SAPHYRE

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Regulation and Standardisation Plan
D7.2c

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Abstract

This document describes the final regulation and standardisation actions plan for the SAPHYRE project.

Keywords

3GPP, CEPT, ETSI, infrastructure sharing, mobile operators, regulation, spectrum sharing, standardisation.

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Contents

Abbreviations

3GPP	3rd Generation Partnership Project
ARIB	The Association of Radio Industries and Businesses
ATIS	The Alliance for Telecommunications Industry Solutions
BEREC	Body of European Regulators for Electronic Communications
BS	Base Station
CAMEL	Customised Applications for Mobile network Enhanced Logic
CCSA	China Communications Standards Association
CEPT	European Conference of Postal and Telecommunications Administrations
COST	European Cooperation in Science and Technology
CR	Cognitive Radio
CSG	Closed Subscriber Group
CT	Core Network and Terminals
EAB	External Advisory Board
ECC	Electronic Communications Committee
EDGE	Enhanced Data Rates for GSM Evolution
eNB	eNode B
EP	European Parliament
EPS	Evolved Packet System
ETSI	The European Telecommunications Standards Institute
EU	European Union
E-UTRAN	Evolved UMTS Terrestrial Radio Access Network
GCF	Global Certification Forum
GERAN	GSM EDGE Radio Access Network
GSM	Global System for Mobile Communications
GSMA	GSM Association
HSDPA	High-Speed Downlink Packet Access
IEEE	Institute of Electrical and Electronics Engineers
IPR	Intellectual Property Rights
ITU	International Telecommunication Union
LTE	Long Term Evolution
MOCN	Multi-Operator Core Network

MDT	Minimization of Drive Testing
NGMN	Next Generation Mobile Networks
OMA	Open Mobile Alliance
OPEX	Operating expense
OSA	Open Service Aspects
PCG	Project Coordination Group
PLMN	Public Land Mobile Network
RAN	Radio Access Network
RAS	Radio Access & Spectrum
RF	Radio Frequency
RRS	Reconfigurable Radio Systems
RSC	Radio Spectrum Committee
RSPG	Radio Spectrum Policy Group
SA	Service and Systems Aspects
SDR	Software Defined Radio
SIG	Spectrum Interservice Group
SOTA	State-Of-The-Art
TBC	To Be Confirmed
TBD	To Be Defined
TC	Technical Committee
TCCN	Technical Committee on Cognitive Networks
TDIA	TD Industry Association
TERRA	Techno-Economic Regulatory Framework for Radio Spectrum Access for CR/SDR
TR	Technical Report
TS	Technical Specification
TSG	Technical Specification Group
TTA	Telecommunications Technology Association
TTC	Telecommunication Technology Committee
UE	User Equipment
UMTS	Universal Mobile Telecommunications System
UTRAN	UMTS Terrestrial Radio Access Network
Uu	Radio Interface

WAPECS	Wireless Access Policy for Electronic Communications Services
WG FM	Working Group Frequency Management
WG	Working Group
WIP	Wireless Industry Partnership
WWRF	Wireless World Research Forum

1 Executive Summary

Sharing scenarios including infrastructure, spectrum, as well as full sharing were covered in this deliverable D7.2c, which contains final considerations of standardisation and regulation actions plan for the SAPHYRE project outcomes, based on the initial and updated considerations, which were captured in deliverables D7.2a and D7.2b, respectively [16], [17]. Above mentioned sharing schemes were considered for relevant technical groups identification, where SAPHYRE might have potential to exert tangible impact in the future, after technical developments will have been matured.

Throughout the project, relevant actors and institutes, which were invited to the SAPHYRE EAB, were supplied with information on the activities in the project with regards to the key SAPHYRE concepts. This information was provided in form of selected deliverables, as well as SAPHYRE White Papers, which were capturing studies on selected sharing scenarios, covering the proposed methods and procedures for resource sharing. Based on the feedback received during co-operation with the above mentioned institutions and experts, proposals for potential directions of the future standards and regulations implementation for the identified sharing scenarios were formulated.

For the standardisation actions, two main standardisation bodies were initially identified, namely 3GPP and ETSI TC RRS. Furthermore, number of additional bodies and organisations were interfaced throughout the project duration, in order to enhance the SAPHYRE project outcomes visibility and the awareness in industry and regulatory environments. After brief description of these bodies, summary of the already performed actions was presented, providing suggestions for future directions of the potential work developments, based on the SAPHYRE contributions and related findings.

On the regulation side, the current landscape was described. Number of regulatory bodies was identified for SAPHYRE contributions – CEPT WG FM, RSPG as well as BEREC. Similar to the standardisation plans, instruments of interest were identified.

2 Introduction

Standardisation bodies play a major role in the telecom markets shaping. As the telecom market development showed during past 20 years, creation of the global initiative for the 3G networks standardisation, as well as its successors, has dramatically increased the pace of the cellular networks developments, their services availability and their population.

The main expectation from the standardisation bodies is to create broadly supported technologies, which are available in possibly highest percentage of the subscriber's locations. The question to be asked is what the reason for the technology driven developments is, with all related behind-the-scene Intellectual Property Rights (IPR) fights. The most important aspect to be realised is that it is not about technology, but it is all about supporting the business. That's why, main leading force in pushing the standards forward are the network operators, who are demanding "faster, higher, stronger" from the hardware vendors. The reason for the network operators to make such pressure is that they need to compete with their competitors, but most importantly, they need to fulfil their subscribers wishes and expectations, and make mobile network offer able to develop and to offer more coverage and capacity, for the growing mobile society. Of course, this goes in line with the network OPEX reductions considerations.

Standard creation boils down to the selection of the agreeable technical solutions, among the proposed ones, based on the discussion between the proponents. It shall be kept in mind, that in many cases the technical solutions are brought to the standards bodies just to anchor the IPR, in order to generate revenues from the competitors, or to block certain technical solutions from the market applications. This IPR fight is the main driver for the standardisation activities, in many cases.

Referring to the above discussion on the potential IPRs, all SAPHYRE project outcomes were listed in SAPHYRE deliverable D7.5 [15], where we present the technical contribution being developed within SAPHYRE project, listing publications, as well as journal submissions and all other dissemination efforts. It is seen, that these contributions might be valuable inputs for future industry developments, as well as basis for future IPR attempts. More detailed description of potential utilization of the SAPHYRE research outcomes within standardization bodies is covered in section 6.

In the following subsections, international standardisation and certification bodies for industry standards and regulations were described, where SAPHYRE could have potential impact. For the industry standards organisations, 3GPP [1] and ETSI TC RRS [3] were initially identified as the most relevant ones, which were later extended by additional organisations and communication channels having impact on the future standards. Based on their description, we attempt to identify potential impact of the SAPHYRE research on the technical work performed in the considered standardisation bodies, as well as to identify the technical working groups, which might be attracted by the sharing scenarios evaluated within our project. Similar, for regulatory bodies, European Conference of Postal and Telecommunications Administrations (CEPT) and RSPG were identified as potential target groups. In co-operation with the above mentioned institutions, proposals for the implementation of new rules or regulations for

various inter-operator resources sharing scenarios in cellular networks were discussed and proposed.

Based on the SAPHYRE consortium, industry partners were identified as the most capable of undertaking activities to inform relevant standardisation and regulatory bodies about the benefits in capacity and deployment costs that can be reached by sharing resources, and which technical solutions would then be required. Furthermore, project partners experience in 3GPP work was planned to be exploited, which resulted in formulation of the identification of linkage between solutions developed within SAPHYRE, and relevant working groups and specification within 3GPP. For the regulatory organisations communication, the SAPHYRE EAB was playing the most important role, due to involvement of multiple regulators from EU countries.

3 3GPP overview

The 3rd Generation Partnership Project (3GPP) was created in December 1998 and stands for collaboration between groups of telecommunications associations, to make a globally applicable third-generation (3G) mobile phone system specification within the scope of the International Mobile Telecommunications-2000 project of the International Telecommunication Union (ITU). 3GPP prepares and maintains the technical specifications for GSM, UMTS, and LTE(-A) radio technologies including the core networks.

The six 3GPP Organisational Partners – from Asia, Europe and North America – determine the general policy and strategy of 3GPP. Theses Organisational Partners are:

- **ARIB** The Association of Radio Industries and Businesses, Japan;
- **ATIS** The Alliance for Telecommunications Industry Solutions, USA;
- **CCSA** China Communications Standards Association, China;
- **ETSI** The European Telecommunications Standards Institute, Europe;
- **TTA** Telecommunications Technology Association, Korea;
- **TTC** Telecommunication Technology Committee, Japan.

