IEEE 802.22 MAC/CC Overview

IEEE P802.22 Wireless RANs Date: 2011-11-02

Authors:

Name	Company	Address	Phone	email
Gwang-Zeen Ko	ETRI	Korea	+82-42-860-4862	gogogo@etri.re.kr
Byung Jang Jeong	ETRI	Korea	+82-42-860-6765	bjjeong@etri.re.kr
Sung-Hyun Hwang	ETRI	Korea	+82-42-860-1133	shwang@etri.re.kr
Jung-Sun Um	ETRI	Korea	+82-42-860-4844	korses@etri.re.kr
Antony Franklin	ETRI	Korea	+82-42-860-0752	antony@etri.re.kr

Abstract

This contribution summarizes the MAC and Cognitive Capability (CC) features in the IEEE 802.22-2011 Standard.

Contents

MAC Introduction (1)

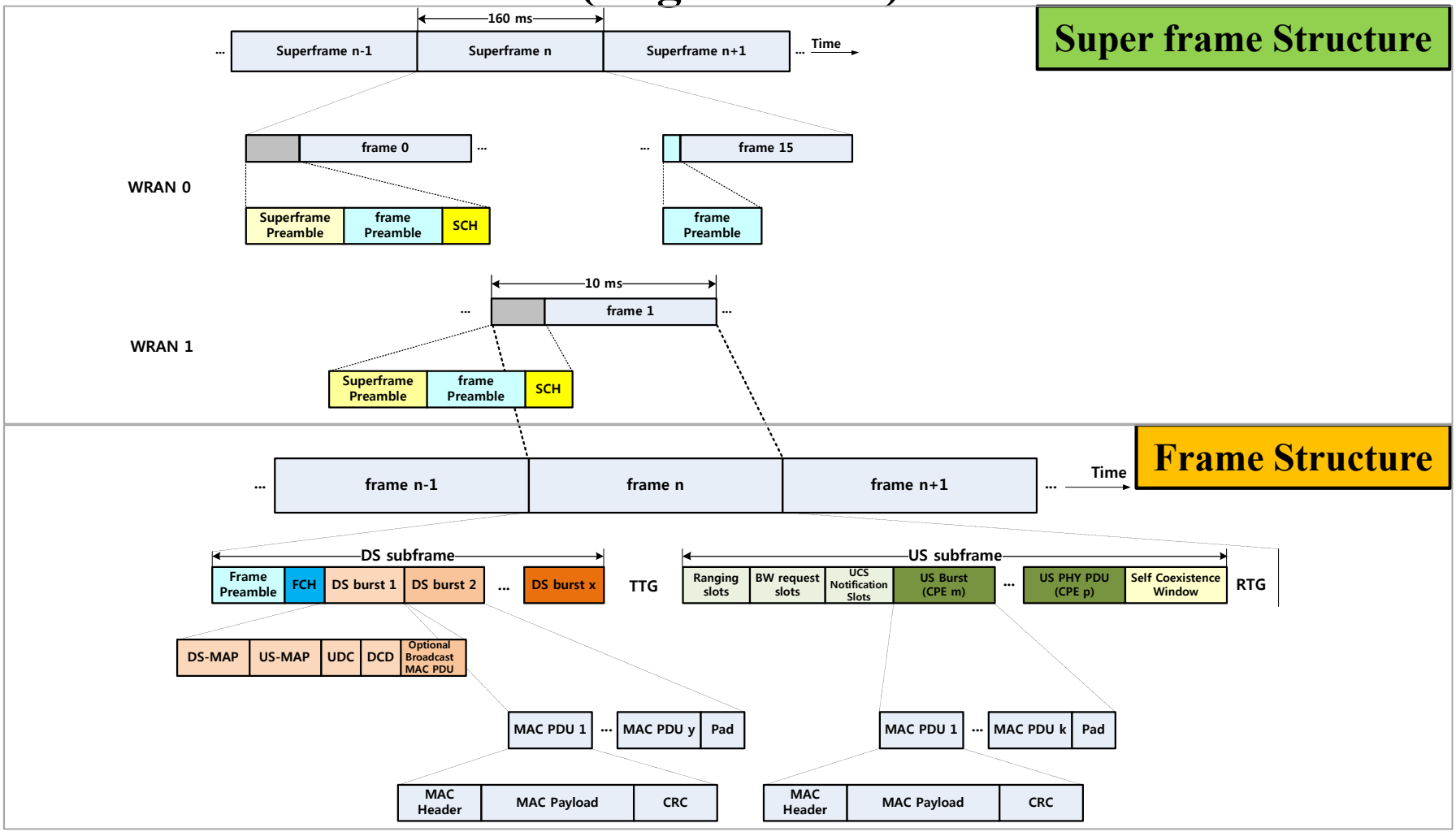
- **Some aspects of IEEE 802.22-2011 MAC have been inspired from the IEEE 802.16 MAC standard**
- **Combination of polling, contention and unsolicited bandwidth grants mechanisms**
- **Support of Unicast/Multicast/Broadcast for both management and data**
- **Connection-oriented MAC**
  - **Connection identifier (CID) is a key component**
    - **IEEE 802.22-2011 CID can be constructed from Station ID (SID) and Flow Identifier (FID) [1]. This new CID definition can reduce overhead and storage requirements [2].**
  - **Defines a mapping between peer processes**
  - **Defines a service flow (QoS provisioning)**

MAC Introduction (2)

