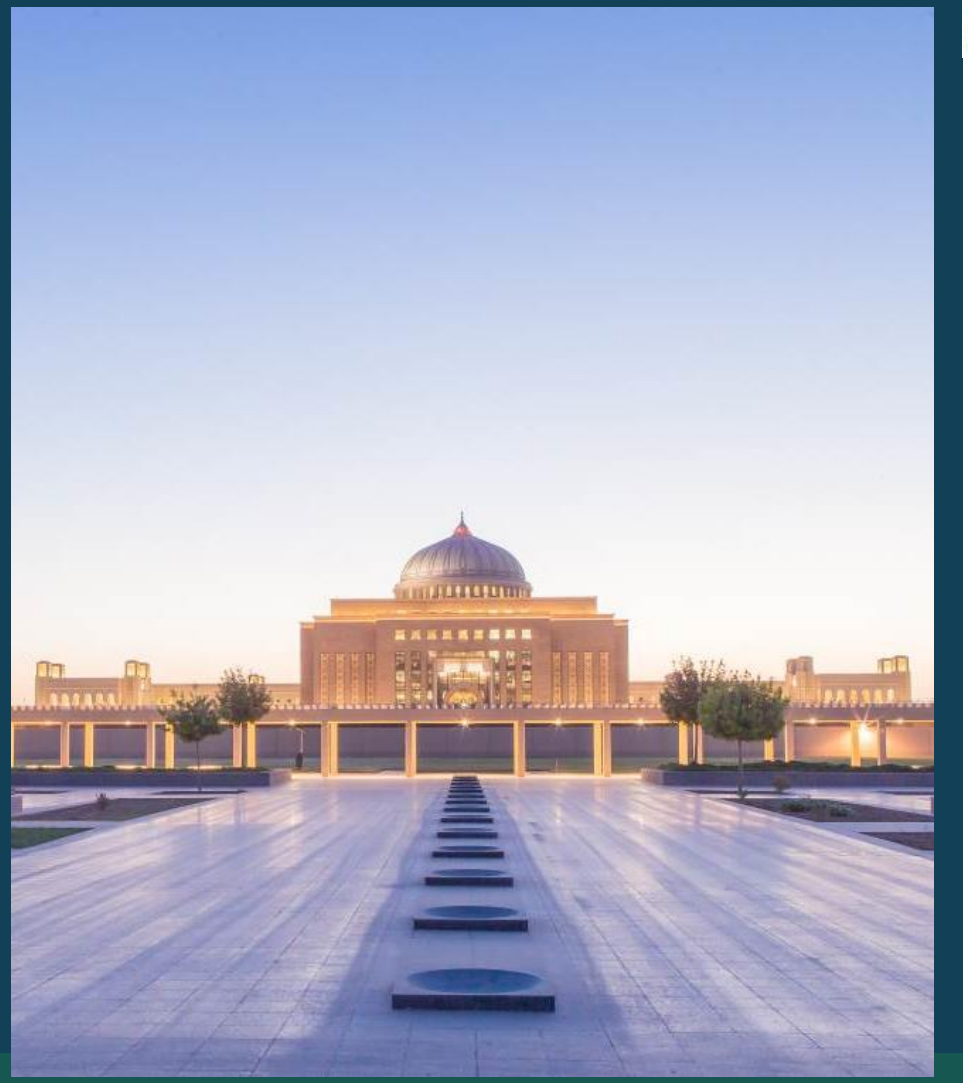


Faculty of Computer and Information Sciences

Information Technology Department

Course Name

Wireless Networks and Mobile Communication Systems

Course Code IT 331T / NET 332D

Lecture 10: WiMAX Networks

Broadband Wireless

- The **main objective** was to **replace coaxial cables** used for **TV** and **Internet access** WANs with **new wireless technology**.

