Computer Networking: Supervision 3

Daniel Chatfield

January 20, 2015

Topic 03 - Data-Link (Physical)

7. *Shared media multiplexing in local area networks*

   (a) Define the term *shared media network*

   > A shared media network is one where the bandwidth of a single medium is shared between all the nodes. Ethernet, Token ring and FDDI are examples of shared media networks.

   (b) Explain how Ethernet performs *carrier sense*, *collision detection*, how it aims to minimise the probability of collision on retransmission and how this is adapted to handle varying load.

   > The node first listens on the wire, if a transmission is already happening then it waits for it to finish (including the additional 96 bit interframe gap period). The node then transmits the frame.
   >
   > If a collision occurs (the transmission gets trampled by another node that did carrier sense at almost the exact same time) then continue transmission with a jam signal until the minimum packet time is reached to ensure that all receivers detect the collision. After this, increment the retransmission counter - if it has reached the maximum number of attempts then abort transmision otherwise wait the backoff period (a random time period that exponentially grows with subsequent collisions).

   (c) Explain why token ring does not share media at the physical level, but is still analyzed as a shared media system.

   > A token ring network consists of several unidirectional, point to point links joining the nodes in a ring. Each node therefore has its own physical link that is not shared with any other node. It is analyzed as a shared media system as for a frame to get to its destination it has

> to travel across multiple links, each of which is exclusively reserved for the token holder.

(d) What is the role of a token monitor in token ring? Why does the monitor *not* prevent failure when one of the nodes in the ring suffers a hardware failure? Suggest how a token ring system might be designed to handle failure of a computer attached to the ring.

> The token monitor ensures that tokens do not cycle around the ring endlessly. It does this by setting a monitor flag on the token as it passes and then if a token with the monitor flag set reaches it again it terminates it.
>
> To handle failure of a single node the ring could bounce tokens off of the end (treating the broken ring as a line).

(e) Explain the meaning of *destination delete* and *source delete* as used in ring-based networks.

> **destination delete** Destination delete is where the destination node for a certain frame is responsible for rleasing the token.
>
> **source delete** Source delete is where the node where a frame originated is responsible for releasing the token.

(f) Explain the difference between conventional token rings and *slotted rings*. What are the advantages of a slotted ring?

> A slotted ring is divided into fixed size slots, each with a bit which can be set to full or empty. The advantage is that higher throughput can be achieved? *Not sure about this - finding it hard to find relevant information*

8. *Multiplexing redux*

(a) Several real-time video streams are to share the same lower-layer channel.

i. Give one example of a lower-layer channel in which the flows might be scheduled, and one in which scheduling is not possible.

> **Streaming Netflix** Can use scheduling
>
> **Terrestrial TV** Uses FDMA and therefore scheduling is not possible.

ii. A lecturer remarks that “centralised multiplexing” offers potential gains in efficiency over non-centralised multiplexing. Give two reasons why this can improve efficiency. What, in general terms, is the “centralised” facility necessary for these gains to be possible?

> Without centralised multiplexing then collisions will occur leading to reduced transmission rates.
>
> With centralised multiplexing the multiplexer knows the length of all the queues and can make a decision about which packet to send next based upon various QoS objectives.
>
> Advanced multiplexers might might even perform introspection on the packets and prioritise certain packets (e.g. those belonging to a video stream/multiplayer game) over others (file downloads) which may give the illusion of a smoother running network as a user who is downloading a large file will not miss 5% of their bandwidth but a user who is streaming video at 95% of the bandwidth required for seemless playback will be very grateful for it.

iii. Using an example, describe why specifying a scheduling policy in terms of priority may cause problems, even where it is safe to use priority within the scheduling mechanism. [Hint: consider CPU scheduling in an operating system.]

> Care has to be taken to ensure that the low-priority packets still make progress, it is counter productive to leave a packet in a queue for so long that the sender has assumed it was lost and resent it.

(b) Code-division multiple access (CDMA) is a code-division multiplexing system, used for mobile telephony.

i. What is a code? What property of codes causes them to be “nearly orthogonal” to each other?

