

Contribution of future networks to standardization: FP7 program



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- **Coordination of standardization activities in FP7**
- **Overview of Radio Access and Spectrum (RAS) cluster projects**
- **Projects' contributions to standardizations**
 - ⇒ End-to-end efficiency (E3)
 - ⇒ CARMEN
 - ⇒ HURRICANE
 - ⇒ MIMAX
 - ⇒ ORACLE
 - ⇒ UCELLS
 - ⇒ Newcom++
 - ⇒ DAVINCI (IMT Adv)
 - ⇒ DAVINCI (DVB-NGH)
 - ⇒ DAVINCI (802.11ac)
 - ⇒ REWIND
 - ⇒ PHYDYAS
 - ⇒ ROCKET
 - ⇒ EUWB
- **Summary and Conclusions**

□ **Major goal of FP7**

⇒ **Research leading to tangible results**

- **Standardization**

- Provision of directives to stakeholders
- Common basis for work
- Facilitation of research outcomes
- Minimization of time to market for products / services / applications

- **Numerous international bodies identified**

□ **Radio Access and Spectrum (RAS) cluster**

⇒ **Provision of a platform**

- exchanges and concertation between FP6 and FP7 projects

⇒ **Coordination of standardization activities in FP7**



E³ RAS cluster projects

Acronym	Project Name
CARMEN	Carrier grade mesh Networks
HURRICANE	Handovers for ubiquitous and optimal broadband connectivity among Cooperative networking environments
MIMAX	Advanced MIMO systems for maximum reliability and performance
ORACLE	Opportunistic Radio Communications in Unlicensed Environments
UCELLS	Ultra-wide band real-time interference monitoring and CELLular management strategies
NEWCOM++	Network of excellence in wireless Communications++
E ³	End-to-End Efficiency
DAVINCI (IMT-Adv), (DVB-NGH (Next Generation Handheld) and (802.11ac)	Design and versatile implementation of non-binary wireless communications based on innovative LDPC codes
REWIND	Relay based wireless network and standard
PHYDYAS	Physical layer for dynamic spectrum access and cognitive radio
ROCKET	Reconfigurable OFDMA-based Cooperative Networks Enabled by Agile Spectrum Use

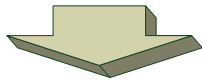
E3 Overview of projects' contributions to standardization bodies

	<u>IEEE</u> <u>P1900</u>	<u>IEEE</u> <u>802.11</u>	<u>IEEE</u> <u>802.16</u>	<u>IEEE 802.21</u>	<u>IEEE 802.22</u>	<u>3GPP</u>	<u>ETSI</u>	<u>CEPT</u>	<u>ECMA</u>	<u>ACF</u>	<u>IETF</u>	<u>DVB</u>	<u>IEEE</u> <u>802.15</u>
E3	X					X	X			X			
CARMEN				X			X				X		
HURRICANE	X			X		X					X	X	
MIMAX		X	X		X								X
ORACLE	X												
UCELLS							X	X					
Newcom++			X										
DAVINCI (IMT Adv)			X			X							
DAVINCI (DVB-NGH)												X	
DAVINCI (802.11ac)		X											
REWIND			X										
PHYDYAS		X	X	X	X	X							
ROCKET			X			X							
EUWB	X						X		X				X



Introducing Cognitive Systems in the B3G World

Goal



- To transform current wireless system infrastructures into an integrated, scalable and efficiently managed Beyond-3rd-Generation (B3G) cognitive system framework, which ensures seamless access to applications and services and exploits the full diversity of corresponding heterogeneous systems.

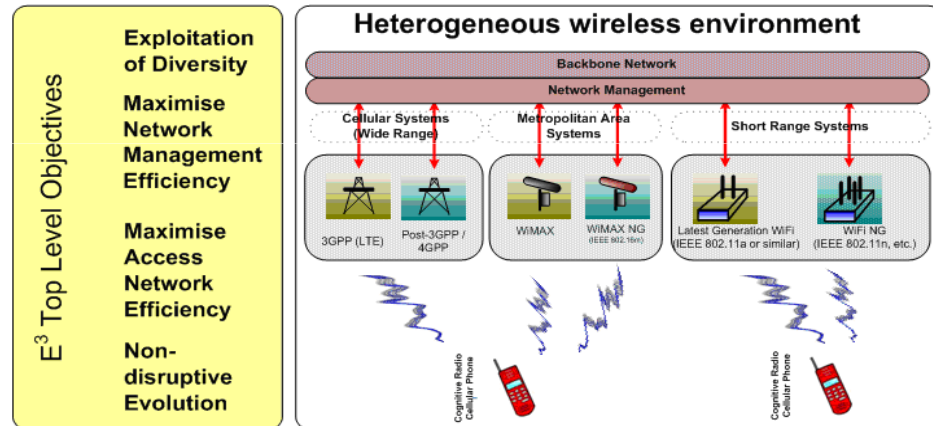
Objective 1

Cognitive Radio System design exploiting the capabilities of reconfigurable networks and self-adaptation to a dynamically changing environment.