- **IEEE Std 802.16 December 2001.**

Comparison between 802.16, 802.11, and 4G

- **802.16** ➔ **WiMAX** combines aspects of both **802.11** and **3G** making it more like a **4G** technology.
- **4G** applications include **mobile web access**, **IP telephony**, **gaming services**, **high-definition mobile TV**, **video conferencing**, **3D television**, and **cloud computing**
- **Like 802.11** it is a wireless technology that **connect devices** to the **Internet** at **megabit/sec speeds**.
- The frames carry **peer-to-peer traffic**, **video**, **VoIP**, or **streaming media** to support range of applications.
- **Like 802.11a,g** it uses **OFDM** technology to ensure good performance and **MIMO** technology to achieve high levels of throughput.

Comparison between 802.16, 802.11, and 4G

- **802.16** is more **like 4G technology** in these aspects:
- Large number of **subscribers** in a coverage area can all get **high throughput** by efficient use of spectrum.
- The converge area is **typically at least 10 times larger** that **802.11** network. It enables communication over a maximum distance of **50km**.
- So, **WiMAX** base stations are **much powerful than APs**.
- To handle weaker signals over **larger distances**, the base station uses **more powerful** and **better antennas**.
- It also perform more processing to **handle errors**.

Comparison between 802.16, 802.11, and 4G

- Transmission are **scheduled** by the **base station** and not by **CSMA/CA**.
- **WiMAX uses licensed spectrum** usually at **2.5GHz** or **3.5GHz**.
- **WiMAX** and **4G** cellular networks are thought to be the transmission trend of the future.
- **An update appeared** in **June 2012,** and originally provides 30-70Mbps.
- Followed by: 802.16p-2012, 802.16n-2013, and 802.16q-2015, 802.16 -2017 and possibly P802.16s-till 2021.
- **http://standards.ieee.org/about/get/**

WiMAX 802.16


zing
3.65 GHz
permission / exclusion zone map
beta v1.1
Search by city or zipcode :
e.g. "90210"
Go!
MORE INFO:
If you are looking to deploy WiMAX gear in the 3.65GHz Range in the United Sates, by now you've heard of the Exclusion / Permission zones.
The problem we found was that there was no quick, easy way to do a look up a by zip or city name or GPS cord to see where your tower or building was within "the zones"
Also there was no quick way to predict, if you would have to negotiate with one, two or even more Ground Based Satellite Operators, in oder to power up that 3.65GHz gear.
This is our "Free" Solution to the above mentioned problems.
MAP CONTROLS
Show Radius
Clear Radius
Reset Map
Show Traffic Info
Clear Traffic Info
Download the 3D Plugin
2D 3D Road Aerial
UNITED STATES
Virtual Earth
POWERED BY NAVICITI SOFTWARE
and Microsoft® Virtual Earth - Produced by Naviciti LLC in association with Zing Wireless - For Promotional Purposes Only - © 2008

