The Next Steps to Implementing the U.S. FCC's TV White Space Rules and Furthering Efforts Around the World to Cash in on the "Digital TV Dividend"

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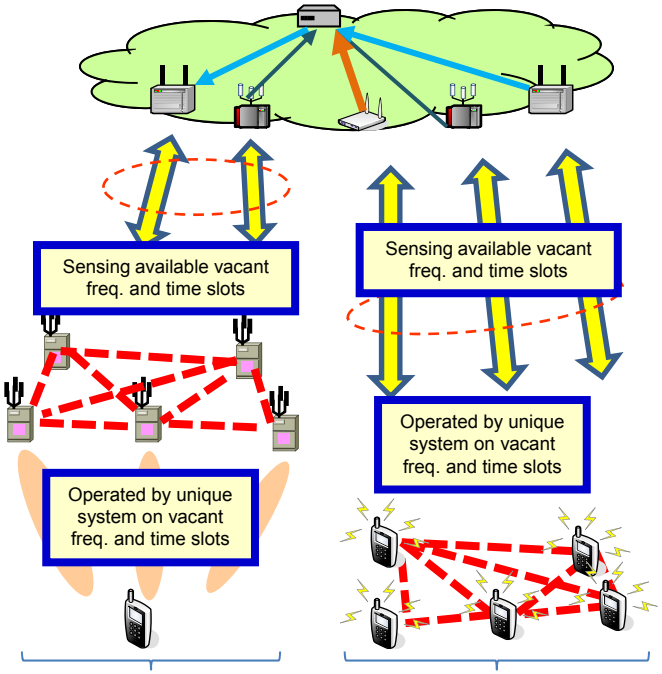
NICT's Current Activities for White Space Radio

- Use case
  - Spectrum sharing-type cognitive base station
  - Spectrum sharing-type cognitive radio terminal
- Research and development
  - Developed white space WiFi access point in 2009
- Standardization: actively contributed to the following standardization bodies
  - **IEEE802.11af**: White space WiFi
  - **IEEE802.19.1**:Coexisting mechanism between white space wireless systems
  - **IEEE1900.4a**: Architectural building blocks enabling network device distributed decision making for dynamic spectrum access networks in white space frequency bands
- Field trial
  - Participate trial of white space technology in Singapore (I2R, Huawei , and NICT)
  - Features (See next slide)
    - Low sensing level: -120 dBm/8MHz
    - Short interval between sensing : < 1 s
    - Short interval to access DB : 1s
  - Develop a fundamental sensing unit and will receive a regulatory test by IDA

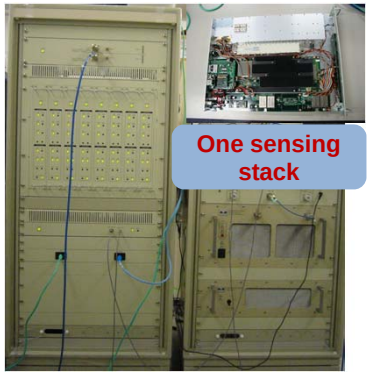


(a) Spectrum sharing-type cognitive radio (for base station)

(b) Spectrum sharing-type cognitive radio (for terminal)

Developed access point

Item	Specification
Sensing frequency band	470M-770MHz, 1884.5M-1919.6MHz, 2210M-2170MHz, 2400M-2497MHz, 2492.5M-2692.5MHz, 5160M-5330MHz
Communication frequency band	2400M-2692.5MHz , 5160M-5330MHz
Communication bandwidth	20MHz
PHY	OFDM (52 carrier, 48 data subcarriers, 4 pilot subcarrier)
PHY frame format	802.11a compliance
MAC protocol	802.11a based MAC
Output power	Maximum 10 dBm



Developed sensing prototype

Operation frequency range	630MHz~742MHz	Noise level	<-99.6 dBm
Sensitivity	-120 dBm/8MHz	Sensing time	≤100 ms
Expected sensing performance	false alarm probability≤ 0.1 & probability of detection ≥0.9		