Gradual, non-disruptive evolution of existing wireless networks in accordance to user requirements

Objective 2

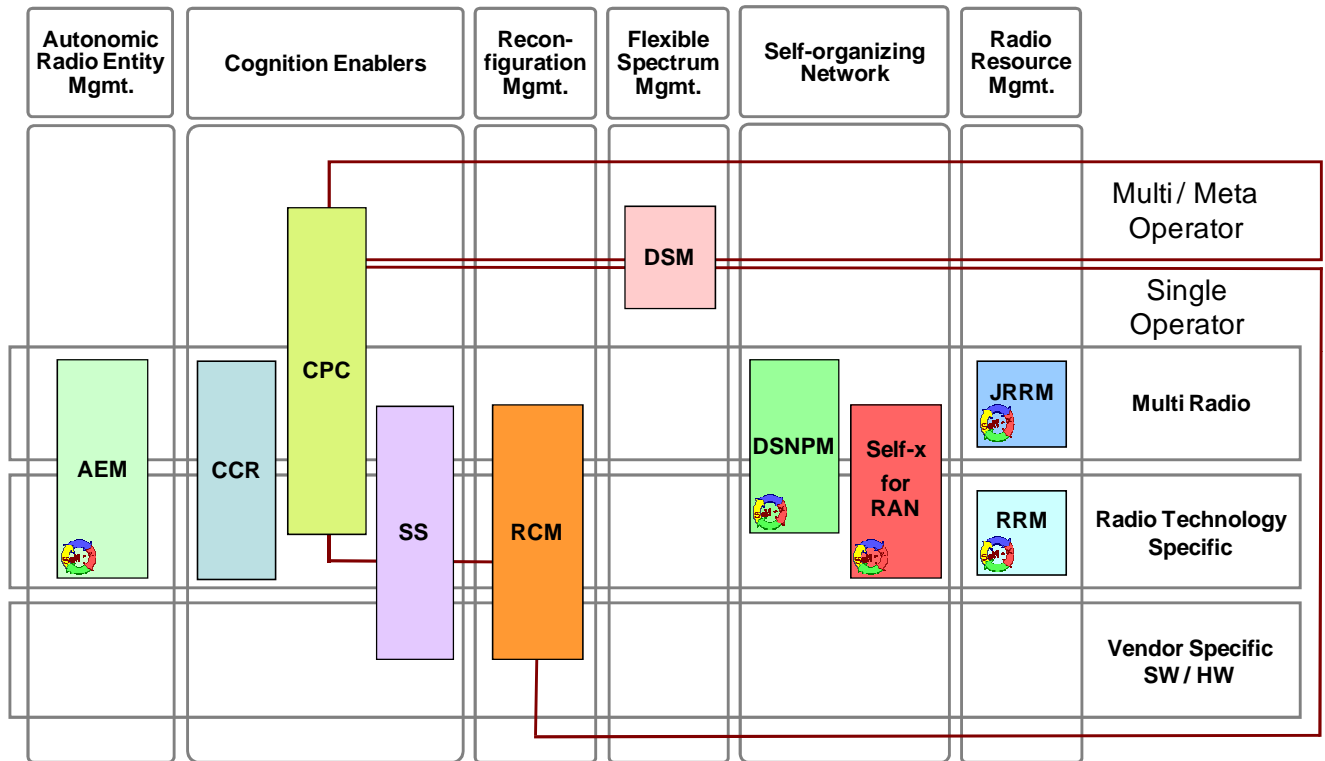
Increased efficiency of wireless network operations, in particular by optimally exploiting the full diversity of the heterogeneous radio eco-space: Increase system management efficiency for network operation and (re-) configuration building on cognitive system and distributed self-organisation principles



Functional Architecture – Pillars

Components

- ⇒ AEM - Autonomic Entity Management
- ⇒ DSNPM - Dynamic Self-organizing Network Planning & Management
- ⇒ DSM- Dynamic Spectrum Management
- ⇒ Self-x-for-RAN - Self-x for Radio Access Networks
- ⇒ JRRM - Joint Radio Resource Management
- ⇒ RRM - Radio Resource Management
- ⇒ CCR - Cognitive Control Radio
- ⇒ CPC- Cognitive Pilot Channel
- ⇒ RCM - Reconfiguration Control Module
- ⇒ SS - Spectrum Sensing

