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Re:	IEEE 802.16m-07/047 - Call for Contributions on Project 802.16m System Description Document. Contribution for protocol architecture topic
Abstract	This contribution proposes a Logical Radio Protocol Architecture for the IEEE 802.16m
Purpose	To include the proposed logical radio protocol architecture in protocol architecture section of the SDD.
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Logical Radio Protocol Architecture for IEEE 802.16m

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1. Introduction

This contribution proposes a logical radio protocol architecture for 802.16m. The radio architecture provides for clear separation of control plane, user plane and management functionalities. It introduces control SAPs and data SAPs for inter-protocol layer interface. This proposed architecture aims to reduce the ambiguity inherent in the 802.16e protocol architecture, while remaining backward compatible. It also aims to minimize the implementation options. It considers future evolution and operational needs such as multi-vendor and inter system working to improve the overall cost efficiency and QoS. We propose that the WG includes this logical radio protocol architecture in the SDD section of protocol architecture.

2. Existing Protocol Architecture

The WiMax OFDMA WMAN 802.16e [1] uses the protocol architecture as shown below in figure 1.

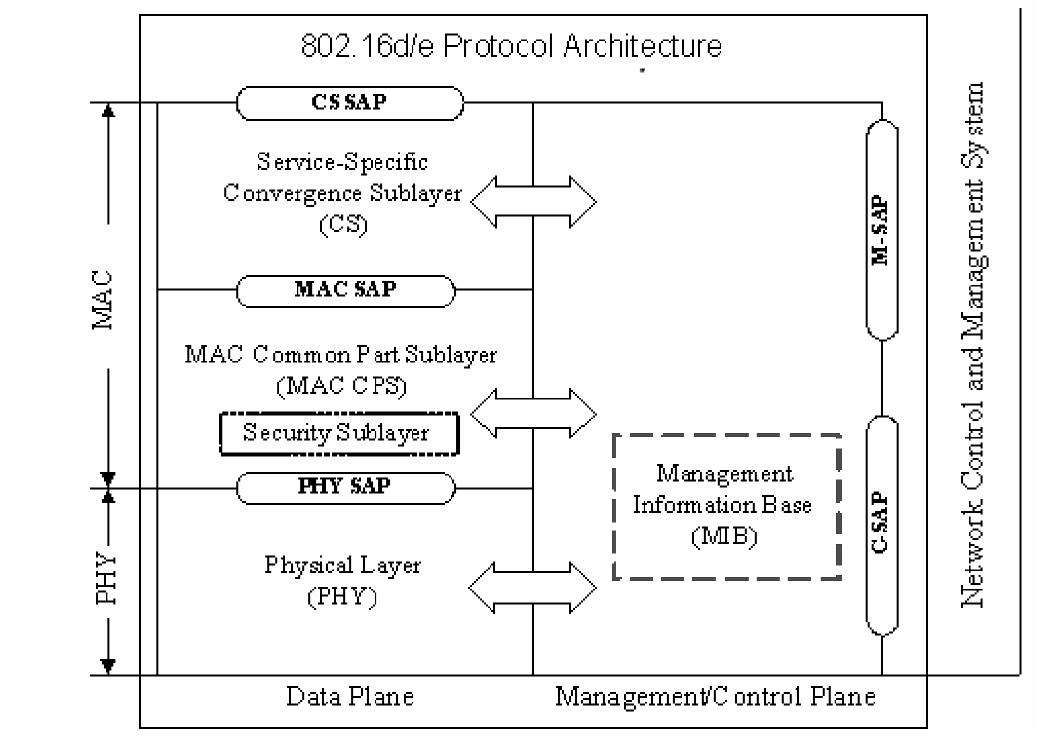

Figure 1 Protocol Architecture for IEEE802.16d/e

The IEEE 802.16e standard defines two major layers Physical (layer-1) and MAC (layer 2) as shown in figure 1. The MAC layer split into various sub-layers CS, CPS and security sub-layer. Additionally figure 1 shows the two major operational components of the architecture, one being the data plane and another being the management/control plane. The management/control plane includes two types of functionalities: radio resource control (RRC) functionalities such as mobility management etc and management functionalities such as system configuration, monitoring etc. The management/Control plane holds a MIB that contains radio control as well as management information. The MAC sub-layers interface with the management/control components of the architecture and the MIB as shown in the figure 1. The physical layer, also interface with the management/control components of the architecture.

The MAC CS layer provides the service specific convergence layer for: ATM CS, Packet CS and generic packet CS. The SCS layer provides SDU classification of higher layer SDUs and associates it to the service flow ID and connection ID (CID). It also optionally provides the packet header compression functionalities and multiplexing of upper layer PDUs for specific services.