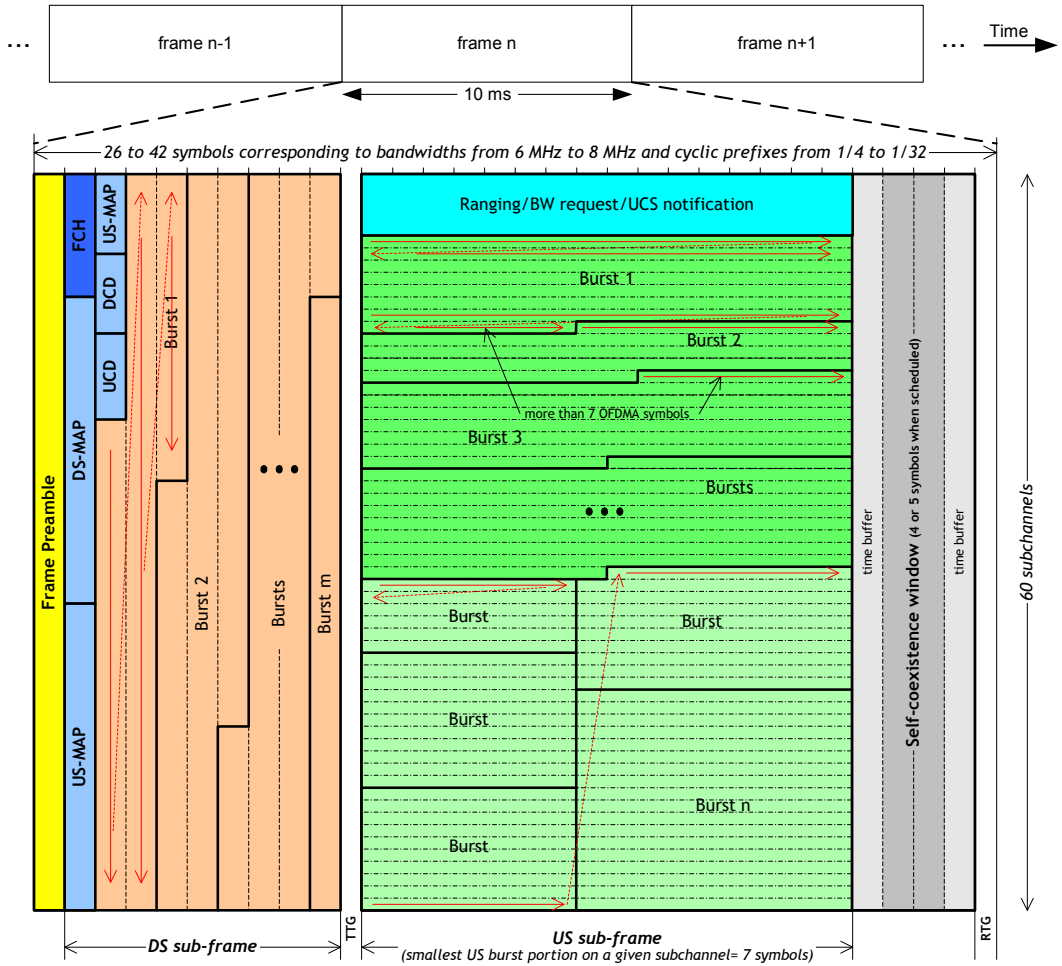
- **However, major enhancements have been made**
  - **Support of Cognitive functionality**
    - **Dynamic and adaptive scheduling of quiet periods**
    - **Various incumbent user detection and notification methods**
  - **Coexistence with both incumbents and other 802.22 systems (self-coexistence)**
    - **Measurements (incumbents and 802.22 operation)**
    - **Spectrum management (time, frequency and power)**
    - **The Coexistence Beacon Protocol (CBP)**
    - **The Incumbent Detection Recovery Protocol (IDRP)**
    - **Wireless microphone beacon mechanism (IEEE 802.22.1)**
  - **Self-coexistence mechanisms**
    - **Spectrum Etiquette**
    - **On-demand Frame Contention**

IEEE 802.22 Frame Structure

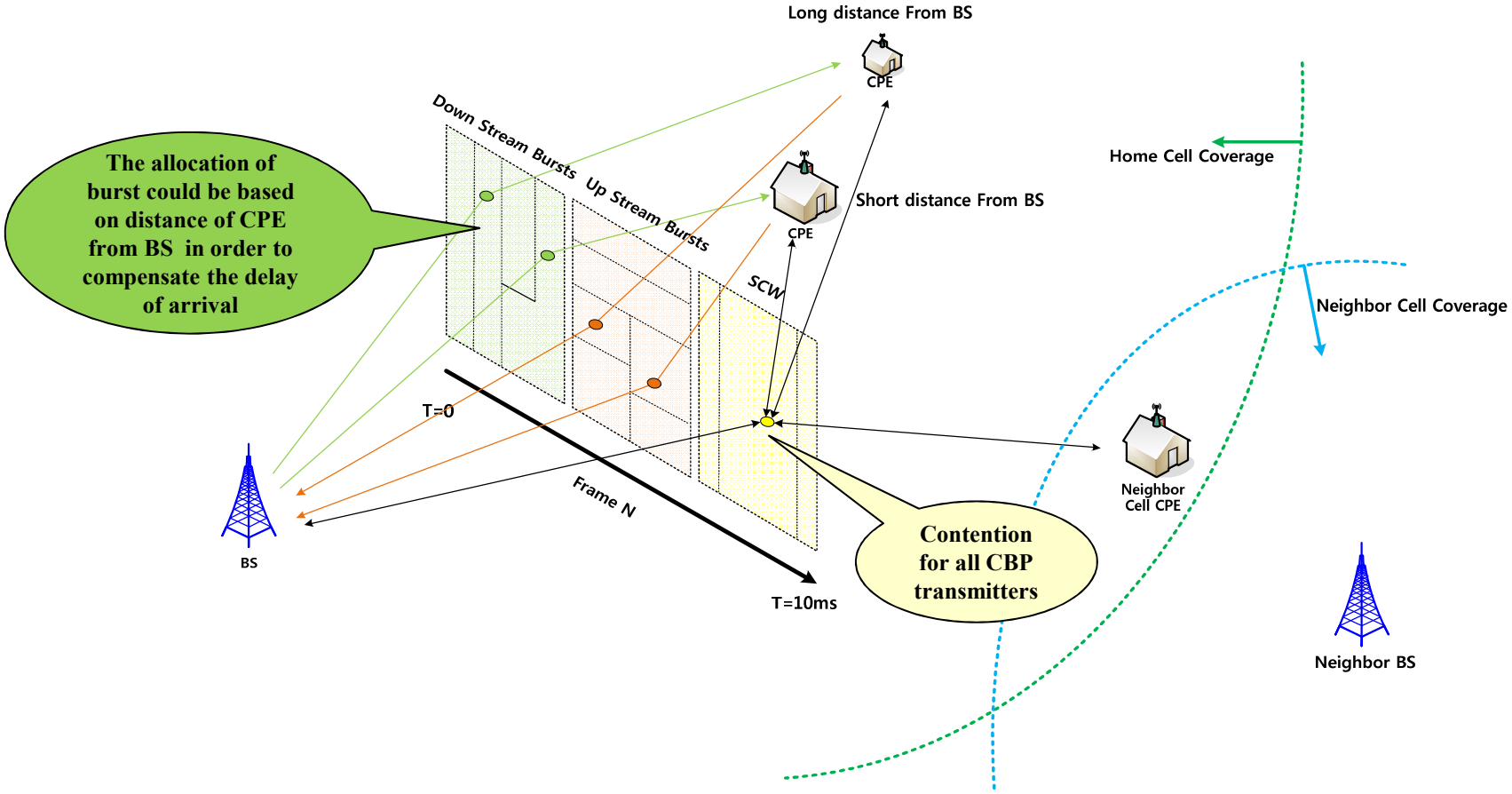
(Logical View)



