School of Computing and Communications

SCC.130 Information Systems (2021-2022)

Home Work 2: Electronic Data Communication in Information Systems

Q1: Information systems rely on electronic data and inter-network communication between two ends of a system.

- The criteria for effective electronic communication for such systems depends on fours characteristics. Identify (not describe) these characteristics and provide different examples for each (other than the ones already presented in the lecture slides).

Example solution:

- Examples relating to:
    - **Delivery:** *Data must be delivered to the correct destination. Data must be received by the intended device or user and only by the device or user.*
        - The lecture slides provided an example of an IP packet header for IP V 4 the shows the header with fields for a source and destination IP addresses as an example.
        - examples:
            - Making a voice or a video call to a specific recipient. Here the sender will dial a *specific number* to connect to and reach the correct destination. The receiver will only receive the call if he has the correct number.
            - Transmitting a message on a specific frequency, for example transmitting a radio or TV program on a specific carrier frequency. These frequencies are "licensed" to transmit to a specific audience. Only those who have the correct type of receiver can tune in and receive this signal.
            - Infrared Tx to control a TV infrared receiver. The Tx has a code that is specific to the individual receiver.
    - **Accuracy:** *Data that has been altered in transmission and left uncorrected is unusable. This can be as a result of distortion or error introduced in the system by noise.*
        - Examples: Multipath where delayed version of the same signal are received by an antenna. This will affect the receiver's signal accuracy if the delated version is out of phase.
    - **Timeliness:** Data delivered late is rendered of no use (dropped packets or failed acknowledgements). In the case of IP packets if no acknowledgment is sent back in time the packet will be resent by the sender.
        - examples: *if an information system contains data in its database that is out of date and that has not been updated (in time due to delays in the system): train, bus and plane arrival times would become of no use. Other data in*

information system that is not updated in time for the system to gain useful information in time e.g. stock data, data required for timely decision making.
        - *It is important to emphasize that it is the electronic system that is of concern here and not the people using it.*
    - ***Jitter:*** *Refers to the variation of the packet arrival time. Uneven delay in the delivery of audio and video packets for example. This is different from delay* where all packets are delayed uniformly by a few milliseconds or seconds.
        - *Examples of jitter in this context relate to applications for audio and video packets using real time multimedia interactive applications e.g. internet telephony and video conferencing where reliability is low (we expect delays) and jitter is high (we expect the variation in the packet arrival times due to congestions in the network). For example, having some packets taking 20 msec to arrive whereas others taking 30 msec which gives uneven quality. Jitter can be fixed by enabling a router to speed up or slow down packets.*
        - *Email, file transfer and Web access are not sensitive to the packets arriving with irregular time intervals. Remote login is somewhat sensitive since characters on the screen will appear in little bursts if the connection suffers much jitter. Video and audio (as mentioned in the lecture) are very sensitive to jitter. If a user is watching a video over the network are all the frames are "delayed" by say 2 seconds no harm is done. But if the delay is uneven between packets the result will be a poor experience. For audio, a jitter, of a few msec is clearly audible.*

Q2: How many components does a communication system have? Provide an example of an Information system that "acts" as a communication system and describe the functions of each component.

Example solution:

- *There are 5 components of a communication system. message, sender, receiver, transmission medium and protocol. Examples of information systems that act as communication systems:*
    - *Web-based information systems: e-businesses, webex by CISCO, any information system that uses the 5 components: message, sender, receiver, channel and protocols.*
    - *Students need to provide detail about what each component is doing.*
    - *A message could be: voice or data.*
    - *A sender: in this context should be the device's compression, encoding and encryption mechanism, modulation and then Tx.*
    - *A receiver: in this context would need to perform the opposite task: Rx, demodulation, decryption., decoding and decompression.*
    - *Medium: this is the channel which can be wired and wireless.*
    - *Protocol: these are the networking protocols used: IP, TCP, HTTP.*
    - *Important and please note:*
        - *Some students will use examples similar to the above, but other may not have the experience and so will use non-technical examples. It is to be able to accommodate both. You may find a variety of examples from the student submissions. Please discuss with me if you need to.*

Please note: this question is not asking you to think about the 5-component model! Rather, it is asking you to think about the components of a communication system. You are encouraged here to think about an Information system that behaves as a communication system and many do! You can use the examples you have already come up with in Home work 1 as a good starting point. Please be creative and draw a block diagram if you wish.
Q3: What is the difference between analogue and digital data?

