SOLUTION NOTES

Digital Communication II 2003 Paper 9 Question 3 (IAP)

In relation to the following headings, compare and contrast the approach taken by BISDN ATM and the Internet Protocol suite:

- signalling and connection establishment
- forwarding/switching
- congestion detection and avoidance
- Quality of Service
- segmentation of large data blocks

[4 marks each]

Signalling. IP provides a datagram service, hence there is no signalling per se required before two hosts can communicate. However, by far the most commonly used higher-level IP protocol is TCP, which uses a three way handshake to establish a connection before communication can commence. In ATM, signalling is essential before two hosts can communicate. It is necessary to fix a path for the traffic and establish whether resources are available to admit the connection, querying switches along the route. Newer additions to IP such as RSVP and MPLS add some of this functionality in a soft-state manner.

Forwarding/Switching. ATM cells contain a virtual circuit/path identifier in their header. When arriving at a switch, the VCI/VPI is looked up in a table (typically SRAM) to determine the ouput port, queue class, and the new VCI/VPI to use for the next hop. The new HEC is then calculted. In contrast IP packets arriving at a router require a longest-prefix-match lookup to determine the appropriate ouput port. The TTL must also be decremented and the checksum recalcualted.

Congestion avoidance and detection. IP requires congestion detection and avoidance to be handled in an end-to-end fashion, without any help from the network. TCP detects lost segments, assumes them to be due to congestion rather than bit errors, and reduces its transmission rate accordingly. Recently however, ECN has been added to enable congestion to be detected without actually requiring loss. ATM switches supporting ABR are more actively involved with the congestion avoidance process. They can explicitly indiciate the presence of congestion, or indicate that more resources are available. A CLP bit allows users to specify influence which cells are dropped during times of congestion. Many switches implement AAL-5 specific discard policies to avoid wasted work.

Quality of Service. ATM switches typically include multiple queues of different priorities to which cells from different VCs can be assigned. They frequently also implement traffic shapping and policing functions. Since ATM VCs are pre-signalled, there are opportunities for admission control to ensure QoS guarantees are met. IP networks traditionally just implement a best effort service. There have been attempts to implement a pre-signalled resource reservation scheme (RSVP), but this has been largely dropped in favour of a simple per-hop queueing class scheme (DIFFSERV). Some IP routers now incorporate traffic shapping and fair queuing schemes, much like ATM switches.

Segmentation. Since ATM uses small (48) byte cells, conventions must be used for segmenting larger data units for transmission. One such scheme is AAL-5, that sends the data followed by a trailer cell containing the length and a 32 bit CRC. Original ATM NICs implemented this functionality in s/w, but modern NICs have segmentation and reassembly hardware. IP links may have differing MTU sizes. Either hosts or intermediary routers may split a datagram into multiple fragements that can be reassembled by the receiver. The IP segment Id and fragment offset fields of the header are used for this purpose.