

The *TYPE* field identifies the message as a request (13) or a reply (14); the *IDENTIFIER* and *SEQUENCE NUMBER* fields are used by the source to associate replies with requests. Remaining fields specify times, given in milliseconds since midnight Universal Time<sup>†</sup>. The *ORIGINATE TIMESTAMP* field is filled in by the original sender just before the packet is transmitted, the *RECEIVE TIMESTAMP* field is filled immediately upon receipt of a request, and the *TRANSMIT TIMESTAMP* field is filled immediately before the reply is transmitted.

Hosts use the three timestamp fields to compute estimates of the delay time between them and to synchronize their clocks. Because the reply includes the *ORIGINATE TIMESTAMP* field, a host can compute the total time required for a request to travel to a destination, be transformed into a reply, and return. Because the reply carries both the time at which the request entered the remote machine as well as the time at which the reply left, the host can compute the network transit time, and from that, estimate the differences in remote and local clocks.

In practice, accurate estimation of round-trip delay can be difficult and substantially restricts the utility of ICMP timestamp messages. Of course, to obtain an accurate estimate of round trip delay, one must take many measurements and average them. However, the round-trip delay between a pair of machines that connect to a large internet can vary dramatically, even over short periods of time. Furthermore, recall that because IP is a best-effort technology, datagrams can be dropped, delayed, or delivered out of order. Thus, merely taking many measurements may not guarantee consistency; sophisticated statistical analysis is needed to produce precise estimates.

## 8.15 Older ICMP Messages No Longer Needed

Originally, ICMP defined a set of messages that a host used at startup to determine its IP address, the address of a router, and the address mask used on the network. Currently, a protocol known as *DHCP* provides all the necessary information in a single exchange<sup>‡</sup>, and the older ICMP messages are no longer used.

*Information Request And Reply Messages.* ICMP's information request and reply messages (types 15 and 16) were intended to allow hosts to discover their internet address at system startup. The IETF has declared them obsolete, so they should not be used.

*Address Mask Request And Reply Messages.* ICMP's address mask request and reply messages (types 17 and 18) were intended to allow a host to obtain the address mask used on the local network. A request was broadcast, and routers on the network sent a reply.

*Router Solicitation And Advertisement Messages.* ICMP's router solicitation and router advertisement messages were intended to allow a host to discover routers currently available on a local network. Unlike DHCP, which uses a configuration file to provide the address of a router, the ICMP router discovery mechanism provides direct communication — a host receives advertisements directly from routers.

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<sup>†</sup>Universal Time was formerly called Greenwich Mean Time; it is the time of day at the prime meridian.

<sup>‡</sup>Chapter 9 explains address masks, and Chapter 22 describes how DHCP returns masks along with other information.