

22.12.2009

**RSPG call for public input on the draft report on “Cognitive Technologies”****Comments and views from Nokia and Nokia Siemens networks****Overall views and comments**

We see cognitive radio as a means to offer new opportunities for the wireless industry and consumers to cope with the continuously growing mobile data traffic.

The UMTS Forum predicted in its report in 2005 that wireless data traffic would grow up to 40 times until year 2020. However, the recent observations and predictions indicate that much faster growth of mobile data traffic is occurring already by year 2015.

There are various ways to deal with the data traffic growth. For example spectral efficiency of individual technologies can be improved, cell size can be reduced by having many small cells or new spectrum bands can be utilized. Unfortunately the spectral efficiency of mobile networks is approaching the theoretical limits where additional improvements would be very costly. There could be an economical limit as having many small cells could mean a rise in the corresponding costs of network deployment. Thus access to new spectrum bands is essential.

Cognitive Technologies can significantly increase the overall utilisation of spectrum, by allowing sharing in bands where it was previously not possible. Thus new spectrum can be made available to applications that can employ the cognitive capabilities, such as sensing, geolocation together with access to database, transmit power control, flexible spectrum use etc.

We welcome the RSPG report on Cognitive Technologies, as it covers extensively the broad range of aspects of Cognitive Technologies addressing both the potential benefits and the challenges. Initiating a proper dialogue in Europe in a timely manner is very important. However, that is not enough. A consistent, standardized and global approach would be needed with applications of Cognitive Radio. Europe has a significant opportunity in driving the regulation through EU and CEPT and standardization through ETSI.

We agree with the observations that applications of Cognitive Technologies should be addressed case by case, meaning for example that for a defined application the spectrum bands need to be identified and the associated technical conditions need to be formulated. This is due to the fact that Cognitive technologies cannot be deployed in all bands, and where the deployment is possible there are still significant differences, band by band. In some bands there is room enough, left from the current spectrum usage so that Cognitive Technologies could be deployed there in an economically viable manner. Sensing also works better if the current spectrum usage and its transmission characteristics are known. This would not be possible in undefined bands.

We also agree that there is a need for harmonised solutions with respect to spectrum bands and the associated technical conditions. Worldwide harmonisation can best compensate for the additional complexity which is needed in implementing the cognitive functionalities in devices. Economies of scale will maximize the benefits for the users and industry.

We also believe that eventually Cognitive Technologies can and are likely to change spectrum management significantly.

22.12.2009

It should also be noted, that deployment of Cognitive Technologies is not only about spectrum. The employment of cognitive capabilities may also open up possibilities for completely new services.

In addition to these overall comments there are some specific comments below, addressing particular parts of the report.

### Specific comments

The last paragraph in the executive summary states: *The overall conclusion is that there are significant benefits by adopting a harmonised approach to cognitive radio technologies. The timely availability of a regulatory response across Europe and harmonised rules for cognitive devices assist in exploiting economies of scale and encourage industry investment, thus enabling new cognitive applications that could bring significant benefits to European markets.*

Comment: This is a very important statement and strongly supported.

Section 3, 6<sup>th</sup> paragraph states: *In such context Software Defined Radio is widely regarded as an important enabler for Cognitive Radio. However, this is not an absolute necessity. A Cognitive Radio could be built purely based on hardware.*

Comment: In addition, SDR may, or may not contain "cognitivity". Thus the two are independent.

Section 3, last paragraph states: *It is suggested to use these definitions in the European debate.*

Comment: It is fine to have commonly agreed definitions. However, the definitions of ITU-R are intentionally generalized to be applicable for all radio-communication services. However, these definitions should not limit the implementation of CRS. The ITU-R definition on CRS does for example not cover the user's needs and behaviour, which we believe to be very important aspect for mobile CRS.

Section 4.2.1, second paragraph states: *Monitoring of spectrum usage and detection of systems present in the spectrum that are to be protected from harmful interference is a non-trivial technical problem, for reasons given below.*

Comment: Agreed. The hidden-node problem, impossibility to sense receive-only or occasionally silent transmitters are limiting factors. This needs to be taken into account in the rules and implementing CRS. Deployment of Cognitive Technologies may not be possible in some bands and may be more suitable to some bands than others.

Section 4.2.1, 9<sup>th</sup> and 10<sup>th</sup> paragraphs state: *...In order to develop adequate sensing technologies, the receiver parameters of the existing users should be known too. This issue needs to be addressed in any future spectrum management decision.*

*Sensing is a technology that is still under development. Sensing becomes more challenging when a wider range of frequencies and/or a wider range of technologies need to be taken into account. Therefore it might be useful to start with the introduction of CRT in a limited frequency range in which the range of technologies used by the other existing users in the band is limited, e.g., within the UHF broadcasting bands.*

22.12.2009

Comment: Agreed. It is useful to have defined cases as starting point and harmonized approaches are needed for them.