IEEE 802.22 Frame Structure
(Physical View)



Concept of 802.22 Frame Operation

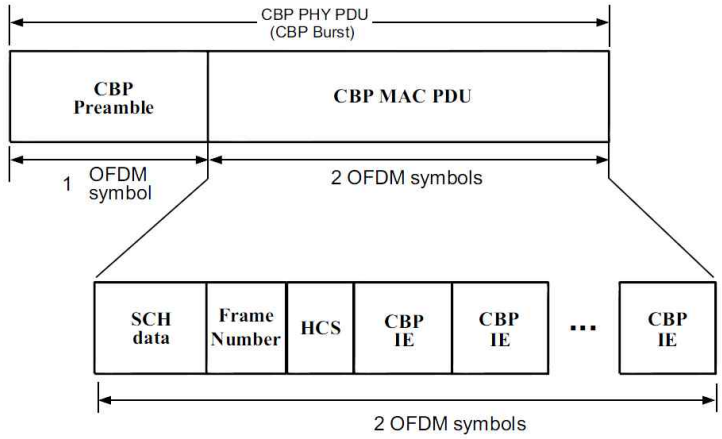


SCH and CBP Features

- **The Super-frame Control Header (SCH)**
  - **Provides the control information for a WRAN cell**
  - **Support the intra-frame and inter-frame quiet periods management mechanisms for sensing**
  - **Support coexistence with incumbents and other WRAN cells (self coexistence)**
- **An SCH can include various CBP (Coexistence Beacon Protocol) IEs**
  - **Backup channel information IE**
  - **Frame Contention information IE**
  - **Terrestrial Geo-location information IE**
  - **Signature IE, Certificate IEs (CBP frame security)**
- **Using SCH, WRAN BS can intelligently manage the operation of its associated CPEs**
- **Also, using CBP (Extended version of SCH), WRAN BS can intelligently manage the operation of neighboring WRAN cell under co-existence situation**

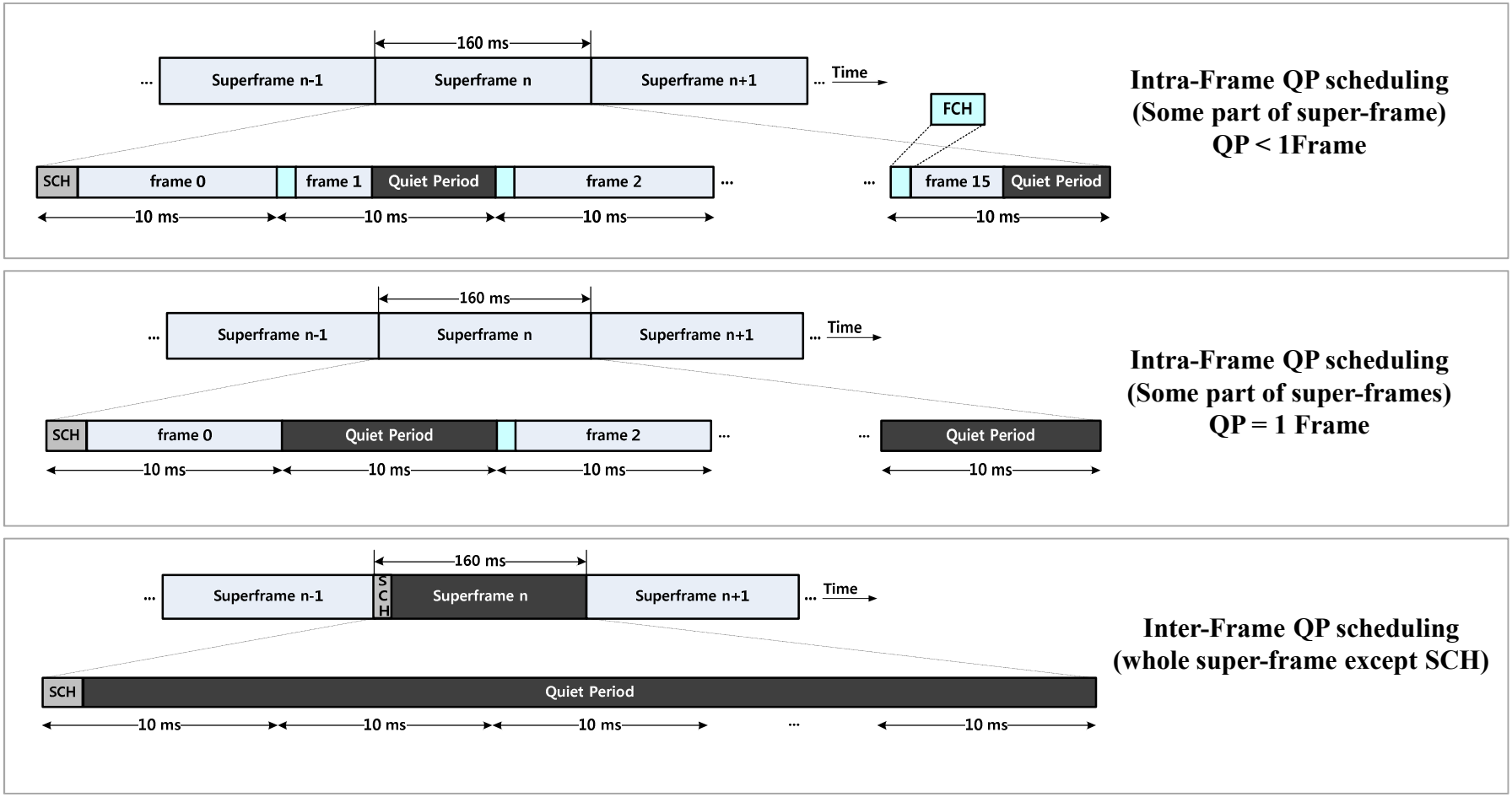
CBP Summary

- **CBP is used to communicate the operating parameters from one WRAN cell to another WRAN cell**
- **CBP packet is transmitted using SCW which contains the SCH of its own WRAN cell**
- **CBP is fully controllable by the BS that decides who sends/listens and when to send/listen for CBP packets (Refer [3])**
  - **The source of a CBP packet can be either a BS or a CPE**
- **CBP packets carry only control information (no data)**