3GPP specifications are based on evolved Global System for Mobile Communications (GSM) specifications. 3GPP standardisation encompasses Radio, Core Network and Service architecture.

3GPP standards are structured as Releases. Each release incorporates hundreds of individual standards documents. Current 3GPP standards incorporate the latest revision of the GSM standards. 3GPP's plans for the future beyond Release 7 are in the development under the title Long Term Evolution (LTE). The releases cover not only the radio part (Air Interface) and Core Network, but also billing information and speech coding down to source code level. Cryptographic aspects (authentication, confidentiality) are also specified.

3GPP systems are deployed across much of the established GSM market. They are primarily Release 99 systems, but as of 2006, growing interest in High-Speed Downlink Packet Access (HSDPA) is driving adoption of Release 5 and its successors.

3GPP Long Term Evolution (LTE) is the latest standard in the mobile network technology tree that previously realised the GSM/EDGE and UMTS/HSxPA network technologies. LTE is a set of enhancements to the Universal Mobile Telecommunications System (UMTS) that was introduced in 3GPP Release 8. Most of 3GPP Release-8 features focuses on adopting 4G mobile communication's technology, including an all-IP flat networking architecture. The LTE standard is a step towards LTE Advanced, a 4th generation standard of radio technologies designed to increase the capacity and speed of mobile telephone networks.

The highest decision making body in 3GPP is the Project Coordination Group (PCG), which carries out the final adoption of 3GPP Technical Specification Group (TSG) work

items, to ratify election results and the resources committed to 3GPP. Standardisation work in 3GPP is divided into Technical Specification Groups (TSGs), which are shortly described in the following subsections.

3.1 TSG GERAN

TSG GERAN (GSM, EDGE Radio Access Network) is responsible for the specification of the Radio Access part of GSM/EDGE, more specifically:

- RF aspects;
- Layer 1, 2 and 3, internal (A_{bis}, A_{ter}) and external (A, Gb) interfaces;
- Conformance test specifications for all aspects of GERAN base stations and terminals;
- GERAN specific O&M specifications for the nodes in the GERAN.

As TSG GERAN is of lower interest from the SAPHYRE project point of view, more detailed information will not be provided, as in case of other TSG groups.

Figure 1. 3GPP Working Group's overview [1]

3.2 TSG RAN

TSG RAN (Radio Access Network) is responsible for the definition of the functions, requirements and interfaces of the UTRA/E-UTRA network in its two modes, FDD and TDD. More precisely, the following Working Groups (WGs) are defined:

– RAN WG1 – Radio Layer 1 specification

  Responsible for the specification of the physical layer of the radio Interface for UE, UTRAN, Evolved UTRAN, and beyond; covering both FDD and TDD modes of radio interface.

– RAN WG2 – Radio Layer 2 and Radio Layer 3 RR specification

Responsible for the Radio Interface architecture and protocols (MAC, RLC, PDCP), the specification of the Radio Resource Control protocol, the strategies of Radio Resource Management and the services provided by the physical layer to the upper layers.

– RAN WG3 – I_{ub}, I_{ur} and I_u specification – UTRAN O&M requirements

  Responsible for the Overall UTRAN/E-UTRAN architecture and the specification of protocols for the I_{ub}, I_{ur}, I_u, S1 and X2 interfaces.

– RAN WG4 – Radio performance and protocol aspects

  RAN4 is responsible for the RF aspects of the UTRAN/E-UTRAN. RAN4 performs simulations of diverse RF system scenarios and derives the minimum requirements for transmission and reception parameters, and for channel demodulation. Once these requirements are set, the group defines the test procedures that will be used to verify them (only for BS). Requirements for other radio elements, like repeaters, are specified in the RAN4 as well.

– RAN WG5 – Mobile terminal conformance testing

  RAN5 is responsible for conformance testing at the Radio interface (U_u) for the User Equipment (UE). The test specifications are based on the requirements defined by other groups such as RAN WG4 for the radio test cases, and RAN WG2 and CT WG1 for the signalling and protocols test cases. RAN WG5 is organised in two subgroups, RF subgroup and signalling subgroup.

3.3 TSG SA

TSG SA **(**Service and Systems Aspects**)** is responsible for the overall architecture and service capabilities of systems based on 3GPP specifications and, as such, has a responsibility for cross TSG coordination More precisely, the following Working Groups (WGs) are defined:

– SA WG1 – Services

  SA1 is responsible for the services and features for 3G. The group sets high-level requirements for the overall system and provides this in a Stage 1 description in the form of specifications and reports.

– SA WG2 – Architecture

  SA2 is responsible for charge of developing the Stage 2 of the 3GPP network. Based on the services requirements elaborated by SA WG1, SA WG2 identifies the main functions and entities of the network, how these entities are linked to each other and the information they exchange. The SA2 outputs are used as inputs for the definition of the precise format of messages in Stage 3 (Stage 2 for the Radio Access Network is under TSG RAN's responsibility). The group has a system-wide view, and decides on how new functions integrate with the existing network entities.

– SA WG3 – Security

  SA3 is Responsible for security in 3GPP systems, determining the security requirements, and specifying the security architectures and protocols. The WG also ensures the availability of cryptographic algorithms, which need to be part of the

specifications. The sub-WG SA3-LI provides the requirements and specifications for lawful interception in 3GPP systems.

– SA WG4 – Codec

  SA4 is responsible for the specifications of speech, audio, video, and multimedia codecs, in both circuit-switched and packet-switched environments.

– SA WG5 – Telecom Management

  SA5 is responsible for the requirements, architecture and solutions for provisioning and management of the network (RAN, CN, IMS) and its services. The WG will define charging solutions in alignment with the related charging requirements developed by the relevant WGs, and will specify the architecture and protocols for charging of the network and its services. The WG will ensure its work is also applicable to the management and charging of converged networks, and potentially applicable to fixed networks. The WG will coordinate with other 3GPP WGs and all relevant SDOs to achieve the specification work pertinent to the provisioning, charging and management of the network and its services.

SA WG1 is responsible for conducting the feasibility study on *RAN Sharing Enhancements* study. So far, it has been looking into different RAN sharing scenarios and has identified requirements for functionality that is not yet included in the 3GPP Release 12 specifications. The results of the study are reflected in 3GPP TR 22.852 [37], which describes number of use cases, recognized by the 3GPP as interesting and relevant for future networks. Further work will have to be done to provide conclusions for the Technical Report. The study may result in specifying normative requirements (and corresponding solutions) within Release-13 and beyond. More details on TR 22.852 were captured in section 6.3.

3.4 TSG CT

TSG CT **(**Core Network and Terminals**)** is responsible for specifying terminal interfaces (logical and physical), terminal capabilities (such as execution environments) and the Core network part of 3GPP systems. More precisely, the following Working Groups (WGs) are defined:

– CT WG1 – Mobility Management /Call Control /Session Management

  CT1 is responsible for the 3GPP specifications that define the User Equipment (UE) – Core network L3 radio protocols and Core network side of the I_u reference point.

– CT WG2 – Terminals Capability

  This WG has been closed.

– CT WG3 – Interworking with external networks

  Responsible for the bearer capabilities for circuit and packet switched data services, and the necessary interworking functions towards both, the user equipment in the UMTS PLMN and the terminal equipment in the external network. In addition CT is responsible of end-to-end QoS for the UMTS core network in Release 5 and beyond.

– CT WG4 – MAP/GTP/BCH/SS

Responsible for standardisation Stage 2 and Stage 3 aspects within the Core Network focusing on Supplementary Services, Basic Call Processing, Mobility Management within the Core Network, Bearer Independent Architecture, GPRS between network entities, Transcoder Free Operation, CAMEL, Generic User Profile, Wireless LAN – UMTS interworking and descriptions of IP Multimedia Subsystem. CT4 is also responsible as a "protocol steward" for the some IP related protocols.

– CT WG5 – Open Service Aspects (OSA)

  This WG has been closed (06.2008) and – work Transferred to Open Mobile Alliance (OMA).

– CT WG6 – Smart Card Application Aspects

  Responsible for development and maintenance of specifications and associated test specifications for the 3GPP smart card applications, and the interface with the Mobile Terminal.

3.5 3GPP working procedures overview

This subsection covers very brief overview of 3GPP working procedures, with respect to the standardisation opportunities from SAPHYRE point of view.

