Computer Networking: Supervision 4

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12. *Digital channels, modulation and transmission*

    (a) Explain the distinctions between baud rate and bit rate and between baseband and broadband.

    > Bit rate is just that, the rate at which binary bits can be sent.
    >
    > Baud rate is the rate that symbols can be sent. In systems where a symbol simply encodes one bit then they are the same but in systems where a symbol encodes multiple bits then the baud rate will be lower than the bit rate (by a factor equal to the number of bits per symbol).
    >
    > Baseband is a type of transmission that uses all the bandwidth and therefore only a single device can transmit at a time.
    >
    > Broadband is a type of transmission that uses a modulated signal, using different frequencies to allow multiple devices to transmit concurrently.

    (b) Why is synchronisation not an issue for transmission of analogue signals?

    > Synchronisation is required when the receiver needs to know where the boundaries between data bits are. Since in an analogue signal there are no such boundaries it does not need to synchronise.

    (c) What problem in synchronous transmission is Manchester coding designed to solve? Suggest a simpler but possibly more expensive way of solving the same problem. Explain why a system which has a slow but accurate oscillator would be more suited to asynchronous transmission than to synchronous transmission using Manchester coding.

> Synchronous transmission requires the sender's clock to be synchronised with the reciever's.
>
> A simpler way of solving this problem is to use start and stop bits. The reciever resyncs their internal clock every time one is recieved and the clock will be accurate enough to not get out of sync within a frame.
>
> If it has a slow but accurate oscillator then the clock will not drift enough to cause the skew between the two clocks to prevent communication.

(d) List three properties of a sinusoidal waveform which admit modulation. Explain the relationship between modulation and shift keying.

> Phase, frequency, amplitude.
>
> Modulation is putting data onto a signal, shift keying is a type of modulation that increased or reduces one of the three properties to send data.

Topic 04 - Network

14. *Switching*

(a) Why is switching a practical necessity in large networks? In what way is switching a form of multiplexing?

> For a large network it is not feasible for every device to have a link to every other device and thus switching of some kind (whether circuit switching or packet switching) is required.
>
> Switching can be thought of as a type of multiplexing as the link between an entity and a switch is shared between all over entitys that want to communicate with it. In a circuit switched network like the phone network then access is on a first-come-first-served basis with the link reserved for the duration of the call. In a packet switched network the switch will buffer packets.

(b) The switching process consists roughly of a demultiplexing stage, a routing stage and a remultiplexing stage. For each of the following examples of switching, explain what is being demultiplexed, what routing decisions are made, and how remultiplexing is performed:

i. packet switching in the postal network;

> When the collection comes in it is demultiplexed into individual envelopes and the postcode is used to decide which mail van to put it on (routing and remultiplexing).

ii. packet switching in an Ethernet switch;

> Packets come in and are put in a queue (demultiplexed). The switch then looks at the MAC table to determine which link to send the packet down and sends it.

iii. packet switching in an IP router;

> Same as above but the router uses a routing table instead of a MAC table.

iv. circuit switching in the telephone network;

> When a telephone call is made the network establishes a circuit, using the area code to route the call.

v. wave-division switching in an optical switch.

> *not sure*

(c) Switching can improve the efficiency of a network's link utilisation, but may also cause problems. In a packet-switched network, two particular problems are increased latency and data loss.

i. For one of the packet-switched examples above, explain how latency and loss might occur.

> Every parcel to and from the same place must go through the same processing, this can cause delays to parcels.
>
> *Not sure about loss*

ii. Using the same example, suggest one way in which latency might be improved, and one way in which loss might be reduced.

> Latency could be improved by collecting from the sender for large businesses as this could reduce the amount of sorting that needs to be done.

iii. To what extent are the problems of latency and loss less significant in circuit-switched networks? Give two disadvantages of circuit-switched networks over packet-switched networks.

> Latency is bounded by number of links in route. Loss is minimal as capacity is reserved.
>
> Reacting to failure is slower and more difficult and is less efficient for bursty transmissions.

16. *General routing concerns*

(a) Following are some examples of routing strategies and real systems which use them. For each one, suggest one reason why the strategy is a good choice, and another in which it might cause problems.

i. flood routing in an Ethernet hub

> If a packet can be delivered it likely will. Since it uses every path it will also use the shortest. Flooding is very costly in terms of bandwidth as even though a message might only have a single destination it will still be sent to all hosts.

ii. random routing in a peer-to-peer file-sharing network

> It is good as clients do not need to have knowledge of the network topology but bad because of high packet loss.

iii. source routing in the road network

> Packets take predictable routes but cannot adapt to changing circumstance and client must know entire topology.

iv. hot potato routing in crowded supermarket aisles (when heading for a target grocery shelf)

> *Not entirely sure on the analogy.* One benefit is that customers will become more spread out as they seek different routes which will

ease congestion. A disadvantage is that without knowledge of all congested areas a customer may walk around and continue to find queues and thus take longer to get to there destination aisle.

(b) As well as benefits of bounded latency and assured capacity, circuit switching allows routing to be performed only once per connection, at set-up time. This contrasts with datagram-based routing, as commonly used in packet-switched networks, where routing is done for each datagram individually.

i. Outline a set of additions or modifications to TCP/IP which would allow routing decisions to be made only once per TCP connection. Identify what (if any) other benefits of circuit switching your modifications provide, and which ones they do not.

Add a circuit setup and teardown request to the protocol. A circuit setup sends a packet like normal but every node stores: the source address, the destination address, the incoming link and the outgoing link. When the circuit setup packet reaches the destination it sends an acknowledgement back (which will be routed via the same route since all the nodes will match the destination and source addresses).

