

**ITU-R SG 1/WP 1B WORKSHOP:
SPECTRUM MANAGEMENT ISSUES ON
THE USE OF WHITE SPACES BY
COGNITIVE RADIO SYSTEMS
(Geneva, 20 January 2014)**

**APT Wireless Group
Activities on
CRS & SDR**

***APT/AWG Task Group
on SDR & CRS***

**ITU-R SG 1/WP 1B WORKSHOP:
SPECTRUM MANAGEMENT ISSUES ON
THE USE OF WHITE SPACES BY
COGNITIVE RADIO SYSTEMS**

**GENEVA, SWITZERLAND
20 JANUARY 2014**

www.itu.int/go/ITU-R/RWP1B-SMWSCRS-14



AWG Activities on CRS

Task Group on CRS & SDR,
APT Wireless Group

Content

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Background

- Software defined radio (SDR) and Cognitive Radio System (CRS) are evolving technologies. Realizing the impact of these upcoming and promising technologies on radio spectrum regulation, WRC-07 adopted Resolution 956 which is “Regulatory measures and their relevance to enable the introduction of software-defined radio and cognitive radio systems” and the subject was under Agenda item 1.19 of WRC-12.
- APT Wireless Group (AWG) established a Task Group on CRS & SDR (TG-CRS & SDR) in April 2009 to facilitate the study on software-defined radio and cognitive radio systems in the Asia Pacific Region.

Terms of References

- The Terms of Reference (TOR) of TG-CRS & SDR was approved in AWF6 meeting (AWF6-/OUT-15)
 - To share the information and review the activities on the development of SDR and CRS in relevant ITU-R Working Parties, Standard Development Organizations (SDOs) and relevant organisations.
 - To exchange views on the studies of SDR and CRS undertaken by APT members.
 - To consider and prepare, as appropriate, APT Recommendations on frequency bands for the use of SDR&CRS technologies in Asia-Pacific countries.
 - To prepare APT Report(s) on technologies and regulatory implications associated with SDR & CRS, application scenarios, impacts on existing radio services and guidelines to the administrations on introducing SDR & CRS.

Possible Deliverables

- The Possible deliverables of TG-CRS & SDR were approved in the AWF-8 meeting (AWF-8/OUT-16)
 - Report(s) on SDR and/or CRS survey results in Asia-Pacific countries. The report(s) can include
 - Status of SDR and/or CRS on the aspects such as key techniques, development, regulation and possible spectrum use.
 - Deployment examples of SDR and CRS
 - Report(s) on applications, deployment scenarios, key techniques and system characteristics, frequency implications for SDR and/or CRS
 - As appropriate, Recommendations/Report on possible harmonized frequency arrangement(s) for certain applications using CRS technologies in Asia-Pacific countries.
 - Other aspects

Latest Progress

- Sharing the latest activities on the development of CRS in relevant ITU-R Working Parties and Standard Development Organizations (SDOs)
- Finalizing a questionnaire report on CRS & SDR in the AWG-12 meeting (AWG-12/OUT-07)
- Initializing and developing a new study report on deployment scenarios and associated technologies

Content of Questionnaire Report

Background

Summary of the questionnaire

Conclusion and further work

Background

- The content of the questionnaire followed the TOR (Terms of Reference) of TG-CRS & SDR, and in order to enable the AWG to have a better understanding of the current stage of CRS and SDR implementation and development or relevant topics concerned in the region, more than eleven questions were made in this questionnaire
- The feedback or answers from administrations are being collected and analyzed as a basis for the further study on CRS and SDR within APT region

Summary of the Questionnaire

- According to the questions, eight administrations (Australia, Brunei, China, Indonesia, Japan, Korea, New Zealand and Singapore) responded the questionnaire to introduce their attitude and the relevant research activities on CRS and SDR in their country
- The administrations attitudes include the information such as
 - If there is any research and development on CRS & SDR related topics in their country
 - they believe the CRS will be a technology to improve the spectrum efficiency or not
 - the possible applications or scenarios for the improvement of the spectrum efficiency by implementing CRS and SDR
 - the time is needed for commercial deployment of CRS
 - consideration on the possible frequency band(s) for the systems or services implementing CRS
 - main issues or challenges in face of the CRS&SDR deployment from the technical and regulatory perspective respectively, etc.