Trying to bring any technical solution to the standard, sufficiently large support has to be gained from the industry partners participating in the standardisation process, with the focus on the operators business, as this would facilitate vendor's interest as well. Each (possible) Study Item or Work Item requires leading Working Group, as well as leading company, whose delegates are active and present on all involved WGs/TSGs. Study Items are aimed at concepts validation, what is an enabler for the Work Item. Technical findings developed during SI phase are captured in the Technical Report (TR). In case of TSG RAN, technical validation of concept consists of link level and system level simulation campaigns, where a number of inputs are collected form interested parties, based on the agreed simulation framework. Clear gains provide good justification for the WI to be opened. Work Items are for the concepts implementation into the Technical Specifications (TS), what means that concept has been standardised. It shall be kept in mind that WI scope does not have to be same as the SI scope.

Especially TSG level WI/SI proposal's visibility is important, as this is the place where the decision on the proposal approval takes place and triggers work in appropriate Working Groups.

In general, the required SI/WI inputs can be summarised as follows:

- Source company/consortium of companies;
- Rapporteur (company's representative);
- Leading WG;
- List of supporting 3GPP members;
- Work Area: Radio Access (TSG RAN) / Core (CT) / Services (SA);

- List of affected specifications;
- Timeline (3GPP release dependant);
- Justification for SI/WI;
- Objectives of SI/WI.

3.6 3GPP RAN workshop

According to the planned standardization actions [23], visit at the 3GPP general future technology meeting or 3GPP TSG RAN/SA plenary meetings were planned. Based on the analysis of the 3GPP meetings calendar [(1)] it was found, that the most suitable meeting for SAPHYRE results dissemination opportunity towards 3GPP, would be the general future technology meeting, called *"On Release 12 and onwards"* [18], being the TSG RAN group workshop. Its main goal was the investigation on what are the main changes that could be brought forward to evolve RAN toward Release 12 and beyond. Contributions to this workshop were required to include requirements, potential technologies and technology roadmap for future 3GPP releases.

Argumentation for the above proposed meeting was as follows:

- The industry audience attending this meeting would be the most competent discussion partner, to identify potential business cases and opportunities for the sharing scenarios to be incorporated in future standardization processes, which were developed within SAPHYRE project,
- Future oriented research conducted in SAPHYRE is more suitable to the future standardization forecasting, instead of being presented during ordinary (i.e. regular meetings for specifications development) working group meetings, which are shaping the currently developed 3GPP specification releases,
- 3GPP workload was another aspect, which played crucial role in the selection of the most appropriate meeting for the research results dissemination. Based on the analysis of TSG RAN working groups meeting reports [24], regular working group meetings were considered as not being the appropriate audience for research project outcomes dissemination due to their continuous overload and focus on currently developed specifications.

WP7 leader initiated discussion with the TGS RAN chairman (i.e. chairman of the above mentioned workshop) in order to identify possible dissemination opportunities during this meeting. It was planned to provide presentation, covering findings described in the SAPHYRE White Papers (for more details on the identified linkage between 3GPP work and SAPHYRE findings, please refer to chapter 6).

Unfortunately, extremely tight schedule of this workshop did not allowed to reserve timeslot for SAPHYRE outcomes presentation. This action has resulted in strict workshop participation rules definition, which were captured in [19] by the statement that only 3GPP members are invited to provide their presentation in the workshop.

[1] For more details on the TSG RAN and TSG SA meetings schedule, refer to Annex A.

Therefore, alternative actions have been considered in order to compensate this refusal, which were covered in section 5.

Nevertheless, TNO representatives have participated in this workshop as one of nearly 250 workshop attendees, reporting the workshop discussion highlights back to the SAPHYRE Management Board.

Based on the meeting summary report [19], the following issues were found to be relevant for the SAPHYRE work:

- Spectrum sharing were raised in number of discussions and some of the network operators have already recognized this solution as potential feature for future networks (e.g. Deutsche Telecom),
- RAN sharing was short-listed by CEWiT as the solution, especially attractive for indoor deployments [20]. Inter-operator scenarios were discussed, indicating challenges in the interference mitigation – topic, which was specifically addressed in SAPHYRE, by development of the non-orthogonal sharing mechanisms for inter-operator scenarios (for more details, refer to chapter 6.1.1). Furthermore, it was referred that the spectrum sharing was allowed by new national telecom policy in India.

The above referred examples are showing increasing interest in various resource sharing scenarios within 3GPP, what justifies the research directions undertaken in SAPHYRE project.

4 ETSI TC RRS overview

The ETSI Reconfigurable Radio Systems (RRS) Technical Committee (TC) activities include studies on the feasibility of RRS standardization and its requirements definition, performing work with focus on functional architectures for SDR, Cognitive Radio (CR) and resource optimisation:

- SDR standards beyond the IEEE scope;
- CR/SDR standards addressing the specific needs of the European Regulatory Framework;
- CR/SDR TV White Space standards adapted to the digital TV signal characteristics in Europe.

ETSI RRS TC created the following four Working Groups (WGs), in which the technical discussions are organised and reports are produced:

- **WG1 System aspects**

  WG1 develops proposals from a system aspects point of view for a common framework in TC RRS with the aim to guarantee coherence among the different TC RRS WGs and to avoid overlapping and gaps between related activities;

- **WG2 Radio Equipment Architecture**

  WG2 focuses on SDR technology and proposes common reference architectures for SDR/CR radio equipment (mobile handset devices, radio base stations), related interfaces, etc.

- **WG3 Cognitive Management and Control**

  WG3 group collects and defines the system functionalities for Reconfigurable Radio Systems, which are related to the Spectrum Management and Joint Radio Resource Management across heterogeneous access technologies. Furthermore, the group has developed Functional Architecture for the Management and Control for Reconfigurable Radio Systems as well as a report on the Cognitive Pilot Channel as an enabler to support the management of the RRS;

- **WG4 Public Safety**

  WG4 collects and defines the related RRS requirements from relevant stakeholders in the Public Safety and Defence domain. The group defines the system aspects for the applications of RRS in Public Safety and Defence.

Technical work within ETSI RRS is structured according to the standardisation process, as depicted on Figure 2.

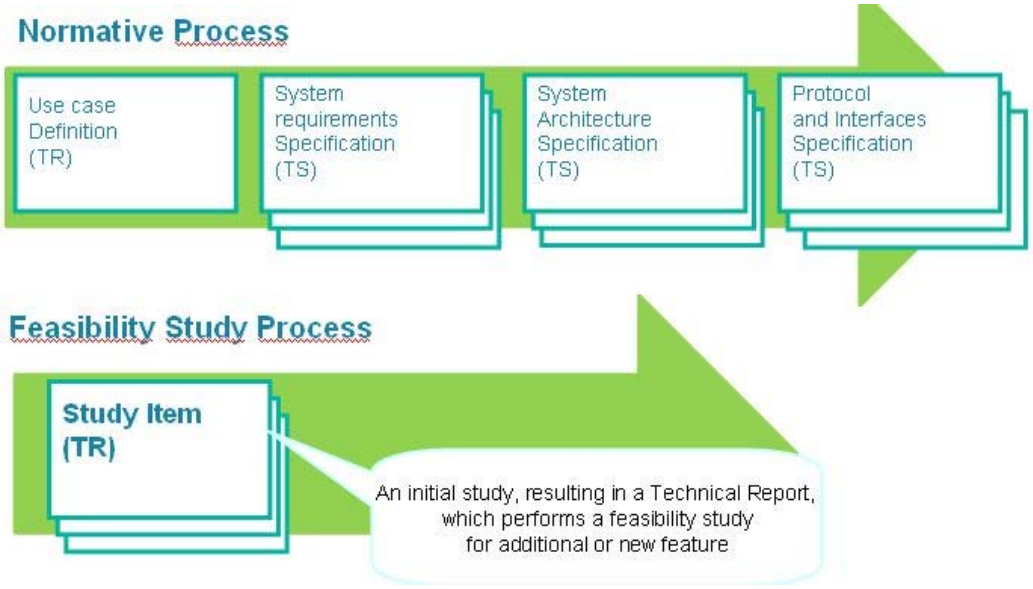

Figure 2. ETSI RRS process overview

Based on the analysis of the technical work performed within ETSI RRS it was found, that this body is mainly focused on the radio resource sharing and its management, while the infrastructure sharing issues are not addressed directly. More specifically, mail area of interest in the field of spectrum sharing is focused on the TV White Spaces studies, where the IMT and SM bands are not really considered.