Section 4.2.1, last paragraph states: *Sensing is a key feature to protect the primary users but may not be sufficient in all cases.*

Comment: We believe that location awareness in connection with access to database will be needed in many cases, due to difficulties related with sensing. In many cases both may be needed to complement each other, and in some cases sensing may not be needed at all.

Section 4.2.2, second bulleted item states: *Out-Band CPC is a radio channel outside the component Radio Access Technologies. It either uses a new radio interface, or alternatively uses an adaptation of legacy technology with appropriate characteristics.*

Comment: The out-band CPC would be a specific technical solution in a specific frequency band. Therefore further analysis is needed about the CPC. Technology choices should not be limited due to certain approach. Possibilities to utilize a legacy technology, such as GSM should be considered.

Section 4.3, second paragraph after the bulleted items states: *It is recognised that a harmonised solution of CRT devices at the European level could reduce complexity and reduce uncertainties and allow the CRT devices market to benefit from a larger geographical spectrum harmonisation.*

Comment: Agreed. Harmonized solutions would be beneficial, especially with spectrum bands, high level technical requirements, interfaces and protocols.

Section 5, text describing Vertical Sharing states: *One approach to sharing spectrum can be referred to as vertical sharing where the cognitive radio shares spectrum with the existing users. The cognitive radio is only allowed to utilize frequencies within the band as long as the existing user(s) is not affected, i.e. the cognitive radio must not cause harmful interference to the existing users. Depending on the spectrum rights of the primary user(s), the conditions under which the CR devices can operate are to be defined in advance by the regulator or could be left to the primary user.*

Comment: The latter approach (i.e., the conditions are left to the primary user) may be problematic as the primary users tend to be negative towards secondary usage.

Section 5.1.1, second paragraph states: *In this model, the regulator will designate the frequency band where cognitive access could be introduced to share spectrum on an opportunistic basis with existing users and set the appropriate technical conditions of spectrum access. Such an initiative is expected to a large extent to be driven by industry's business models and the foreseen cognitive applications.*

Comment: European harmonisation of spectrum bands and setting "appropriate technical conditions" is supported as a way forward. It makes sense to have the foreseen applications as a basis.

Section 5.1.2, first paragraph states: *In this model a frequency band dedicated to collective use is identified by the regulator and has usage restrictions to ensure compatibility with existing users. The*

22.12.2009

*regulator may also define some conditions of access for the collective use in the band which may require the devices to have cognitive features. These usage restrictions are established policies in order to ensure that various applications could share the frequency band on a non-discriminatory basis. These cognitive features are used to dynamically share the spectrum with each other in such a way that all devices have the same rights and an equal chance to access the spectrum, i.e. the cognitive features are used to ensure a fair distribution of rights to access the spectrum.*

Comment: European harmonisation of spectrum bands and identification of fair "usage restrictions" is supported.

Section 5.3, one bullet point in table, in part related to CUS model states: *CT devices will need to be able to adapt to new sharing conditions in line with evolution of other radio systems.*

Comment: In some cases there may be technical limitations in the ability of sensing to adapt to the evolution of the other radio systems. This is an issue depending on the details of the evolution and implementation of the CT devices. Usage of geolocation in connection with access to database may help solving this issue.

Section 5.3, last sentence at the bottom of the table states: *Identification of spectrum for cognitive access lies with the existing licensed holders and not with regulators*

Comment: In case the spectrum is tradable, and the initial license holder has allowed secondary usage of the band for Cognitive Technologies, the sharing conditions should not change in an unexpected harmful manner towards the CT usage if the band is traded and the licence holder is changed. Thus some regulation may be needed also in this case to ensure regulatory certainty to the CT usage.

Section 5.3, 1<sup>st</sup> paragraph under the table states: *When addressing the introduction of cognitive radio systems in a given band, the spectrum manager will assess the most suitable regulatory framework in accordance, amongst other criteria, technical sharing feasibility and the foreseen cognitive applications.*

Comment: This should be done at least on European level, preferably on global level.

Section 5.3, 3<sup>rd</sup> paragraph under the table states: *The authorisation regime will depend on the established conditions to ensure coexistence between CRT applications and existing spectrum users. This would be developed on a case by case basis according to the requirements of the given frequency band. The current regulatory framework provides sufficient flexibility in terms of possible licensing regimes at national level: from general authorisations to individual authorizations.*

Comment: Country specific solutions need to be avoided.

Section 5.4.1, 1<sup>st</sup> bulleted item states: *The cognitive device will need to know its position; the positional accuracy should be specified and agreed by the national regulator.*

Comment: Specifying a positional accuracy requirement for the cognitive device may not be needed and in fact may need to be avoided, since such specifications may mandate a certain technical solution.

22.12.2009

The accuracy of spatial resolution may be implementation and device specific, and the database should take that into account when replying to channel availability queries. For example, if the accuracy reported by the device is poor, the database would need to limit the available channels it reports to only those that are available over the uncertainty area of the device's spatial location. It must be noted that such uncertainty in the device's location by no means threatens the protected areas of the primary service users; it mainly limits the spectrum potentially available to the device.