WiMAX 802.16

WiMAX

Worldwide Interoperability
of Microwave Access

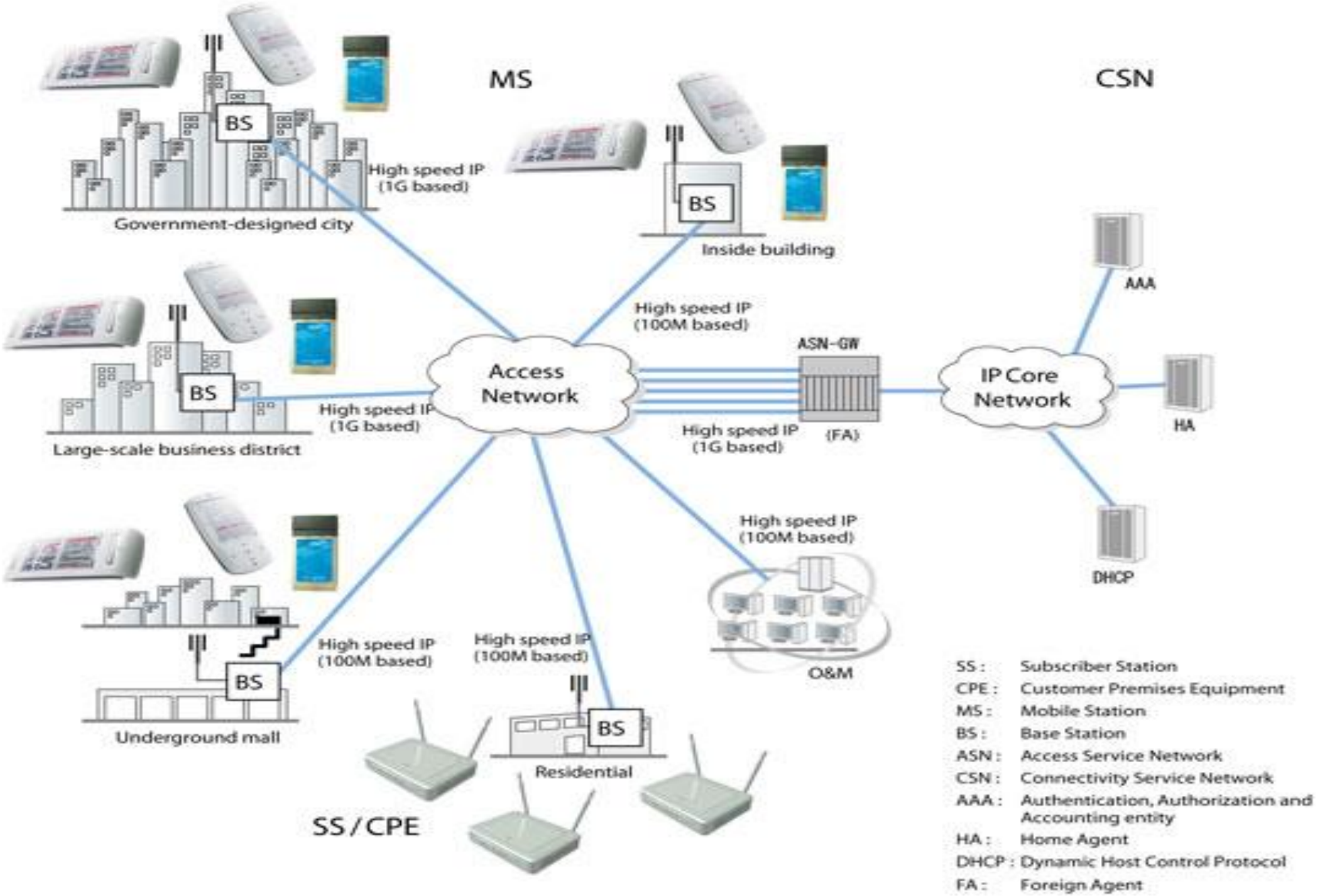
WiMAX 802.16 Frequency Bands

Region	Frequency Bands (GHz)
Canada	2.3/ 2.5/ 3.5 /5.8
USA	2.3/2.5/5.8
Central and South America	2.5/3.5/5.8
Europe	2.5/3.5/5.8
Middle East and Africa	2.5/5.8
Russia	2.5/3.5/5.8
Asia Pacific (inc China, India, Australia, etc)	2.3/2.5/3.3/3.5/5.8

