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# Spectrum-Sharing Research and Policy Formulation in Asia-Pacific

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SINGAPORE



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, 10/2/2008

# Agenda

- Regulatory Developments in Asia Pacific
- National Level Projects and Programs
- CRAVE – a White Space Testbed in Singapore
- Issues to Resolve for Mass Market Deployment

# Regulatory Developments in Asia Pacific

# Regulatory Developments – the Players



- **International Telecommunication Union (ITU)**

- 191 Member States, Global



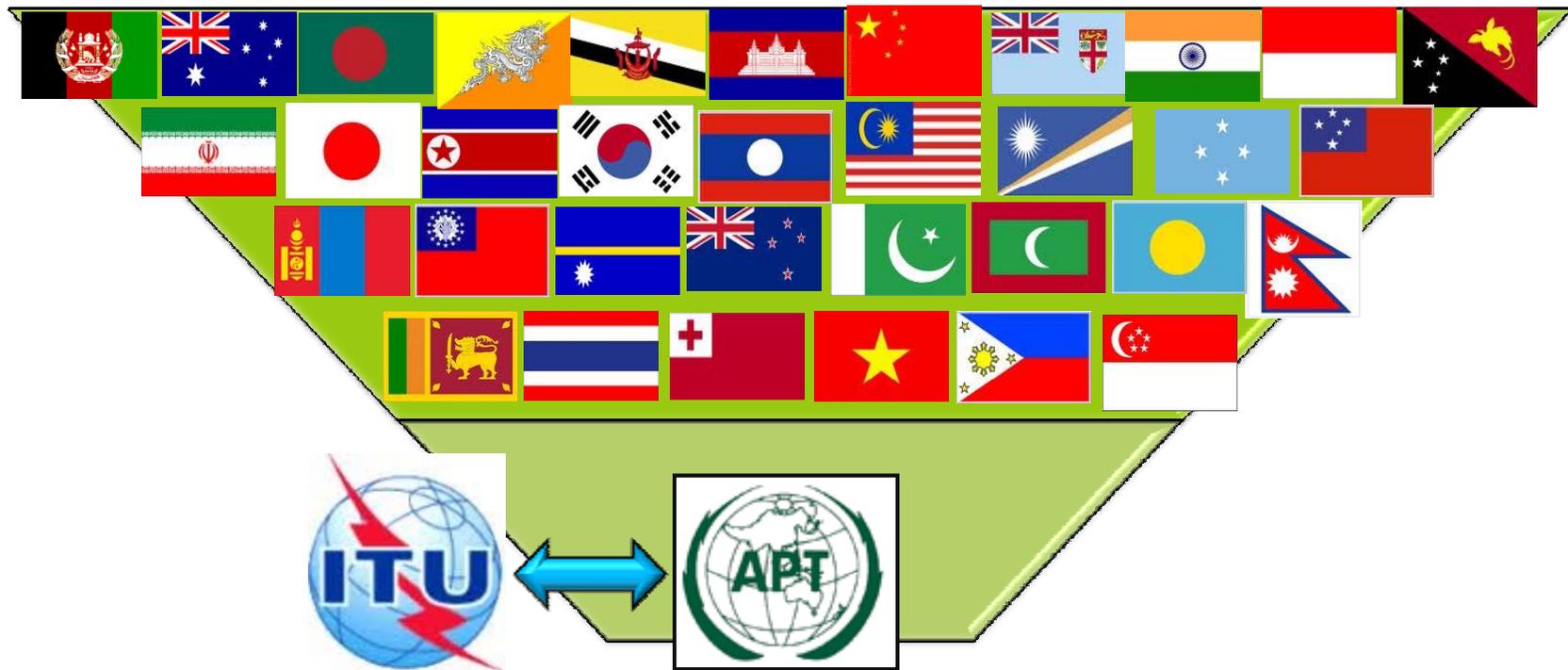
- **Asia-Pacific Telecommunity (APT)**

- 34 Member States in Asia Pacific
- Intergovernmental Organization established in July 1979
- To foster the development of telecommunication services and information infrastructure throughout the region

- **National Bodies**

- Singapore (IDA), Japan (MIC), Korea (KCC), Hong Kong (OFTA), Australia (ACMA), ...