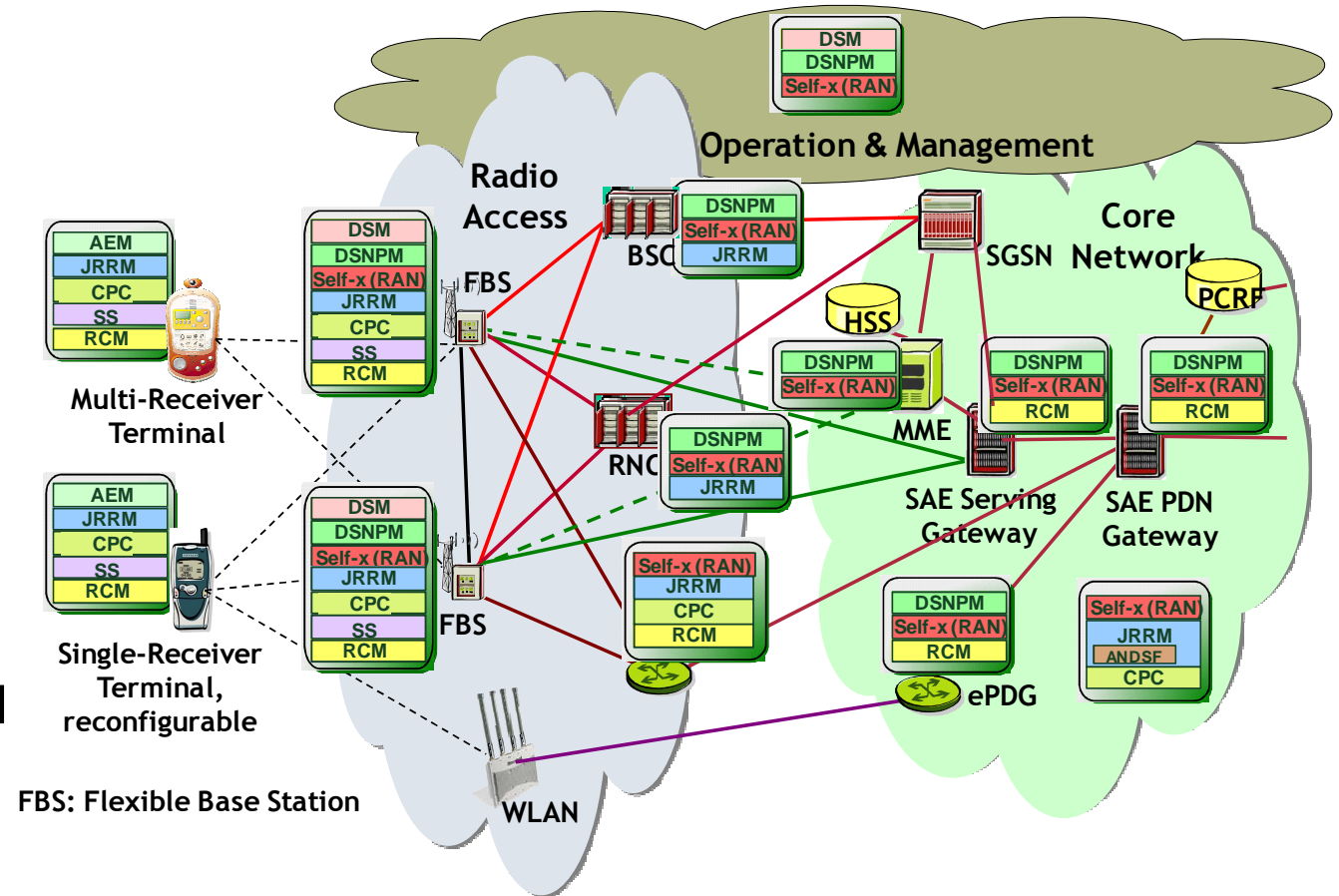


 Self-x pattern applies

E³ System Research – Requirements, Functions and Information Models

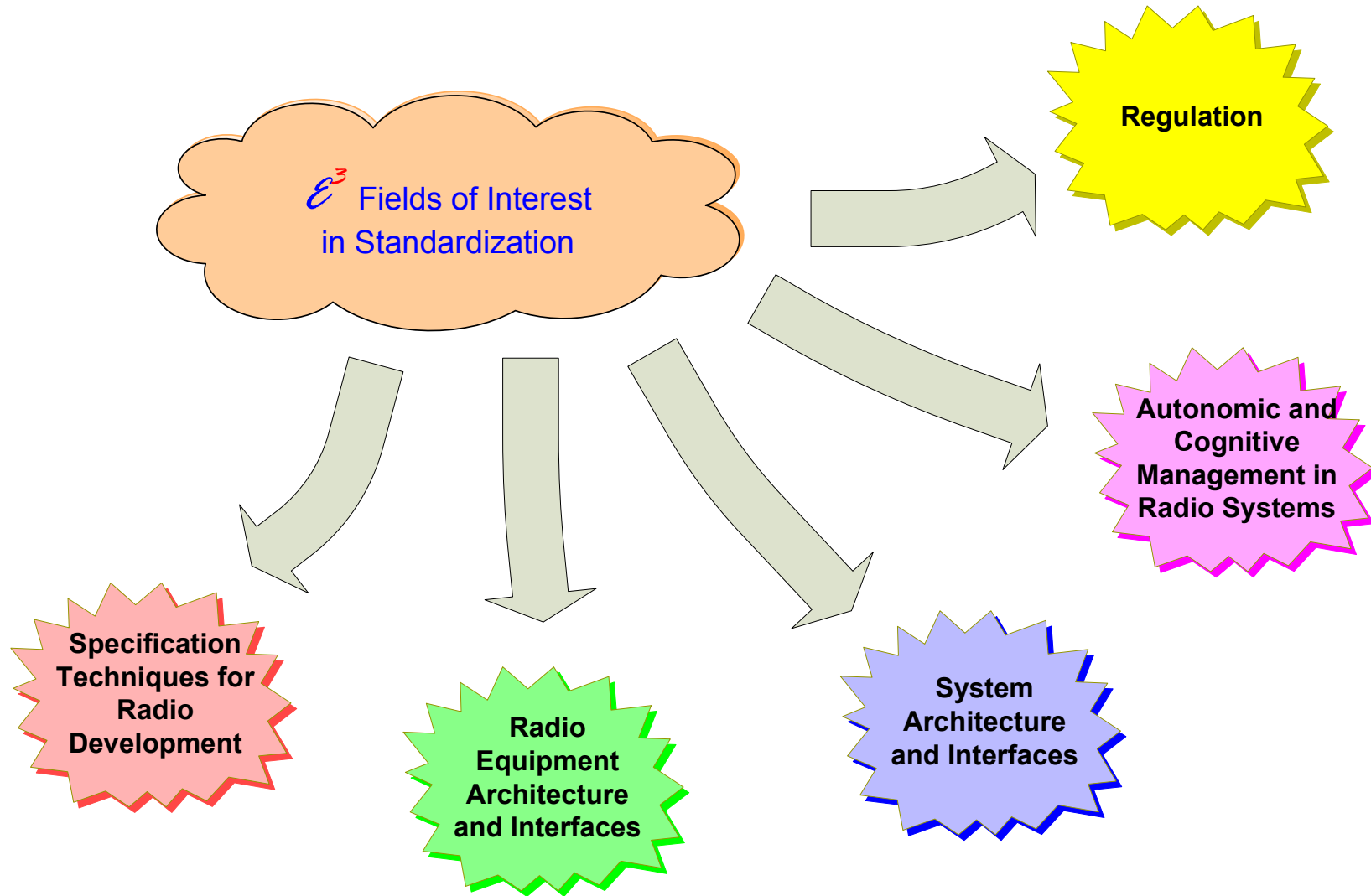
System architecture: deployment of functional entities onto physical elements (network elements – terminals).

- Approach for deriving System Architecture
- Mapping functional architecture to physical architecture
- Work in progress
- Consolidation and finalization is due in M21-M24





Regulation/Standardization and E³





Standardization work – ETSI TC RRS (1/4)

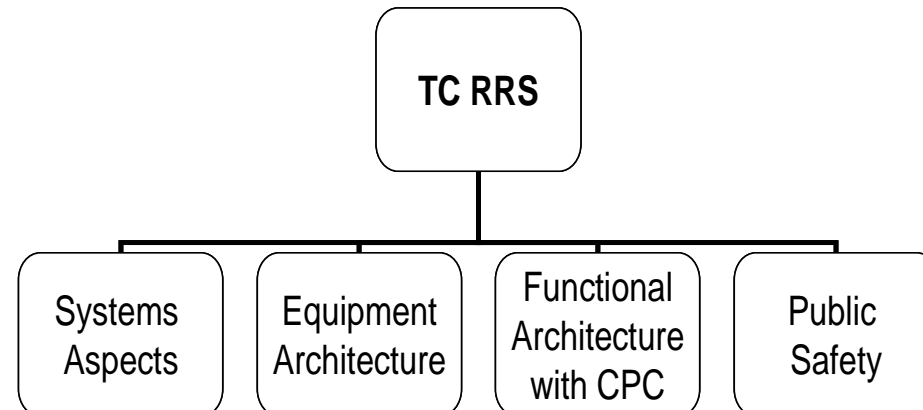
- TC RRS shall have responsibility:
 - ⇒ to study the feasibility of standardization activities related to Reconfigurable Radio Systems encompassing radio solutions related to Software Defined Radio (SDR) and Cognitive Radio (CR) research topics;
 - ⇒ to collect and define the related Reconfigurable Radio Systems requirements from relevant stakeholders;
 - ⇒ to identify gaps, where existing ETSI standards do not fulfil the requirements, and suggest further standardization activities to fill those gaps;
 - ⇒ to deliver its findings in the form of Technical Reports or ETSI Guides. First version of its findings will be produced within 18-24 months of commencing activity;
 - ⇒ to provide the ETSI main centre of expertise in the area of Reconfigurable Radio Systems.

ETSI RRS is currently transitioning from the study phase to the normative work phase. From Dec-2009 on, there will be the opportunity for interested organizations to Participate in the standardization of SDR/CR technology.