Conclusion and further work

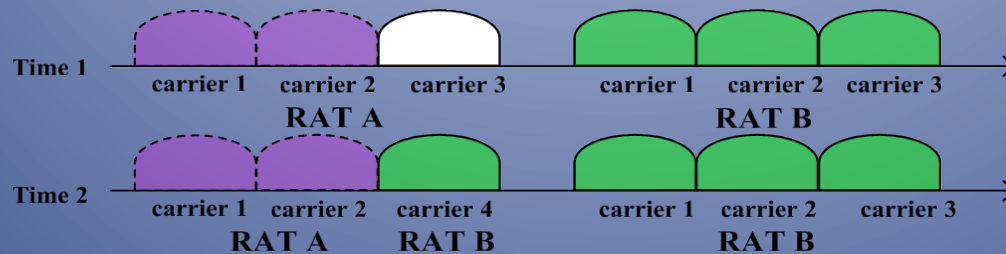
- Considering the feedback from APT administrations, with regard the answers on SDR, it seems that SDR is a relatively mature technology which has been successfully deployed
- APT administrations also hold the views that CRS technology could be treated as an evolving and promising technology to improve spectrum efficiency and may see commercial deployment in ten years, meanwhile relevant studies is carried on in their countries respectively
- CRS still needs to face some challenges not only from technical aspects but also regulation and policy aspects
- Further study on CRS is needed, and it was proposed to draft a new report on CRS in AWG and the questionnaire result could also be a reference to the new CRS report

Contents of Study Report

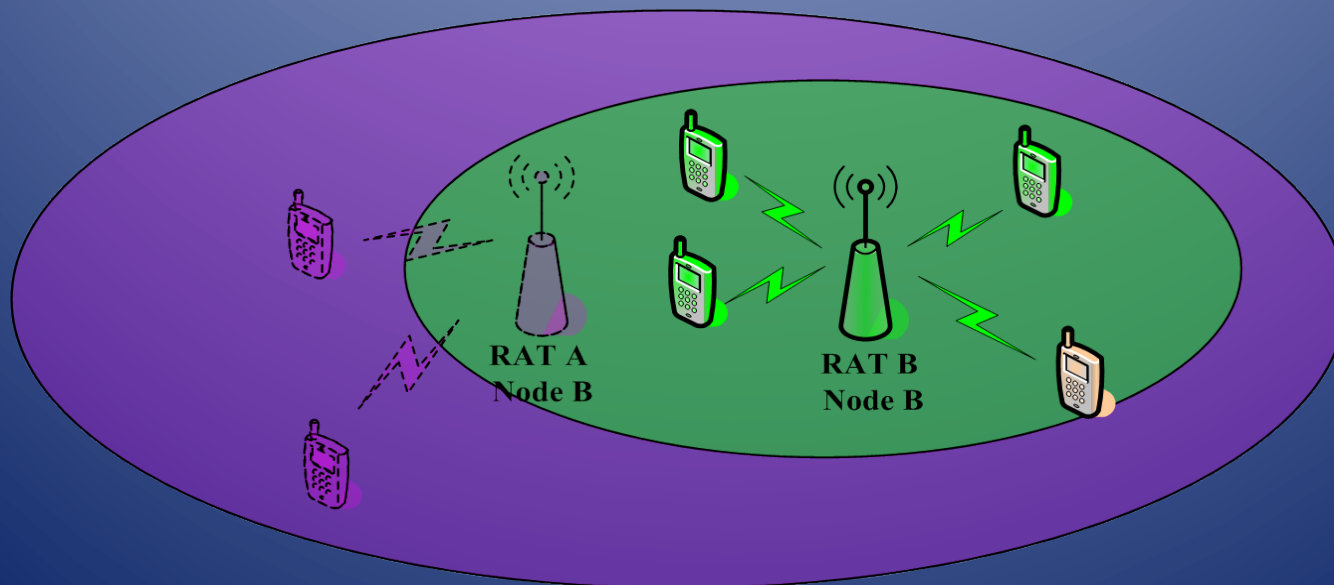
- Application scenarios of cognitive radio systems
- Key technologies of CRS
- CRS solutions for various scenarios
- Impacts of cognitive radio systems (TBD)

Application scenarios(1)