# Asia-Pacific Telecommunity (APT)



# Asia-Pacific Telecommunity Wireless Forum (AWF)



- **Sub Working Group 4: Broadband Wireless Access**
  - Investigation on New Technology facilitating BWA services
  - Includes the analysis of feasibility/applicability of new technologies such as SDR and Cognitive Radio in BWA services

# Asia-Pacific Telecommunity Wireless Forum

## ■ Sub Working Group 7: Software Defined Radio and Cognitive Radio Systems



- To conduct surveys on current status of the introduction, development, regulation and possible spectrum use of SDR and CRS
- To conduct survey on possible deployment examples of SDR and CRS across different countries or operators in Asia-Pacific countries
- To study and discuss the possible applications, deployment scenarios and/or standardisation processes of SDR and CRS
- To study the possible harmonised frequency arrangement(s) for certain applications using CRS technologies in Asia-Pacific countries, taking into account of the studies in other regions
- To study the key techniques, system characteristics and requirements of SDR and CRS

# National Level Projects and Programs

# Japan – ICT Policies & Cognitive Radio

## > Part of the u-Japan Strategy

- Realization of a society in which networks are comfortably used anytime, anywhere with seamless inter-connectivity

## > Study Group on Policies Concerning the Effective Radio Spectrum Use (Oct 2004)

- To consider economic values of radio spectrum upon calculation of the Spectrum User Fee to encourage efficient spectrum use
- To double available frequencies through intensive and strengthened R&D for development of wireless industry
- To narrow digital divide in cellular telephones

# Japan – ICT Policies & Cognitive Radio

R&D on elemental technologies for cognitive radio terminals

**Research theme :**

- ❑ Multi-band and tunable devices for cognitive radio hardware platform
- ❑ Hardware platform for cognitive radio terminal
- ❑ Software platform for cognitive radio terminal

R&D on key technologies for Software Defined Cognitive Radio (SDCR) equipment

**Research theme :**

- ❑ Baseband signal processing architecture
- ❑ Software architecture based on software defined radio technology
- ❑ Sensing algorithm
- ❑ Reconfiguration algorithm

R&D on software defined cognitive wireless networking and its related technologies

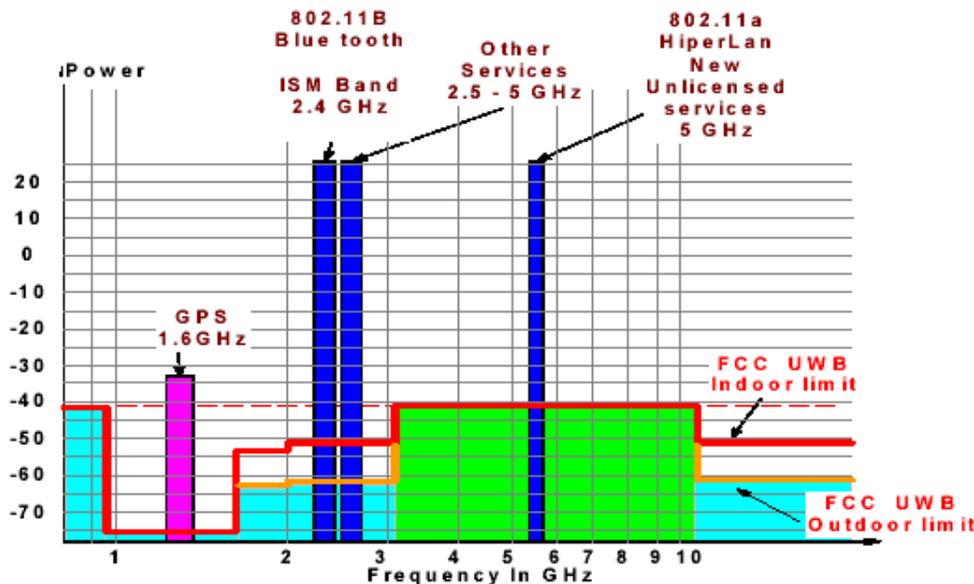
**Research theme:**

- ❑ System architecture
- ❑ Functional architecture
- ❑ Common signaling architecture
- ❑ Link aggregation/selection algorithm

