TUCN RESEARCH CONFERENCE – 15.12.2014

Communications Department

Energy Efficiency in Cognitive Wireless Networks

Project manager:

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Project team

Coordinator: Ligia Cremene, Ph.D
Members: Mihai Suciu, Ph.D, Noemi Gasko, Ph.D

In collaboration with the Centre for the Study of Complexity, UBB, http://csc.centre.ubbcluj.ro

Project manager – brief presentation

Romanian Academy Award 2012

Ericsson Award for Excellence in Telecommunications 2006

Over 50 scientific works among which 42 indexed scientific papers (7 ISI journal papers, 13 ISI proceedings papers, 6 book chapters (Springer), 16 IDB (9 journal papers + 7 conf. proc.), 2 books, one manual, an edited book.

Over 20 scientific and technical reports presented at national and international scientific events.

7 national competition grants, 5 international projects

1 patent (OSIM), 2 patents pending (OSIM).

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Summary

A new power coordination model for mitigating interference and energy consumption in cognitive wireless networks was proposed.

The model was adopted as a pivotal solution for the ISM-Advanced concept (COST-TERRA IC0905 Action) that proposes novel spectrum access rules for unlicensed frequency bands.

Furthermore, the possibility of eliminating the EIRP limit has been demonstrated (100mW in the 2.4 GHz band and 250mW in the 5 GHz band).

General context / problem

Inefficient use of radio resources

Deregulation of the frequency spectrum

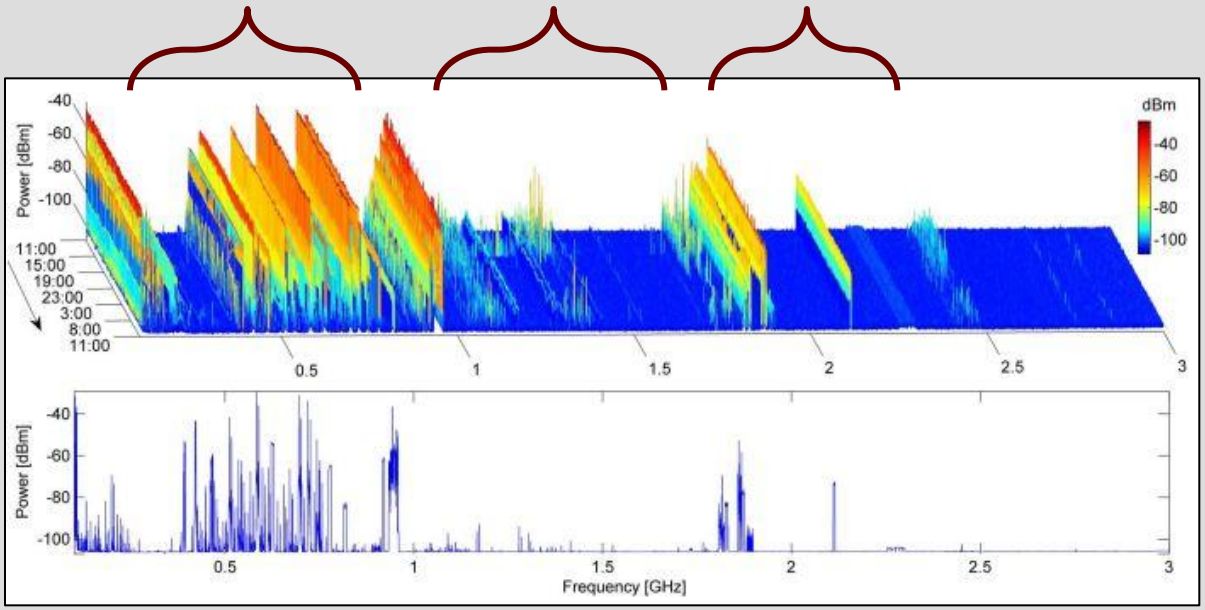
Crowding of the unlicensed bands

Need for dynamic radio access

Interference mitigation

Solutions

Highly used low medium



Cognitive Radio (CR)