802.16 Architecture and Protocol Stack

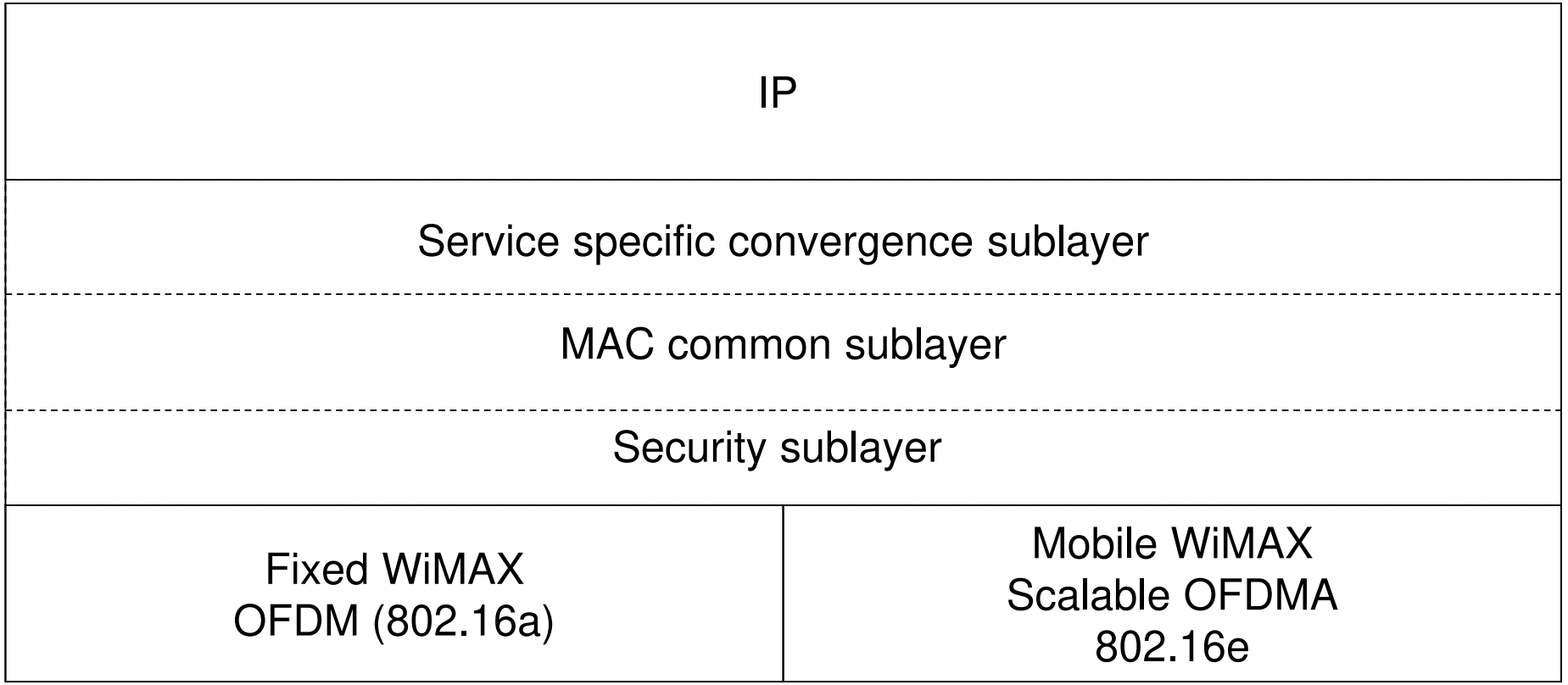
- **Base station** connects directly to provider's **backbone network**, which in turns connect to the Internet.
- The **base station connects** to **stations** over the **wireless** air **interface**.
- Two kinds of station exists: **Subscriber stations** which has **fixed locations**, and **mobile stations** such as laptops iPads.

802.16 Architecture and Protocol Stack



802.16 Architecture and Protocol Stack

802.16 Architecture and Protocol Stack



802.16 Physical Layer

- In **WiMAX**, the channel is divided into more subcarriers with longer symbol duration than **802.11**.
- Symbols on each subcarrier are sent with **QPSK**, **QAM-16**, **or** **QAM-64** modulation schemes.
- Because of this modulation, the base station can support **12.5Mbps** of **downlink** traffic and **6.2 Mbps** of **uplink traffic**.
- Stations are assigned subcarriers using **OFDMA** (Orthogonal Frequency Division Multiple Access).
- In **OFDMA**, assigning a subcarrier is not fixed.(i.e. subcarrier might be faded at one station and clear at another). Subcarriers are assigned to stations that can use them best.