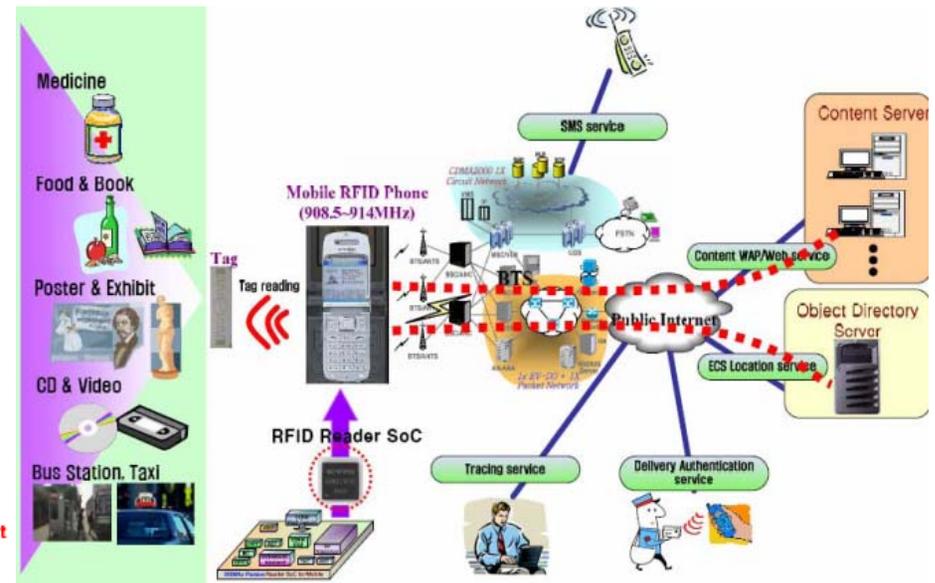
**Cognitive Wireless Cloud (CWC) Project by NICT**

# South Korea – Policy & Technology of DSA (1/2)

> To promote efficient access and use of the radio spectrum.