Application scenarios for the spectrum sharing in systems

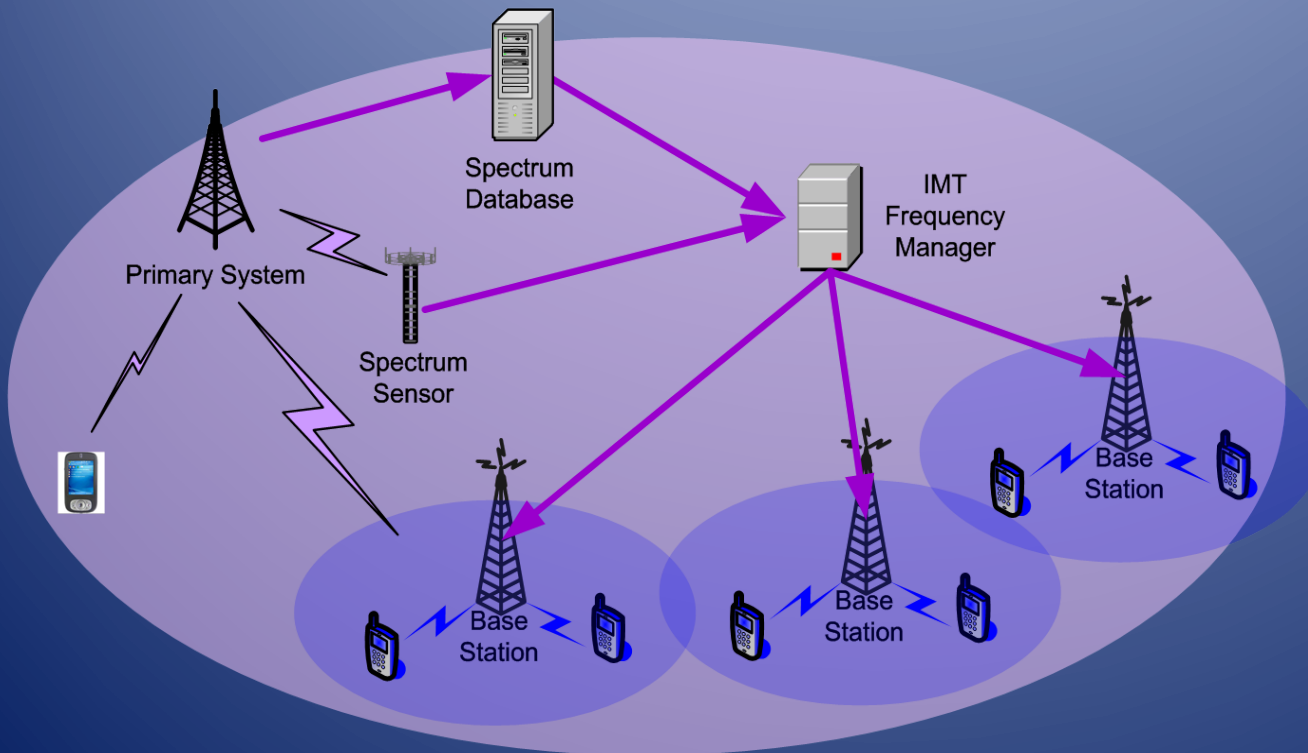


Scenario of CRS in intra-operator



Application Scenarios(2)

Scenarios for IMT sharing the spectrum of other services(1)

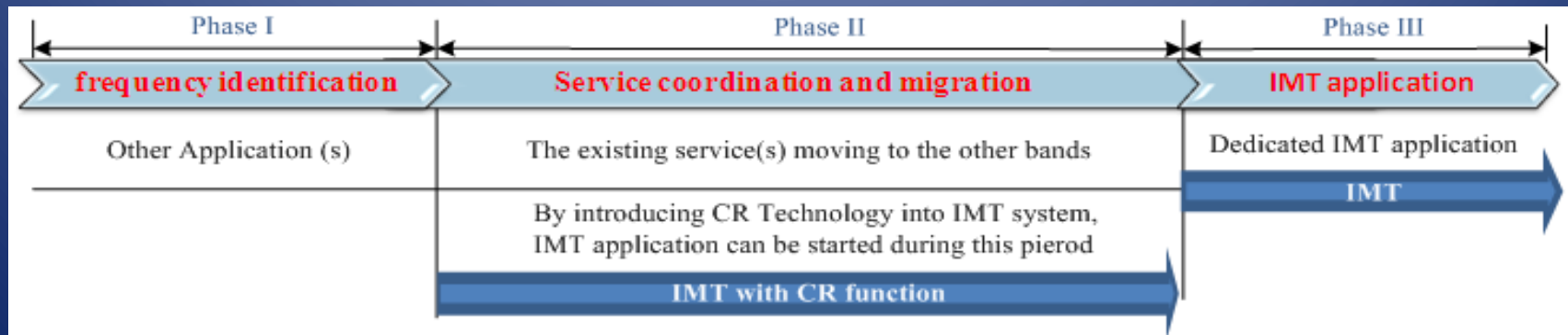


Scenario of IMT with CR functions to sharing the spectrum of other radio system

Application Scenarios(3)