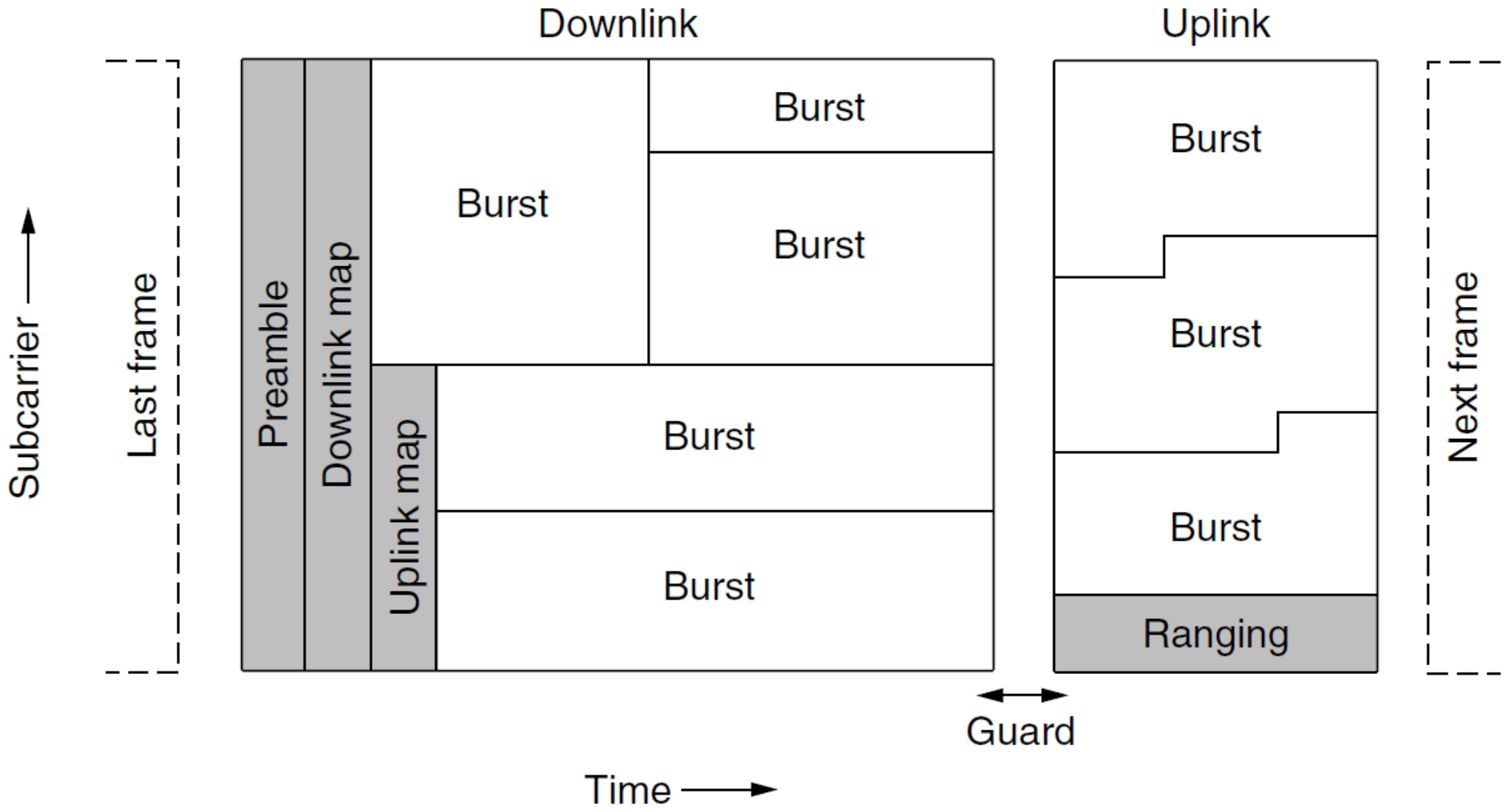
802.16 Physical Layer

- Stations usually alternate **between send and receive** using **Time Division Duplex** TDD scheme.

- **Or**, they can send and receive at the same time (on different subcarrier frequencies) under the **Frequency Division Duplex** FDD scheme.

- **WiMAX allows both** methods, but **TDD** is **preferred** because it is **easier** to implement and **more flexible**.