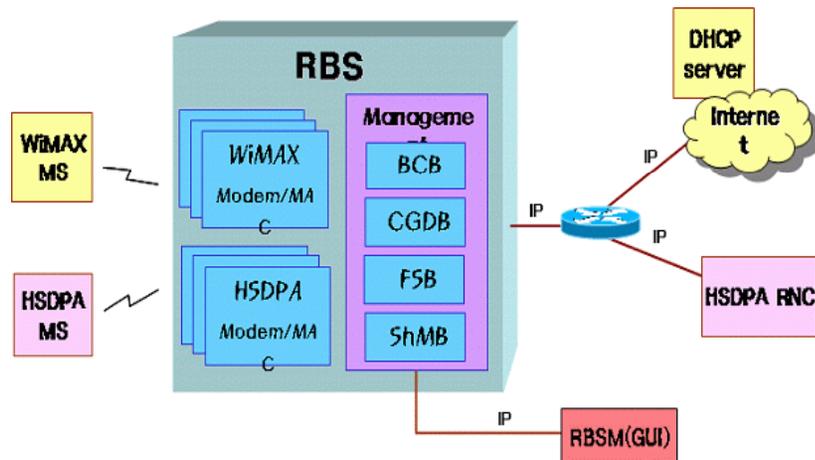


A) UWB with DAA (Detect and Avoid) mechanism

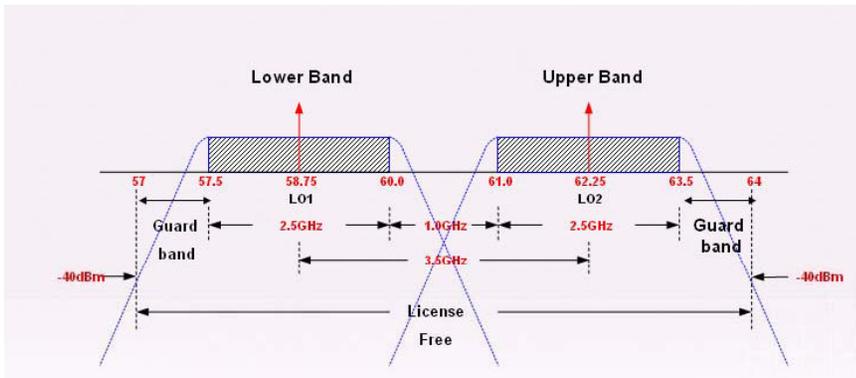


B) LBT protocol for RFID

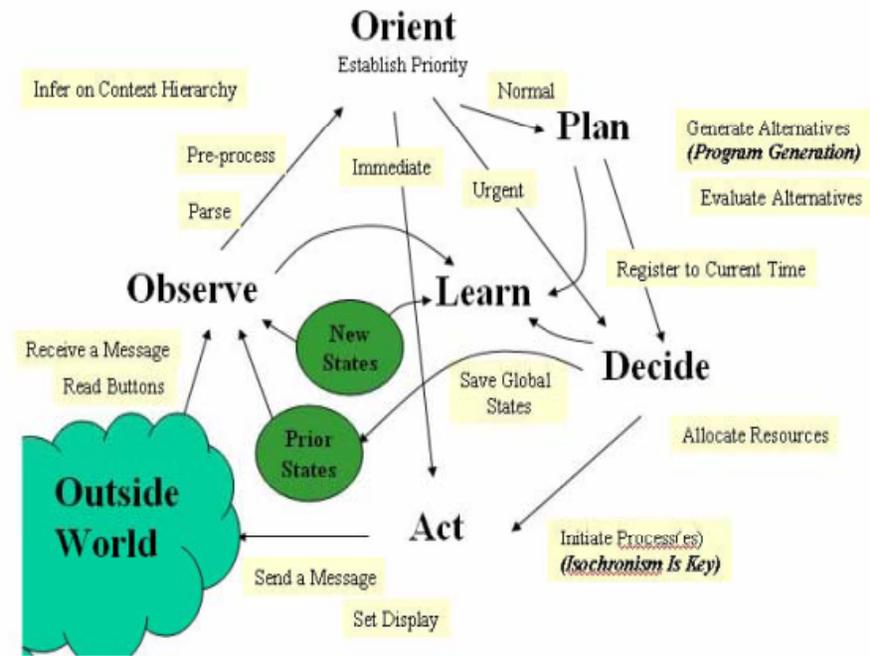
# South Korea – Policy & Technology of DSA (2/2)



C) SDR-based reconfigurable base station



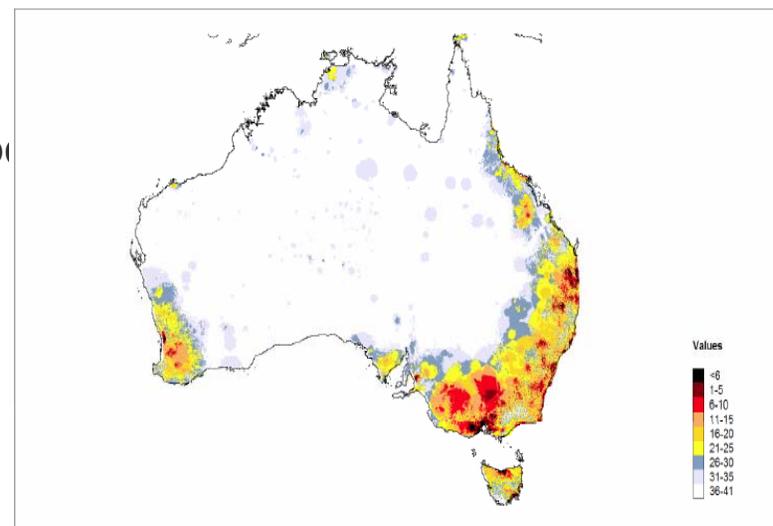
D) 60 GHz Flexible Access Common Spectrum