Scenarios for IMT sharing the spectrum of other services(2)

- After a frequency band is identified to IMT, a transfer period is needed for the existing application(s) to migrate from this band and IMT service can be provided only after this transfer period. However, sometimes this migration period will last a long time due to the complex service transformation.
- the main purpose and application scenario of introducing CR into IMT system is to accelerate the implementation of IMT spectrum during this conversion period.

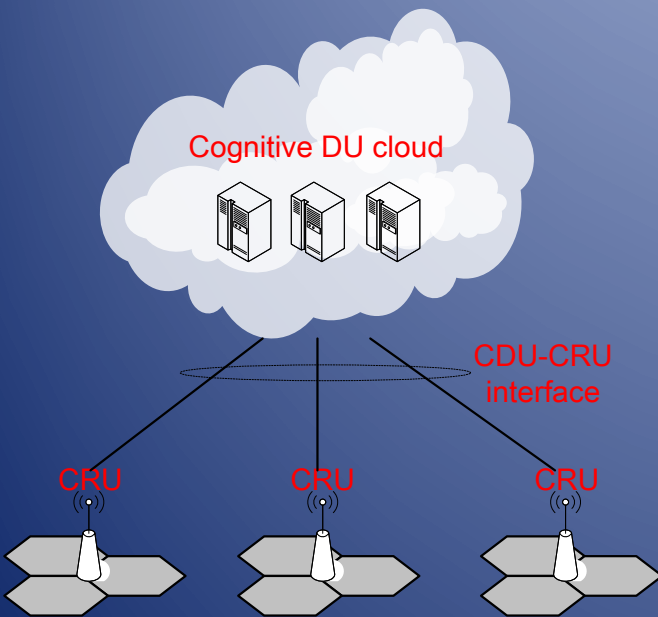


Key Technologies

- Cooperative sensing- Spectrum sensing technology is used for spectrum holes detection in cognitive radio systems. A cooperative sensing scheme could make multiple sensors which are distributed in different locations cooperate together
- Spectrum management- Spectrum management technology is used for dynamic spectrum resource allocation to satisfy the communication requirements of each radio access system implementing cognitive radio technology

CRS Solutions(1)

- Solution of CRS Based on C-RAN Architecture



Functional Architecture of
Cognitive C-RAN

There are two main functional blocks in Cognitive C-RAN:

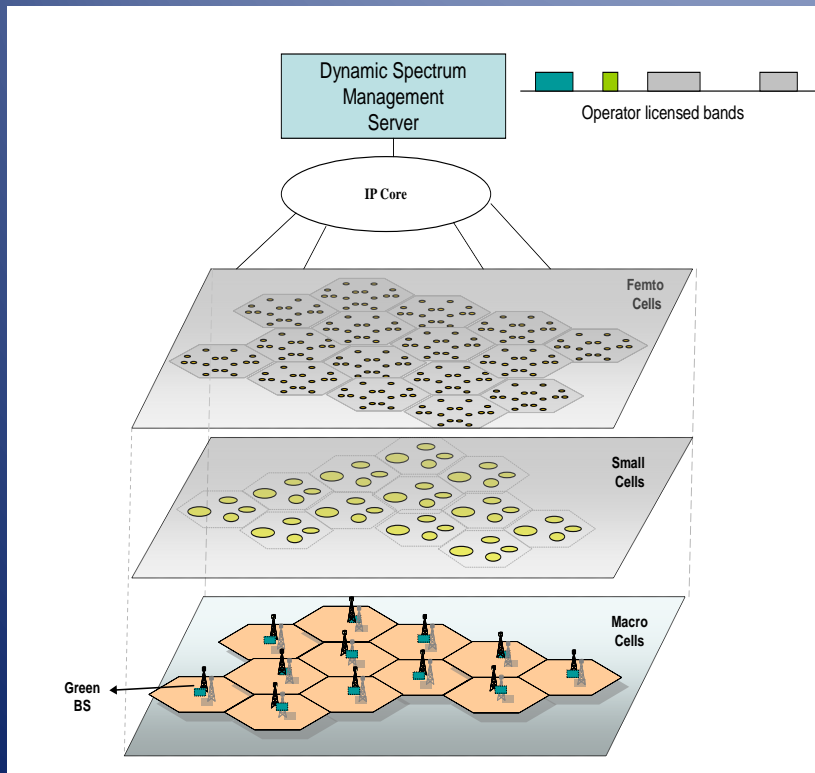
- **CRU** is in charge of the radio functions from RF transmission and reception to digital baseband in operating frequency and adaptation to the transport network. Besides, the CRU is responsible for receiving sensing data according to sensing control signaling and adjusting operating frequency according to the requirement of reconfiguration
- **CDU cloud** is composed of DUs (Digital Unit) which are mainly used for performing the functions of conventional BS. CDU cloud is in charge of spectrum sensing, incumbent database maintenance, spectrum allocation and reconfiguration management
- CDU cloud and CRUs are connected via CDU-CRU interface