Some of the work items, potentially related to the SAPHYRE work were listed below:

- Use Cases for Operation in White Space Frequency Bands (TR 102 907)

  The scope of this work is to provide a Technical Report (TR) describing how radio networks might operate on a secondary basis, in frequency bands licensed to primary users. Use cases related to inter-operator resource sharing are possible.

- Use Cases for Reconfigurable Radio Systems operating in IMT bands and GSM (TR 103 063)

  This TR collects use cases for operating network scenarios - to be described in the form of system use cases - for Reconfigurable Radio Systems and operating in IMT bands and GSM bands i.e. licensed spectrums allocated to IMT and GSM systems. Use cases will focus on intra-operator scenarios for which the spectrum resources are assigned to and managed by a single operator.

- System requirements for Operation in UHF TV Band White Spaces System requirements for Operation in UHF TV Band WS (TS 102 946)

  Defines system requirements for operation in UHF TV band white spaces, based on the use cases, as described in TR 102 907. TS 102 946 shall define requirements based on which the coexistence system architecture can be specified.

- Feasibility study on RF performances for Cognitive Radio Systems operating in UHF TV band White Spaces (TR 103 067)

This TR aims to identify the relevant RF scenarios and RF performance applicable to Cognitive Radio Systems for: Coexistence between Cognitive Radio Systems when such Cognitive Radio Systems are operating in UHF TV band White Spaces. This WI seems to be more focused on spectrum sensing. Potential SAPHYRE input towards this work, might cover presentation of the technical outputs, showing that the coexistence between secondary CRS based on the inter-operator feedback exchange is feasible and allows for efficient inter-operator resource sharing.

- Feasibility Study on Control Channels for Cognitive Radio Systems (TR 102 684)

  The scope of this WI is to identify and study communication mechanisms for the coexistence and coordination of different cognitive radio networks and nodes, operating in unlicensed bands like the ISM band or as secondary users in TV White Spaces. Potential SAPHYRE contribution towards this WI might be to show/propose possible mechanisms for the exchange of information between different operators, based on the sharing mechanisms developed within WP4.

- Coexistence Architecture for Cognitive Radio Networks on UHF White Space Frequency Bands (TS 102 908)

  This TS defines system architecture for spectrum sharing and coexistence between multiple Cognitive Radio Networks (CRN). SAPHYRE might present results, describing how the inter-operator interfaces to enable resource sharing between operators were approached and modeled.

It was concluded, that TR 102 907 seems to be the most appropriate technical document, to incorporate potential technical inputs from our project, despite of the fact, that the solutions evaluated in SAPHYRE might not perfectly fit to the already defined RRS scenarios.

What was considered as being one of the main and relevant scenario assumptions for SAPHYRE scenarios was the consideration of the inter-operator information exchange. This aspect was discussed within ETSI RRS under the system architecture discussions and it was concluded, that some limited feedback information exchange might take place among network operators.

What has to be highlighted, is that the work within ETSI RRS is strongly influenced by the industry partners, such as Intel, Nokia, or Alcatel-Lucent, as well as mobile network operators, e.g. Telecom Italia. For that reason, SAPHYRE contribution towards this body is seen as significant dissemination input, making the industry partners aware of the research development within this project.

SAPHYRE outcomes were presented by project coordinator during ETSI RRS technical meetings, what has been captured in [15]. Furthermore, SAPHYRE findings were interfaced with ETSI RRS representatives during COGEU workshop, discussing potential usage of TV whist spaces in Europe [25].

5 Additional communication channels

Due to the limited number of active 3GPP and ETSI members within the SAPHYRE project consortium, additional options for the projects results presentation towards industry players were presented in this section. Below, we are presenting additional communication channels, technical bodies and organisations, which were interfaced in order to enhance SAPHYRE's visibility in the industry, with the aim to increase the possible impact on standards.

5.1 NGMN Alliance

During the second SAPHYRE EAB meeting [(2)], it was identified that Next Generation Mobile Networks (NGMN) Alliance might provide very valuable communication channel towards the industry players.

The NGMN Alliance currently comprises 70 [(3)] partners from telecommunications industry and research societies, from around the world [2]:

- 18 mobile network operators (Members);
- 41 vendors/manufacturers (Sponsors);
- 11 universities or non-industrial research institutes (Advisors).

Moreover, NGMN Alliance cooperates with several important partners from the industry and research communities, standard bodies, groups and forums, to attain the goal of a coherent vision for the mobile evolution beyond 3G.

NGMN cooperation partners are: 3GPP, 4G Americas, ETSI, Femto Forum, Global Certification Forum (GCF), GSM Association (GSMA), TD Industry Association (TDIA), TM Forum, UMTS Forum, Wireless Industry Partnership (WIP), Wireless World Research Forum (WWRF).

Proposal from the NGMN Alliance was received, to publish SAPHYRE White Papers towards the NGMN members (i.e. MNO operators) and sponsors (vendors and manufacturers) via their website as well as their mailing lists. This is expected to enhance SAPHYRE results visibility in the industry, also beyond the EU borders.

What has to be highlighted is that cooperation under the SAPHYRE project has also resulted in further NGMN members board extension, as SAPHYRE participants decided to join NGMN Alliance. Currently, Fraunhofer Heinrich Hertz Institute as well as TNO are the NGMN Advisors.

5.2 RAS Cluster

The EC concertation cluster Radio Access & Spectrum (RAS Cluster) aims to provide a platform for exchanges and concertation between FP6 and FP7 projects. SAPHYRE was participating in RAS workshop on "*Cognitive Radio – Technology and*

[2] EAB meeting: NGMN Alliance, Frankfurt, 09/2011

[3] As of 12/2012.

Regulation" [29]. SAPHYRE has provided significant inputs also to the RAS Cluster White Paper [26]. This White Paper was presented during recent EC Concertation meeting as covered in section 5.5 [28].

5.3 COST Terra

COST IC0905 TERRA stands for *Techno-Economic Regulatory Framework for Radio Spectrum Access for Cognitive Radio / SDR* and is one of the European networking activities within the framework of *COST - European Cooperation in Science and Technology*. The idea with COST-TERRA is to establish a multi-disciplinary European forum, a Think-Tank, focused on coordinating techno-economic studies for the development of a harmonized European regulatory framework to facilitate the advancement and broad commercial deployment of Cognitive Radio/Software Defined Radio systems. This Action should leverage on results and experiences from national and international research initiatives and early standard-setting activities by recommending sound regulatory policies that would facilitate fastest possible uptake and proliferation of CR/SDR. Realizing the important of engaging in discussion with all the major stakeholders in the process, TERRA has been endorsed by and has established working relationships with such bodies as CEPT, ETSI, Wireless Innovation Forum, IEEE DYSPAN SC and the Technical Committee on Cognitive Networks (TCCN) of the IEEE Communications Society.

SAPHYRE has been presented within this forum, giving presentation on the business model related analyses for spectrum sharing scenario, based on the deliverable D5.3 content [31].

5.4 SAPHYRE EAB

In order to achieve maximum impact with SAPHYRE's dissemination and exploitation plans, the EAB consortium has been intensively interfaces throughout the duration of the project during 4 physical meetings, in order to receive feedback on project results to ensure that SAPHYRE considers topics which are relevant for the European industry, complements current activities in standardization and regulation, and keeps track of recent developments in these areas. Secondly the EAB was considered as an important channel to disseminate the results of SAPHYRE. It was considered as the direct way to inform the industry and business partners about the project outcomes. EAB was comprised from key personnel from organisations and companies for which the SAPHYRE results were of interest. EAB consisted of the following members:

- Regulatory bodies:
  - DG Energy and Telecom, The Netherlands,
  - Bundesnetzagentur, Germany,
  - RTR-GmbH, Austria,
  - Comreg, Ireland.
- Mobile Network Operators:
  - Vodafone Group Research and Development,

- PTK Centertel (Orange Poland),
- T-Mobile Netherlands B.V.,
- Swisscom AG (Schweiz),
- KPN, The Netherlands.

- Industry-driven consortia:
  - NGMN (Next Generation Mobile Network) Alliance,
  - GSM-A,
  - ETNO.

5.5 EC initiatives

In this section, we are shortly describing the European Commission initiatives, which have recognized SAPHYRE project as contributor towards flexible spectrum usage and spectrum sharing scenarios promoting entity.

