



SPORTVIEWS

Spectrum **P**olicies and **R**adio **T**echnologies **V**iable In **E**merging **W**ireless **S**ocieties

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Regulatory and Policy Implications of Emerging Technologies to Spectrum Management

January 2007

ITU - Geneva

Frédéric Pujol – IDATE/SPORT VIEWS coordinator

1. Agenda

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2. Presentation of the SPORT VIEWS R&D project
3. Impact of new radio technologies on spectrum management
4. Conclusions





2. Presentation of the **SPORT VIEWS** project

Technological developments and their impact
on spectrum management

2. Presentation of the SPORT VIEWS project

Main objectives

- study evolutions in radio spectrum management methods conducive to spectrum usage optimisation for innovation and diffusion of new information technologies and services
- assess the future impact of new wireless technologies and how these technologies will impact spectrum usage and help improve spectrum usage optimisation
- analyze how these new technologies can provide or require new methods for spectrum management

Partners

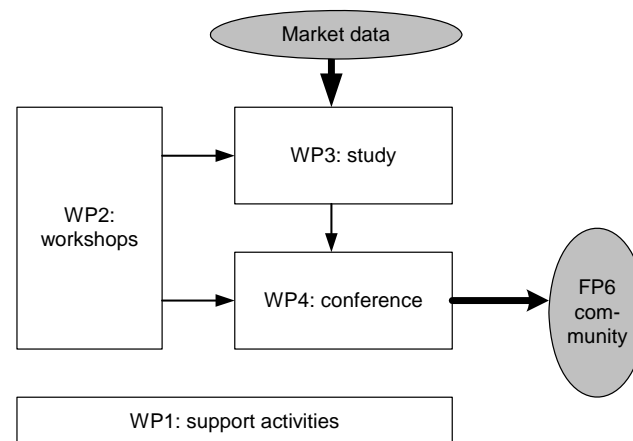
Partner Short Name	Department / Research Unit
IDATE	Mobile division
GET-ENST	Ecole Nationale Supérieure des Télécommunications – Economics and Management Sciences Department
	Institut National des Télécommunications – Management Sciences Department
University of Warwick	Warwick Business School-Centre for Management under Regulation
TNO	TNO Information and Communication Technology
WIK Consult	Wissenschaftliches Institut für Infrastruktur und Kommunikationsdienste GmbH
Alcatel	Mobile Comms. Group Mobile Radio Division MCG/MRD
Bouygues Telecom	Spectrum Department
Orange	Frequency Services – Strategy & Brand Direction
PUT-ET	Poznan University of Technology – Institute of Electronics and Telecommunications