Standardization work – ETSI TC RRS (2/4)

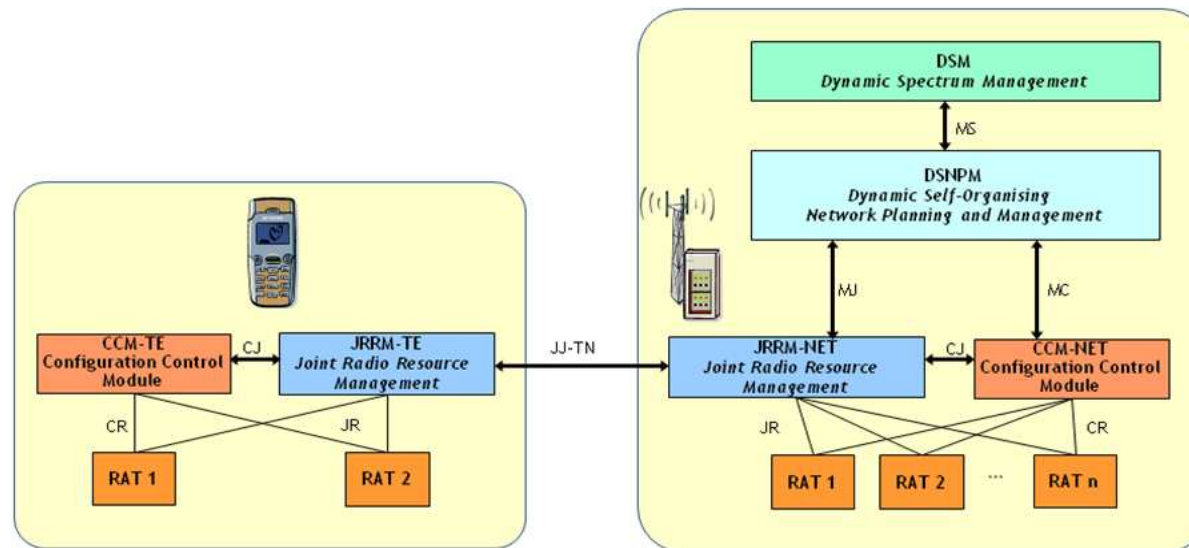
- **Prime objective: to support global harmonization by providing a forum in which all the key players can contribute actively**
 - ⇒ **E²R II opened the path towards ETSI activities, and E³ continued participating actively**
 - ⇒ **The ETSI organization chart includes several technical committees.**
 - **ETSI Reconfigurable Radio System Technical Committee (RRS TC) has been created in January 08.**
 - 4 working groups
 - E3 participates in all, emphasis in groups 2 and 3 (E3 members chairing and acting as rapporteurs)





Standardization work – ETSI TC RRS (3/4)

- **Functional architecture for reconfigurable radio systems**
 - ⇒ **Optimization of the spectrum and radio resources usage**
 - ⇒ **Practically led by E3**
 - ⇒ **Goals reached**
 1. Definition of architectural components
 2. Initial specification of interfaces
 3. Report prepared
 - ⇒ **Work finalized**
 - Report approved





Standardization work – ETSI TC RRS (4/4)

- A technical report on Cognitive Pilot Channel (ETSI TR 102 683) produced.
- CPC is defined as a channel which conveys the elements of necessary information facilitating the operations of Cognitive Radio Systems.
 - ⇒ It provides information on which radio accesses can be expected in a certain geographical area. This information includes operator information, radio access technology type as well as used frequencies.
- Advantages
 - ⇒ simplifying the RAT selection procedure;
 - ⇒ improving secondary system start-up procedure;
 - ⇒ avoiding a large band scanning, possibly simplifying the terminal implementation (physical layer) for manufacturers;
 - ⇒ the CPC concept seems relevant for the implementation of DSA/FSM schemes;
 - ⇒ enabling collaboration between network and terminal management entities for spectrum usage optimization;
 - ⇒ the CPC concept as a download channel could be useful to the operator and user in a roaming scenario where it could be necessary to download a new protocol stack to connect to the network.



Standardization work – P1900.4

- **IEEE P1900.4 is one of the P1900 series of standardization projects under the IEEE Standards Coordinating Committee 41 (SCC 41)**
- **Motivated by E²R II and newly formed by the IEEE Standards Board to cover the area of Dynamic Spectrum Access Networks (DySPAN)**
- **Officially launched in February 2007**
- **Field of application: radio systems forming a composite radio access network (with multi-Radio Access Networks (RAN) using different Radio Access Technologies (RAT))**
- **E³ project has been very active in the initiation, consolidation and successful finalization of the first P1900.4 version of the draft standard**
 - ⇒ **Various contributions have been submitted and finally taken into account by the WG while drafting the baseline standard document**
 - ⇒ **E3 member has been acting as technical chair**

