2 G Architecture– GSM, GPRS and Others

Lesson 02
Data Transmission

Data Transfer

- Transparent
- Non transparent

Transparent Data transfer

- Means that the interface for the service is using only physical layer protocol
- Physical layer means the layer which transmits or receives data after formatting or multiplexing using wired (wire or fibre) or wireless (radio or microwave) medium
- The physical layer protocol in GSM bearer service– provides for FEC (forward error correction)

No Handshaking in Case Of Transparent Data transfer

- Handshaking refers to interchange between two networks or systems
- Provisioning for acknowledgement from data-link or higher layer at receiver so that appropriate actions at transmitter data-link or higher layer
- Acknowledgements interchange once the connection is established between systems

FEC

- Entails insertion of redundant bits along with the transmitted data
- Redundant data allows the receiver to detect and correct errors

FEC

- Also enables broadcast to multiple destinations from a single source
- Advantageous in situations where retransmission is not convenient though FEC requires higher bandwidths– more bits per second
- Helps in broadcasting without handshaking and at FEC transmission reduced data rates

Reduction in data rate

- Assume *m* redundant bits appended in a data stream of *n bits* with *m* redundant bits appended in a data stream of *n bits*
- Total numbers of data bits transmitted from the sender's end = (*n* + *m*) bits
- At the receiving end, an algorithm employed to detect and correct transmission errors (error means 0 received as 1 or 1 received as 0)
- When m = 2 × n, data rates reduce by 1/3.

Reduction in data rate

- The algorithm extracts the original n bit streams from the received $(n + m)$ bit sequences
- Therefore, for every $(n + m)$ bits sent by the sender, the receiver receives only n bits of actual data
- Means that if the transmission channel offers a data rate r, then the actual data transmission rate with FEC is $r \times n \div (n + m)$

Non-transparent Data transfer

- When data transmits at GSM 9.6 kbps the data error rates are high
- This is because when non-transparent data transmits at GSM 9.6 kbps, no provision exists for retransmission
- When erroneous data, then that get rejected in 9.6 kbps case
- Data above 9.6 kbps, non-transparent data-transfer used

Non-transparent Data transfer

- Non-transparent means the service interface uses the physical layer, special physical layer radio-link, data-link layer, and flow control layer protocols

Data link layer

- Data link layer– the layer which frames the data and appends additional bits plus performing other functions
- Framing refers to combining and appending the additional bits and header

Protocols for data link and flow control layers

- Provide for (i) error detection and correction and (ii) selecting, rejecting, and re-transmitting the data, respectively

Flow control layer (Network layer)

- Flow control layer controls the flow of data by selecting or rejecting erroneous data transmitted and by re-transmitting erroneous data

Data error rate

- Becomes negligibly small at slow data rates (300 bps)
- Because when non-transparent data transmits at 300 bps, then the erroneous data is corrected or gets retransmitted at data link and flow control layers

Data error rate

- A special error correction facility called RLP (radio link protocol), used in GSM networks, is an example of a non-transparent communication protocol
- RLP results in more robust transmission with very small BER (bit error rate)

Special error correction facility

- Non-transparent communication protocol RLP results in more robust transmission
- Very small BER

Data transmission Modes

- Synchronous data transfer
- Asynchronous data transfer
- Synchronous data packet transfer

Synchronous data transmission

- Data transmitted from a transceiver at a fixed rate
- Constant phase differences (and thus time intervals) maintained between data bursts or frames
- Receiver must synchronize the clock rate according to the incoming data bit rates

Synchronous data transmission

- Receiver also synchronizes data bits coming in from multiple paths or stations and compensate for the varied delays in received signals
- Handshaking is not required in synchronous transmission of data
- Synchronous data transmission fast
- No waiting period during data transfer

Examples of synchronous data transfer in a GSM system

- Voice converted into bits after coding in a GSM system and the bits are transferred at data rates of 13 kbps as synchronous data
- No in-between acknowledgements or waiting periods in this faithful transmission of bits

Examples of synchronous data transfer in a GSM system

- An SMS transmits through a GSM channel as synchronous data
- No in-between acknowledgements
- Transmission errors correction using FEC

Asynchronous data transmission

- Data transmitted by the transceiver at variable rates and constant time intervals are not maintained between consecutive bursts or frames
- Usually data handshaking or acknowledgement in asynchronous data transfer

Asynchronous data transmission

- But even if there is no acknowledgement, data flow maintained by using the FEC plus buffers can still be asynchronous
- Use of buffers causes variable delays in reception

Examples of acknowledgement messages

- receiver ready
- receiver not ready
- unnumbered acknowledgement of acceptance of data at the receiver, rejects, set asynchronous balance mode, or disconnect
- Program files containing middleware for mobile devices have to be transmitted by the mobile service while maintaining full data integrity

Examples of acknowledgement messages

- In-between acknowledgements of faithful transmission of bits and reporting of errors during transmission important during the file transfer
- Non-transparent Flow

Examples of acknowledgement messages

- An acknowledgement is sent by the receiver for each data set to the effect that the data set received is identical to the one transmitted
- Time is, therefore, spent in implementing appropriate algorithms for data set integrity checks and acknowledgements
- This results in asynchronous data transmission

Synchronous packet transmission

- After formation of packets
- Different packets transmitted through different interfaces, routes, channels, or time-slots to reach a common destination
- At the destination, various packets are arranged in their original sequence

Synchronous packet transmission

- A sequence number transmitted along with each packet helps in sequential arrangement of packets at the receiver
- Each packet flow transmitted as synchronous data
- There is no handshaking or acknowledgement of the data during the flow of packets

Example

- *N* bits of data are to be transmitted as packet switched data
- The packets can have a maximum of *n* bits each
- The data transmission rate is $n \div T$
- The time taken to complete the synchronous packet transmission = $(T \div n) \times n = T$

Example Data transmission

- Assume formatted into 4 packets *A*, *B*, *C*, and *D*
- Three different routes available for transmission
- Time taken = $2 \times T$
- 1 T for three packets by three routes at the same instance plus 1 T when fourth packet transmits separately because $N > 3 \times n$
- To transmit the same data through one single path time taken would have been = $4 \times T$

Summary

- Transparent data in which only physical layer used, no handshaking or acknowledgement or flow control
- Non Transparent data in which physical layer or special Radio Link Protocol or data link plus higher layer used, also used handshaking or acknowledgement or flow control

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… Summary

- Synchronous data transfer with constant phase differences between bits and frames
- Asynchronous data transfer use varying phase differences between frames and when using handshaking or acknowledgement or controlled data flow
- Synchronous data packet transfer

End of Lesson 02

Data transmission