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Technical approach

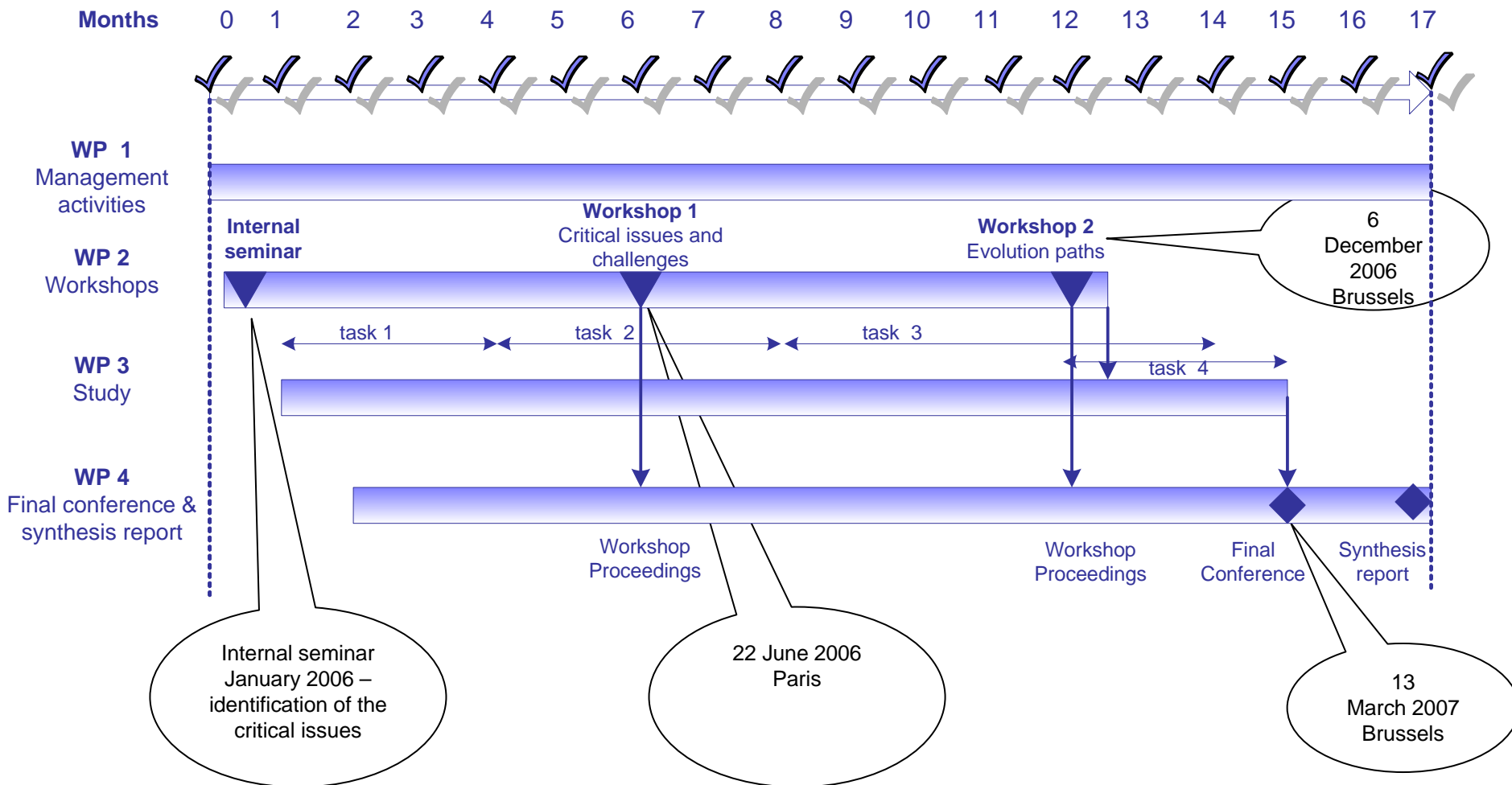
- WP1: support to achieve the execution and the completion of all SPORT VIEWS specific activities
- WP2: two **workshops** will convene experts from academia, industry, and invited NRAs in order to identify the major challenges and propose options with regard to efficient radio spectrum usage, management and regulations in relation to emerging and future technologies
- WP3: The objective of WP3 is to carry out a comprehensive **study** on spectrum management optimisation, putting together radio technologies impact assessments, and exploring new options for spectrum management
- WP4 will disseminate SPORT VIEWS project main results and achievements to a broad community interested in spectrum management and radio technologies. Most of the resources will be dedicated to the organisation of a Final Conference