- EC directives

According to recent announcements, EC gets behind spectrum sharing [22], by the declaration, that it wants quicker regulations towards spectrum sharing between carriers, between multiple air interfaces, or between mobile operators and other services like TV. It has defined list of objectives, as part of RSPG program, to harmonize spectrum allocations and rules for mobile broadband, unify processes for national regulators to monitor and extend access to license exempt spectrum and to regulate in consistent manner the approaches to encourage spectrum sharing. Furthermore, secondary spectrum access grants trading was recognized by the EC among technical concepts.

What shall be pointed out is that this declaration is following similar action of the US regulator for the spectrum sharing (e.g. [35]).

- Perspectives on the value of shared spectrum access

EC workshop on "*Perspectives on the value of shared spectrum access*" (Brussels, 2011), has generated technical report, where SAPHYRE project outcomes were recognized, showing that adaptive sharing among separate networks using beamforming techniques can support much more intensive spectrum utilization than the static partitioning of frequencies and operating areas, assuming certain level of cooperation among MNO's [14].

- Spectrum sharing promotion by EC

In [21], the European Commission has published their report, promoting shared use of spectrum resources in the internal markets. SAPHYRE was referred among other FP7 projects, dealing with spectrum sharing research towards dynamic spectrum access.

- EC Concertation meetings

European Commission, under its Information Society division, is organizing Future Network Concertation meetings on regular time basis. The purpose of the Concertation

meeting is to bring together the ongoing FP7 projects funded under the *Network of the Future objective* and facilitate exchange of results and achievements, and build consensus. The Network of the Future projects are organized into three clusters: Future Internet Technologies (FI Cluster), Radio Access and Spectrum (RAS Cluster) and Converged and Optical Networks (CaON Cluster) [28].

SAPHYRE was present at 5th concertation meeting, participating in RAS Workshop on "*Cognitive Radio – Technology and Regulation*", and at 10th concertation meeting.

6 SAPHYRE White Papers analysis

In this section, we present analysis of the SAPHYRE White Papers, from the potential 3GPP influence point of view. The aim was to provide the most concrete and detailed proposals of the SAPHYRE research results consideration in the 3GPP developments. Due to diversity of technical contributions within our project, it was decided to limit this analysis to the SAPHYRE White Papers content. We attempt to identify potential impact of the SAPHYRE research on the technical work being under continuous developed within 3GPP, as well as to identify the technical working groups, which might be attracted by the scenarios evaluated within our project.

Based on the EAB feedback, it was proposed to perform more detailed standardisation opportunities analysis of the SAPHYRE outcomes, on the “per feature” granularity. This would fit into the 3GPP working procedures, which are highly functionality driven, being expressed by the work split into Work Item (WI) and Study Items (SI). This means, that 3GPP standards development will require close tracking, in order to be able to perform valuable analysis afterwards. Furthermore, looking at the TSG RAN technical specifications structure, the most visible aspect is the division into the RAT specific specifications. Therefore, all proposals shall consider RAT specific analysis and applicability.

Based on the argumentation in 3.6, the below presented analysis identifies the following items, being relevant for consideration:

- TSG WG;
- RAT and its release, if applicable;
- WI / SI.

In order to increase reliability of this analysis, 3GPP experience of the consortium members (i.e. ALUD, ECM, TNO, WRC) was used to shape the below presented analyses. Purpose of this review, was motivated by the intention, to keep it possibly realistic and reasonable. It was planned to rely on the experience of active 3GPP delegates, representing industry partners of the SAPHYRE consortium. In case of real business case identification and fruitful inclusion of particular technical solution into the vendors products roadmap, this process would trigger long-term standardization process (interest group formation, definition of SI/WI, feature performance verification, provision of technical contribution in appropriate WG, potential inclusion in technical report / specification, etc.).

6.1 White Paper #1: Spectrum sharing

Based on the SAPHYRE White Paper #1 [32], the following technical solutions were identified for possible 3GPP impact for inter-operator spectrum sharing scenarios:

- Non-orthogonal sharing: Inter-operator cooperative beamforming;
- Orthogonal sharing: Advanced spectrum allocation strategies; prioritised resources allocation.

Currently, there are no activities at 3GPP on spectrum sharing. However, this technology area will be monitored for potential inputs that could be provided by SAPHYRE partners. According to the interviews conducted with the operators/ regulators of the EAB on spectrum/infrastructure sharing, these mechanisms are receiving attention from the telecom community.

6.1.1 Non-orthogonal Sharing: Cooperative beamforming

During State-Of-The-Art analysis for the cooperative beamforming, the following Work Items were identified as relevant, as presented in Table 1, below.

Table 1: 3GPP SOTA for cooperative beamforming

WI/SI	Release	Leading WG / owner	Brief description
ICIC – Inter Cell Interference Coordination	Rel-8		Interference info exchange via X2 for intra–operator scenario
eICIC – Enhanced Inter Cell Interference Coordination	Rel-10		Enhanced ICIC
Further Enhanced Non CA-based ICIC for LTE WI	Rel-11	RAN1 / ChinaMobile	Follow-up of ICIC and eICIC WI's
Coordinated Multi-Point (CoMP) (UL / DL)	Rel-11	RAN1 / Samsung	Coordinated Multi-Point transmission and reception

Furthermore, as the proposed solution is highly related to the BS antenna configuration, LTE-A support of up to 8 Tx (LTE up to 4) antennas in eNB can be seen as enabler for the discussed feature in E-UTRAN networks.

For the cooperative beamforming, it is expected, that RAN1–RAN4 specifications would be impacted due to introduction to the standard. Trying to perform the standardisation forecast, it was found, that the main missing element for the implementation of the cooperative beamforming, is the inter-operator interface for the information exchange. Looking at currently existing solutions within 3GPP standards, the possible candidates for realisation of such interface might be X2 based (for E-UTRAN) or backbone network based solution.

Furthermore, as the CoMP WI is currently being developed within 3GPP, it is not precluded, that the technical solutions created within this WI in RAN1-3 will create attractive candidate also for the cooperative beamforming implementation. Another hypothetical solution might be the creation of the cooperative inter-operator beamforming as the COMP WI follow-up in future releases, but this is for further study.

6.1.2 Orthogonal Sharing: Advanced Spectrum Allocation Strategies

By the advanced spectrum allocation strategies we understand SAPHYRE concepts like prioritised spectrum allocations, online spectrum auctioning etc. – those solutions were described in more details in WG4 deliverable D4.1 [36]. From the technical point of view, these solutions are considered as scheduling techniques. Due to the fact, that

schedulers are considered as implementation specific in 3GPP, scheduling techniques might be seen as not suitable for the standardisation process.

Despite of the above discussion, inter-operator interface would be needed for cooperation techniques covered within this subchapter. It shall be highlighted, that detailed solution might depend on the scenario and relations between operating nodes (e.g. co-located vs. neighbouring BS).

6.2 White Paper #2: Infrastructure sharing

Based on the SAPHYRE White Paper #2 [33], infrastructure sharing scenario in the form of relay sharing was analyzed. During State-Of-The-Art analysis for shared relays, the following Work Items were identified as relevant, as presented in the following table.

Table 2: 3GPP SOTA for shared relays

WI / SI	Release	Leading WG / owner	Brief description
LTE-A relay	Rel-10		Fixed relay for the coverage extension
Improvements to LTE Relay Backhaul	WI postponed		WI postponed: could be proposed again in March 2012
Mobile Relay for E-UTRA	Rel-11 SI		SI opened 09.2011

Based on the already existing relay node Work Item and the analysis of the technical solutions proposed within SAPHYRE project, it was identified that shared relay applicability might be an issue which require more attention. It was questioned, what would be the network prerequisites for the shared relays and whether it is reasonable for the operators to share only relay nodes. Therefore, shared relay analysis requires much more detailed scenario specification before further analysis can be performed. What has to be further analysed, is the UE mobility analysis. Moreover, it is expected, that possible requirements will depend on the spectrum sharing configuration in the deployed network.

Similar to the analysis of the cooperative beamforming, it is expected that standardisation of the shared relay will require addition of the inter-operator interface.

6.3 White Paper #3: Full sharing

Based on the SAPHYRE White Paper #3 [34], full sharing scenario analysis was found to be related to the Network Sharing concept, which has been already considered within 3GPP, being RAT specific functionality. For UMTS, Network Sharing has been introduced in Rel-99 already, where introduction of equivalent PLMNs and Multi-Operator Core Network (MOCN) for UMTS was applied.

For LTE, terminals were mandated to support MOCN (Rel-8), i.e. UE's able to receive "Multiple PLMN IDs". Network sharing was standardised as integral part of Evolved

Packet System (EPS). For legacy GSM networks, Network Sharing has been introduced in Rel-10.

