



Wimax MAC – Upperlayer Services

S-72.4210 Postgraduate Seminar on Wideband Radio Communications

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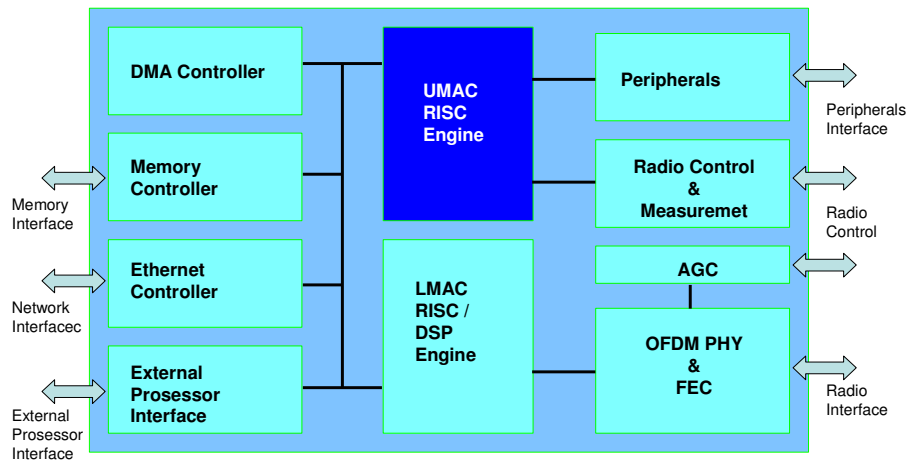
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WIMAX, baseband chip



Example: Thephanos Thomopoulos, May 12, 2005
London (Fujitsu)



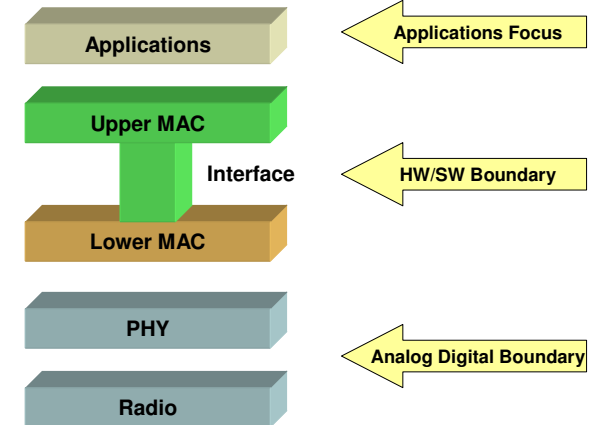
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WIMAX, partitioning



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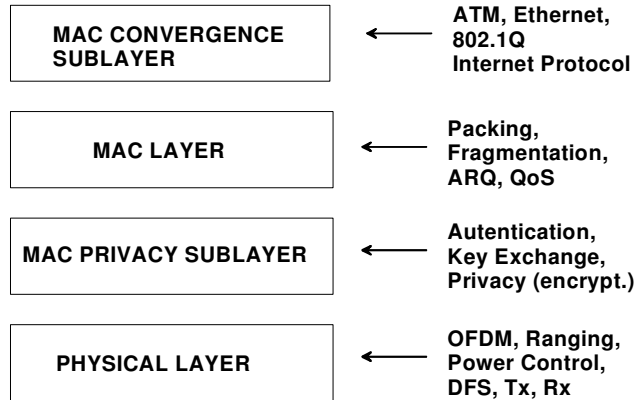
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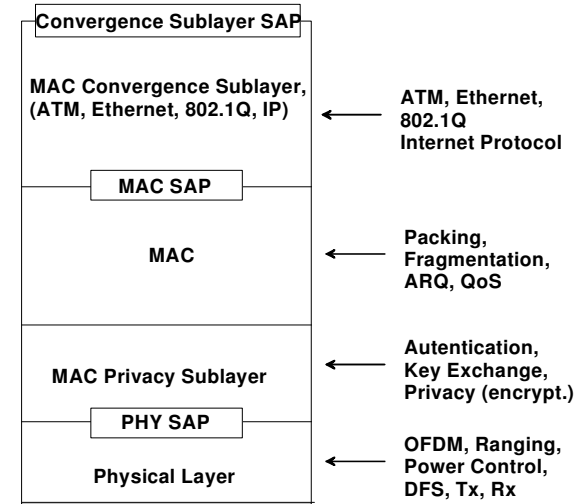
MAC and Physical Layers (1)



MAC and physical layers of IEEE 802.16 as detailed by the IEEE



MAC and Physical Layers (2)



PHY and MAC layers of WIMAX specification showing MAC privacy sublayer (INTEL).



Why we need QoS in WIMAX

Question are network delays and used bandwidths.