Game Theory (GT)

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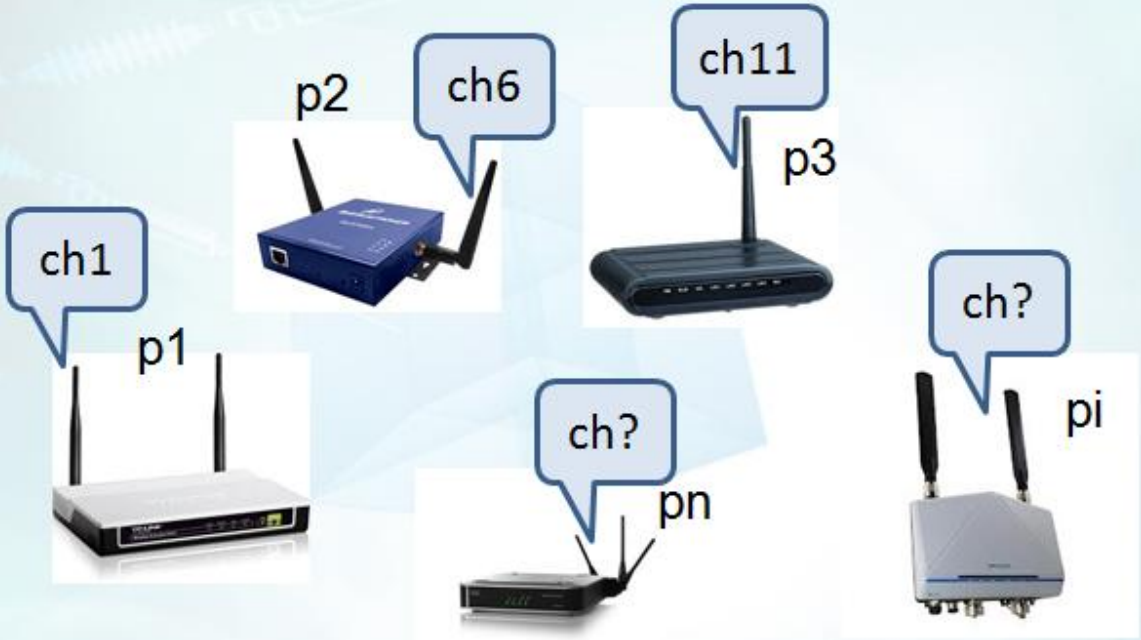
It was posited that,

With appropriately designed rules, the CR-enabled devices should be perfectly capable of choosing most appropriate transmit power while seeking the optimum compromise between link range/quality, ambient interference level, and its own energy consumption.

Conceptual and computational framework to solve this → Game Theory

CR interactions are strategic interactions: each player's payoff depends on the other players' actions.

(basis of GT)



RESOURCE ACCESS

CRs are independent, autonomous decision makers

Objectives & Activities

Main objective:
Introducing new distributed power allocation algorithms for energy efficiency in cognitive wireless networks.

Activities:
- Investigate optimality of Nash equilibrium in interference-aware power coordination games
- Choose and adjust the appropriate GT model
- Design and test GT-based algorithms
- Demonstrate convergence to stable states (e.g. NE)

Additional objectives&activities: experimental validation of the proposed algorithms on real-world testbeds