Our recommendation is that location accuracy should be imposed only to the database as the granularity of geometrical grid points, each of which holds specific existing user information. Rather than determine its location with a specified accuracy, the cognitive device should instead send its location and the accuracy it thinks it was able to determine (whatever that is), which then would be considered as the area of operation of the device

Section 5.4.2, 2<sup>nd</sup> paragraph states: *According to market needs, relevant regulatory solutions could be studied in cooperation between administrations and industry to develop the most suitable forms of CPC, particularly for the frequency to be used by the CPC. The form of regulatory intervention may differ according to the form of CPC.*

Comment: There can be many scenarios to provide the information of the CPC. However designated frequencies for CPC may need to be justified and further studies would be needed.

Section 6.3, 2<sup>nd</sup> paragraph states: *Agenda item 1.19 of WRC-12 deals with regulatory measures needed for the introduction of Software Defined Radio and Cognitive Radio. ITU-R Study Group 1 came to the preliminary conclusion that Software Defined Radio (SDR) and Cognitive Radio Systems (CRS) are related technologies which can be used in any radio service within the Radio Regulations, therefore there is no need to incorporate the definitions of SDR and CRS in the Radio Regulations. The definition of SDR and CRS are captured in an ITU-R Report. It remains unclear what the potential changes to the Radio Regulations should be in addition to the need for more flexibility (which is tackled under WRC-12 agenda item 1.2).*

Comment: It is obvious that Cognitive Technologies can be utilized in various radio systems. It may not be feasible at the moment to define amendments to the Radio Regulations addressing deployment of a generic CRS. In the future a regulatory framework addressing spectrum bands and the technical capabilities needed to allow access to those bands would best facilitate deployment of Cognitive Technologies. A globally common approach would best facilitate exploiting economies of scale and encourage industry investment, thus enabling new cognitive applications that could bring significant benefits globally and also to European markets. Examples of the required regulatory measures are those employed in the deployment of RLAN in the 5 GHz bands based on DFS.

Section 8.2, 1<sup>st</sup> paragraph states: *Benefits from the introduction of CR appear in several areas. The main benefits are the improved efficiency in the overall spectrum use and facilitating access to "new" spectrum. Detection of unused spectrum (spectrum sensing), utilization of free available spectrum slots (spectrum management within the scope of spectrum usage rights), dynamic selection of frequencies when the presence of other users is detected (spectrum mobility), coordination & sharing of spectral resources among users (spectrum sharing) may provide new opportunities for industry and operators.*

Comment: We agree that introduction of CR may provide new opportunities for industry and operators. However, they do not come from cognitive capabilities (e.g. sensing and other required capabilities) as such, but mainly from the additional capacity and evolved networks that facilitate new services and more



22.12.2009

traffic in an economical manner. However, it is true that employment of some of the cognitive capabilities may facilitate totally new services, which would be an opportunity for industry.

Section 8.2, 1<sup>st</sup> paragraph continues: *Nevertheless, the benefit of CR could be reduced by additional costs of the equipment complexity and possible deployment restrictions on devices using cognitive features and incumbents applications. Harmonisation of CRT capabilities and spectrum usage should therefore be further studied in order to reduce the risk of additional costs due to equipment complexity.*

Comment: Agreed. Harmonization is needed to compensate for the additional complexity.

Section 9, 4<sup>th</sup> bullet states: *Sensing is a key feature to protect the primary users but may not be sufficient in all cases. A case by case approach is required which takes into consideration the current usage and expected applications. Obtaining knowledge of this environment may require a combination of the cognitive features.*

Comment: This should mean band specific approaches, but not country specific approaches. Different sets of cognitive capabilities may be needed in different bands.

Section 9, 8<sup>th</sup> bullet states: *Future CR systems and relevant spectrum regulation should use experience from deployment of precognitive radio systems.*

Comment: The RLAN in the 5 GHz range and the requirement for DFS is a realistic example of regulatory measures and technical conditions that were needed on a global level to make dedicated bands available and new possibilities of sharing/coexistence feasible.

Section 9, 12<sup>th</sup> bullet states: *According to market needs, relevant regulatory solutions could be studied in cooperation between administrations and industry to develop the most suitable forms of CPC, particularly for the frequency to be used by the CPC. The form of regulatory intervention may differ according to the form of CPC (see WRC 1.19 agenda item).*

Comment: It is unclear if separate frequencies are the preferred way for implementing CPC. Instead, frequency bands suitable for CT will be needed and harmonised regulatory solutions are needed for them.

Section 9, last bullet related to cognitive access in the UHF band states: *There are significant benefits in adopting a harmonised approach to this work. The timely availability of spectrum across Europe and the harmonised specification of cognitive devices will exploit economies of scale and encourage industry investment, thus enabling new cognitive applications that could bring significant benefits to European markets by maximising the effective and efficient use of spectrum. This will only be achieved if common technical conditions can be agreed at the European level on identified frequency bands, which provide sufficient certainty and stability to industry within an appropriate timeframe.*

Comment: This statement is very much supported.