MAC-CPS layer performs the MAC functionalities such as PDU packing, PDU fragmentation, PDU scheduling, ARQ functionalities and mapping of data units to CS layer and Layer 1 etc. Additionally MAC CPS sub-layer includes the following control/management functionalities. Note that these functionalities generally consider radio resource control layer functionalities and belong to protocol layer 3 (RRC).

- System information broadcast,
- MBS,
- Connection establishment, maintenance and tearing down,
- UE state management (idle, sleep etc mode)
- Mobility and
- Paging

The MAC Security sub-layer is responsible for encryption of MAC PDUs and privacy key management between the BS and UE to enforce the conditional access to network services.

The physical layer included the typical layer functionalities such as coding, modulation etc.

3. Problems with existing architecture

The existing radio protocol architecture shown in figure 1, has the following limiting features.

1. Inflexible in implementation options
2. Mix of radio control plane and management plane & radio data plane
3. Ambiguous inter-protocol layer interfaces
4. Not compatible with standards such as OBSAI[1] & CPRI[2]

Above limitation may not bring the considerable problem with isolated deployment cases, however, those limitation could be complete hindrance to the system migration and adding OPEX.
The mix of protocol layer functionalities introduces interoperability problems as well as migration and evolution of the protocol stack. The mix of protocol layer functionalities also restricts the options for various deployments scenarios such as for ASN profile A, B and C as per reference [2]. Additionally this may add to downgrading of system performance especially for intra-RAT & inter -RAT system mobility.

Similar problems are added when the standard is ambiguous and does not define the interface Control SAP and Data SAP between the protocol layers. Additionally, this may be interpreted by vendors as a leverage in system implementation in various ways and bringing nightmares to operation, upgrade and evolution of the system, leading to the higher OPEX. Hence there is an explicit need to define standards in a clean manner without ambiguity. This brings the need for explicit control and data SAPs definition between the protocol layers and protocol layer separation as per the functionalities.

For the same reasons it is argued that a separation of the radio control/management plane is desired in the new revision of the standards as control plane and management plane. The management plane includes the

[1] Open Base Station Architecture Initiative (OBSAI)

[2] The Common Public Radio Interface (CPRI)

functionalities not only related with radio control plane but also the management functionalities such as network management etc. Standard [1] and [2], mandates that the WiMax BS implements the complete control/management/control plane in the BS. Control/Management Plane in BS means the whole MIB will be implemented in the BS. The MIB contains the subscriber's life time information as well as active session information, making it difficult to scale and design and deploy and maintain the BS as number of UE grows in BS and or relays stations connected to it. The current protocol architecture is mixed with implementation view leading to ambiguity and various interpretations and mandates that all of the entities be implemented in BS.

Hence, for all the above reasons mentioned briefly here, we, see a strong need to have a logical radio protocol architecture for 802.16m. The logical architecture with clear definition of SAPs for control and data; clear peer to peer interfaces; with control, management and user plane split; and yet remain implementation independent. Additionally it is to be noted that there is a need to minimize the architectural implementation options in the evolved protocol architecture. The changes in the protocol architecture proposed here allows for architectural improvements to the system evolution and improved overall cost efficiency on upgrade, maintenance and evolution. In the following section, we propose a logical architecture fulfilling these requirements.

4. Proposed Logical Radio Protocol Architecture for 16m

The logical radio protocol architecture is shown in Figure 2. The architecture is layered into three layers L3 (Network layer), L2 (data link layer) and L1 (physical layer). Layer 2 is split into MAC-CPS-L, RLC and CS layer. Part of L3 is shown as radio resource control RRC layer (CPS-H). Layer 3 exists in control plane and CS layer exist in the user plane. The radio protocol architecture provides the inter-layer interfaces as control SAP and data SAP. There exists a control and data SAP between each protocol layer.