> **Truly orthogonal codes** Two codes are said to be orthogonal if when they are multiplied together, the sum over a period of time is zero. An example of an orthogonal code set is the Walsh codes.
>
> **Pseudo noise codes** Another code type for CDMA is a pseudo-random code, these can be generated very easily and are used in mobile telephony as the handset to base-station links cannot be coordinated due to the large quantity and mobility of the handsets.

> A PN code is a binary sequence that appears random but can be reproduced in a deterministic manner by intended receivers.
>
> The Pseudo-random generators produce sequences that when time shifted are nearly orthogonal (narrow ambiguity function).

ii. Two transmitters, A and B, both want to transmit a four-bit message at the same time using CDMA. Transmitter A has code 10010111 and message 1001. Transmitter B has code 00111101 and message 0011. Write down the bit sequences transmitted by A and B. Write down the bit sequence seen by a receiver, stating any assumption you make. Show that the original messages of both A and B may be recovered. [Each bit is transmitted as the exclusive OR of the code sequence with the bit value.]

```
The bit sequence from A is encoded as:
 1 -1 -1  1 -1  1  1  1
-1  1  1 -1  1 -1 -1 -1
-1  1  1 -1  1 -1 -1 -1
 1 -1 -1  1 -1  1  1  1

The bit sequence from B is encoded as:
 1  1 -1 -1 -1 -1  1 -1
 1  1 -1 -1 -1 -1  1 -1
-1 -1  1  1  1  1 -1  1
-1 -1  1  1  1  1 -1  1

The signal seen by the receiver is:
 2  0 -2  0 -2  0  2  0
 0  2  0 -2  0 -2  0 -2
-2  0  2  0  2  0 -2  0
 0 -2  0  2  0  2  0  2

The signal after combining with A's code:
 2  0  2  0  2  0  2  0
 0 -2  0 -2  0 -2  0 -2
-2  0 -2  0 -2  0 -2  0
 0  2  0  2  0  2  0  2

And then after converting into message:
1 0 0 1

The signal after combining with B's code:
-2  0 -2  0 -2  0 -2  0
 0 -2  0 -2  0 -2  0 -2
 2  0  2  0  2  0  2  0
 0  2  0  2  0  2  0  2

And then after converting into message:
0 0 1 1
```

9. *Coding, digitisation, error detection and error correction*

(a) Give, with examples, three advantages of digitising audio, and three corresponding disadvantages. (Compare with storing and processing it exclusively on analogue media and equipment.)

> Different types of audio have different characteristics, speech is typically within the range 300–3400 Hz whilst music contains many repeating waves. These properties make them ideal for digitisation as they can be heavily compresses without losing any perceivable quality. In the first case the other frequencies can be safely "chopped off" and in the second the audio can be represented using a fourier transform. This gives the advantage that less space is required to store it.

(b) Explain quantisation and sampling of analogue signals, and the distinction between these. State an upper bound for the signal-to-noise ratio of a signal quantised at b bits resolution, assuming the analogue original to be noiseless and the quantisation process completely accurate.

> *Skipped as per email*

(c) Outline encode and decode procedures for a simple (m,k) block code. Show that the minimum distance of any simple checksum code is always 2.

> *Skipped as per email*

10. *CRCs*

(a) Explain, giving an example, how to write a binary message (i.e. a sequence of binary digits) as a polynomial.

> Each bit is a coefficient of terms in increasing order of power.
>
> E.g. 010111 becomes $0x^5 + 1x^4 + 0x^3 + 1x^2 + 1x + 1$ which simplified is $x^4 + x^2 + x + 1$.

(b) Outline send and receive procedures for CRC-based message coding and error detection. What information must be agreed in advance by the sender and reciever?

> To send a message $M(x)$ of size k bits. We find the remainder:
>
> $$R(x) = x^n M(x) \, rem \, P(x)$$
>
> and send:
>
> $$T(x) = x^n M(x) \, rem \, P(x)$$

(c) Draw a shift register which will compute the remainder on division of an input polynomial by the CRC-8 polynomial $x^8 + x^2 + x^1 + 1$.