802.16 Physical Layer



802.16 Physical Layer

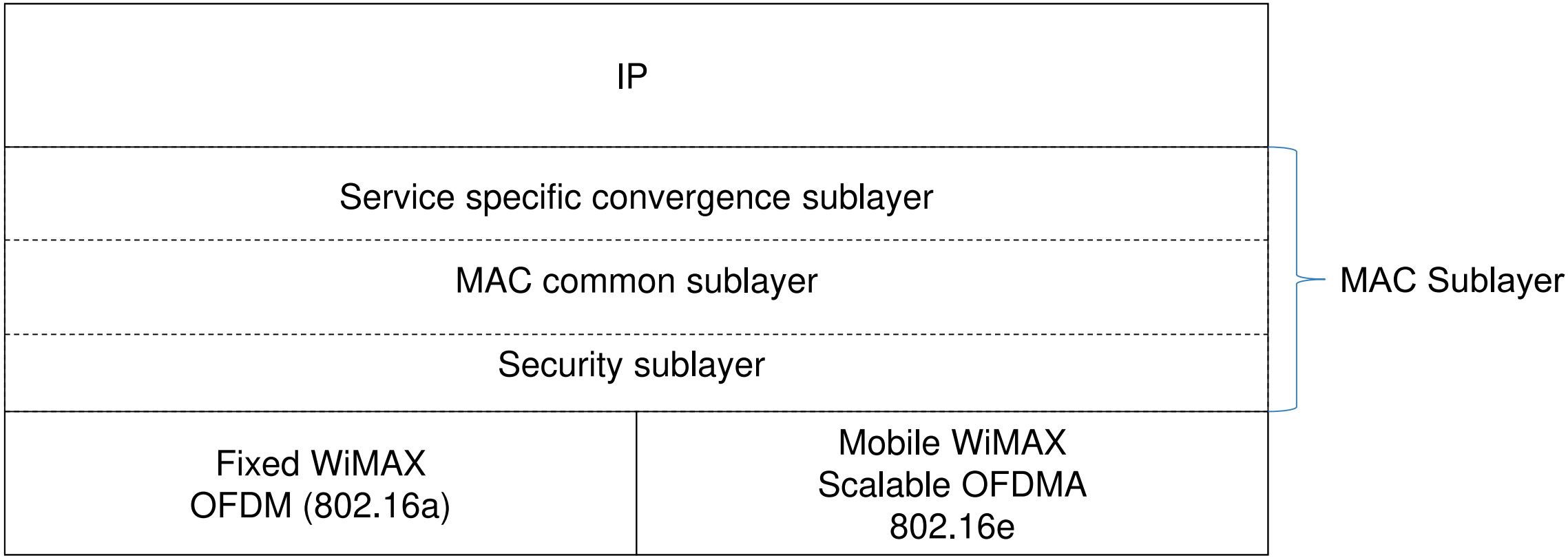
- The previous figure shows an example of the frame structure that is repeated over time.
- It starts with a **preamble** to **synchronize** all stations, followed by **downlink** transmissions from the base station.
- At the **start** of transmission, the base station **sends** a **map** to **all stations** that tells them how **downlink** and **uplink subcarriers** are assigned along with the **intended transmission times**.
- The **base station** **controls** the **maps**, so it can allocate different amounts of bandwidth to stations from frame to frame depending on the needs of each station.
- Next, the **base station** sends **bursts** of traffic to different stations at the **time** given in the **map**.

802.16 Physical Layer

- The **stations** also **send** their **traffic** to the base station **according** to the **uplink positions reserved** for them on the map.
- One of the uplinks is reserved for **ranging**.
- Ranging is a process by which **new stations** adjust their timing and **request initial bandwidth** to connect to the base station.

The 802.16 MAC Sublayer Protocol

- The data link layer is divided into three **sublayers**



The 802.16 MAC Sublayer Protocol

- In the MAC Sublayer performs medium access control functions and they are:
  - On transmission, assemble data into a frame with address and error detection fields.
  - On reception, disassemble frame, and perform address recognition and error detection.
  - Govern access to the wireless transmission medium.

The 802.16 MAC Sublayer Protocol

- When a subscriber connects to a base station, they perform **mutual authentication** with **RSA public-key** cryptography using X.509 certificates.