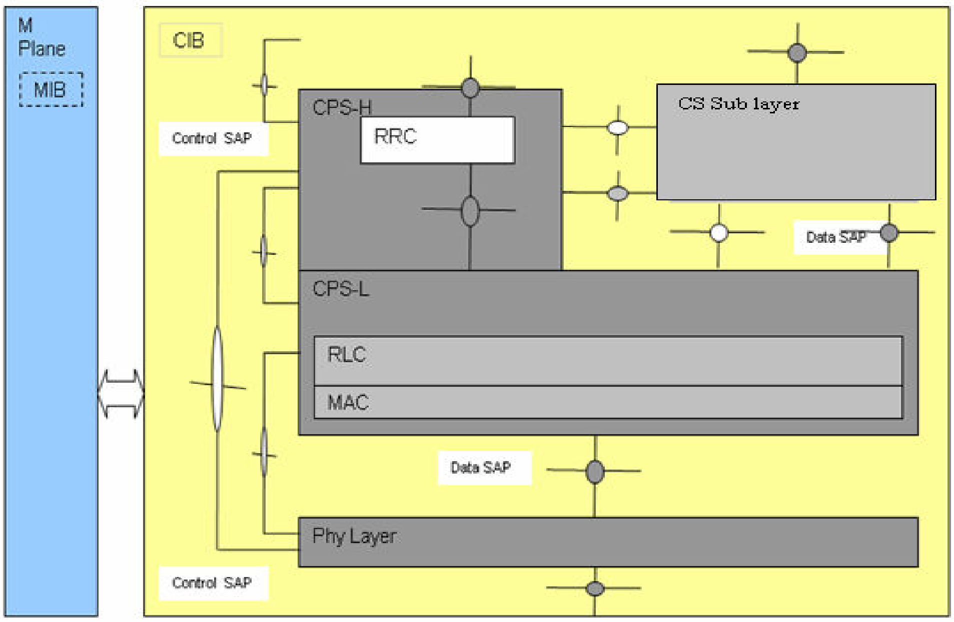

Fig 2 Logical Radio Protocol Architecture for 16m

The logical radio protocol architecture proposed here includes two main types of changes to the architecture shown in figure 1. It provides architectural improvement based on a few new concept introductions and additionally it provides organization of functionalities into appropriate layers.
The improvement to the existing protocol architecture brings in the following basic concepts

1) A clear-cut separation of control, management and data plane

   Management Plane / M-Plane: deals with functionalities such as installment, system configuration, system resource monitoring, alarms etc. Management Plane exists between the BS and NMS, UE and NMS.

   Control Plane/ C- Plane: Deals with radio functionalities that are required to manage the peer-to-peer radio resources for example RRC functionalities. Control Plane manages the radio control information between BS and UE. It includes control signaling for connections, UE/BS state, UE mobility is taken care by the control plane.
   User plane/Data plane/ D Plane: Actual user data streams.

   Such a separation allows for evolution of the protocol architecture functionalities. For example: The M-plane can be moved into the NE management node aligning with the TMN model [3]. The control plane can be implemented in various nodes as per the ASN profile A, B, C reference [2] meeting the operator deployment requirements in a cost effective manner.

2) The original MIB is split into CIB and MIB.

   CIB: The control information base contains the active RL related information, commonly referred as MS context. CIB may contain the active service flow, link IDs and measurement information for radio connection etc. Control plane maintains the CIB.

   MIB: The maintenance information base contains the life time information of a subscriber/Node. The Management plane maintains the MIB.

3) New control SAPs are introduced to allows the interaction between the protocol layers.

   Control SAP: is defined as the service access point between the protocol layers, such as between RRC and PHY layer. Control SAPs are required for transferring to and from control related information that are essential for protocol layer functioning. Information such as measurement info from layer-1 to layer 3 (RRC) are needed to be passed down, and there is no provision for doing so in the current standard.

   Data SAP: carries the data unit between the protocol layers

4) The layer separation idea extracts the existing functionalities and groups them into appropriate layers. MAC-CPS is divided in two parts as higher sub-layer CPS-H and lower sub-layer CPS-L to accommodate this extraction.
   The control functionalities (RRC) are moved to higher CPS-H layer. These functionalities are

   - System information broadcast
   - MBS
   - Connection establishment, sustenance and tearing down
   - Mobility
   - Paging
   - Measurements (Timing advance, inter/Intra RAT etc)
   - Etc

   In order for RRC to function efficiently it needs the RRM (resources such as power, connection/UE/BS state etc) and measurement functionalities. However, note that RRM functionalities are implementation specific and may be implemented in various protocol layers. Hence the RRM is not shown in the architecture of figure 3 because although they are essential they are implementation dependent functionalities and figure 3 only includes the protocol layer view and not a functional view.

The CPH-L layer contains the following existing MAC function

- ARQ, Segmentation/delivery
- Packing unpacking
- Multiplexing De-multiplexing
- Reporting measurements
- Scheduling
- Measurement
- Etc

5) The RLC layer is advisable for future prone architecture. Additionally to ease MAC & CS layer and deal with various radio conditions and quality.

Proposal

We propose that the logical architecture proposed in this contribution, to be included in SDD.

References

1. IEEE 802.16e Standards

2. IEEE 802.16g Standards

3. WiMax Forum Network Architecture – Stage 3 – Detailed Protocols and Procedures - Release 1.1.0

4. ITU TMN Model