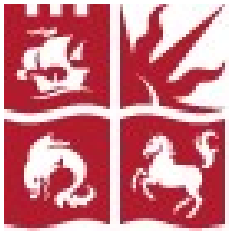
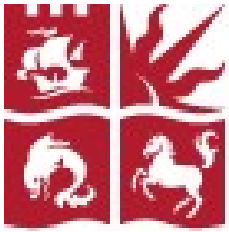


# EENGM4221: Broadband Wireless Communications

## Lecture 17: Bluetooth Service Types, Frame Structure and Error Control

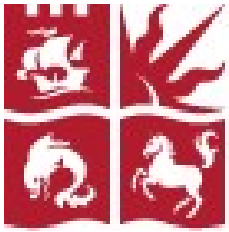
Dr Simon Armour

# Service Types for QoS



- Bluetooth recognises that different applications have different QoS requirements
- This is handled by the definition of two service types:
  - Synchronous Connection Oriented (SCO) services are provided with ‘pseudo-circuit switched’ fixed rate connections
  - Assynchronous Connectionless (ACL) services are provided with a ‘best effort’ variable rate, packet switched connections
- This is far from perfect but is nevertheless very useful
  - If nothing else its better than basic 802.11!

# SCO



- SCO services are facilitated by scheduling regular packet exchanges between the Master and relevant Slave
  - The Master must make this provision for any SCO service it has agreed to support
- These regular slots provide limited but fixed bit rate connections
- Only a finite number of connections can be handled
  - i.e. until all slots are allocated
- Intended for CBR traffic
  - Particularly voice
  - E.g. the Mobile Phone to Headset link for which Bluetooth is probably most famous

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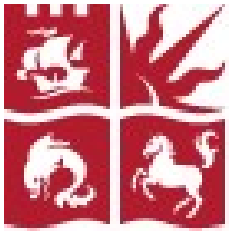
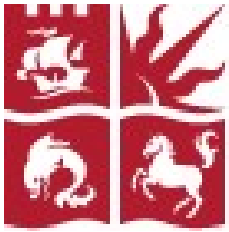
# ACL

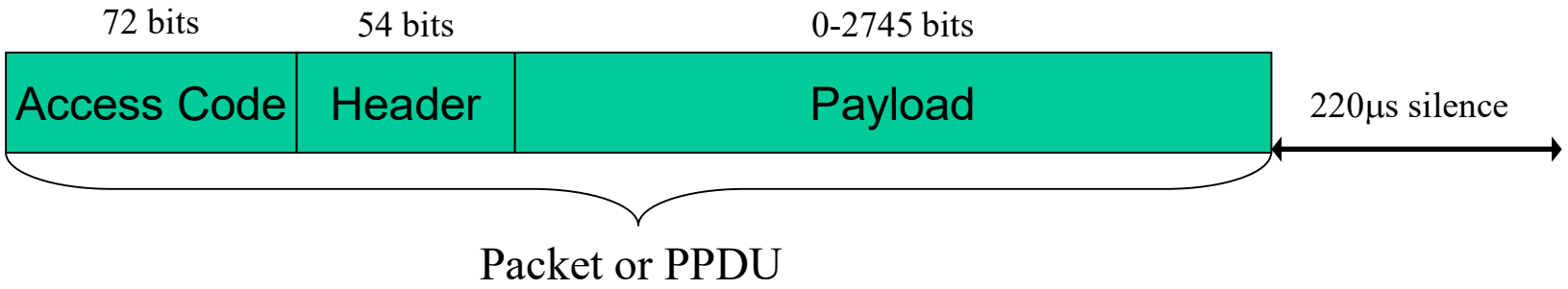


- ACL services are essentially allocated ‘whatever is left’ after the SCO services have been scheduled
- If there are lots of SCO services allocated within a Piconet this may equate to little or nothing!
- If there are very few SCO services, there may be plenty of resources available for ACL services
- ACL is best suited to services which want data rate to be ‘as fast as possible’ but are tolerant to delays
  - E.g. File Transfer

# Bluetooth Packet Structure



- The Bluetooth ‘Packet’ (PPDU) consists of 3 actual fields:
  - Access Code (72 bits)
  - Header (54 bits)
  - Payload (up to 2745 bits)
- All packets are followed by a fixed period of silence
- All but the payload represent overhead

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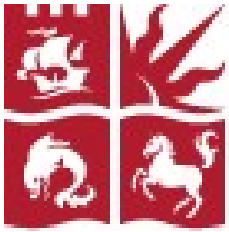
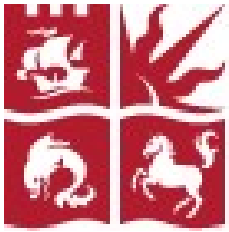
# Access Code



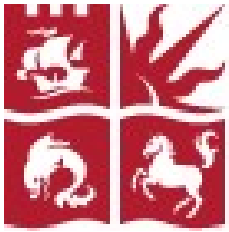
- The Access Code part provides for synchronisation of the piconet and may indicate whether the packet:
  - Contains data
  - Is intended to page a specific Slave or respond to a page
    - The Master may page slaves to enquire whether they have data to send
  - Be a general enquiry along the lines of ‘is there anyone there?’
    - A useful thing to do when trying to establish a Piconet or trying to find an existing Piconet to join – remember Bluetooth is for Ad-hoc networks

