Multimedia performance of IEEE 802.16 MAC

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1. Summary

The purpose of this paper is to analyze IEEE 802.16 medium access control (MAC) sublayer for multimedia. The IEEE 802.16 standard specifies the air interface for fixed point-to-multipoint broadband wireless access (BWA) systems providing multiple services The specifications include the medium access control layer (MAC) and physical layer (PHY) layers. The MAC is structured to support multiple PHY specifications, each suited to a particular operational environment.

We will consider two kinds of traffic type to simulate how to allocate bandwidth efficiently with various traffic combinations to maximize the link utilization.

2. IEEE 802.16 Reference model

Figure 1 illustrates the reference model and scope of this standard.

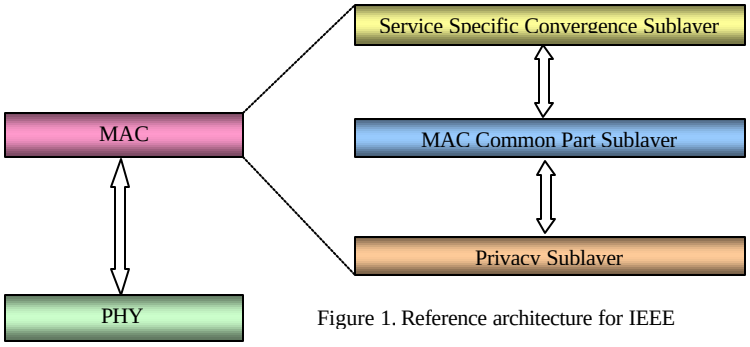

Figure 1. Reference architecture for IEEE

The MAC is comprised of three sublayers. The Service Specific Convergence Sublayer (CS) provides any transformation or mapping of external network data, received through the CS service access point (SAP), into MAC SDUs received by the MAC Common Part Sublayer (MAC CPS) through the MAC SAP. This includes classifying external network Service Data Units (SDUs) and associating them to the proper MAC service flow and Connection Identifier (CID). It may also include such functions as payload header suppression. Multiple CS specifications are provided for interfacing with various protocols. The internal format of the CS payload is unique to the CS, and the MAC CPS is not required to understand the format of or parse any information from the CS payload.

The MAC CPS provides the core MAC functionality of system access, bandwidth allocation, connection establishment, and connection maintenance. It receives data from the various CSs, through the MAC SAP, classified to particular MAC connections. Quality of Service (QoS) is applied to the transmission and scheduling of data over the PHY. The MAC also contains a separate Privacy Sublayer providing authentication, secure key exchange, and encryption.

Data, PHY control, and statistics are transferred between the MAC CPS and the PHY via the PHY SAP.

The PHY may include multiple specifications, each appropriate to a particular frequency range and application.

3. Network model

Figure 2 shows a conceptual view of an IEEE 802.16 deployment.

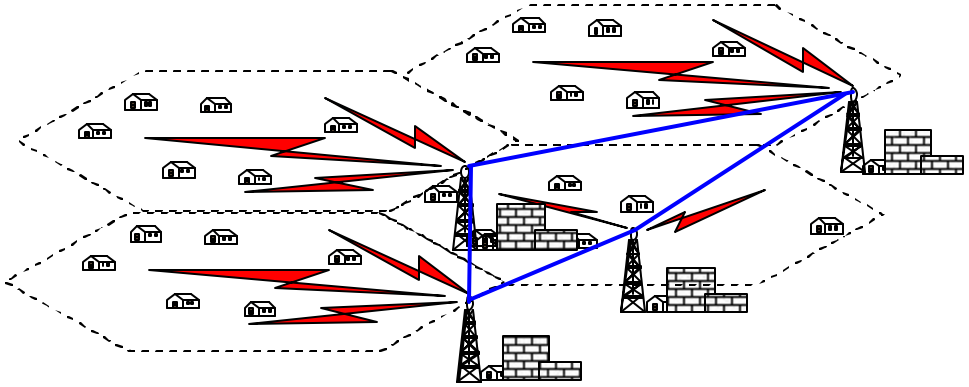

Figure 2. Point-to-multipoint network. Solid blue lines are wired connections between the BS towers.