Next steps to study on cognitive radio technology

# Australia – Applications for Cognitive Radio

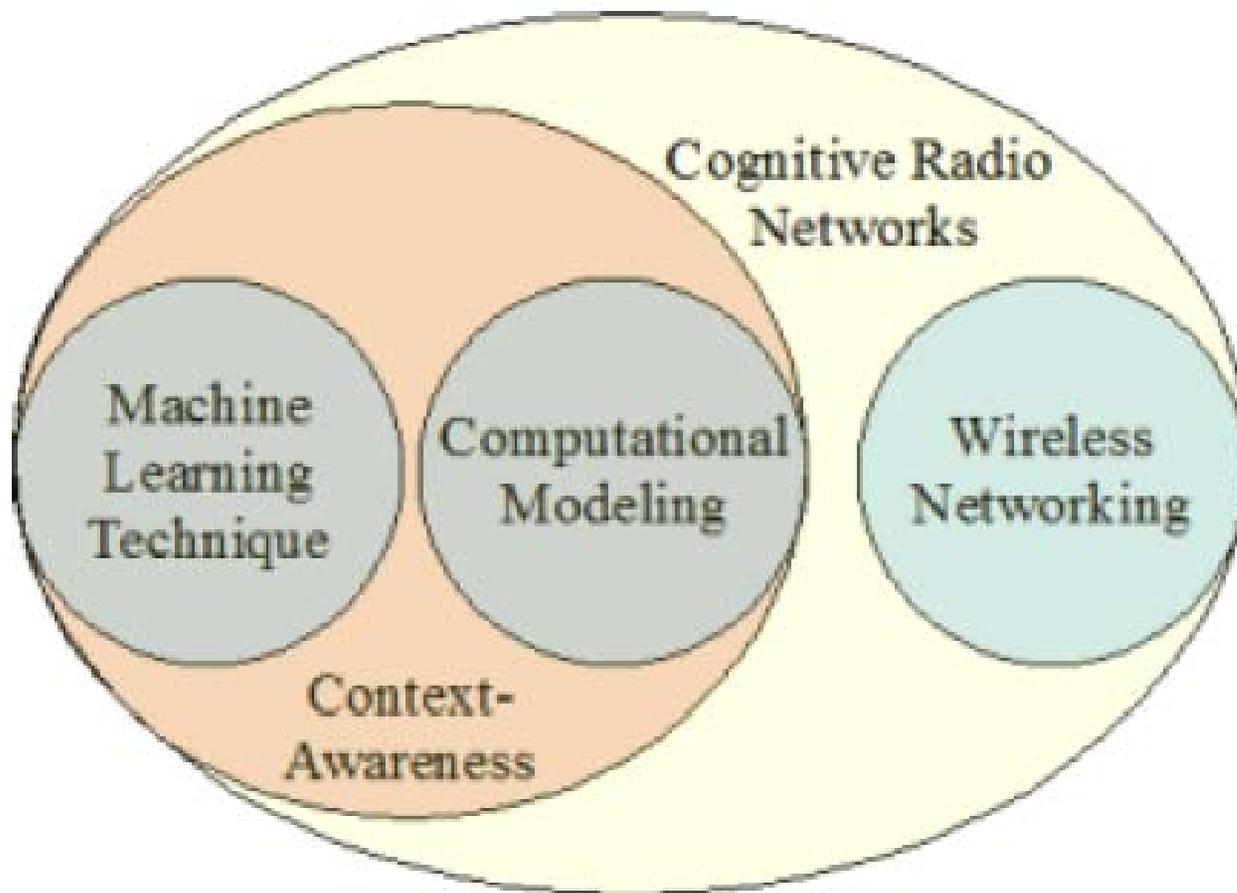
- > Why Cognitive Radio is important
  - Rapidly emerging technology
  - Potentially viable in land mobile bands and remote areas in coming years
  - Better utilization of spectrum
  - A resolution for congestion in land mobile
  - Affordable (class licensed spectrum) to support wireless in remote areas
  
- > Potential Applications
  - CR in land mobile to help agencies in the defense of Australia
  - Possible classification for commercial uses
  - Either class license or 'pay as you go' in 'owned' spectrum
  - 802.22 for efficient provision of wireless to remote areas



*Number of Channels possible for TV White Space  
(map before digital switch-over)*

# New Zealand – Cognitive Radio Networks

- > To Investigate;
  - Quality of Service (QoS) Architecture for Cognitive Radio Networks
  - Medium Access Control (MAC) Protocols for Cognitive Radio Networks
  - Context-Awareness in Cognitive Radio Networks
  - Application of Context-Awareness in Cognitive Radio Networks



# Hong Kong – Public Consultation on Policy Framework for White Space

## > Considerations for Spectrum Policy Framework

- Future Shape of Radiocommunications
  - *19 (c) the need for different radiocommunications systems, whether they are of the same type or whether different services are involved, to share the same band of spectrum because of strong demand. For example, in 10 to 15 years' time, cognitive radio technologies should be able to improve the degree to which spectrum sharing is possible;*

## > Current OFTA view of use of White Space Spectrum

- Commercial products of white space devices are still in development state and database support for geolocation remain unsolved.
- To monitor closely on further development of White Space overseas.