- Balancing voice quality, packetization delay and bandwidth utilization efficiency is very important to the service provider.

How much delay is too much?

- Latency less than 100 ms does not affect toll quality voice.
- However latency over 120 ms is discernable to most callers.
- Latency at 150 ms and more the voice quality is noticeable impaired resulting
- Humans are intolerant of speech delays of more than about 200 ms.

The challenge for VoIP service providers and their vendors is to keep the latency of any conversation on their network about 100ms.



QoS in WIMAX

Quality of Service:

1. FEC (Forward error Correction)

- Without FEC, error correction would require the retransmission of whole blocks or frames of data. And resulting of that is in added latency and degrees of QoS value.
- Throughput and latency are two main and essentials thinks for network performance.

To ensure consistent QoS, WIMAX ensures consistent bandwidth. The WIMAX MAC accommodates two classes of SS that are differentiated by their ability to accept bandwidth grants for a single connection or for the SS's as a whole.

Both classes of SS request bandwidth per connection to allow the BS UL scheduling algorithm to properly consider QoS when allocating bandwidth. They are GPC and GPSS

GPC () BS grants bandwidth explicitly to each station.

GPSS () bandwidth is granted to all connections belonging to the station





QoS in WIMAX (SS connections)

SS connections (SS = Subscriber Station):
 SS is three management connections in each directions.
 These three connections reflect the three different QoS requirements used by different management levels:

- Basic connection:
transfer short, time critical MAC and radio link control (RLC) messages.
- Primary management connection:
transfer longer, more delay tolerant messages, such as those used for authentication and connection setup. The secondary management connection transfer standards based management messages such as Dynamic Host Configuration Protocol (DHCP), Trivial File Transfer Protocol (TFTP) and Simple Network Management Protocol (SNMP). In addition to these management connections, SS are allocated transport connections for the contracted services.
- Transport connections:
are unidirectional to facilitate different UL and DL QoS and traffic parameters: they are typically assigned to services in pairs.

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Service Classes and QoS in WIMAX

Each sector, users adhere to a transmission protocol that controls contention between users and enables the services to be tailored to the delay and bandwidth requirements of each user application.
 This is accomplished through four different types of UL scheduling mechanisms.

- Unsolicited Grand Services (UGS):
UGS is designed to support constant bit rate (CBR) services (T1/E1, VoIP without silence suppression...).
- Real Time Polling Services (rtPS):
rtPS is designed to support real time services that generate variable size data packets(MPEG video, VoIP with silence suppression...).
- Non Real Time Polling Services (nrtPS):
nrtPS is designed to support non real time services that require variable size data grant burst types on a regular basis.
- Best Effort (BE) Services: used in Internet for web surfing

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Service Specific Convergence Sublayer

The WIMAX standard defines two general service specific convergence sublayer for mapping services to and from WIMAX MAC connections:

- The ATM convergence sublayer is for ATM services
- The packet convergence sublayer is defined for mapping packet services such as IP version 4 or 6 (Ipv4, IPv6), Ethernet and virtual local area network (VLAN)

The most important tasks of the sublayer is to classify service data units (SDUs) to the proper MAC connection preserve or enable QoS and enable bandwidth allocation.

SDUs are units exchanged between two adjacent protocol layers. Mapping takes various forms depending on the type of services.
 In addition to these basic functions, the convergence sublayers perform sophisticated functions, such as payload header suppression and reconstruction to enhance airlink efficiency.

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Common Part Sublayer

The MAC reserves additional connections for other purposes.

- One is reserved for contention based initial access
- Second is reserved for broadcast transmissions in the DL as well as for signaling broadcast contention based polling of SS bandwidth needs. Additional connections are reserved for multicast rather than broadcast contention based polling.

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MAC PDU Formats 1(2)

A MAC PDU consist of a fixed length MAC header, a variable length payload and an optional cyclic redundancy check (CRC).

Two header formats are defined:

- the generic header
- the bandwidth request header

MAC PDUs contain either MAC management messages or convergence sublayer data.

Bandwidth request MAC PDU don't contain payload



MAC PDU Formats 2(2)

There are three types of MAC subheaders:

- Grant management subheader:

is used by an SS to convey bandwidth management needs to its BS

- Fragmentation subheader:

contains information that indicates the presence and orientation in the payload of any fragments of SDUs

- Packing subheader:

indicates the packing of multiple SDUs into a single PDU. The grant management and fragmentation subheaders may be inserted in MAC PDUs immediately following the generic header if so indicated by the Type field. The packing subheader may be inserted before each MAC SDU if so indicated by the Type field.



Packing and Fragmentation

WIMAX are the packing and fragmentation processes with the bandwidth allocation process to maximize the flexibility, efficiency and effectiveness of both processes.