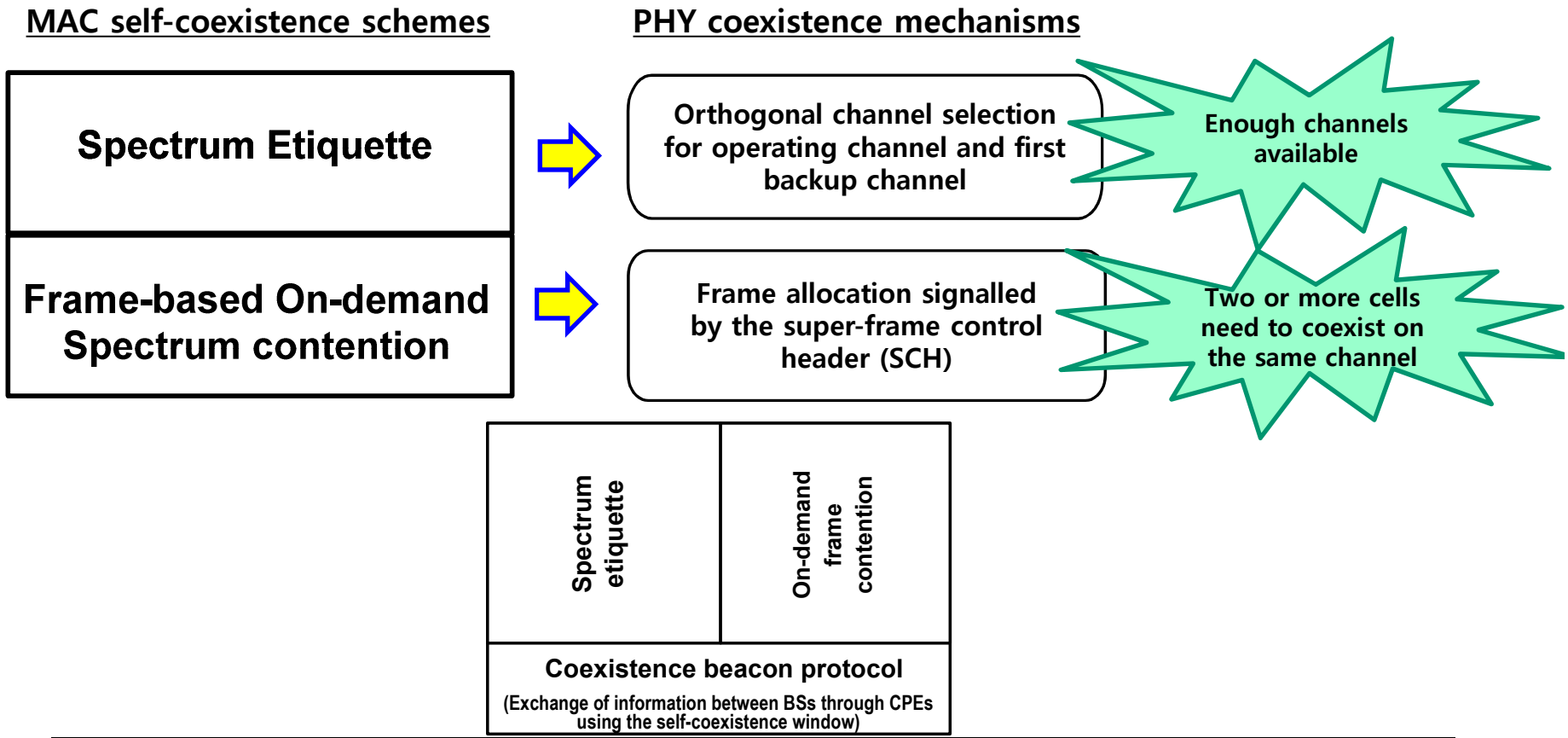
Structure of a CBP packet

Dynamic Quiet Period Scheduling



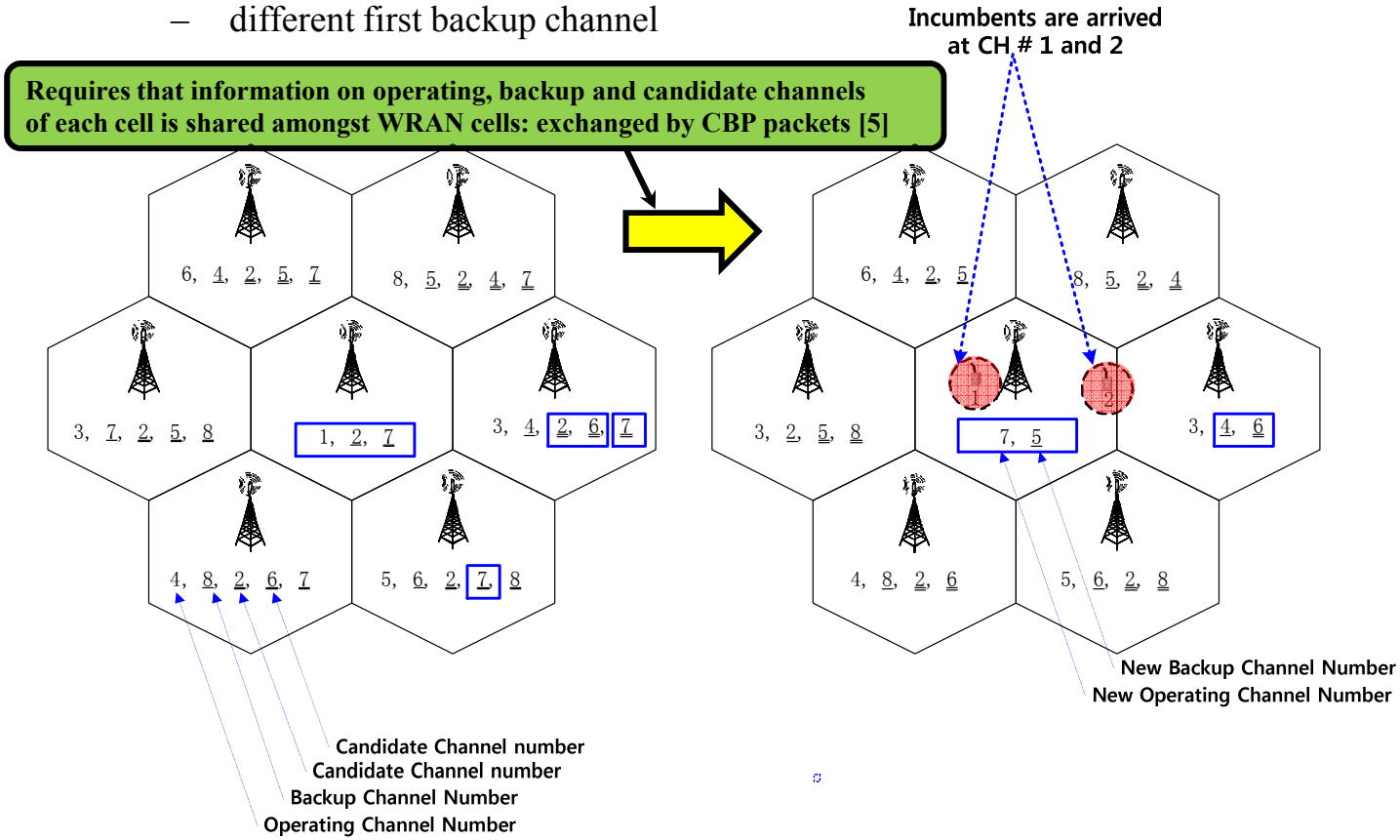
Self-Coexistence Mechanism (1)