TS 23.251 (*Network sharing: architecture and functional description)* specification was issued in the latest version of v11.0.0 in September 2011 by the SA WG2 [4]. This technical specification covers details of the network sharing (i.e. PLMNs in a shared network has the same features/capabilities and the same operational situation as a standalone PLMN) for GERAN, UTRAN and E-UTRAN, what makes it relevant to the technical scope and standardisation interests of SAPHYRE. Moreover, it shall be highlighted, that current specification requires all UTRAN and E-UTRAN capable UEs to support network sharing, by means of the requirements, as specified in TR22.951 [5]. Another network sharing related specification is TS22.101, *Service aspects: Service principles* [10], being maintained by TSG SA WG1. Therefore, in case of further updates required by the considerations of the full sharing scenario (including spectrum sharing), involvement of TSG SA WG1/2 are envisioned.

In relation to the mentioned technical specification, network sharing brought recently attention in the 3GPP [7], based on the operators (TeliaSonera, Orange, Telefónica) concerns related to the service provision in the shared networks. It was claimed by the network operators that Shared Network support should be considered as the default for Work Items and shall be applicable to all new features (or enhancements to existing features). Furthermore, it was proposed that once the Shared Networks cannot be supported, it should be documented as early as possible during the development of the work.

As an outcome of this issue, a clarification [9] was added to the specification TS23.251 [4] and was communicated to most WGs in RAN, CT SA and GERAN, indicating that the provision of services and service capabilities in a network should not be restricted by the existence of network sharing. Therefore, all new features (as well as enhancements to existing features) should be specified to work in network sharing environments.

Furthermore, it was identified, that it is not possible to specify complete support for RAN sharing for Closed Subscriber Group (CSG) and hybrid cells, at lease at this stage of the specification. A CSG cell cannot broadcast the PLMN ID of each PLMN, and shall only broadcast one PLMN ID.

Another 3GPP technical report, which treats about resources sharing in cellular networks, is TR 22.852: *Study on RAN Sharing enhancements* [37]. This report provides a study on scenarios of multiple operators sharing radio network resources and creates potential requirements that complement existing system capabilities for sharing common RAN resources. Proposed reference use cases are covering various scenarios for common RAN resources, as well as means to verify that the shared network elements provide allocated RAN resources according to sharing agreements/policies. Overload situation were also considered. Selected scenarios and use cases are as follows:

- RAN Sharing Monitoring
- Maximization of RAN sharing revenue

- Participating Operator managing allocated resources
- MDT Support for RAN operator
- Operational Information Retrieval by RAN operator
- Asymmetric RAN Resource Allocation
- Load balancing in shared RAN
- RAN Sharing Charging Event Triggering
- RAN Sharing Charging Reconciliation

The list of the considered use cases shall not be considered as final due to ongoing work. Use case specific requirements and preconditions were elaborated in this work. This work is considering such aspects as networks evolution, as well as security in the inter-operator scenarios. Final conclusions and recommendations are still not completed.

The above indicates that the industry is aware of the huge potential in the sharing scenarios.

7 Regulatory bodies overview

In the following, possible regulation bodies where SAPHYRE can have an impact are described, including CEPT WG FM and RSPG.

What has to be highlighted, is that EAB has allowed SAPHYRE to disseminate its outcomes towards regulatory bodies, such as RSPG, as well as CEPT FM.

7.1 CEPT – WG FM

The Electronic Communications Committee (ECC) of the European Conference of Postal and Telecommunications Administrations (CEPT) is a regulatory body that considers and develops policies on electronic communications activities in a European context, taking account of European and international legislation and regulations. Furthermore, the ECC develops European common positions and proposals, as appropriate, for use in the framework of international and regional bodies and it forwards plans and harmonises within Europe the efficient use of the radio spectrum, satellite orbits and numbering resources, so as to satisfy the requirements of users and industry.

Within the ECC, the Working Group Frequency Management (WG FM) has been identified during the WP7 discussions as the most relevant one to be targeted by SAPHYRE.

The WG FM is responsible for:

- Developing strategies for the implementation of long term plans for future use of the frequency spectrum;
- Updating and maintaining the European Table of Frequency Allocations and Utilisation (ERC Report 25) as the strategic framework for frequency allocations and use in Europe;
- Promoting harmonised national frequency allocation tables and co-ordinating the use of frequency bands for the same purpose, for applications and for systems throughout CEPT countries;
- Selecting and applying appropriate criteria for sharing and compatibility between radiocommunications services and systems;
- Recommending methods of co-ordinating frequency assignments.

Within CEPT ECC, SAPHYRE has been recognized as one of the research projects, which relates to the Cognitive Radio systems, as well as Software Defined Radio systems

7.2 RSPG

The Radio Spectrum Policy Group (RSPG) is a high-level advisory group that assists the European Commission in the development of radio spectrum policy.

The RSPG is established under Commission Decision 2002/622/EC, which was one of the Commission initiatives following the adoption of the Radio Spectrum Decision 676/2002/EC and it adopts opinions, position papers and reports, as well as issuing statements which are aimed at assisting and advising the EC at strategic level on:

- Radio spectrum policy issues,
- Coordination of policy approaches and,
- Harmonised conditions, where appropriate, with regard to the availability and efficient use of radio spectrum necessary for the establishment and functioning of the internal market.

As part of its advisory function, the RSPG consults extensively on a variety of technological, market and regulatory developments relating to the use of radio spectrum in the context of relevant EU policies such as electronic communications and the information society, as well as other sectors and activities such as transport, research and development, or health.

The RSPG publishes an annual work programme. In 2010, a work item *Competition aspects in spectrum Assignment and Usage* is present that is of relevance to the SAPHYRE WP7 efforts in the regulatory area.

7.3 SAPHYRE Regulatory Contributions

In this section, an updated plan of SAPHYRE contributions to regulatory bodies is outlined.

This plan is constructed around three main axes:

- Analysis of regulatory relevance of SAPHYRE
- Description of the regulatory ecosystem in Europe
- Identification of candidate bodies and expected interests.

7.3.1 Regulatory Relevance of SAPHYRE

The regulatory relevance of SAPHYRE is twofold:

1. SAPHYRE performs research on novel ways of spectrum sharing, i.e. multiple entities sharing the same spectrum (WP2–WP4);
2. SAPHYRE deals with impact of resource sharing on business models and markets. Effect on competition is key regulatory matter (WP5).

The approach at regulatory institutions can be summarised in Figure 3 , whereby impact of spectrum allocation and assignment strategies and models is analysed with reference to three key pillars. Solutions worked out in the SAPHYRE project will be evaluated with respect to these three pillars, i.e.:

a) Market Competition – in terms of supporting it;

b) External Trade obstacles – in terms of removing them;

c) Single Market barriers – in terms of overcoming them.

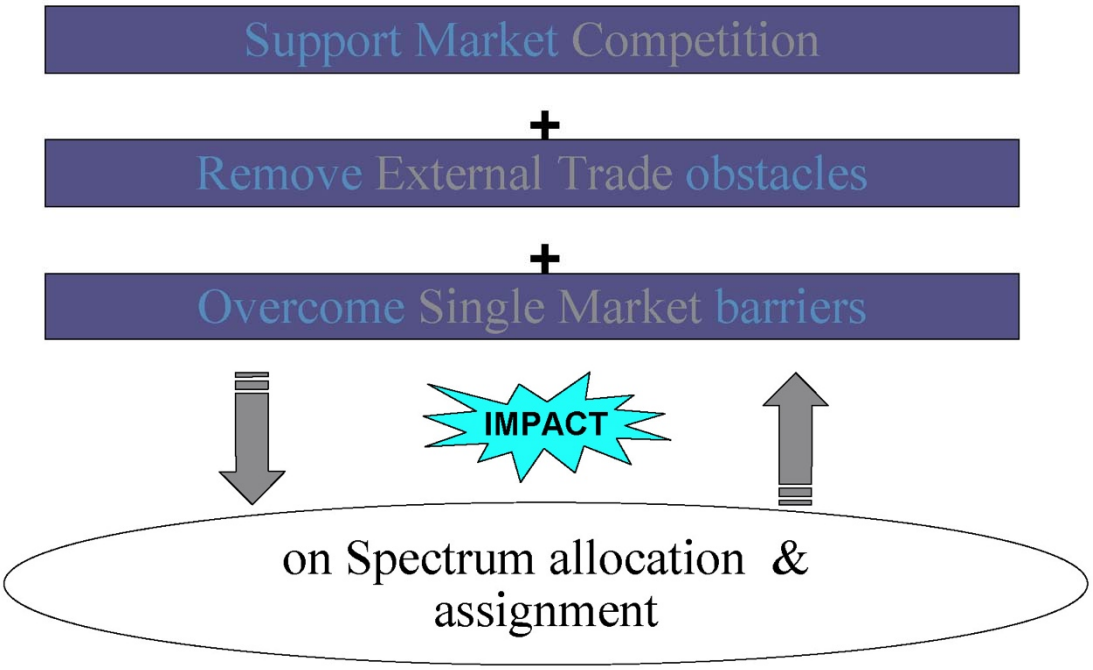

Figure 3: Approach at regulatory institutions

7.3.2 Regulatory Ecosystem in Europe

The regulatory eco-system in Europe is depicted in Figure 4. Correct understanding of its mechanisms is vital for proper positioning of SAPHYRE impacts. Policy making and technical implementation measures are illustrated in the flow chart in Figure 5. Coordination of spectrum aspects in the framework of EU policies id conducted by a number of bodies with different responsibilities. Internal coordination is performed by the SIG Commission Interservice, while specific policies are analysed by selected experts. External coordination is under the umbrella of two other institutions, namely CEPT ECC as a counsellor and ITU WRC as observer.