The state in the routing table persists until either it timeouts or a teardown packet is sent. If the routing table is full and a setup circuit packet is sent to it then it will reject the packet.

ii. Do your modifications preserve the reliability properties of datagram-based routing? Specifically, the property in question is that end-to-end connections can be maintained across a catastrophic failure of a router or link, assuming that an alternative path through the network exists. If they do, explain why. If not, suggest how this could be achieved, or explain why your modifications expressly preclude it.

If a node on the circuit fails then the circuit will break and the network does nothing to recover from this - it is up to the sender to realise that they are not receiving acknowledgement packets and request a new circuit.

(c) You are required to design a topology discovery protocol for a network of switching nodes interconnected by links. There are n nodes, l links, the maximum degree of any node is k and there is a path between any two nodes of not more than d hops. All links are bi-directional.

Each node has a unique identifier of four bytes which it knows.

i. Outline a protocol (including message formats) for a node to learn about its immediate neighbours.

> The node sends a discover packet to its immediate neighbours with its own `NODE ID`. The neighbours then reply with a discovery reply packet with their IDs.

ii. Design a protocol (including message formats) for distributing this information across the network.

> When a node has established the identity of its neighbours it floods this to the network. It only floods the neighbours for which its own ID is greater than theirs. Since the network guarantees that no other node is more than d hops away d should be used as the TTL.

iii. Give a bound on the total amount of information which is transmitted to ensure that every node acquires complete topology information.

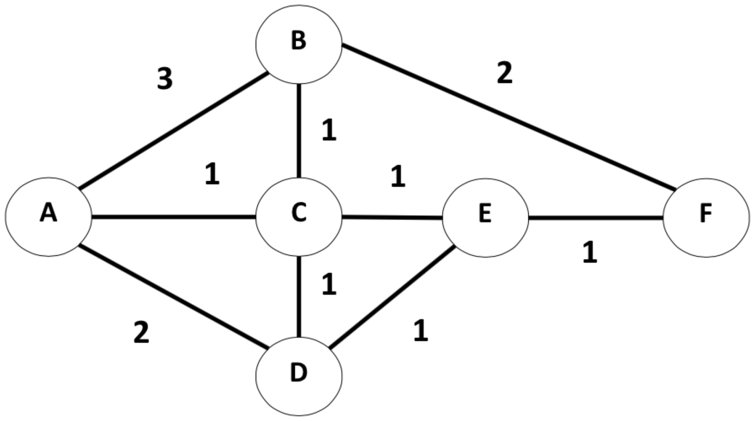
> There are l links, each link is flooded once to every other node and thus the bound on the total amount of information (assuming no retransmission is required) is $O(l * n)$.

(d) Consider a Distance-Vector Routing protocol. The routing table for node A is expresed in a format where the rows indicate the destination and the columns indicate the first hop. That is, the number in (row C column D) denotes the cost of the best currently known path to C that starts with A and sending to D. The initial table for Node A, before A has exchanged any routing information with any other node, takes the form:

Table for A	B	C	D
B	3	∞	∞
C	4	1	∞
D	∞	∞	2
E	∞	∞	∞
F	∞	∞	∞

Note that in this initial routing table, A does not know paths to any destinations except its immediate neighbours.

Figure 1: A network topology. Numbers refer to the link-cost of indicated link.



i. After A receives a route update from B (B sends its initial table), what are the entries in the routing table for A?

Table for A	B	C	D
B	3	∞	∞
C	4	1	∞
D	∞	∞	2
E	∞	∞	∞
F	5	∞	∞

ii. After A receives a route update from C (C sends its initial table), what are the entries in the routing table for A?

Table for A	B	C	D
B	3	2	∞
C	4	1	∞
D	∞	2	2
E	∞	2	∞
F	5	∞	∞

iii. Assume now that all nodes exchange tables in an iterative process until steady-state is achieved. What are the steady-state entries in the table for node A?

Table for A	B	C	D
B	3	2	4
C	4	1	3
D	5	2	2
E	5	2	3
F	5	3	4

Now consider the network of Figure 1 and a Link-State Routing algorithm.

iv. If A sends a packet to B, what path does the packet take?

It goes via C.

v. If A sends a packet to F, what path does the packet take?

It goes to C, then to E then reaches its destination.

vi. Now assume that the link cost for the links $C - E$ and $E - F$ both change to 6. E announces these changes and all nodes but C get the update (that is, C still thinks $C - E$ and $E - F$ are link-cost 1). Now A sends to F, what path does the packet take?

A sends the packet to C, C sends the packet to E. E sends the packet to F

vii. Finally, C gets the new link-weight information and now knows that $C - E$ and $E - F$ are link-cost 6. When A sends to F, what path does it take?

A sends to C whic sends to B which sends to F.

17. *Supervision discussion questions*

(a) Compare Forwarding versus Routing

(b) Compare and contrast Link-State Routing with Distance-Vector Routing. What are the (information) consistency models of each? What information is exchanged?

(c) What makes a fast LPM algorithm? (Longest-Prefix-Match)?

(d) What happens when (packet) fragment loss occurs?

(e) What is the state held by a NAT box? How does a NAT box work out its state?

(f) Why do packets tend towards the same path(route) through the network?

(g) How does ARP work?

(h) Compare DNS and ARP

(i) Why would I (or wouldn't I) want to broadcast an ARP response?

(j) How does Gateway ARP do its thing?