- **Self-Coexistence: Co-existence among WRAN Systems [4]**



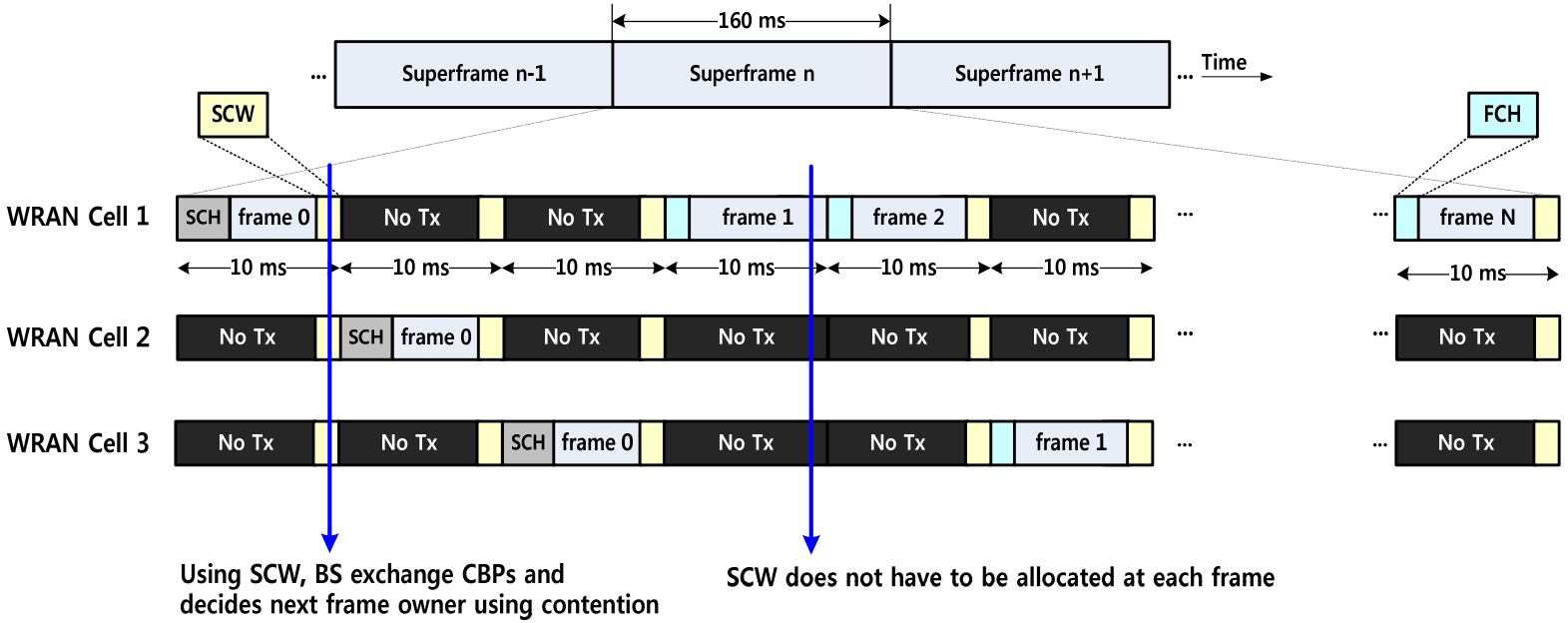
Self-Coexistence Mechanism (2)

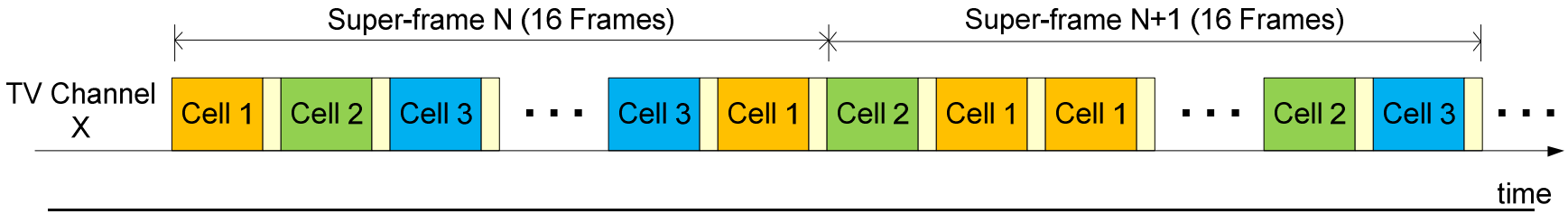
- **Spectrum Etiquette [4]**
  - Orthogonal channel assignment scheme between adjacent cells
    - different operating channel for overlapping or adjacent cells
    - different first backup channel



Self-Coexistence Mechanism (3)