Furthermore, going into more detail of associated processes, regulatory mechanisms are described in Figure 5. There are in principle two layers, a policy making one, residing with RSPG group and a technical implementation one, residing with RSC Committee. The RSPG collects inputs and contributions from its members and observers and then issues an advice to the EU Commission. The EU Commission issues a proposal and sends it to the RSC. In the close interaction between the RSC, the RSPG and mandated CEPT, the RSC issues an opinion on the Commission initiative. If this opinion is positive, the Commission issues a decision on particular matter.

SAPHYRE project will seek possibility to impact regulatory landscape through close interaction with regulatory members of the External Advisory Board, as covered in Section 7.3.4.

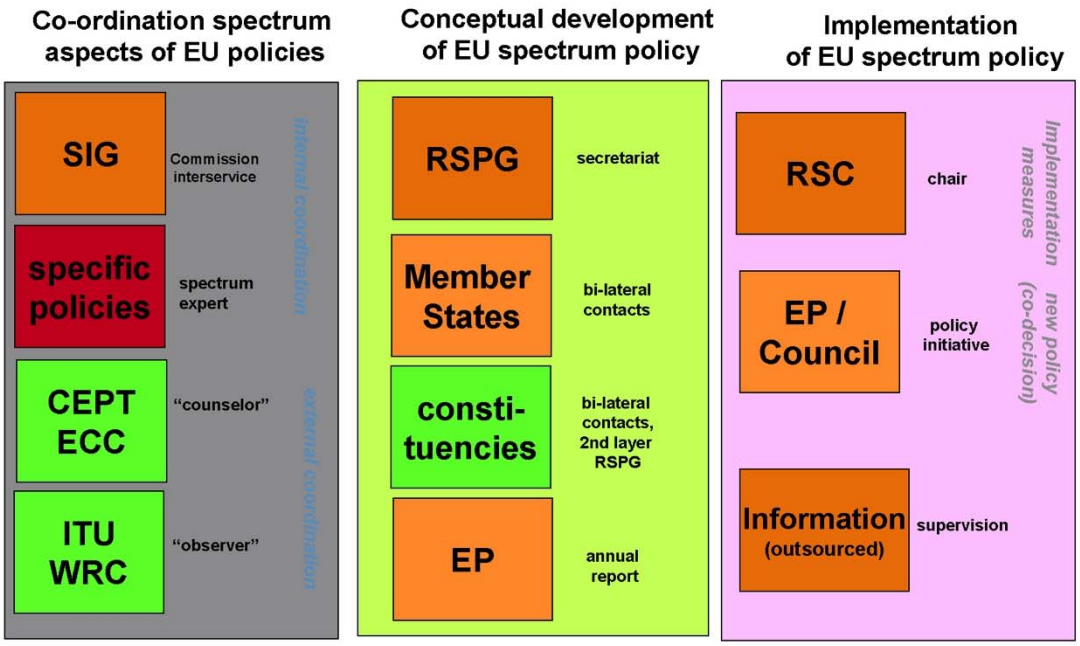

Figure 4: Regulatory eco-system in Europe

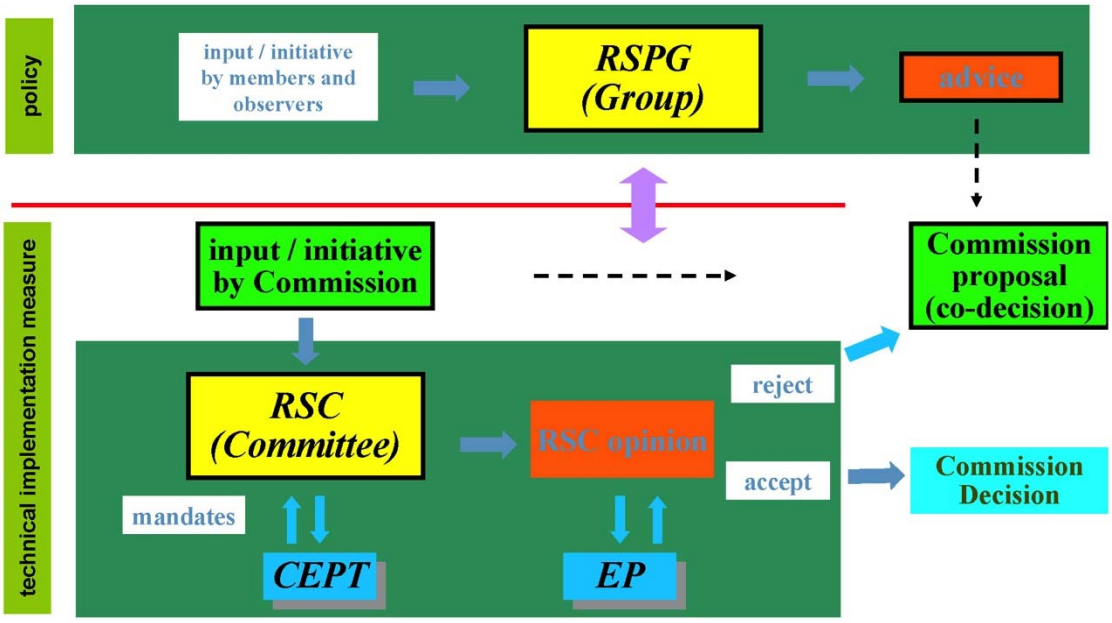

Figure 5: Regulatory mechanisms

7.3.3 Candidate Regulatory Bodies and Expected Interests

In the following, an analysis of concrete SAPHYRE actions that were taken or are still planned to be taken at impacting regulatory landscape are described along with the specific targeted regulatory bodies. Most of the actions go in cooperation with the EAB, where selected results of SAPHYRE were presented.

1. Radio Spectrum Policy Group (RSPG)
   - TNO gave a presentation to the RSPG Plenary [38], covering those SAPHYRE results, which were considered to be of interest to this group. For example, spectrum sharing was discusses and the business and regulatory evaluation model developed in WP5 was presented. The RSPG chair explained that spectrum sharing was still a future topic for the RSPG. The current policy discussions within RSPG focus on infrastructure sharing only.
   - Follow-up at RSPG is not clear from public documentation;
   - The results on market/competition regulations reform will be most relevant for this group.
2. Radio Spectrum Committee (RSC)
   - RSC does not show work items on their current agenda directly related to spectrum sharing;
   - RSC deals with pan European spectrum requirements and changes in use (e.g. including WAPECS). SAPHYRE does not directly relate to this.
3. CEPT
   - Within CEPT, the Electronic Communications Committee (ECC) body exists. The ToR of the ECC reveals its potential interest in SAPHYRE innovations.
   - SAPHYRE should not target the ECC directly, but the most appropriate of the underlying Working Groups. Candidates: WG FM, WG RA and WG Policy.
   - The interest will be in spectrum sharing innovations (as opposed to market regulations).
   - Hence, TNO has successfully requested to give a presentation at the WG FM meeting in February 2013 in Warsaw [39]. Key SAPHYRE results, which were considered relevant to this group, will be brought under their attention. Specifically, TNO intends to focus on spectrum sharing aspects.
4. BEREC (Body of European national regulators)
   - The BEREC represents the member states' regulators. It is an entity created by the EC in order to stimulate cooperation between the EC and the national regulators.
   - The BEREC of which only a few members have joined the EAB, can be seen as 'the big' forum for external regulatory interaction and to sense wide support for certain regulatory reforms. As such SAPHYRE approaches them through the EAB.
   - Nonetheless, TNO has requested, via the Austrian EAB member, to give a presentation at the first BEREC meeting in 2013. TNO is currently in negotiation for this opportunity. TNO intends to present SAPHYRE as a whole, and focus on the business and regulatory evaluation model developed in WP5, which is considered of specific interest to the BEREC.

