed spectrum sensing, REM and Cognitive Resource Management technologies in the context of full system models
- Pursue **standardization (SCC41/P1900; ETSI)**

FARAMIR Project structure



FP7 FARAMIR Project (ICT -248351, STREP) (4)

WiNGroup's Contribution



- Definition of a **system architecture for sensing and spectrum management**
- Evaluation and further definition of **spectrum sensing concepts and empirical models of spectrum usage**
- **Cooperative spectrum sensing** and neighborhood mapping
 - Develop algorithms for distributed spectrum sensing and test their performance through measurements
- **Resource management** for adaptive and flexible spectrum systems
- **Prototyping and field testing** (**UKIM is the leader of this task**)
- Exploitation and dissemination

FP7 ProSense Project (SSA-205494) (1)

Factsheet



- **The acronym = Promote, Mobilize, Reinforce and Integrate Wireless Sensor Networking Research and Researchers: Towards Pervasive Networking of WBC and the EU**
- **Partners**
 - Ericsson Ireland Research Centre (EIRC), Ireland
 - **University Ss. Cyril and Methodius, Skopje, Faculty of Electrical Engineering and Information Technologies, Macedonia**
 - INRIA, France
 - Department of Electronic, Electrical and Computing Engineering, University of Birmingham, UK
 - Institute of Telecommunications, Warsaw University of Technology, Poland
 - Research Academic Computer Technology Institute (CTI), Greece
 - School of Electrical Engineering, University of Belgrade, Serbia
 - Department of Communication Systems, Jozef Stefan Institute, Slovenia
- **Frame**
 - Duration: March 2008 – August 2010

FP7 ProSense Project (SSA-205494) (2)

Goals



- Improve the **wireless sensor networking research capacity** and capability of two selected WBC centres of excellence (Skopje and Belgrade) in terms of scientific and technical human resources and S&T infrastructure to enable them to drive and actively contribute to this research field
- **Promote and reinforce researchers** and research institutions from the EU's convergence regions
- **Build a sustainable cooperation framework** to support continuous collaboration in the **wireless sensor networking research** field between research institutions based in the WBC, the EU's convergence regions and Member States, particularly under the FP7 framework
- **Establish** means for **closer collaborations** of the WBC research centres and researchers from the WBC region that have left the region to prevent brain drain and support brain gain
- **Disseminate** economic and social benefits of potential key applications for the region and identify newly accessible market niches within the EU and WB countries to generate interest and opportunities for the local industry and particularly SMEs

FP7 ProSense Project (SSA-205494) (3)

WiNGroup's Contribution



- Research infrastructure improvement
 - Procurement of Sun SPOTs + RFID kits
 - Development of several use-cases (e.g. vehicular communications, smart home, forest fire protection etc.)
 - Interconnecting the sensor network with other partners and creation of a web based remote access to the deployed sensor networks
 - Demonstration of the application of the upgraded research infrastructure
- Researchers mobility
 - Young researchers mobility (from FEEIT to EU research centres)
 - Experienced researchers mobility (form EU to FEEIT)
- FEEIT FP7 integration
- Dissemination and Exploitation
 - Cross-fertilize research communities and initiate multidisciplinary research work in the targeted regions

NATO SfP-982469 RIWCoS Project (1)

Factsheet



- **The acronym = Reconfigurable Interoperability of Wireless Communications Systems**
- **Partners**
 - University POLITEHNICA of Bucharest, Romania
 - University Ss. Cyril and Methodius, Skopje, Faculty of Electrical Engineering and Information Technologies, Macedonia
 - Aalborg University, Denmark
 - University of Peloponnese, Greece
- **Frame**
 - Duration: October 2007 – July 2010

NATO SfP-982469 RIWCoS Project (2)

Goals



- Definition of a flexible architecture for a service delivery platform that manages a reliable data content distribution through any wireless access networks to mobile and residential end-users
- Develop service scenarios for data content distribution over this platform (heterogeneous wireless access technologies)
- Define, develop and implement a Resource Management System of the resulting hybrid communication network, able to ensure the fast reconfigurability of the network in a secure manner
- Definition, selection, design, configuration, development and implementation of a networking infrastructure (including DVB-T, DVB-H, HSDPA/UMTS, WLAN, WMAN) and integration of these technologies in the experimental platform
- Execution of real-time experiments to demonstrate the functionalities of the system, conduct performance measurements and validate the efficiency of the Resource Management System

NATO SfP-982469 RIWCoS Project (3)

WiNGroup's Contribution



- Definition of a hybrid wireless system architecture for resource management
- Specification, development and performance evaluation of a resource management system for an interoperable heterogeneous networking environment
 - A unique SDL+QualNet platform
- Prototype of a reconfigurable terminal (3G, WiFi, Ethernet)

Relevant Past International Projects



- **MAGNET Beyond, FP6**
 - *Prof. Gavrilovska was Deputy Coordinator/Technical Project Manager with affiliation to the Aalborg University, Denmark*
- FP6-IST **MAGNET**
- FP5-IST **PACWOMAN**
- ACTS FP4 **ASAP**
- Several **TEMPUS** projects

Past Domestic Projects

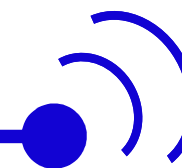


- “Providing reliable ad-hoc communication in emergency situations”
 - financed by the Ministry of Education and Science of the Republic of Macedonia
- several in the field of performance analysis of IEEE 802.11 WLANs
 - financed by the Ministry of Education and Science of the Republic of Macedonia and GTZ

The Future

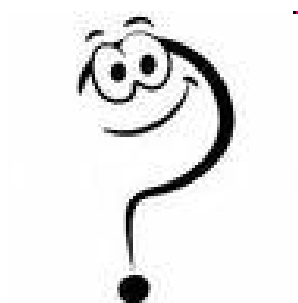


- Participation in the NoE project **ACROPOLIS**
 - Also in the cognitive radio research area
- **EHM** – from the SEE-ERA.NET PLUS call
 - Passed the first evaluation, awaiting final evaluation
- Involvement in COST action IC0902 (cognitive networking aspects)
- Cooperation with local SMEs for providing different technical solutions for third party beneficiaries
- Cooperation with local telecommunications companies in terms of consultancy, knowledge sharing, joint project proposals preparation, continued education



THANK YOU!

Questions?



Contact: liljana@feit.ukim.edu.mk