An IEEE 802.16 system consists of a Base Station(BS) and one or more Subscriber Stations(SS). In the downlink direction (from the BS to SS) the system operates in a TDM fashion. In the uplink all SSs share the link capacity on a demand basis.

The MAC sublayer is connection-oriented. All data transmissions take place in the context of connections. A service flow is mapped to a connection and the connection is associated with a level of QoS. Connections Connections in the downlink direction are either unicast or multicast while uplink connections are always unicast. During initialization of an SS, three particular connections are established in both directions. The *basic connections* is used for short time critical messages. The *primary management* connection is used to exchange longer more delay tolerant messages. Finally the *secondary management* connection is intended for higher layer management messages and SS configuration data. The messages on the Secondary Management Connection are carried in IP packets. Each SS comes with an unique 48-bit MAC address. It merely serves as an equipment identifier. During initialization each SS is also assigned an IP address by means DHCP. This allows the SS to be managed, e.g., by means of SNMP. It also allows the SS configuration to be down loaded via TFTP.

4. Simulation model

Based on the network model, we build our simulation model which has one basestation and ten subscriber stations. Five of them generate Ethernet packet traffic and five of them generate constant bit rate traffic, such as in ATM network. There are some assumptions about the simulation environment: both of the traffic typrs satisfied by Poisson arrival distribution, the maximum length for Ethernet packet is 1500 bytes, and the data length for ATM Cell is 53 octets, of which 48 are user payload. The packet-length of Ethernet packets has an exponential distribution.

Figure 3 shows the topology of the simulation model.

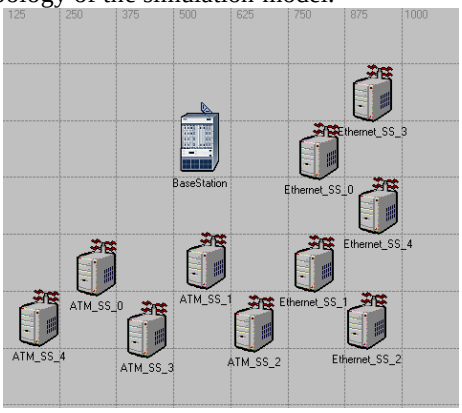

Figure 3. The topology of the simulation model

When traffic comes into the basestation, the appropriate convergence sublayer(CS) deals with different types of data through different paths. The ATM cells go through ATM CS. ATM CS is a logical interface that associates different ATM services with the MAC CPS SAP. The ATM CS accepts ATM cells from the ATM layer, performs classification and, if provisioned, payload header suppression (PHS), and delivers CS PDUs to the appropriate MAC SAP.

The packet data goes through packet CS. The packet CS does almost the same thing with ATM CS but it uses a different MAC PDU format.

Figure 4 shows the data path in 802.16 protocol stack with convergence sublayers.

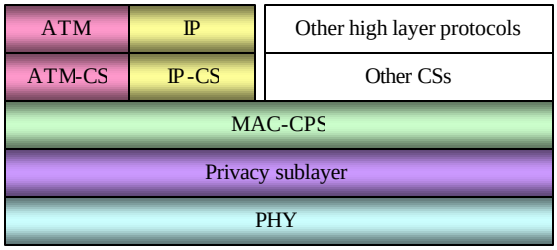

Figure 4. Each upper layer protocol requires a convergence sublayer to conform back and forth with MAC sublayer.

During simulation execution, several statistics will be collected to analyze the performance of WMAN.

• **Delay**: End-to-end delay of all packets received by the node's wireless LAN MAC and forwarded to the higher layer.
• **Load**: Total number of bits received from the higher layer. Packets arriving from the higher layer are stored in the higher layer queue.
• **Throughput**: Total number of bits sent to the higher layer from the MAC layer. The data packets received at the physical layer are sent to the higher layer if they are destined for this station.

5. Conclusion

In this paper we will determine the efficiency of the IEEE 802.16 convergence sublayers for multimedia traffic.

6. Reference

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[5] Carl Eklund, "The IEEE 802.16 Standard for Broadband Wireless Access", Nokia Research Center