CRS Solutions(2)

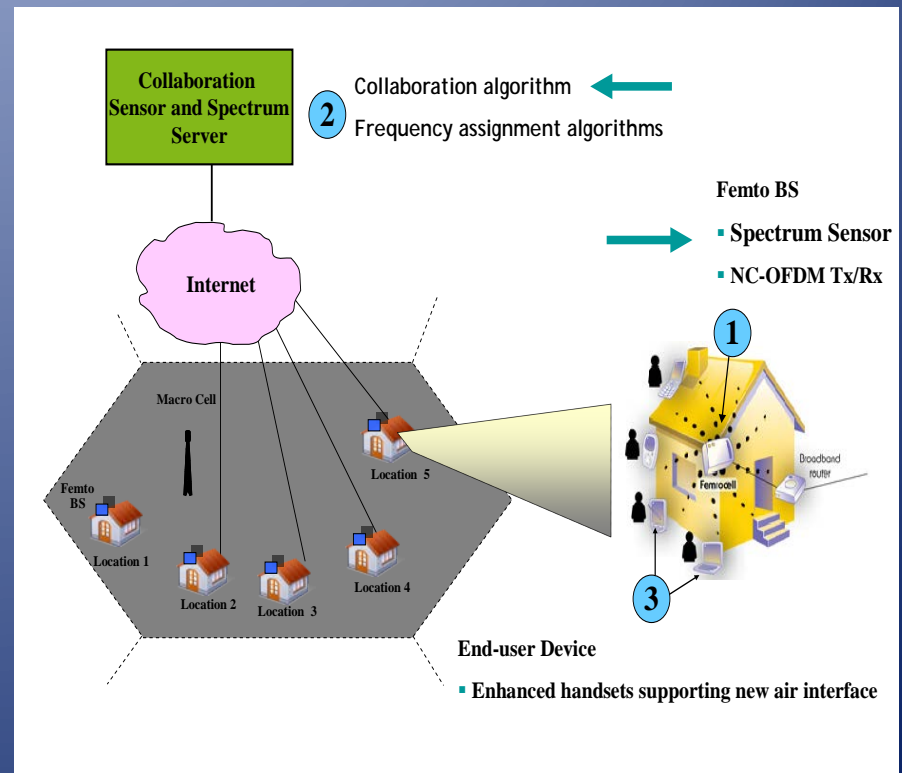
- Solution for IMT sharing the spectrum of other services
- In this solution, two functions of cognitive radio shall be added to IMT system.
 - To obtain the information of the spectrum occupancy of primary system
 - To switch to other spare frequency when primary system reoccupies the frequency used by IMT
- Frequency manager is the core of the spectrum sharing in IMT system.
 - To collect the spectrum occupancy information from spectrum database and spectrum sensor and allocates the spare spectrum to base stations according to the their spectrum demands
 - To inform the IMT base station to switch to a new spare frequency with all the UEs in its cell according to the alarm sent by spectrum sensor when primary system reoccupies the spectrum used by IMT system

CRS Solutions(3)

- Intelligent/dynamic spectrum allocation in hierarchical networks with macro, metro and femto cells



- WhiteCell-A Distributed control architecture for femto and small cells



Thanks for your attention!