- The payloads themselves are encrypted using a **symmetric-key** system, either **AES** (Rijndael) or **DES** with cipher block chaining.

- The MAC sublayer is **connection-oriented** and **point-to-multipoint**, which means that **one base station** communicates with **multiple subscriber stations**.

The 802.16 MAC Sublayer Protocol

- The downlink direction is fairly straightforward.
- The **base station** **controls** the physical-layer **bursts** that are used to **send information** to the different **subscriber** stations.
- The MAC sublayer simply packs its frames into this structure.
- To **reduce overhead**, there are several different **options**.
- For example, MAC frames may be sent **individually**, or **packed back-to-back** into a group.

The 802.16 MAC Sublayer Protocol

- The uplink channel is more complicated since there are **competing subscribers** that need access to it.

- Its allocation is tied closely to the **quality** of **service issue**.

802.16 Services

- All **802.16** services are connection oriented and each connection gets one of these service classes:

- **Constant bit rate service**: is intended for **uncompressed voice**. It needs to **send predetermined** amount of **data** at **predetermined time interval**.

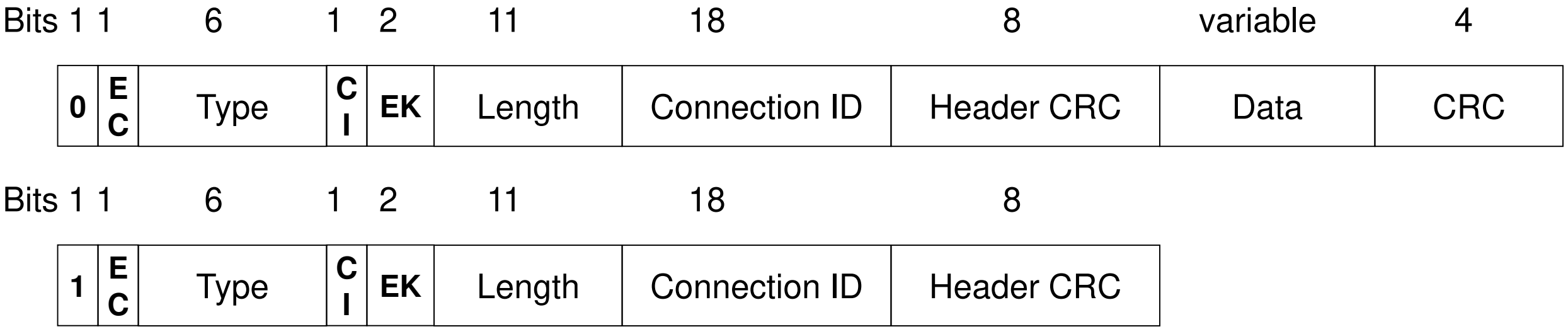
- **Real-time variable bit rate service**: is for **compressed multimedia** and other soft real-time application. In which the amount of bandwidth needed may vary.

- **Non real-time variable bit rate**: is for **heavy transmission** that are not real time, such as **large file transfer**.

- **Best effort service** is for **every thing else**. In this service requests for bandwidth are sent in bursts and stations contend for bandwidth. Collisions may occur and binary **backoff** is used.

802.16 Frame Structure

- 802.16 has many types of frames such as **generic data frame** and **bandwidth request frame**.



802.16 Frame Structure

- ***EC*** bit tells if the payload is **encrypted**.
- The ***Type*** field identify the **frame type**.
- The ***CI*** indicates the **presence** or **absence** of final **checksum**.
- The ***EK*** field tells which **encryption** key is used (if any).
- The ***Length*** filed gives the **complete length** of the **frame**.
- The ***Connection identifier*** tells which connection this frame **belongs** to.
- The ***Header CRC*** which is applied for the **header only**.

Book Chapter/ References or Other materials:

- William Stallings Wireless Communications 2nd Edition: chapter 1pp: 4-8
- Data Communications and Networking 5E “, By Behrouz A.Forouzan , Fifth edition, 2013: chapter 1pp: 2-22

THANK YOU