Internet Protocol Operation

Operation of a Connectionless Internetworking Scheme

IP provides a connectionless, or datagram, service between end systems. There are a number of advantages to this approach:

- A connectionless internet facility is flexible. It can deal with a variety of networks, some of which are themselves connectionless. In essence, IP requires very little from the constituent networks.
- A connectionless internet service can be made highly robust. This is basically the same argument made for a datagram network service versus a virtual circuit service.
- A connectionless internet service is best for connectionless transport protocols, because it does not impose unnecessary overhead.

Design Issues

- Routing
- Datagram lifetime
- Fragmentation and reassembly
- Error control
- Flow control

Routing

The routing table may be static or dynamic. A static table, however, could contain alternate routes if a particular router is unavailable. A dynamic table is more flexible in responding to both error and congestion conditions. In the Internet, for example, when a router goes down, all of its neighbors will send out a status report, allowing other routers and stations to update their routing tables. A similar scheme can be used to control congestion.

Routing tables may also be used to support other internetworking services, such as security and priority. For example, individual networks might be classified to handle data up to a given security classification. The routing mechanism must assure that data of a given security level are not allowed to pass through networks not cleared to handle such data. Another routing technique is source routing. The source station specifies the route by including a sequential list of routers in the datagram. This, again, could be useful for security or priority requirements.

Datagram Lifetime

If dynamic or alternate routing is used, the potential exists for a datagram to loop indefinitely through the internet. This is undesirable for two reasons. First, an endlessly circulating datagram consumes resources. Second transport protocol may depend on the existence of an upper bound on datagram lifetime. To avoid these problems, each datagram can be marked with a lifetime. Once the lifetime expires, the datagram is discarded. A simple way to implement lifetime is to use a hop count. Each time that a datagram passes through a router, the count is decremented. Alternatively,

the lifetime could be a true measure of time. This requires that the routers must somehow know how long it has been since the datagram or fragment last crossed a router, to know by how much to decrement the lifetime field. This would seem to require some global clocking mechanism.

Fragmentation and Reassembly

The Internet Protocol accepts a block of data from a higher-layer protocol, such as TCP or UDP, and may divide this block into multiple blocks of some smaller bounded size to form multiple IP packets. This process is called fragmentation.

Error Control

The internetwork facility does not guarantee successful delivery of every datagram. When a datagram is discarded by a router, the router should attempt to return some information to the source, if possible. The source Internet Protocol entity may use this information to modify its transmission strategy and may notify higher layers. To report that a specific datagram has been discarded, some means of datagram identification is needed.

Flow Control

Internet flow control allows routers and/or receiving stations to limit the rate at which they receive data. For the connectionless type of service we are describing, flow control mechanisms are limited. The best approach would seem to be to send flow control packets, requesting reduced data flow, to other routers and source stations.