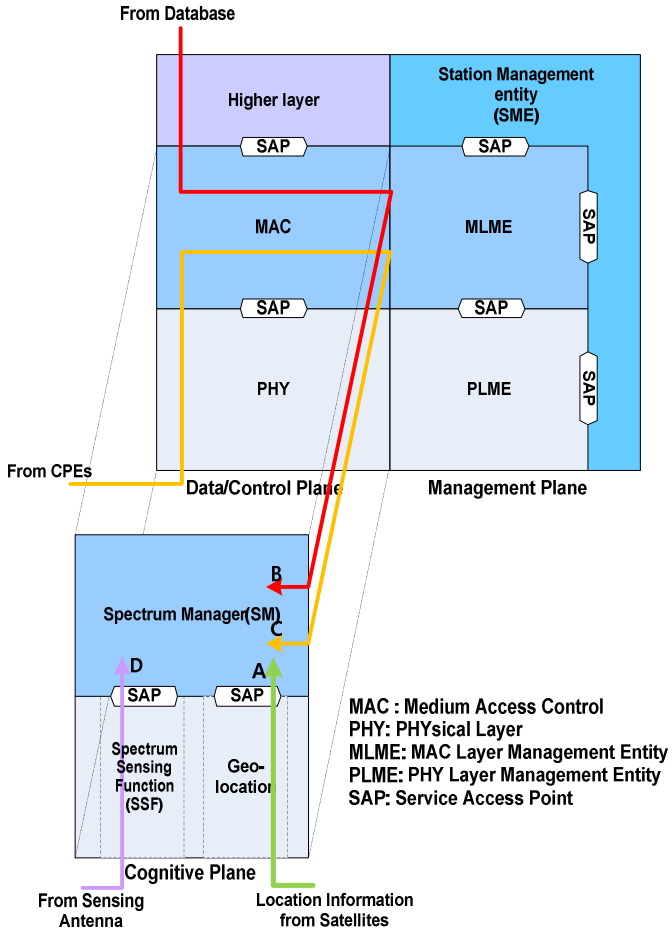
- **On-demand Frame Contention**
  - Two or more cells need to co-exist on the same channel