Challenges

To establish realistic simulation scenarios

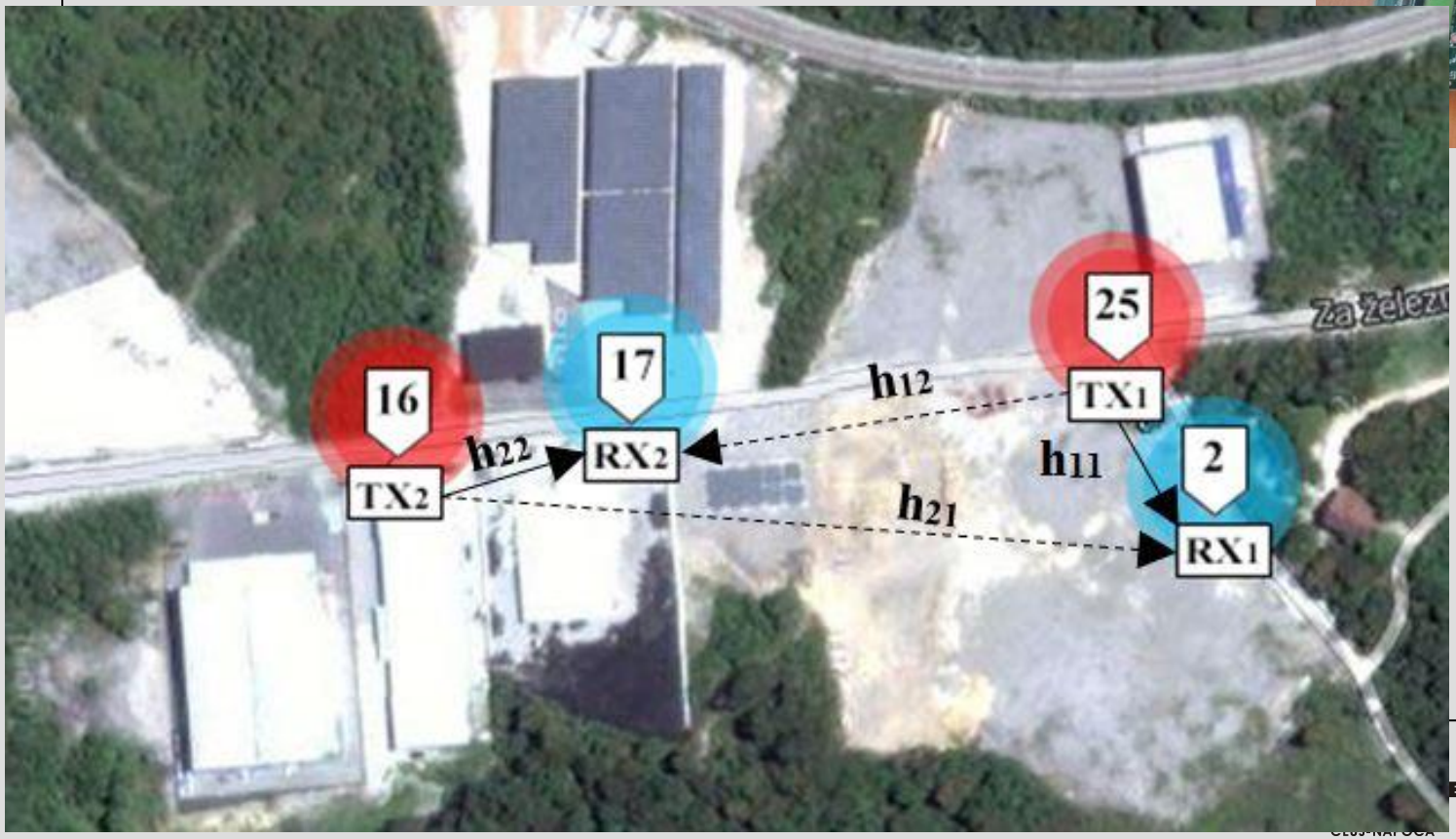
To design game scenarios that lead to stable states and to ensure that those equilibria are optimal

To devise simple, distributed algorithms to be embedded in the reconfigurable radio devices

To transfer theoretical concepts and models into practice.