– The results on market/competition regulations reform will be most relevant for this group.

In cooperation with the University of Auckland, TNO conducted research on the potential spectrum efficiency gain (on macro level) in the coming decade in case of orthogonal sharing in mobile spectrum bands. This will result in a white paper that is specifically targeted to the regulatory community. A summary of this work will also be presented during the WG FM presentation.

7.3.4 Regulatory Bodies Interface via EAB

Second dedicated meeting of the EAB took place in September 2011 at the NGMN premises in Frankfurt, Germany, where potential regulatory actions were discussed, with feedback received from national regulators representatives participating in this meeting, e.g. from Ireland, Austria or The Netherlands.

It was observed, that SAPHYRE results presenting different approaches to the network sharing possibilities, brought the attention and interest, in general. Nevertheless, it was captured, that network sharing can be seen by some regulators as risk for the current telecom markets due to concerns related to potential market competitiveness reduction and market dynamics limitation coming from unification of services and their offer. Based on the feedback received, it was concluded that those concerns needs to be carefully addressed during future EAB meetings.

It is planned, that further SAPHYRE results dissemination towards EAB will take place in March 2012 and November 2012, considering feedback received during previous meetings.

Conclusions

Based on the initial and updated standardisation and regulation plan, final version of the planning has been described, covering the already performed actions, as well as those reaching beyond the project's timeframe. Standardisation and regulatory meetings participation actions were described, providing conclusion for future actions, towards further exploitation of the research outcomes, especially for the 3GPP interactions purposes.

List of the initially considered bodies and organisation being interested in the project's outcomes has been extended, in order to improve the dissemination of the research results of the project and to improve potential impact on the standards development. Sharing mechanisms performance evaluations have been extended by the techno-economic analyses, in order to provide readable arguments for various audiences and experts, belonging not only to research environments, but also to various regulation bodies and advisory units across Europe.

It has been observed, that the industry's awareness, as well as the regulators view on the resource sharing in cellular networks, has been changing over the duration of this project, as the sharing scenarios were evaluated by many research groups, considering various scenario setup's and assumptions. It is felt, that the conservative and exclusive resources usage for provision of the wireless broadband is no longer considered as the one and only rule and that the future networks. We believe, that future networks will incorporate certain level of spectrum usage flexibility, including also inter-operator deals and scenarios.

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Annex A: 3GPP Calendar Extract

In this Annex, we provide an extract from the 3GPP physical meetings calendar [6], listing plan of Europe based meetings of TSG RAN and TSG SA as well as all respective WGs meetings, during the SAPHYRE project's duration [(4)]. It shall be noted, that usually, TSG SA meetings are held in the same place as the TSG RAN meetings, with one week delay.

Table 3: TSG RAN meetings [6]

Feb 2012				
TITLE	**TYPE**	**DATES**	**LOCATION**	**COUNTRY**
3GPPRAN5#54	Ordinary	6–10 Feb 2012	Dresden	Germany
3GPPRAN1#68	Ordinary	6–10 Feb 2012	Dresden	Germany
3GPPRAN2#77	Ordinary	6–10 Feb 2012	Dresden	Germany
3GPPRAN3#75	Ordinary	6–10 Feb 2012	Dresden	Germany
3GPPRAN4#62	Ordinary	6–10 Feb 2012	Dresden	Germany
May 2012				
TITLE	**TYPE**	**DATES**	**LOCATION**	**COUNTRY**
3GPPRAN1#69	Ordinary	21–25 May 2012	Prague	Czech Republic
3GPPRAN2#78	Ordinary	21–25 May 2012	Prague	Czech Republic
3GPPRAN3#76	Ordinary	21–25 May 2012	Prague	Czech Republic
3GPPRAN4#63	Ordinary	21–25 May 2012	Prague	Czech Republic
3GPPRAN5#55	Ordinary	21–25 May 2012	Prague	Czech Republic
Jun 2012				
TITLE	**TYPE**	**DATES**	**LOCATION**	**COUNTRY**
3GPPRAN-on Rel-12 onward	**Work Shop**	**11–12 Jun 2012**	**Ljubljana**	**Slovenia**
3GPPRAN#56	Ordinary	13–15 Jun 2012	Ljubljana	Slovenia
Oct 2012				
TITLE	**TYPE**	**DATES**	**LOCATION**	**COUNTRY**
3GPPRAN2#79-BIS	Ordinary	8–12 Oct 2012	Bratislava	Slovakia
3GPPRAN3#77-BIS	Ordinary	8–12 Oct 2012	Lecce	Italy
Dec 2012				
TITLE	**TYPE**	**DATES**	**LOCATION**	**COUNTRY**
3GPPRAN#58	Ordinary	4–7 Dec 2012	Barcelona	Spain

NOTE: Presented plan is limited to Europe located meetings only. Presented timeline was limited to the end of 2012, i.e. finalisation of SAPHYRE project.

[4] Timing of the preparation of this analysis caused limitation of the meetings list to M24-M36

Table 4: TSG SA meetings [6]

Dec 2011				
TITLE	**TYPE**	**DATES**	**LOCATION**	**COUNTRY**
3GPPSA#54	Ordinary	12–14 Dec 2011	Berlin	Germany
3GPPSA4-MBS SWG	Ad Hoc	13–15 Dec 2011	Copenhagen	Denmark
Jan 2012				
TITLE	**TYPE**	**DATES**	**LOCATION**	**COUNTRY**
3GPPSA3#44-LI	Ordinary	17–19 Jan 2012	Barcelona	Spain
3GPPSA4-EVS SWG	Ad Hoc	28–29 Jan 2012	Edinburgh	United Kingdom
3GPPSA4#67	Ordinary	30 Jan–3 Feb 2012	Edinburgh	United Kingdom
Feb 2012				
TITLE	**TYPE**	**DATES**	**LOCATION**	**COUNTRY**
3GPPSA5#81	Ordinary	6–10 Feb 2012	Dresden	Germany
Apr 2012				
TITLE	**TYPE**	**DATES**	**LOCATION**	**COUNTRY**
3GPPSA2#90	Ordinary	16–20 Apr 2012	Bratislava	Slovakia
May 2012				
TITLE	**TYPE**	**DATES**	**LOCATION**	**COUNTRY**
3GPPSA5#83	Ordinary	7–11 May 2012	Sarajevo	Bosnia and Herzegovina
3GPPSA1#58	Ordinary	7–11 May 2012	Seville	Spain
3GPPSA4#69	Ordinary	21–25 May 2012	Erlangen	Germany
Jun 2012				
TITLE	**TYPE**	**DATES**	**LOCATION**	**COUNTRY**
3GPPSA#56	Ordinary	18–20 Jun 2012	Ljubljana	Slovenia
Jul 2012				
TITLE	**TYPE**	**DATES**	**LOCATION**	**COUNTRY**
3GPPSA3#68	Ordinary	9–13 Jul 2012	Bratislava	Slovakia
3GPPSA2#92	Ordinary	9–13 Jul 2012	Barcelona	Spain
Aug 2012				
TITLE	**TYPE**	**DATES**	**LOCATION**	**COUNTRY**
3GPPSA5#84	Ordinary	20–24 Aug 2012	Berlin	Germany
Oct 2012				
TITLE	**TYPE**	**DATES**	**LOCATION**	**COUNTRY**
3GPPSA2#93	Ordinary	8–12 Oct 2012	Sofia	Bulgaria
Nov 2012				
TITLE	**TYPE**	**DATES**	**LOCATION**	**COUNTRY**
3GPPSA3#69	Ordinary	5–9 Nov 2012	Edinburgh	United Kingdom
3GPPSA4#71	Ordinary	5–9 Nov 2012	Bratislava	Slovakia
3GPPSA1#60	Ordinary	12–16 Nov 2012	Edinburgh	United Kingdom
Dec 2012				
TITLE	**TYPE**	**DATES**	**LOCATION**	**COUNTRY**
3GPPSA#58	Ordinary	10–12 Dec 2012	Barcelona	Spain