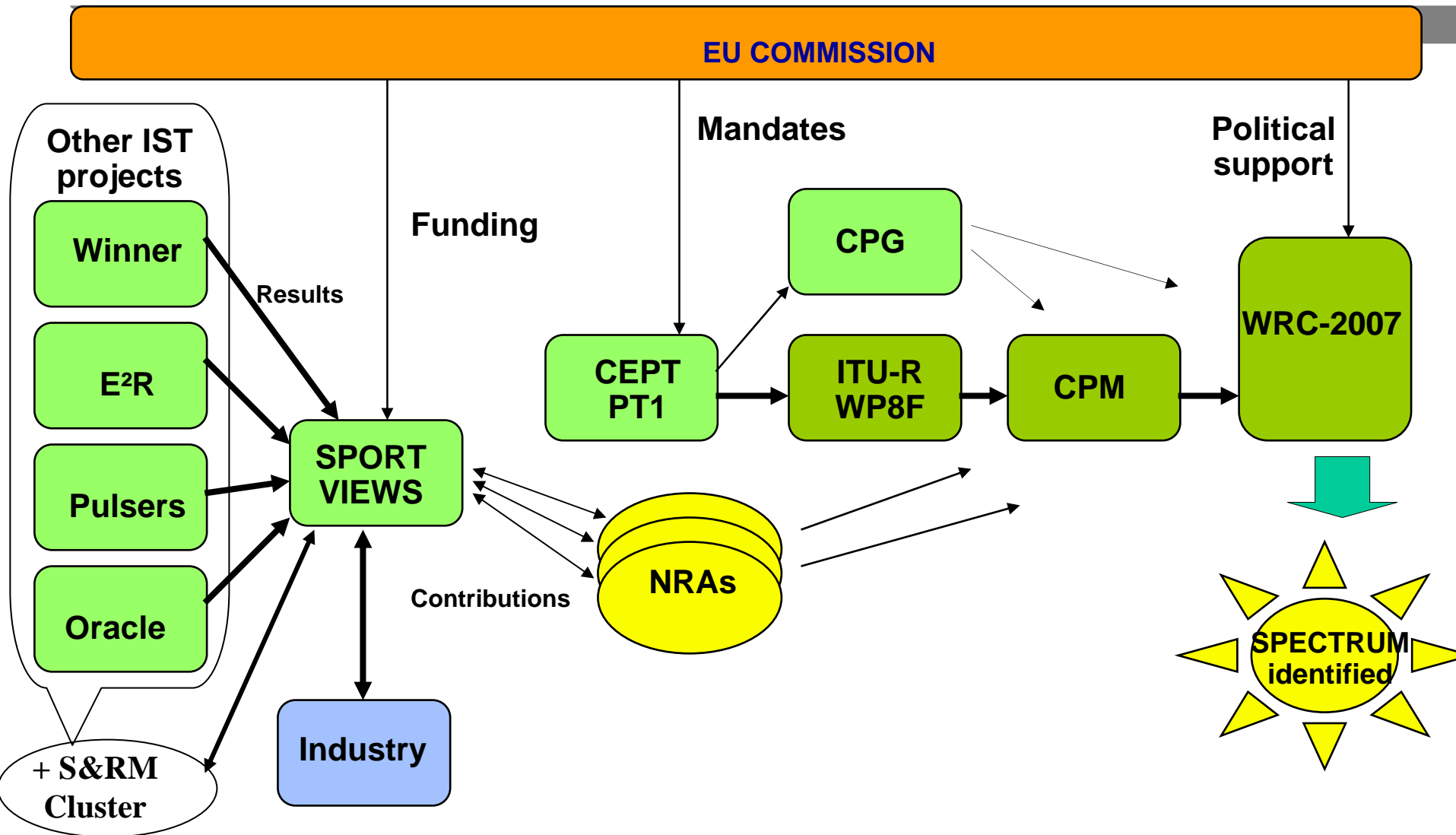
Duration: 17 months – Start date: 01/01/2006



2. Presentation of the SPORT VIEWS project Timetable



2. Presentation of the SPORT VIEWS project Collaboration with other IST projects & the Industry



2. Presentation of the SPORT VIEWS project Study

- The study is based on the participants and other actors contributions and workshops discussions and results. It will provide:
 - a survey of new and emerging radio technologies and their relevant characteristics with regard to spectrum management
 - an analysis of the challenges facing prevalent ideas on spectrum technologies, usage, and management and existing mechanisms for spectrum allocation
 - an assessment of the possible consequences of these technical evolutions for spectrum management from different policy angles and the way spectrum management can support innovation and economic efficiency
- Task 1: Technological developments and their impact on spectrum management (focus on technologies)
- Task 2: Impact of market developments on business models
- Task 3: Novel spectrum management approaches
- Final Conference and Synthesis Report

2.Presentation of the SPORT VIEWS project

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The future impact of new wireless technologies on spectrum usage

-

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Focus:

► Relations with main stakeholders

SportViews consortium collaborates with IST projects, NRAs and Industry stakeholders.