# Header and Payload



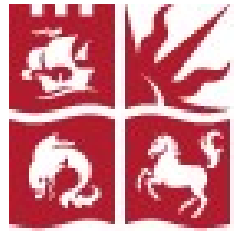
- The header contains amongst other things:
  - The address of the source or destination Slave
  - The packet type
  - A 1 byte CRC check sequence for ARQ Purposes
- The Payload is simply the ‘useful’ data
  - Equivalent to the MSDU

# ARQ (1)

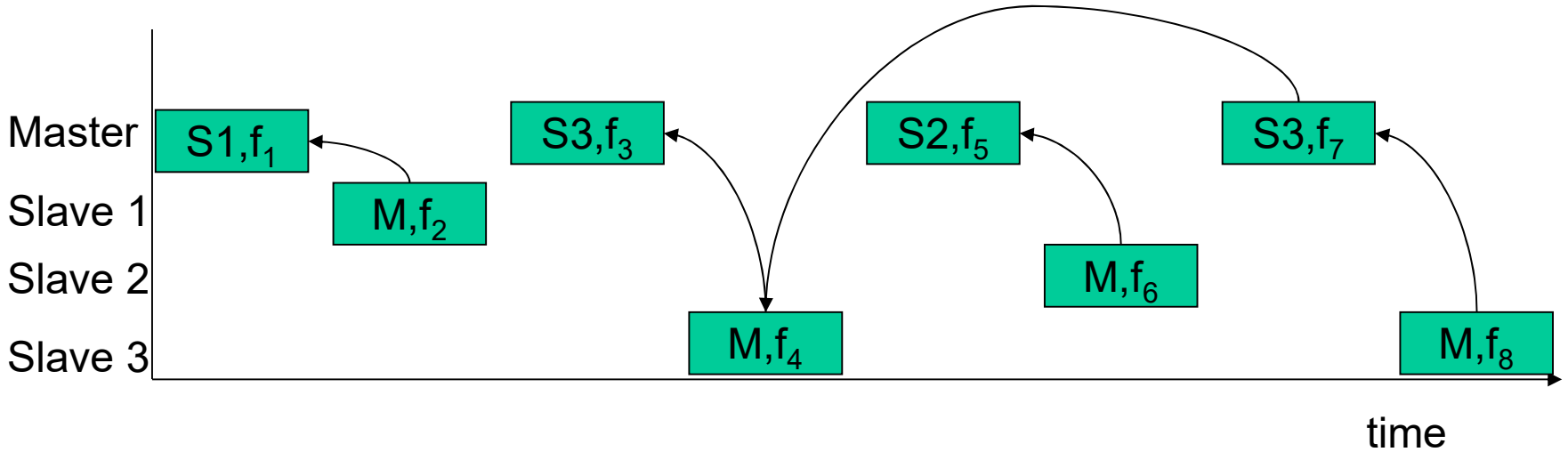


- The ping-pong MAC protocol of Bluetooth makes ARQ easy
- Upon receiving a packet a node performs an error check by undertaking a Cyclic Redundancy Check between the payload and the error check sequence in the packet header
- On this basis it 'piggybacks' either an ACK or NACK on the next frame going to the required destination node (i.e. the source of the packet that the ACK/NACK relates to)
  - If a packet is sent from Master to Slave the slave must immediately respond with a packet of its own and can piggyback the ACK or NACK onto that packet
  - If the packet is sent from Slave to Master, the Master must wait until it next needs to send a packet to THAT slave and then piggyback the corresponding ACK or NACK onto that frame
    - Potential delays and QoS issues can arise from this

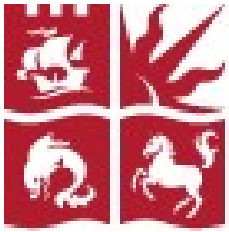
# ARQ (2)



- In the diagram below, the arrows indicate where an ACK or NACK in one frame relates to a previous frame

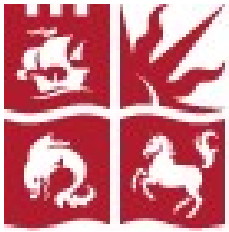


# FEC Coding



- Bluetooth allows for the following FEC options:
  - Uncoded data
  - Rate 1/3 Repetition coding (i.e. transmit every bit three times and go with the majority at the receiver)
  - Rate 2/3 Shortened Hamming Code
- The last is easily the most advanced but is still VERY basic by modern wireless communication standards
- The 1/3 rate repetition code provides better error correction capability
  - For this reason, it is used to protect the Header content

# Review of Lecture 17



- Traffic classes in Bluetooth
  - SCO for real time
  - ACL for non-real time
- Frame structure and piggyback ‘ARQ’
- Introduced the FEC coding (more on that next lecture)

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