- **Title: Interfaces and protocols enabling distributed decision making for optimized radio resource usage in heterogeneous wireless networks**
- **Scope: This standard uses the IEEE 1900.4 standard as a baseline standard. It provides detailed description of interfaces and service access points defined in the IEEE 1900.4 standard enabling distributed decision making in heterogeneous wireless networks and obtaining context information for this decision making.**
- **Purpose: This standard facilitates innovative, cost-effective, and multi-vendor production of network side and terminal side components of IEEE 1900.4 system and accelerates commercialization of this system to improve capacity and quality of service in heterogeneous wireless networks.**
- **Need for the Project: The IEEE 1900.4 is the baseline standard defining architectural building blocks enabling network-device distributed decision making for optimized radio resource usage in heterogeneous wireless networks. To ensure interoperability between network side and terminal side components of the IEEE 1900.4 system, detailed description of interfaces and service access points defined in the IEEE 1900.4 standard is required.**

- **Title: IEEE Standard for Architectural building blocks enabling network-device distributed decision making for optimized radio resource usage in heterogeneous wireless access networks – Amendment: Architecture and interfaces for dynamic spectrum access networks in white space frequency bands**
- **Scope: This standard amends the IEEE 1900.4 standard to enable mobile wireless access service in white space frequency bands without any limitation on used radio interface (physical and media access control layers, carrier frequency, etc) by defining additional components of the IEEE 1900.4 system.**
- **Purpose: This standard facilitates cost-effective and multi-vendor production of wireless access system, including cognitive base stations and terminals, capable of operation in white space frequency bands without any limitation on used radio interface, as well as, accelerates commercialization of this system to improve spectrum usage.**
- **Need for the Project: Wireless access network, including cognitive base stations and terminals, is capable of providing cost-efficient service in white space frequency bands. To enable such network, the proposed standard defines new components (entity(s) and interfaces) in addition to IEEE 1900.4 entities and interfaces.**



Standardization work – P1900.6

- ❑ **P1900.6 focuses on the interfaces between the sensing and decision making mechanisms in cognitive radios, cognitive radio systems and in dynamic spectrum systems in general**
- ❑ **The P1900.6 working Group aims at developing a “Standard for Spectrum Sensing Interfaces and Data-Structures for Dynamic Spectrum Access and Other Advanced Radio Communication Systems”**
- ❑ **E³ has been present in 2008 meetings of SCC 41**
- ❑ **E³ will continue its active work and participation in the standard’s future meetings that will take place in 2009**

□ Standardization activities

- ⇒ **Definition of a media independent layer for mesh in IEEE 802.21**
 - The IEEE 802.21 standard specifies a set of primitives and control flows needed for media independent handover of mobile nodes. The focus of IEEE 802.21 is thereby on media independence, i.e. the standard is applicable to different underlying radio technologies

- ⇒ **IP address autoconfiguration and mobility in the IETF**
 - IP address autoconfiguration for wireless multi-hop networks
 - Extensions to the network-based localised mobility protocols

- ⇒ **ETSI (CARMEN has also had some initial interaction with ETSI)**
 - The AFI “Autonomic Network Engineering for the Self-Managing Future Internet” Industry Specification Group.
 - The RRS technical committee.
 - The LTE Self-Organizing Network (SON) activity

□ Standardization activities

- ⇒ **IEEE 802.21.** HURRICANE is particularly interested in contributing to the IEEE P802.21b project regarding required extensions to the IEEE 802.21 standard to support handovers between 3GPP or IEEE 802, and DVB downlink-only technologies.
- ⇒ **IEEE 1900.4.** It is of particular interest to HURRICANE to provide further input to the distributed radio resource usage optimization use case of IEEE P1900.4 that is closely related to the project's concept.
- ⇒ **IETF.** HURRICANE is investigating enhancements/optimizations to global/local mobility protocols, like MIP and Proxy MIP, to allow them exploit cross-layer and cross-system information. The project is also interested in contributing to the work of MIPSHOP WG regarding the transport of IEEE 802.21 signaling messages.
- ⇒ **3GPP.** The HURRICANE project is particularly interested to the architecture of the 3GPP evolved packet core and in particular the System Architecture Evolution (SAE) mobility management entities that will support handovers between heterogeneous networks comprised of 3GPP and non-3GPP access segments.
- ⇒ **DVB.** It is anticipated that the project's results could be forwarded to the standardization of vertical handover procedures (and related quality criteria) between DVB systems and Broadband Wireless Access (BWA) systems. Emphasis will be also given to the provision of amendments to the DVB-T/DVB-H standards to accommodate the proposed media independent and mobility management frameworks in the context of a generic optimized handover operation applicable to all examined cooperative radio technologies (3G, WLAN, WiMAX, DVB).