[More](#)

News:

◉ 22-06-2006

Sportviews June Workshop in Paris

First Sportviews Workshop: stimulate a dialogue between spectrum management specialists and European Union sponsored research projects

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January 2007



SPORTVIEWS

Spectrum Policies and Radio Technologies Viable In Emerging Wireless Societies

3. New radio technologies and their impact on spectrum management

- **Objective**

- ➔ Survey of wireless technology developments which are disruptive in terms of expected impact on spectrum use and spectrum management. We analyze how these new technology innovations can support or in other cases require new methods for spectrum management.

- **Scope**

- ➔ Focus is on technology innovations in fixed, mobile (including nomadic) and broadcasting systems.

- ➔ The focus is on frequencies below 6 GHz that is considered the prime frequency range for fixed, mobile and broadcast services.

3.1 Overview of the main innovations in radio technology

3.2 Technology Roadmap

3.3 Disruptive technologies and their impact on Spectrum Management

3.1 New radio technologies and their impact on spectrum management

Spread Spectrum Technologies

Characterization

<p>Multi-carrier transmission</p> <p>- <i>OFDM</i> - <i>MC-CDMA</i></p>	<p>Modern spectrum efficient transmission technologies</p> <p>Robust / Adaptive</p> <p>Improvement of radio performance</p> <p>Applied in many state-of-the-art radio systems</p>	
<p>UWB (Ultra Wide Band transmission)</p>	<p>Spreading signal power over ultra wide bandwidth</p> <p>Low power / short range</p> <p>New application possibilities</p> <ul style="list-style-type: none">• very high data rate communications• radar applications• indoor location determination	

3.1 New radio technologies and their impact on spectrum management

Dynamic Spectrum Access Technologies

Characterization

SDR (software defined radio)	Radio functionality implemented in software (to a large extent) Flexibility in: <ul style="list-style-type: none">• radio signals characteristics• radio transmission standard• frequency band choice	
Cognitive Radio	The flexibility of SDR Awareness of the environment (sensing) Autonomy in decisions on the radio transmission behavior Ability to learn from its behavior, observations and feedback	

3.1 New radio technologies and their impact on spectrum management

Dynamic Spectrum Access Technologies

Characterization

Inter System Control

Note: Intersystem control is in some cases seen as a variants of cognitive radio

Central spectrum coordination over:

- multiple networks
- multiple radio technologies
- multiple operators
- multiple spectrum users

Central automated spectrum resource controller (Spectrum Policy Server)

Transmission protocols to share spectrum control information (Common Spectrum Coordination Information Exchange)

Real-time negotiation on / allocation of spectrum resources

3.1 New radio technologies and their impact on spectrum management

Advanced Antenna Technologies

Characterization

Advanced Antenna Technologies <ul style="list-style-type: none">- Space-time Coding- MIMO	Improvement of radio signal transmission Enhancement by combining the signals of multiple antennas Focus the transmission and reception on actual user positions Improvement of the interference situation Increase spectrum efficiency	

3.2 New radio technologies and their impact on spectrum management

Technology Roadmap Estimation

Antennas technologies:
No previsions regarding wideband and reconfigurable antennas.

SDR.

Many experiments.
Wired remote upgrade in base stations from **2007**.

Mesh networks.

Many experiments and first practical applications.

MIMO.

Experiments
Pre-standard MIMO equipments.
MIMO applications will be part of the IEEE 802.11n High-Throughput standard which is expected in **2006**

Cognitive radio:

Simple Dynamic Spectrum Access technologies already available

SDR:

Soft upgrades for mobile devices from **2011**.

Multiple standards in mobile devices (GPS, WiMAX, 3G, WiFi).