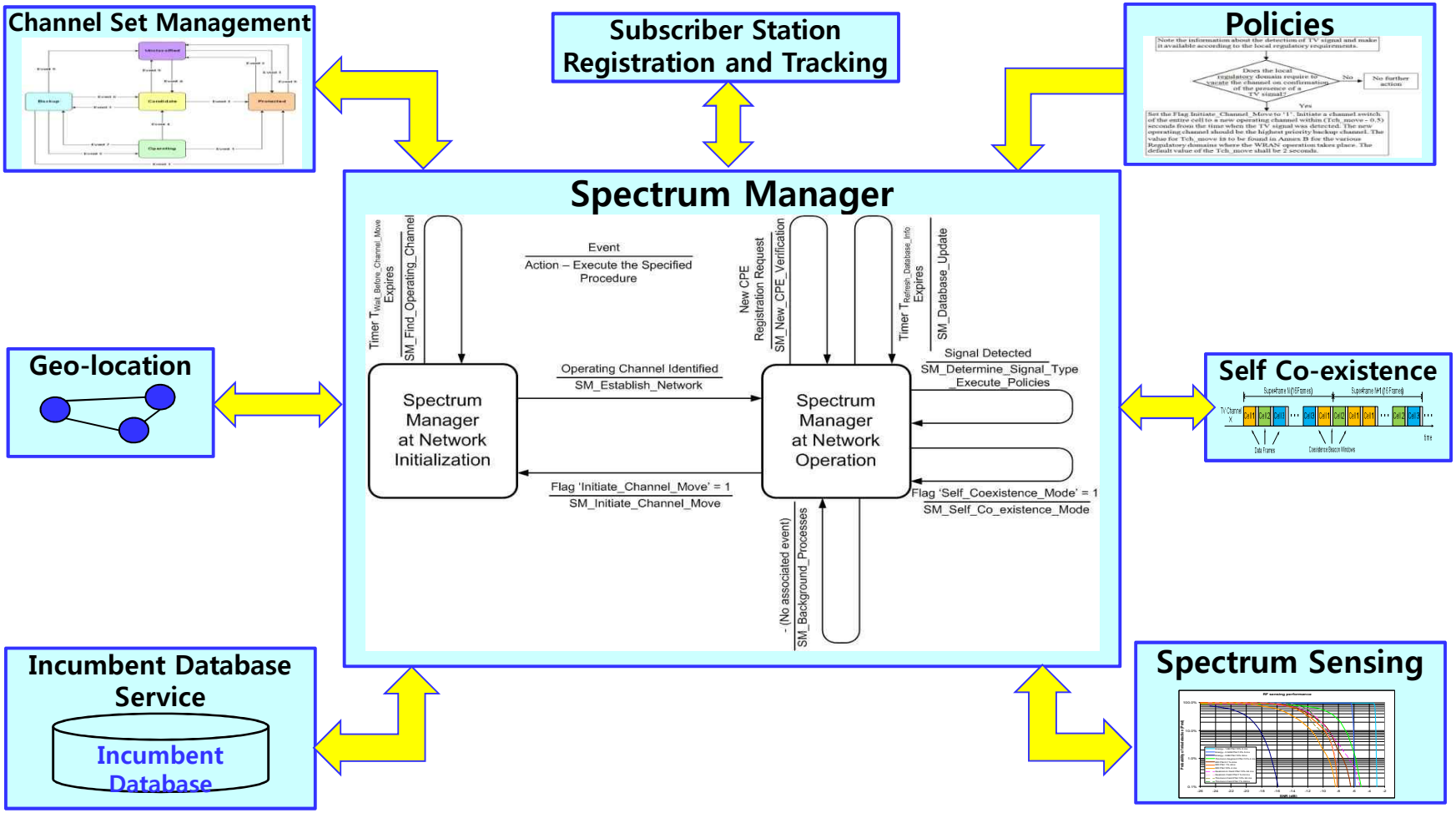


Cognitive Capability

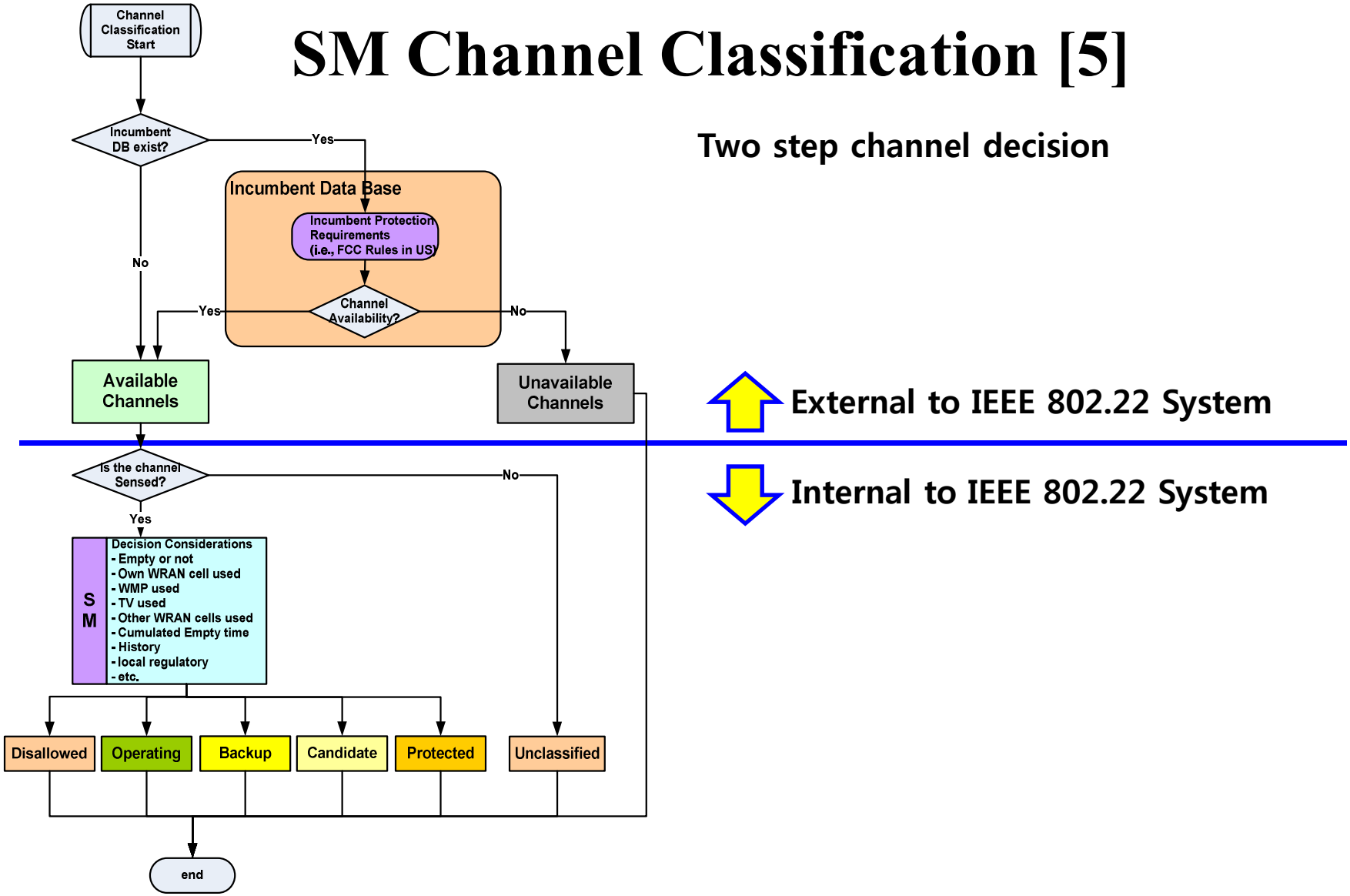
- Collection of Spectrum Information
  - Geo-location information (A)
  - TVWS Database (B)
  - CPE Spectrum Sensor (C)
  - BS Spectrum Sensor (D)
- Cognitive Engine (Decision Maker)
  - Spectrum Manager (BS)
  - Spectrum Automation (CPE)
- Configurable Communication System
  - 802.22 PHY
  - 802.22 MAC



Summary of Spectrum Manager [4]



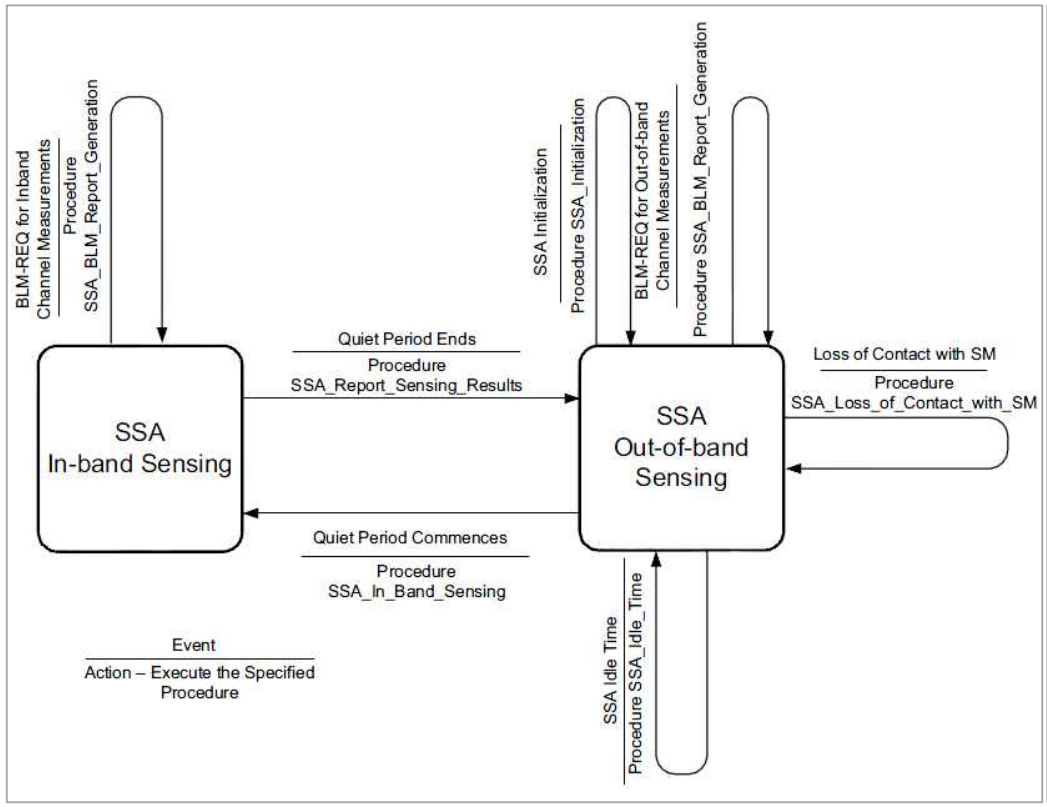
SM Channel Classification [5]