□ **Standardization activities**

- ⇒ **IEEE 802.11: IEEE802.11 group is now finalizing the 802.11n in which baseband MIMO techniques are incorporated (mainly spatial multiplexing for increased rate and orthogonal coding for increased reliability). MIMAX will observe the standardization progress to provide further technical inputs for advanced MIMO and MAC functionality.**
- ⇒ **IEEE 802.15: This working group was chartered to enable low data rate solutions for extremely low power consuming network topologies in WPANs. MIMAX will observe the ongoing progress in the standardization activities, e.g. for 802.15.4e, an amendment to enhance and add functionality of the MAC to better support the industrial markets.**
- ⇒ **IEEE 802.16: This group works on standards and recommended practices to support the development and deployment of broadband Wireless Metropolitan Area Networks. MIMAX will observe the standardization progress.**
- ⇒ **IEEE 802.22: The working group develops a standard for a cognitive radio-based PHY/MAC for the TV Broadcast Services which are of large interest for MIMAX because of their market potential. Thus, the project will observe the progress in this working group. For more information see <http://www.ieee802.org/22/>.**
- ⇒ **3GPP: Within the future LTE MIMO technologies are used in the specifications of the physical layer (see for instance 3GPP TS 36.213 physical layer procedures). There is improvement for advanced functionalities of the MAC and baseband and especially technical inputs for RF MIMO. MIMAX will observe the ongoing standardization progress and might contribute results for RF MIMO enhancing the base station and, especially, mobile transceivers.**

- **Standardization activities targeted at IEEE SCC 41 P1900.6**
 - ⇒ **The key contribution of ORACLE is focused on sensing techniques for cognitive radio**

 - ⇒ **Relevant objectives**
 - **O1: Single device sensing**
 - **O2: Collaborative sensing covering cooperative sensing methods**
 - **O3: Usage of spectrum sensing CR terminals for the investigation of policy violations**
 - **O4: Reporting data format of the of the sensing parameters**
 - **O5: Performance metrics for spectrum sensing**

- **The target standardization bodies are the ones related with UWB regulation at European level:**
 - ⇒ **European Conference of Postal and Telecommunications Administration (CEPT) -> Electronics Communication Comitee (ECC)-> Task Group 3 (TG3)**
 - ⇒ **Also, ETSI Task Groups 31a, 31b and 31c are involved in UWB.**

- **The UCELLS contribution would be reflected in:**
 - ⇒ **Radio coexistence studies evaluating the interference level on UWB operation at higher transmission levels (5 dB above current regulation).**
 - ⇒ **Radio coexistence studies also evaluating the interference level in a picocell cluster environment with centralized spectrum management for DAA**

- **Focuses mainly on contributing to the IEEE 802.16m standards working group.**
 - ⇒ **In this contribution, a RA strategy that exploits partial CSI is proposed by appropriate formulation of the RA problem and incorporation of both optimal and sub-optimal solution techniques that provide tradeoff between performance and complexity. A simple algorithm based on a closed-form, approximate solution is derived that performs close to optimal (under certain scenarios) with significant computational savings compared to the optimal solution.**

- The target standardization bodies are 3GPP LTE-Advanced and WiMAX IEEE 802.16m.
- In DAVINCI deliverable D2.2.1, performance evaluation at the link level has been conducted and has clearly shown *DAVINCI codes to significantly outperform IEEE 802.16m and LTE-Advanced advanced channel codes in all usage scenarios*. Performance evaluation at the system level (Deliverable D2.3.1) is being now conducted to confirm the link level results and quantify the gain of DAVINCI codes in terms of system performance metrics used in standardization.
- Although the results are in favour of DAVINCI technologies, pushing for the support of DAVINCI codes into IEEE 802.16m and LTE-Advanced standards' proposals to IMT-Advanced appears to be quite difficult to achieve due to multiple reasons such as:
 - ⇒ legacy issues;
 - ⇒ concerns on the complexity issues and their potential impact on the achievements of some performance metrics (e.g. latency, etc.);
 - ⇒ non-availability in due time of the specification needed for the link level technologies dependent on DAVINCI non-binary LDPC codes;
 - ⇒ all necessary performance evaluation at the link and system levels;

- ❑ The target standardization body is DVB (Digital Video Broadcasting) – NGH (Next Generation Handheld).
- ❑ In DAVINCI deliverable D2.2.1, performance evaluation at the link level has been conducted and has clearly shown *DAVINCI codes to significantly outperform reference advanced channel codes*. Significant gains are obtained with DAVINCI codes for high order modulation (e.g. 16QAM, 64QAM, etc.) and high SNR as shown in [DAV-D2.2.1]. This is of particular relevance to DVB which uses high order modulations and where Line of Sight (LoS) is more often assumed. The gain is also higher for short limited code word length, which can also be of particular interest of DVB community especially with the trends for IPTV.
- ❑ DAVINCI project plans then to follow up the development of DVB-NGH and set up a framework for effective contribution accordingly.