Solution:
The two definitions provided in the lectures are:

1. Analogue: continues in time and continuous level. Examples include the voltage or current output signal of a microphone (audio signal), acoustic pressure, ambient temperature and the video output signal of a television camera.
2. Digital: continues in time but discrete in level (see the slides attached e.g. slide 23) can be represented as a bit stream of highs and lows to be transmitted e.g. if a zero represents the voltage level zero or a one represents the voltage level of say 5 volts (a high). Notice that such a bit stream is produced at the transmission stage (on the line as rectangular pulses). Please note that this bit stream of 0's and 1's are already *sampled* from an analogue signal obtained from whatever its origin e.g. ASCII coded textual information or a digitized analogue signal. A well know process used to convert an analogue signal to its digital "word" equivalent is PCM -pulse coded modulation- where the analogue signal is sampled, each sample is converted to a digital work then transmitted. The example of the rectangular pulses used is implemented for the transmission of baseband communication signals such as line codes. A good example of this is the Manchester code was used for telephone signals and in early Ethernet physical layer standards. Example: https://en.wikipedia.org/wiki/Manchester_code

Q4: The transmission of voice and data relies on the use of a medium's bandwidth.
Define the term bandwidth and give relevant examples to support your definition(s).

Please note: There may be more than one definition for bandwidth.

Solution:

Bandwidth in Hertz, Bandwidth in bits per second (as a bit rate).

Bandwidth in Hertz, refers to a range of frequencies in a composite/complex signal or the range of frequencies that a channel or medium can allow (pass). A relevant example is the bandwidth of an audio signal (20 KHz), or the domestic telephone bandwidth e.g. 3-4 KHz.

Bandwidth in bits per second refers to the speed or rate of bit transmission that a channel, a link or a section of a communication system can transmit. For example Ethernet as a standard provides a bandwidth of 10 Mb/s.

Q5: Assume that we need to download text documents at the rate of 25 pages per second. What is the required bit rate of the channel? For this example, assume the following:

- 24 lines per page
- 80 characters in each line
- Each character is represented by 8 bits

Solution:
25 x 24 x 80 x 8 = 384 kbps

Q6: Relating to Q5 above, how many pages can be transmitted per second if the channel can only support a bit rate between 150-200 kbps?

Solution:

If the channel can only support a bit rate of 150 kbps as a lower bound:
Number of pages = 384 000/ 150 000 = 2,56 as a ratio. 25/2.56 = 9,76 pages.
If we are sending 9.76 pages per second, the bit rate achieve is: 9.76 x 24 x 80 x 8 = 149,913.6 kbps.
So approximately 9.8 pages will achieve a bit rate of 150,528 kbps.

If the channel can only support a bit rate of 200 kbps as an upper bound:
Number of pages = 384 000/ 200 000 = 1,92 as a ratio. 25/1.92 = 13,02 pages.
If we are sending 13.02 pages per second, the bit rate achieve is: 13.02 x 24 x 80 x 8 = 199,987.2 kbps.
So approximately 13.02 pages will achieve a bit rate of 199,987.2 kbps.

A page range from 9.8 to 13 pages per second will meet the requirements for this channel.

Q7: Alice, an environmental scientist, would like to send her data across a link that support a data rate of 100 kbps.

- How long will it take to send out 10 bits on this link?
- How long does it take to send out a single character (8 bits)?
- How long does it take to send out a file of 100 000 characters?

Solution:
10/100,000 = 0.0001s

8/100,000 = 0.00008s

(8x100,000)/100,000 = 8s