- Fragmentation is the process in which a MAC SDU is divided into one or more MAC SDU fragments.
- Packing is the process in which multiple MAC SDUs are packed into a single MAC PDU payload.

Either a BS for a DL connection or an SS for an UL connection may initiate both processes.

WIMAX allows simultaneous fragmentation and packing for efficient use of the bandwidth



PDU Creation and Automatic Repeat Request (ARQ)

ARQ blocks are distinct units of data that are carried on ARQ enabled connections.

ARQ processing retransmits MAC SDU blocks (aka ARQ) that have been lost or garbled.

The WIMAX MAC uses a simple sliding window based approach where the transmitter can send up to a negotiated number of blocks without receiving an acknowledgment.

The receiver sends acknowledgement or negative acknowledgement messages to indicate to the transmitter which SDU blocks have been received and which have been lost.

And then the transmitter retransmits blocks that have were lost and moves the sliding window forward when SDU blocks are acknowledged and so have been received.

Each SS and BS connection is assigned a service class as part of the creation of the connection. When packets are classified in the convergence sublayer the connection into which they are placed is chosen based on type of QoS.





QoS Measures Specific to the WIMAX Specification

WIMAX employs legacy and next generation QoS measures:
WIMAX QoS mechanisms function in both UL and DL frames through the SS and BS.

The WIMAX specification for QoS include the following items:

- A configuration and registration function for preconfiguring SS based QoS service flows and traffic parameters
- A signaling function for dynamically establishing QoS enabled service flows and traffic parameters
- Utilization of MAC scheduling and QoS frame parameters for UL service flows
- Utilization of QoS traffic parameters for DL service flows
- Grouping of service flow properties into named service classes so upper layer entities and external applications (at both the BS and SS) with desired QoS parameters in a globally consistent way



QoS Measures Specific to the WIMAX Specification, Theory of Operation

For providing QoS it is to associate packets traversing the MAC interface into a service flow as identified by the CID (Connection identifier).

A service flow is a unidirectional flow of packets that is provided a particular QoS.

BS and SS provide this QoS according to the QoS parameter set defined for the service flow.

The primary purpose of the QoS features defined is to define transmission ordering and scheduling on the air interface.

But these features often need to work together with mechanisms beyond the air interface in order to provide end-to-end QoS or to police the behavior of SSs.

Service flows in both the UL and DL direction may exist without actually being activated to carry traffic.

All service flows have a 32 bit service flow ID (SFID).

Admitted and active flows also have a 16 bit CID.



Service Flow (1)

For the minimizing customer intervention we are using Service Flow system in WIMAX (Service Tables):

- The Provisioned Service Flow Table
- Service Class Table
- Classifier Rule Table

They are configured to support self installation and auto configuration.

When customer subscribe to the services they tell the service provider the service flow information including the number of UL/DL connections with data rates and QoS parameters and also the types of applications (for example Internet, Voice or Video) customer intends to run.

The service provides preprovisions the services by entering the service flow information into the service flow database.

When the SS enters the BS by completing the network entry and authentication procedures the BS downloads the service flow information from the service flow database.



Service Flow (2)

- A service flow is a MAC transport service that provides unidirectional transport of packets either to UL packets transmitted by the SS or to DL packets transmitted by the BS.

- A service flow is characterized by a set of QoS parameters such as latency, jitter and throughput assurances.

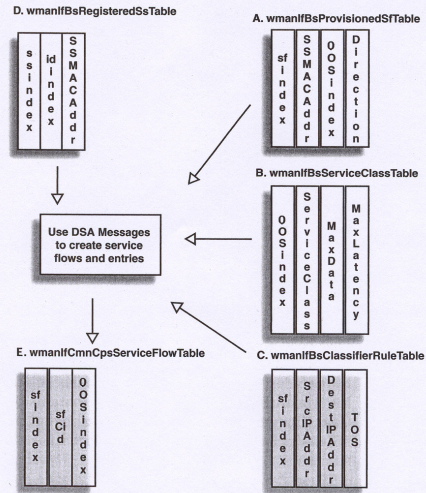
- In order to standardize operation between the SS and BS these attributes include details of how the SS requests UL bandwidth allocations and how BS UL Scheduler is expected to behave.





Service Flow Tables

Figure 4-4
Service flow
provisioning
(Source: Intel)



REFERENCES

- [1] IEEE 802.16 specification, 2004.
- [2] IEEE 802.16d specification, 2005
- [3] Wimax Handbook, Frank Ohrtman, McGraw-Hill, USA 2005



HOMEWORK

1. What are those biggest challenges in the Voice communication in the wireless networks.
2. What Flow means in the WIMAX systems?