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Regulation Comparison

Parameters	FCC	Ofcom	Singapore IDA
Is sensing required ?	Required for sensing only device, not required if having database access	Required	Required
Sensitivity assuming 0dBi gain antenna	-114dBm/6MHz (for sensing only TVBD)	-120dBm/8MHz (DTT), -126dBm/200kHz for wireless microphone	-120dBm/8MHz
Interval between sensing	<60 s (for sensing only TVBD)	<1 s	<1 s
Out of band performance	72.8dBc	<-46dBm	<-48dBm
Maximum continuous transmission	N/A	400 milliseconds	400 milliseconds
Minimum pause after transmission	N/A	100 milliseconds	100 milliseconds
Operation frequency range	Channels 21-36 (512-608MHz) and Chs 38-51 (614-698MHz), additional channels Ch2 (54-60MHz), Chs5-6 (76-88MHz) and Chs7-13 (174-216MHz) for fixed-to-fixed communication	Channels 31-37 (550-606 MHz) and channels 61-69 (790-862 MHz)	channels 41-49,51,53,54 with 8 MHz for each and covers range of 630-742 MHz
bandwidth	6MHz channel	unlimited	Multiple of 8 MHz channels
Transmit power	Fixed device: 12.2 dBm/100kHz Sensing-only devices: -0.8dBm/100kHz Personal/Portable with adjacent channel: -1.8dBm/100kHz All other Personal/Portable : 2.2dBm/100kHz	4 dBm (adjacent channels) and 17dBm	4 dBm (adjacent channels) and 17dBm
Is database access required ?	Required (except for sensing only TVBD)	Required	Optional but recommended
Geolocation accuracy	<50 meters	<100 meters	<50 meters
Interval between database access	24 hours for the fixed, Re-access is required for personal/mobile once moving more than 50 meters	24 hours	1 second

Answers for the questions 1

Q1: Next steps for companies interested in deploying technologies in the TV bands

- **Application oriented standardization**
  - By focusing on several application field, application oriented standardizations are needed
  - For example
    - Wireless LAN : IEEE 802.11af is currently on-going
    - Smart utility network, Smart meter, wireless smart grid
    - Femto cell base station for IMT advanced
    - Public broadband wireless communication systems

- **Interoperability test (IOT) environment**
  - To keep connectivity between products by different companies, IOT test environment must be arranged in all over the world

- **Data base (DB) construction**
  - Description language for DB must be standardized (same as html in WWW)
  - Interface to DB may be standardized
  - Access protocol to DB may be standadized

Answers for the questions 2

Q2: Other pending proposals and initiatives

- **Spectrum mask for white space communication systems**
  - Background
    - To protect primary users and adjacent channel users, spectrum mask for transmission shall be narrowed as much as possible.
    - But if the spectrum mask is too narrow, it is something difficult to develop consumer product that needed small size
  - Resolution
    - For high power communication systems, the severe spectrum mask shall be needed.
    - For the low power communication systems (e.g less than 10 mW), the tempered spectrum mask may be needed to reduce the burden for the commercial products (to reduce power consumption or to reduce the size of RF components)

- **Protection of old type TV receiver**
  - Background
    - Old type TV receiver may equip a broadband band pass filter that may receive other TV channels
  - Resolution
    - WS database may need to control assignment of spectrum by considering tendency of such filter
    - For example, not to assign spectrum that is adjacent to the primary users' service, primary

Answers for the questions 3

Q3: Possible scenarios for success or disaster in these prime spectrum bands for new and innovative broadband applications

- **Share white space trial test results held in the world (by 2012)**
- **Get consensus between the countries on the radio specification to white space (in ITU?, by 2012-13)**
  - Number of items to be specified (to be tested)
  - Channelization of white space
- **Continue application oriented standardization for each region (US, Europe, and ASIA, by 2012)**
- **Develop WSDB specification (by 2011-2012)**
- **Develop WSDB (2012-2013)**
- **Develop products for some applications (by 2014)**
- **Launch IOT environment (by 2014)**
- **Open the market (2014-2015)**