Signal Theory

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Digital signal processing/methods also known as DSP is a group of various techniques which are used to improve the accuracy of data sent over telecommunication. These methods work by clarifying the data signal. This is beneficial by when the signal is received, an example of this would be data being sent over a network the DSP acts upon that signal which removes irregularities caused by the transmission and therefore increases the accuracy of the data.

Digital Signalling Methods:
• **Bits** – Bits are the smallest unit of data used in computing, because they are so small they only have a single binary value (0 or 1). They are used to store data and follow instructions. A large amount of bits make a byte.

• **Bytes** – Bytes are a unit of used is computing, they contain several bits (8) meaning that they can have a larger value and therefore store more data. Similar to bits, they are used to store data and follow instructions.

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**Representing Data Electronically:**
• **Packet Structures** - A packet is a unit of data which is carried across a network, they are transferred in this manner because this the bandwidth of communication can be better and stronger between users when it comes to network communication. Packets have structures which contain different layers, this can be seen on the diagram. They have a header, which is the data needed to ensure that the packet of information arrives at the correct destination, the middle section is known as the payload, which is the data the user wants to transmit, and also the trailer which ensures that the data has arrived in the correct destination, and also this is there the DSP occurs to ensure that errors are removed.

<table>
<thead>
<tr>
<th>Header</th>
<th>Sender’s IP address</th>
<th>Receiver's IP address</th>
<th>Protocol</th>
<th>Packet number</th>
<th>96 bits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Payload</td>
<td>Data</td>
<td></td>
<td></td>
<td></td>
<td>896 bits</td>
</tr>
<tr>
<td>Trailer</td>
<td>Data to show end of packet</td>
<td>Error correction</td>
<td></td>
<td></td>
<td>32 bits</td>
</tr>
</tbody>
</table>
• **Synchronous Transmission** – Synchronous transmission is a method in which a sequence of data signals are sent accompanied by timing signals, this is to ensure that the transmitter and the receiver are in sync together. The data is sent in packets or frames and is used in network protocols such as Ethernet for example.

• **Asynchronous Transmission** – Asynchronous Transmission is the opposite to synchronous transmission since the data in this form of transmission is sent in spurts, also because a bit character must entered before each bit of is sent to inform the receiver when the transmission is finished. This type of transmission is used often in communications and especially in telephone lines.

**Data Transfer Methods:**
• **Error Detection** – Error detection is a technique which is used to ensure the reliability of data, errors occur because of channel noise (irregularities in the signal) which occurs during the sending of data

• **Error Correction** – Error correction occurs after the process of error detection has occurred (after the packet of data has been sent, since it is in the trailer of the structure) and reconstructs the data and therefore ensuring errorless data has been transmitted.

**Error Detection and Correction:**
• Bandwidth is a measurement of how much data can be transmitted through a single communication channel. Bandwidth is normally expressed in bits per second (bps). Modern networks now have the capability to transfer millions/billions of bits per second meaning that gigabits of information can be transferred within a single second.
• **Bandwidth Limitation** – Bandwidth limitation, also known as a bandwidth cap are put into place by internet service providers, they limit the speed of data transfer on a broadband internet connection. The more the user pays the higher for their internet service (such as fibre optic etc.) the higher the limit of data transfer therefore allowing for a faster into speed.

• **Bandwidth Noise** – Noise is a unwanted electrical energy which decreases the quality of signals during transmission, it can cause errors in all types of data, such as text and audio. The effects of bandwidth noise can be aided by the user of the error detection and correction.
• **Telephone** – Telephone communication is the transmission of speech over a distance which occurs by electric signal conductors or by the use of radio signals. They occur over the use of a radio channel, which is a bit-stream of information sent from the transmitter to the receiver.

• **Satellite** - Satellites can be used for communication, the definition of a satellite is an artificial device which orbits the earth for the purpose of communication. The advantage of communication via the use of satellites would be that they allow for a high bandwidth, are fairly cheap and also cover a large area due to their position.
• **Microwave** - Microwaves are a form of electromagnetic radiation in which the length of the waves differ in size. An advantage of the use of microwaves is that no cables are used in the transmission, multiple channels are also available and data is transmitted at a high bandwidth.

• **High Frequency (HF) Radio** – HF Radio waves is a radio frequency in which the waves are between 3-30 MHz, because this is a high frequency this therefore allows for the quick transmission of data over a network, such as mobile phones etc.
• **Data Compression** – There are two different types of data compression, one of these been lossy (file size decrease, as does the quality of the data such as an image etc.) the other been lossless (the file size decreases however the data remains the same.) Because data compression makes files smaller this often means that more data can be transferred quickly because of the size of the file.