A Wireless Network System in TV White Space

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The number of radio stations has been increased and reached to more than 100 millions
The issue how to secure spectrum for future broadband becomes main issue
New frequency action plan has been issued in Sept. 2011
  Main part is 700M-900MHz
Analog TV services were successfully finished
  The remained frequency bands has already been assigned to the some system
The argument on white space use in TV channel is quite active

Current status in Japan

Total approx. 117.60 million stations

- Mobile sta.  approx. 116.28m
- Fixed sta.  approx. 0.106m
- Broadcasting sta. approx. 0.026m
- Others  approx. 1.19m

2009 (as of the end-December)

Mobile phones and internet terminals

Wireless LAN
Cognitive radio is a radio or system that senses, and is aware of, its operational environment and can dynamically and autonomously adjust its radio operating parameters accordingly by collaborating wireless and wired networks.

(a) Heterogeneous type cognitive radio

By sensing frequency bands that systems have been allocated on and time slots, users secure adequate bandwidth by selecting existing systems.

(b) Spectrum sharing (White space) type cognitive radio

By sensing vacant frequency band and time slot, users secure adequate bandwidth by bundling vacant freq. bands.
WSDB to coexist between primary and secondary systems

(a) Co-existing servers (Databases) between primary and secondary users

(1) All secondary users access to servers (DBs) to know which frequency bands are available (vacant) by sending their radio parameters and location.

(2) Servers (DBs) calculates contour of primary users and secondary users and also calculate interference radio for all channels and decide available channel by using their selection criteria and finally inform the channels to secondary users.

Secondary user A1 (Using wireless access A)

Secondary users B1 (Using wireless access B)

Servers are launched with centered or distribution manner.

Calculation of interference
NICT’s world’s first WSDB supporting Japan and US primary systems’ protection

Contour calculation (13 ch) based on FCC algorithm

Contour calculation (52 ch) based on FCC algorithm

Contour calculation based on NICT original calculation algorithm

NICT’S TVWS database
(Technically transferred to ISB corporation)
Current status in Japan on WS

- Five main applications are under discussion in the Meeting (Council) for White Space Promotion in Ministry of Internal Affairs and Communications (MIC)
  - Wireless microphone (Will start in FY 2012)
  - Ubiquitous broadcasting (Area-one-segment broadcasting service, Area oneseg)
    - White space operation has already started
  - Sensor network
  - Wireless broadband
  - Wireless access systems for emergency situation (disaster)

- Area oneseg services have been permitted to do actual services in TV white space with conditions summarized by White space utilized broadcasting system WG, Broadcasting system committee, Information and Communications Council in MIC
  - Not license-exempt
  - Actual services can be started (Japan is second country that allows commercial service of white space)

- Coexisting mechanism: Coexistence WG is launched under council for white space promotion and is studying the concrete schemes
NICT's experts on white space communications

- Developed world’s standards IEEE802 based WS products
  - World’s first IEEE802.22 BS and CPE (Demonstrated in Supper WI-FI summit and NAB show)
  - World’s first IEEE802.11af BS and MT
  - World’s first IEEE802.15.4m (NB-OFDM) products
  - World’s first tablet terminal based on IEEE802.11

- Contributed to IEEE 802/1900 standards and alliances and trials
  - Taking leadership in WS communications standards
    - Chair: IEEE 1900, IEEE802.22b, IEEE802.19.1 (ex)
    - Vice Chair: IEEE802.11af, IEEE 802.22, IEEE802.15.4m
    - Board of Directors: Wireless Innovation forum, whitespace alliance
  - From 2006, NICT provided more than 1200 contributions to IEEE802
  - Done several WS trials in Japan and Singapore (member of Singapore White Space Pilot Group)

- Developed WS databases supporting US and Japan
  - Support multiple contour calculation algorithms (Japan, US FCC)
NICT’s world’s first products

IEEE 802.11af/a based TVWS/2.4G access point and
IEEE 802.11 based TVWS/2.4 G tablet terminal

IEEE 802.22 radio for regional area network
(Demonstrated Super WiFi Summit and NAB show)

IEEE 802.15.4m NB-OFDM radio for sensor networks
Standardization of TVWS devices and technical certification by alliance

- Except for Japan, standardized products have not been used in the trials
  - Recommend to use IEEE standards
- Technical certification process has not been established by alliance
  - IEEE802.22 → WhiteSpace Alliance, IEEE802.11af → WiFi alliance

Coexistence between secondary systems has not been established

- Ex. Between 802.22 and 802.11af
- 802.19.1 supports the role and Coexistence DB must be established

Mechanism to change its operational frequency band between TVWS and conventional frequency bands
White space mesh network (TVWS, 2.4G)

**Configuration A:** WS for BS-BS
Primary-Secondary coexistence management

**Configuration B:** WS for BS-Terminal
Primary-Secondary coexistence management

- **WSDB:** Primary-secondary coexistence management
- **CDIS:** Secondary-secondary coexistence management
- **Mesh Manager:**
- **BS1, BS2, BS3, BS4, BS5, BS6, BS7:**
- **Terminals (operated in 2.4GHz band):**
- **IEEE 802.11g (2.4GHz):**
- **TV White Space (UHF) or, WLAN (2.4GHz):**
- **Router:**
- **Ethernet switch:**
- **Internet:**

Terminal1
Freq A
Terminal2
Freq B
Terminal3
Freq C

**Configuration of mesh manager**