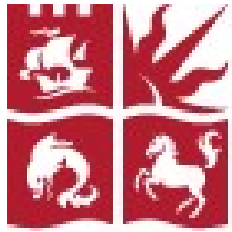
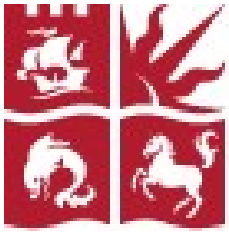


EENGM4221:
Broadband Wireless Communications

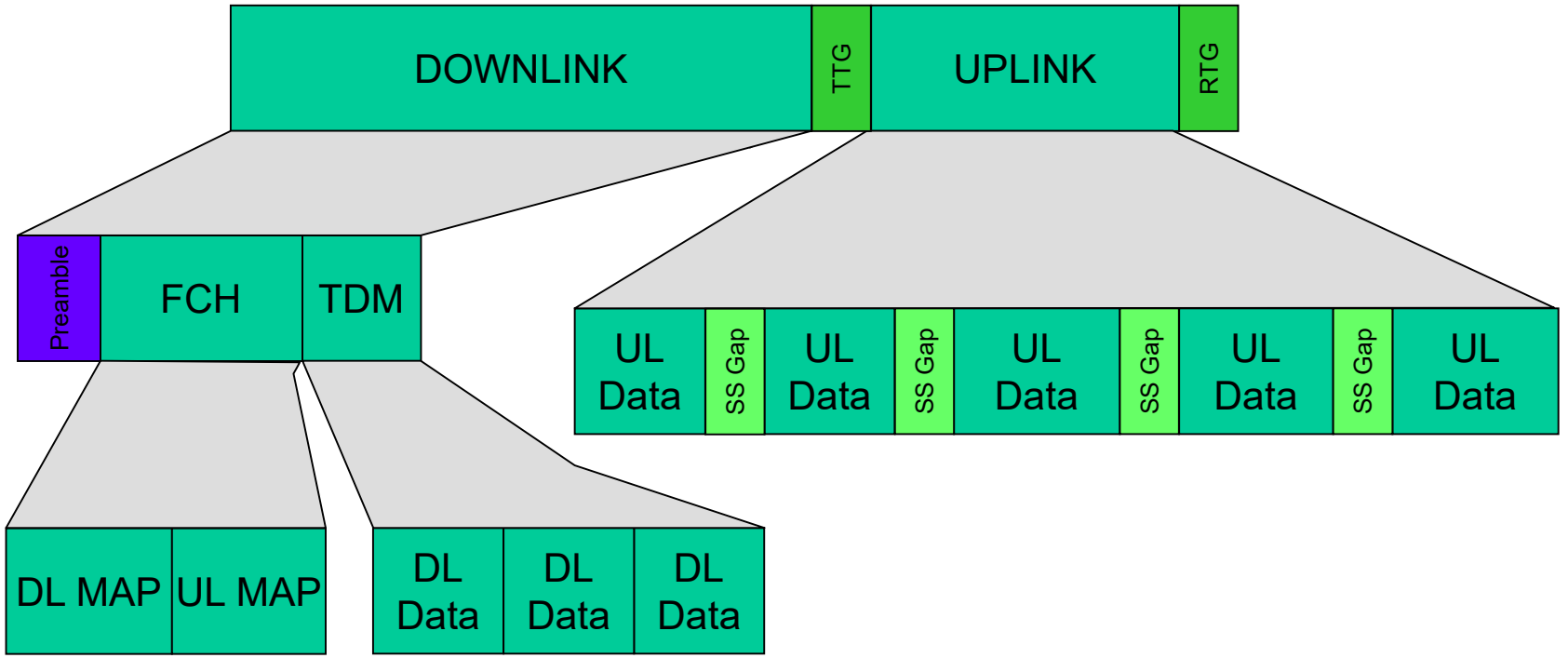
Lecture 20: WiMax MAC

Dr Simon Armour

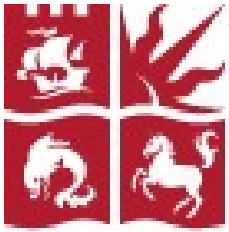
MAC Frame Structure (TDD)



- The MAC is best understood by considering its frame structure –TDD is simplest

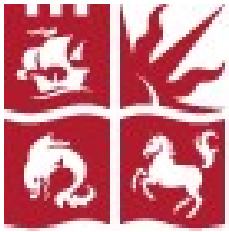


MAC Frame Structure – Top Level



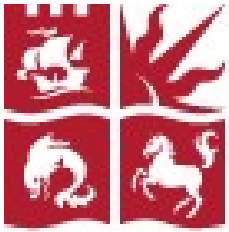
- At its highest level, each MAC frame consists of two phases: Downlink and Uplink, to accommodate TDD transmission
  - A Transmit Turnaround Gap (TTG) is placed between the uplink phase and following downlink phase to allow a period of time in which no data is transmitted so that the BS may turn its radio from transmitter to receiver and the SSs may turn their radios from receivers to transmitters
  - A Receiver Turnaround Gap (RTG) is placed between the downlink phase and uplink phase of the next MAC frame to allow the reverse process