Source: [http://www.cedb.gov.hk/ctb/eng/paper/pdf/SPR-Consultation\\_Paper.pdf](http://www.cedb.gov.hk/ctb/eng/paper/pdf/SPR-Consultation_Paper.pdf)

Source: [http://www.ofta.gov.hk/en/ad-comm/rsac/paper/rsac04\\_2009.pdf](http://www.ofta.gov.hk/en/ad-comm/rsac/paper/rsac04_2009.pdf)

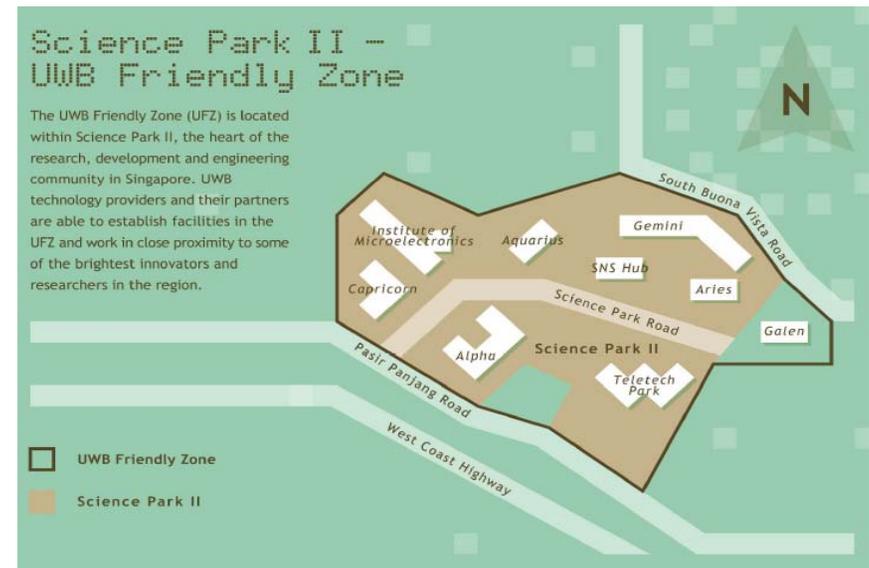
# Singapore – Infocomm Development Authority of Singapore



- > Mission: The importance of infocomm as an engine of growth for the economy. 3 strategic thrust:-
  - Encourage sophisticated demand for infocomm
  - Fostering creation of innovative services and knowledge capital
  - Strengthening Singapore as an economic hub

- > Spectrum Sharing programme at IDA

- Ultra-WideBand in Singapore
  - UWB Friendly Zone
- Cognitive Radio Venue (CRAVE)
  - A test bed for TV Whitespace



# Singapore – Institute Of Infocomm Research

- > TV Whitespace Device (TV-WSD)
  - Signal detection prototype used by FCC for detection of ATSC (6 MHz) and wireless microphones
  - Further research on TV-WSD to detect signals from 7, 8 MHz DVB-T
- > Actively contributing to IEEE 802.22, IEEE 802.11 TGaf, IEEE 802.19 and SDR forum
- > Collaborating with NICT in wireless research for maritime



# NICT – Singapore Wireless Communications Laboratory

## > Cognitive Radio Research

- Heterogeneous type cognitive radio system
- Spectrum sharing type cognitive radio system



### NICT Leadership in standard for

- IEEE SCC41
- IEEE 1900.4
- IEEE 1900.6
- IEEE SCC41 White Space PHY-MAC WG
- IEEE 802.19.1
- IEEE 802.11af