- **The target standardization body is the “IEEE 802.11 WIRELESS LOCAL AREA NETWORKS”, which is a Working Group within the “IEEE 802 LAN/MAN Standards Committee”. The work is carried out in the “IEEE802.11ac Task Group, Very High Throughput <6GHz”.**
 - ⇒ **In DAVINCI deliverable D2.2.1, performance evaluation at the link level has been conducted and clearly showed *DAVINCI codes to significantly outperform reference advanced channel codes*. Significant gains are obtained with DAVINCI codes for high order modulation (e.g. 16QAM, 64QAM, etc.) and high SNR as shown in Error! Reference source not found..**
 - ⇒ **The DAVINCI coding scheme can easily be combined with OFDM(A). The DAVINCI partners are likely to propose the DAVINCI coding scheme independently of any modulation choice. If the coding scheme attracts interest within the 802.11ac group, we might combine the DAVINCI scheme with the selected modulation to show its performance. For cost reasons, a simpler coding scheme might be selected as mandatory and the DAVINCI could be an optional scheme.**

- **The main target standardisation bodies for REWIND to contribute to the WiMAX Multi-hop Relay standardisation process are the IEEE and WiMAX Forum:**
 - ⇒ **The IEEE 802.16j Mobile Multi-hop Relay (MMR) specifications are aimed to extend base station reach and coverage for WiMAX networks. The relay architecture will allow operators to use in-band wireless backhaul while retaining all the standard Mobile WiMAX functionality and performance**
 - ⇒ **The WiMAX Forum is aimed to certify and promote the compatibility and interoperability of broadband wireless products based upon the IEEE 802.16 standard. The WiMAX Forum has commenced an activity of forming a WiMAX Relay profile (IO-Relay), based on the IEEE 802.16j standard**
- **REWIND project partners actively participate and contribute to these standardisation bodies, in areas such as: Requirement and Specifications, Development, Testing and Interoperability.**

- ❑ **The Phydyas physical layer can be used in networks ruled by a base station (LAN, RAN, cellular) and in networks not necessarily ruled by a base station (opportunistic, peer-to-peer). Therefore, contributions to standardization can address these two contexts.**

- ❑ **As the work progresses and simulation and experimental results become available, contributions to the standardization bodies dealing with networks ruled by a base station will be considered such as IEEE 802.xx and 3GPP.**
- ❑ **In the near future, an opportunity exists to contribute to the activity of ITU-R (Question ITU-R 241/8) relative to the introduction of software-defined radio and cognitive radio systems. Two kinds of contributions are envisaged, about**
 - ⇒ **the cognitive radio physical layer,**
 - ⇒ **networks exploiting this physical layer.**

- **The main goal of ROCKET is to match the requirements of future IMT-Advanced Systems. Hence, the targeted standardization bodies of ROCKET are, firstly the IEEE 802.16 Task Group m (TGm) for Advanced Air Interface and secondary the 3GPP Long Term Evolution (LTE).**
 - ⇒ ***System Requirements Document (SRD)* which contains a set of possible deployment scenarios, applications, performance targets and features to be met or exceed by 802.16m systems. Such requirements are also defined in ROCKET.**
 - ⇒ ***Evaluation Methodology Document (EMD)* that includes among others, a complete set of parameters, models, and methodologies for the link-level and system-level simulations for fair evaluation/comparison that are inline with the simulation methodology of ROCKET. A set of spatial channel model parameters are also specified to characterize particular features of MIMO radio channels. Certain of these models are also defined and used in ROCKET.**
 - ⇒ ***System Description Document (SDD)* describes the architecture and design of the air interface and the core technical concepts behind the features in the amendment. Most of the techniques investigated in ROCKET could be converted to contributions to this document.**
 - ⇒ ***Amendment Working Document (AWD)* is the amendment document of IEEE 802.16m containing the modifications of the Standard that define the Advanced Air Interface of the project. Refined contributions of ROCKET to this document will have a direct impact to the standardization body.**

- ❑ **The targets international standardization bodies are ETSI TG31a, EIST TG31c, ETSI RRS, ECMA, WIMedia, IEEE 802.15.4a, IEEE802.15.3c, P1900.4, etc.**

- ❑ **EUWB WP9 members are active driver for the major European regulation activities currently ongoing, namely ETSI ERM TG31a for Short Range Devices using UWB technologies and ETSI TG31c for UWB location tracking and sensing devices. EUWB also participate ETSI RRS of standardization of reconfigurable radio system especially WG3 by submitting technical contribution.**

- ❑ **EUWB actively contributes to the European Computers Manufactures Association (ECMA) for high rate UWB PHY and MAC standard and updated the ECMA 368 in order to include the future requirements.**

Summary and conclusions

- ❑ **Coordination of standardization activities in FP7**
- ❑ **RAS cluster**
- ❑ **Contribution of projects in standardization activities**

- ❑ **Significant work has been done**
- ❑ **Continuation is expected**

- ❑ **Expected outcomes**
 - ⇒ **Strengthen position of FP7 projects in standardization domain**
 - ⇒ **Identify new areas**