MAC Frame Structure – Mid Level, Downlink



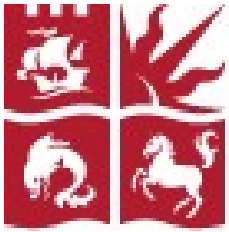
- The Downlink Phase begins with a preamble (training sequence)
  - This known sequence allows all SSs to synchronise to the BSs signal
- This is followed by the Framing Channel (FCH)
  - The FCH describes the detailed structure of the remainder of the MAC frame
    - The start and end times of all following sub-frames is specified here
    - This structure is chosen by the BS and so must be explained to the SSs so that they know what to expect
- Subsequently, the BS transmits a stream of Time Division Multiplexed Data to the BSs

MAC Frame Structure – Bottom Level, Downlink (1)



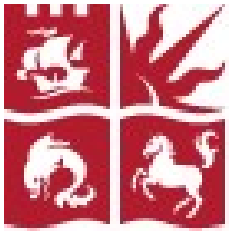
- The FCH consists of two ‘maps’
  - The DL Map describes the format of the Downlink
  - The UL Map describes the format of the Uplink
- The downlink describes the start and end time of the DL data phases in the TDM phase and the modulation and coding to be used in each
  - It does not specify the recipient of data in each DL data phase
- The uplink map specifies the start and end time of each UL Data phase in the UL phase as well as the modulation and coding to be used AND the SS which is scheduled to transmit

MAC Frame Structure – Bottom Level, Downlink (2)



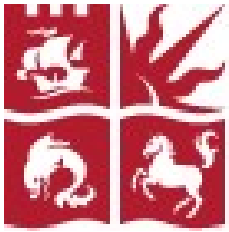
- The DL phase consists of a sequence of DL Data phases
- Each DL Data phase uses different modulation and coding
  - The first DL Data phase uses the most robust of the modulation and coding schemes scheduled
  - Subsequent DL Data phases may use decreasingly robust modulation and coding schemes
- Each SS receive all the DL Data phases from the beginning until it the modulation and coding used becomes too unreliable for it to correctly receive data
  - This will happen at different times for different SSs due to different signal quality
  - Since all SSs must listen to the DL Data phases the transmission is TDM not TDMA
- Packets transmitted in the DL Data phase are individually addressed – each SS must receive each packet and determine if it is the intended recipient or not
  - This is why the DL Map doesn't specify recipients

MAC Frame Structure – Mid Level, Uplink



- The Uplink consists of a series of UL Data frames
- TDM in the uplink is impossible
- Each SS transmits its data during the UL Data frame(s) specified for it in the UL Map
- SS Gaps are inserted between UL Data phases
  - These are silent periods
  - This allows for the fact that the signals from different SSs in different locations will arrive at the BS after different propagation delays
  - The BS must finish receiving the signal from one SS before it can receive the signal from the next
    - This might be impossible with a zero SS Gap – UL signals could 'collide'
- Some UL Data frames may be left free
  - Nodes can contend for use of these

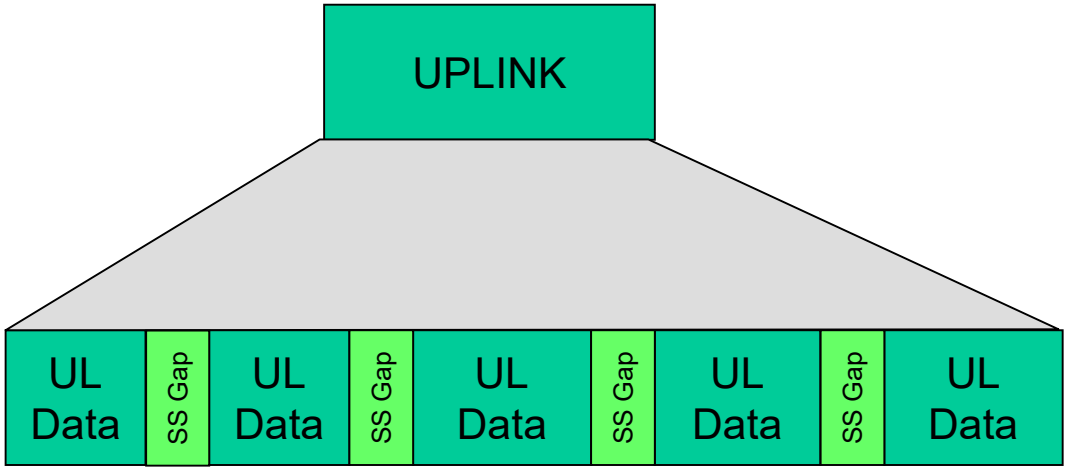
Overheads & MAC Efficiency



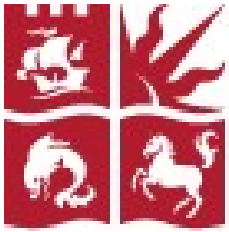
- The TTG, RTG, Preamble and SS Gaps are all overheads – no useful data is transmitted
- We have seen similar overheads for 802.11 and Bluetooth and investigated their implications
- The overheads and hence the MAC efficiency in 802.16 remains an open question. However:
  - The overheads are relatively small and should give good efficiency
  - The overheads are independent of packet size and data rate and so efficiency should remain approximately constant
  - Efficiency may be effected by some degree by the number of SSs since more SSs will require more complex DL and UL Maps