### Major contributors of

- ITU WP5A
- ITU WP1B
- ETSI-RRS



# **CRAVE – A White Space Testbed in Singapore**

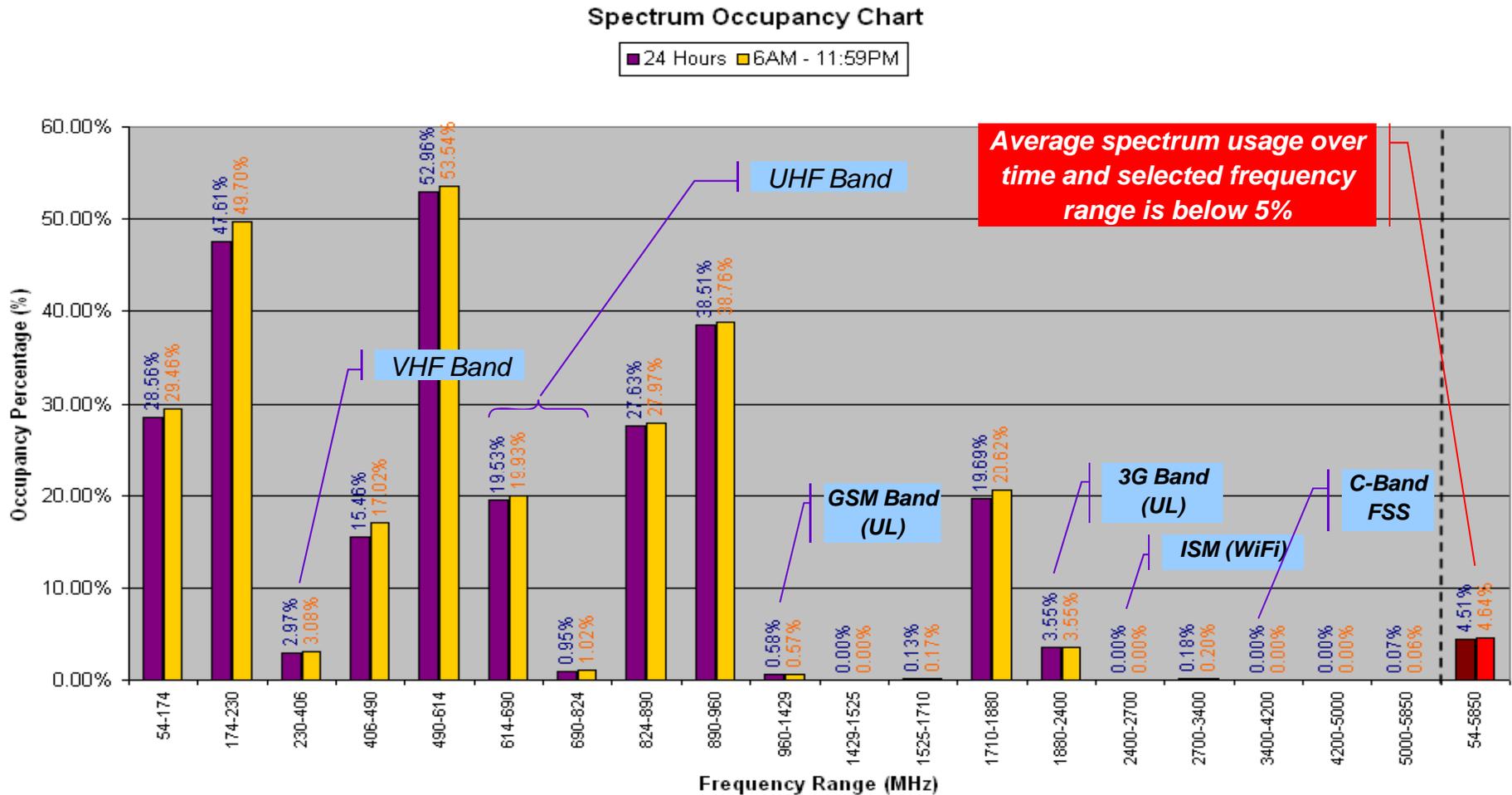
# Singapore – the local environment

- > Singapore is a small country of about 710.2 Km<sup>2</sup>
  - Close proximity to Malaysia and Indonesia
  - Spectrum coordination between administrations



SINGAPORE

# Average spectrum usage in Singapore < 5%



Source: IDA and I2R Singapore



# Cognitive Radio Venue (CRAVE)

- > A White Space Testbed for evaluating promising technologies to enhance radio spectrum utilization
  - Local broadcast TV band provides little opportunity for white space exploitation
    - An initiative to study the feasibility of using spectrum from the neighboring counterparts for TVBD trials on a non-interfering basis
    - To study into performance and impact of TVBD in dense-urban environments, such as multi-storey built-up terrain like Singapore

# Cognitive Radio Venue (CRAVE)

- > To trial on TV channel on neighboring countries' TV allotment
- > To test accuracy of detection on non-broadcasting channels