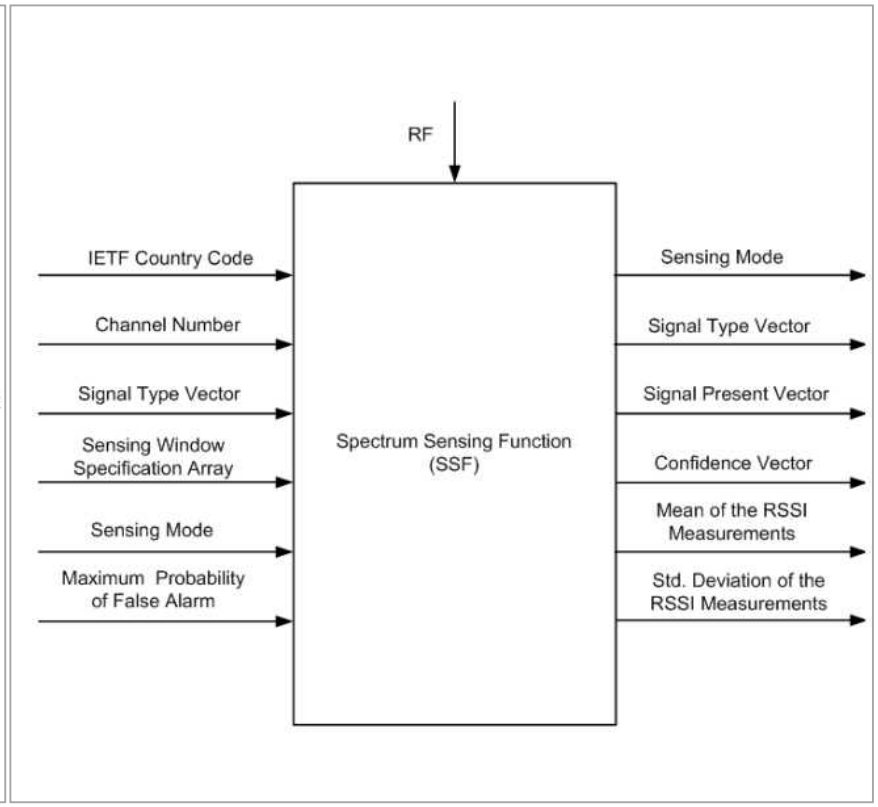
Spectrum Sensing[6]

- **IEEE 802.22 supports spectrum sensing capability by using SSA and SSF**
- **Spectrum Sensing Automation (SSA, sensing manager)**
  - **All the IEEE 802.22 devices (BS and CPEs) shall also have an entity called the Spectrum Sensing Automaton (SSA). The SSA interfaces to the Spectrum Sensing Function (SSF) and executes the commands from the SM to enable spectrum sensing**
- **Spectrum Sensing Function (SSF, sensor)**
  - **Spectrum sensing is the process of observing the RF spectrum of a television channel to determine its occupancy (by either incumbents or other WRANs).**
  - **The base station and all CPEs shall implement the Spectrum Sensing Function (SSF)**
  - **The SSF shall be driven by the SSA. The SSF shall observe the RF spectrum of a television channel and shall report the results of that observation to the SM (at the BS) via its associated SSA**

Spectrum Sensing [6]



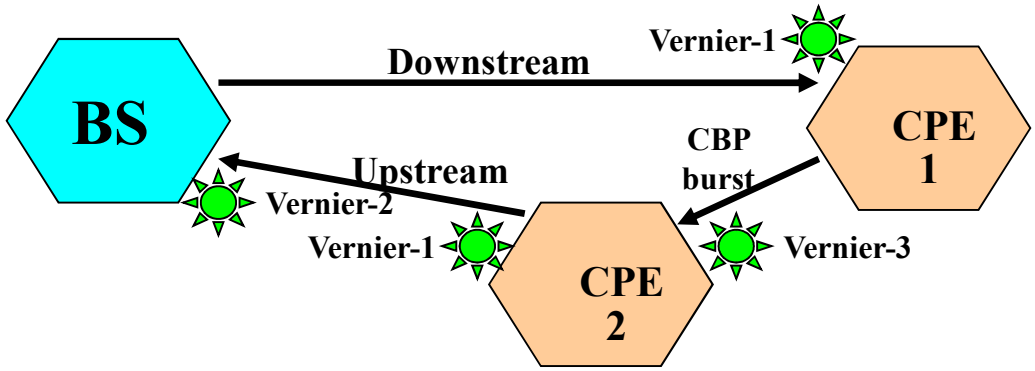
Spectrum Sensing Automation state machine



Input/Output of the Spectrum Sensing Function

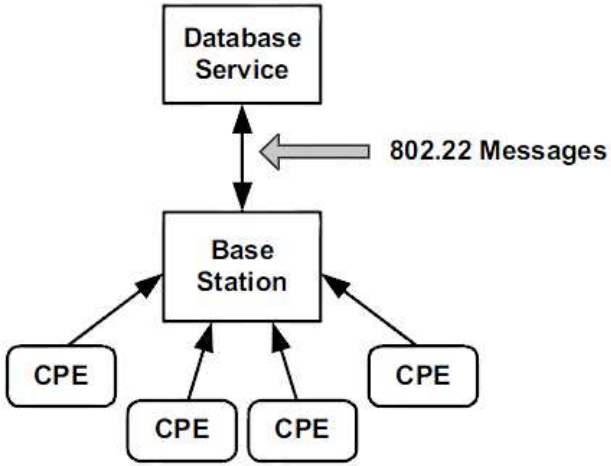
Geo-Location

- **Satellite based geo-location [7]**
  - **Requires GPS antenna at each device**
  - **NMEA 0183 data string used to represent geo-location**
  - **Poor accuracy in Northern hemispheres**
- **Terrestrial based geo-location [4]**
  - **Besides satellite-based geo-location, the 802.22 standard includes terrestrial geo-location using inherent capabilities of the OFDM based modulation and the coexistence beacon protocol bursts transmitted and received among CPEs**
  - **Propagation time measured between BS and its CPEs and among CPEs of the same cell using *Fine Time Difference of Arrival: TDOA***



DB Access

- **WRAN DB access [6]**
  - **802.22 WG defined DB access structure**
  - **Interfaces are defined between DB and BS**
- **Defined number of primitives for DB access**
  - **M-DB-AVAILABLE-REQUEST**
  - **M-DEVICE-ENLISTMENT-REQUEST**
  - **M-DB-AVAILABLE-CHANNEL-REQUEST**
  - **M-DB-AVAILABLE-CHANNEL-INDICATION**
  - **M-DB-DELIST-REQUEST**
  - ***Etc.***



Structure of the IEEE 802.22 WRAN access to the database service

References

[1] "Additional text to implement new connection identifier management approach", 22-10-0137-02-0000, Aug. 2010.

[2] "New connection identifier approach", 22-09-0112-05-0000, Jul. 2010.

[3] "Overview of CBP", 22-07-0136-00-0000, Apr. 2007.

[4] "802.22 Coexistence Aspects ", 22-10-0121-02-0000, Sep. 2010.

[5] "Channel Management in IEEE 802.22 WRAN Systems", IEEE Communication Magazine, vol.48, No.9, Sep. 2010.

[6] "IEEE P802.22-2011: Standard for Wireless Regional Area Networks Part 22: Cognitive Wireless RAN Medium Access Control (MAC) and Physical Layer (PHY) specifications: Policies and procedures for operation in the TV Bands", Jul. 2011.

[7] "IEEE 802.22 Wireless Regional Area Networks", 22-10-0073-03-0000, Jun. 2010.