The FDD MAC Frame Structure

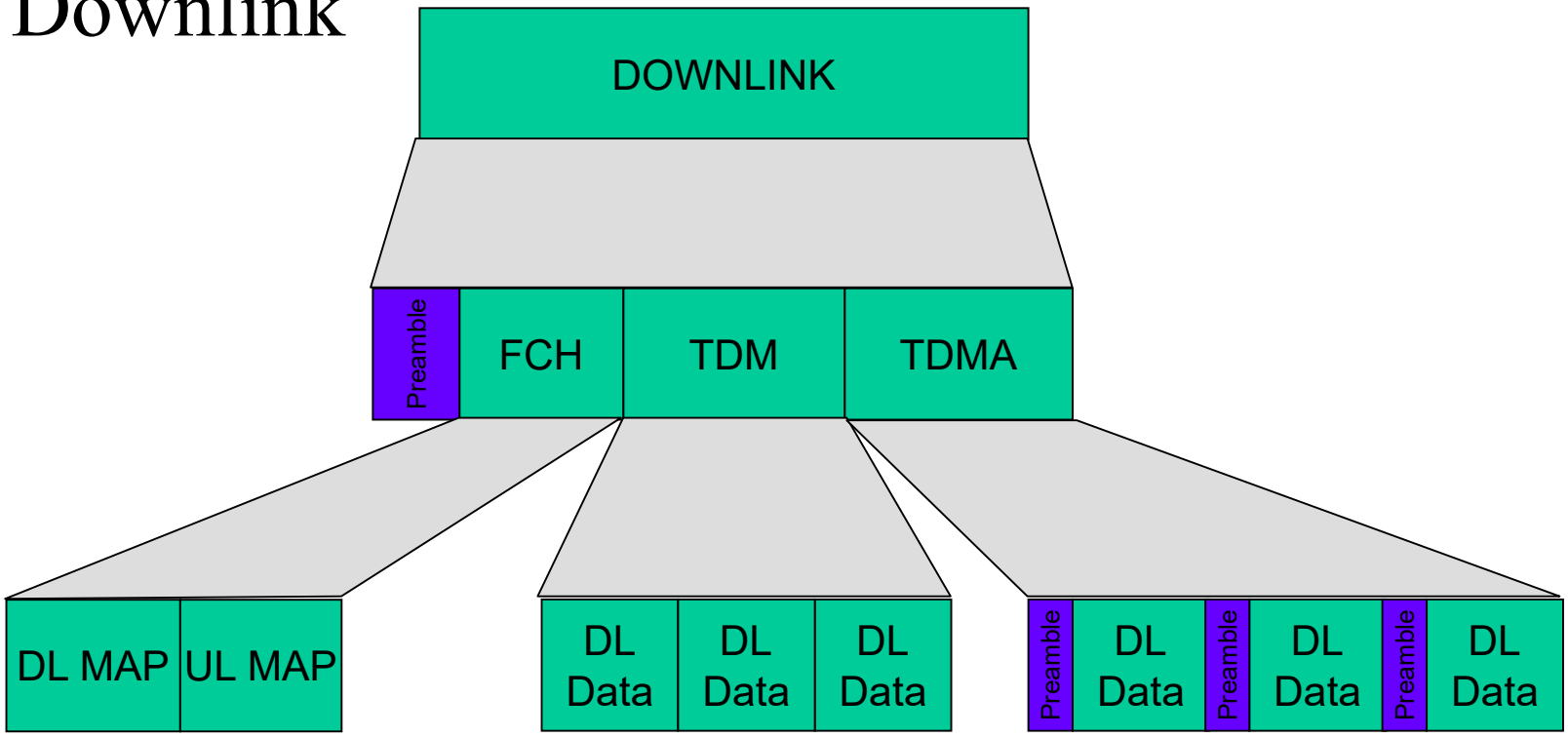
- The FDD MAC frame is similar to that for TDD
  - Obviously, the uplink and downlink take place at the same time but on different frequencies
  - No TTG or RTG is required
  - The Uplink frame structure is unchanged



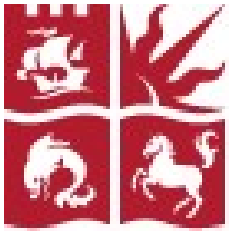
The FDD Downlink Frame Structure (1)



- A TDMA phase follows the TDM phase in the Downlink



Review of Lecture 20



- We reviewed the MAC frame structure used in 802.16
  - We focussed on the TDD MAC
  - We discussed the various sub-frames in detail
  - We reviewed the FDD MAC and identified a few differences
  - We discussed MAC efficiency but did not analyse it in detail