PAL Channel	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40		
Singapore Channels																						
Neighbor Channels																						
<b>CRAVE Trial</b>																						
Start Freq (MHz)	470	478	486	494	502	510	518	526	534	542	550	558	566	574	582	590	598	606	614	622		
PAL Channel	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
Singapore Channels																						
Neighbor Channels																						
<b>CRAVE Trial</b>																						
Start Freq (MHz)	630	638	646	654	662	670	678	686	694	702	710	718	726	734	742	750	758	766	774	782	790	798

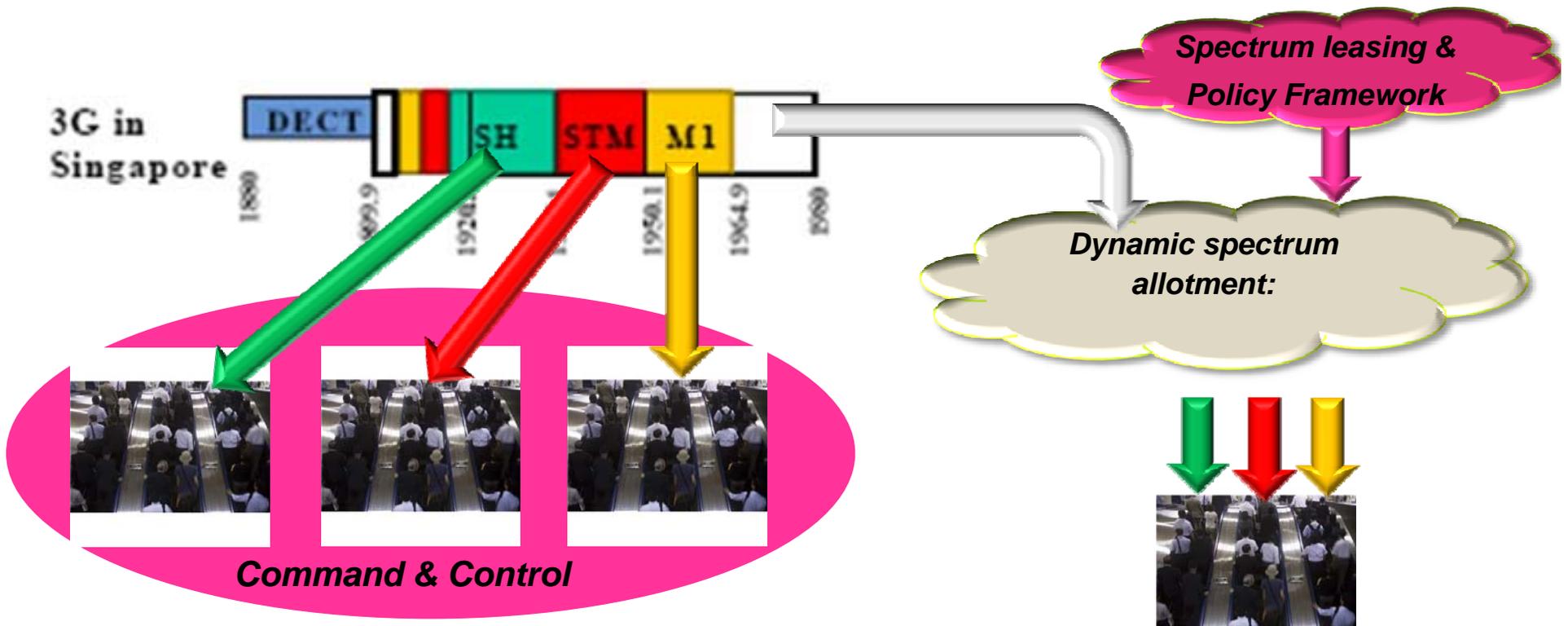
# CRAVE test locations in Singapore



S/N	Test Location
1	Singapore / Malaysian Coast
2	Singapore / Indonesia Coast
3	Mitigation capabilities near broadcast tower
4	Application in Dense urban environment
5	In-building environment performance

# Cognitive Radio using current technology?

- > Explore feasibility of CR in existing 3G/WCDMA bands



# Issues to Resolve for Mass Market Deployment

# Open Issues that still needs to be resolved

## > Regulatory Front

- What Regulatory regime
- Efficient use of spectrum
- Contamination of “clean radio bands”
- New infrastructure such as neutral spectrum manager?
- Spectrum harmonization across countries
- Roaming across countries

## > Industry Front

- Availability of mass market devices to drive down costs
- Standards and possible fragmentation
- Certification and certification bodies

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