First set of experiments conducted on real infrastructure by mixed team UTCN – JSI/ Ljubljana

LOG-a-TEC testbed (VESNA platforms)



Convergence to NE has been demonstrated

(lots of challenges on the hardware part)

Results

A new Interference-aware Power Coordination Game for ISM Bands

A set of energy-efficient interference coordination algorithms (that minimize power and maximize throughput)

First CR GT experiment on a real-world testbed (transferring a theoretical model into practice) - in collaboration with JSI Slovenia (lead to FP7 CREW Open Call)

Other experiments on real-world testbeds – in collaboration with VGTU Lithuania (COST Action IC0905 TERRA)

Publications 2014:
4 top conference papers
1 Springer book chapter
4 journal papers under review

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Published papers

T. Cuzanauskas, A. Medeisis, A. Anskaitis, L. Cremene, J. Sydor, O. Holland, Y. Haddad, M. Nekovee, "Interference-aware Power Coordination Game for ISM Bands", International ICST Conference on Cognitive Radio Oriented Wireless Networks and Communications - **CROWNCOM 2014**, Oulu, Finland, 2014.

A. Medeisis, J. Sydor, L. Cremene, O. D. Holland, A. Anskaitis, D. Wiecek, Y. Haddad, T. Cuzanauskas, ”ISM-Advanced: Improved Access Rules for Unlicensed Spectrum”, IEEE International Conference on Dynamic Spectrum Access Networks - **DySPAN 2014**, McLean, VA, USA, April 1-4, 2014.

C. Anton, A. Toma, L. Cremene, M. Mohorcic, C. Fortuna, "Power Allocation Game for Interference Mitigation in a Real-world Experimental Testbed", IEEE ICC 2014 - International Conference on Communications, Cognitive Radio and Networks Symposium - **ICC'14 CRN**, Sydney, Australia, June 2014.

Published papers

Medeisis, J. Sydor, L. Cremene, D. Wiecek, Y. Haddad, O. Holland, A. Anskaitis, T. Cuzanauskas, “ISM-Advanced band concept”, **Springer book chapter** in Cognitive Radio Policy and Regulation Techno-Economic Studies to Facilitate Dynamic Spectrum Access Series: Signals and Communication Technology, 2014.

L. Cremene, D. Dumitrescu, ”A Relevant Equilibrium in Open Spectrum Sharing: Lorenz Equilibrium in Discrete Games, the 14th Int. Conf. on Next Generation Wired/Wireless Advanced Networking - **NEW2AN 2014**.

Under review

L. Cremene, D. Dumitrescu, A. Vlaicu, ”Emergence of Techno-Social Norms in Cognitive Radio Environments”, under review at *Telecommunications Policy* .

A. Medeisis, L. Cremene, J. Sydor, O. D. Holland, A. Anskaitis, D. Wiecek, Y. Haddad, “A New Game for Future Wi-Fi Spectrum Sharing”, under review at *IEEE Communications Magazine*.

L. Cremene, N. Gasko, M. Suciu, D. Dumitrescu, A. Vlaicu, ”Scarce-Resource Capacity Sharing in Cognitive Radio Environments: A game theoretical approach”, under review at *IET Communications*.

M. Suciu, L. Cremene, C. Fortuna, M. Mohorcic, ”Cost-adaptive, Discrete-Power Interference Mitigation for Constrained Devices”, under review at *IEEE Transactions on Wireless Communications*.

Next steps

Expand the experimentation scenarios on the JSI testbed

Continue transferring theoretical models for efficient use of radio resources into practice

Integrating the validated GT-based model into new protocols

Investigating new capacity dynamics models.

How will the radio spectrum look like in 10 or 20 years from now on?

chaos

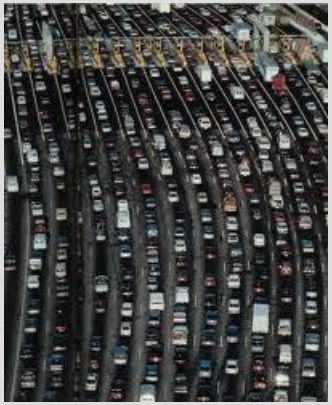
bottleneck

Central authority

Self-organization attempt

Emerging structure

whitespaces



Efficient use, full capacity

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