SDR:

Radio systems with full flexibility available from **2015**.



2002
UWB:
50 models of UWB devices approved by the FCC since **2002**.

2006
UWB:
CEPT defines a spectrum mask for generic UWB applications.
Harmonized standard in **2006** or **2007**.

2008
MIMO is expected to be deployed in commercial networks in the **2008** timeframe.

2010
Cognitive radio:
Smarter cognitive radios techniques from **2010**.

UWB: take-off of large scale deployment

2015
Cognitive radio:
Full dynamic spectrum access beyond **2015**.

3.3 New radio technologies and their impact on spectrum management

Disruptive Technologies – Ultra Wide Band

Concept

State-of-the-art

UWB

Disruptive
Technology

Extremely wide instantaneous bandwidth
Extremely low spectral power density

R&D focused on sophisticated UWB waveforms and on commercial applications

US: IEEE 802.15 standard in progress. FCC rules in place.

EU: Work on harmonised standards (ETSI) and spectrum (CEPT) in progress. Commercial deployment will take more time.

3.3 New radio technologies and their impact on spectrum management

Disruptive Technologies – Ultra Wide Band

Disruptive features

Opportunities & issues

UWB

Disruptive
Technology

UWB bandwidths go far beyond typical spectral allocation widths.

UWB is not compatible with current spectrum allocation regime

Opportunities:

- Very high data bit rates on short ranges
- Sharing of spectrum resources

Issues:

- Doubts about 'underlay' use due to feared interference aggregation effect
- Discussion about spectral masks for UWB transmission
- Lack of sufficient practical evidence

3.3 New radio technologies and their impact on spectrum management

Disruptive Technologies – Cognitive Radio

Concept

State-of-the-art

Cognitive Radio

Disruptive
Technology

Dynamic frequency selection
Adaptive Modulation
Transmit Power Control
Location Awareness and
Policy based transmission

} standard

Learning capability
Undefined environments
Behavior unpredictability

} novel

Full CR is still in research phase
Different approaches in civil and military R&D

Oracle (IST-FP6):

- Spectrum Sensing techniques
- Intelligent Decision making process
- Waveform agility

XG (DARPA US):

- enabling technologies for opportunistic spectrum access
- policy based meta language to transform spectrum policy into system behaviour rules



3.3 New radio technologies and their impact on spectrum management

Disruptive Technologies – Cognitive Radio

Disruptive features

Opportunities & issues

Cognitive Radio

Disruptive Technology

Capability to sense wide RF bands and occupy vacant parts of the spectrum

Opposes the concept of exclusive spectrum usage rights

Unpredictable behaviour.

Opportunities:

- Opportunity based spectrum use
- Autonomous coexistence in shared spectrum

Issues:

- Guaranteeing interference free coexistence
 - sensing capabilities
 - preventing undesirable behavior
- Declining control of the regulator
- Risk of **intentional or unintentional software modifications** and use of frequencies, output power, or modulation types that are not approved.

3.3 New radio technologies and their impact on spectrum management

Disruptive Technologies – Intersystem control

Concept

State-of-the-art

Intersystem control

Disruptive Technology

Central spectrum coordination over:

- multiple networks
- multiple radio technologies
- multiple operators
- multiple spectrum users

Central automated spectrum resource controller
(Spectrum Policy Server)

Transmission protocols to share spectrum control information
(Common Spectrum Coordination Information Exchange)

Sophisticated coordination mechanism under study (I.e. simulations) under FP5 and FP6

Standardisation work in IEEE 802.11k and 802.16h

3.3 New radio technologies and their impact on spectrum management

Disruptive Technologies – Intersystem control

Disruptive features

Opportunities & issues

Intersystem control

Disruptive Technology

Opposes the concept of individual licensing as spectrum users (operators) cooperate through dynamic sharing mechanisms

Opportunities:

- Optimize overall spectrum resource allocation
- Enhance spectrum utilization
- Enable economic mechanisms on a 'real-time' basis

Issues:

- Implementation of the new concept
- Forming a regulatory framework
- Establishing policies and rules for dynamic spectrum allocation
- Acceptance by operators

4. Conclusions

- **UWB and Cognitive Radio and Inter System Control are technology innovations that:**
 - have a significant impact to spectrum management
 - can contribute to improvement of the spectrum utilization
 - require changes in spectrum management
 - have a broad interest in research and industry
 - have a significant application potential

- **UWB has a strong impact on the spectrum management framework since the technology is getting mature at this moment**

- **Inter System Control is expected to be technically feasible within 5 to 10 years**

- **Cognitive Radio with full features is expected to become available around 2020 to 2025**

4. Conclusions

- **Treated technologies (will) have impact on spectrum management, but UWB and Cognitive Radio (including Inter system control) are considered truly disruptive.**
- **In engineering a future proof spectrum policy framework, the fact should be taken into account that many disruptive developments could rise above our horizon.**

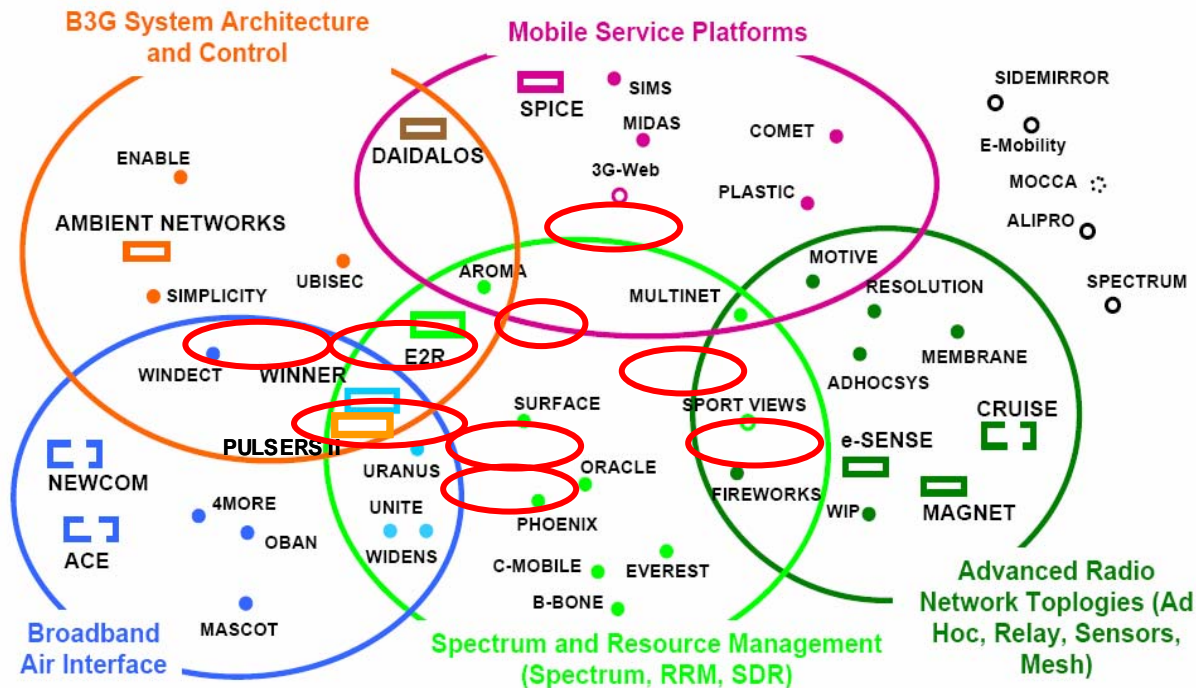
Thank You!

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ANNEX - Presentation of the SPORT VIEWS project Collaboration with other IST projects: S&RM Cluster

Project Clustering - Mobile



Instruments :

Integrated Project (IP)

Network of Excellence (NoE)

Specific Targeted Research Project (STREP)

Specific Support Action (SSA)

Coordination Action (CA)

