

to the Internet. For example, when computer 192.168.0.1 first sends a datagram to destination 198.133.219.25, NAT adds an entry to its table. Later, when it receives a reply from 198.133.219.25, NAT finds the entry in the table, and translates the destination address to 192.168.0.1.

## 23.17 Transport-Layer NAT (NAPT)

The basic version of NAT described above only handles situations in which each host at a site communicates with a unique server in the Internet. If two hosts at the site attempt to communicate with remote server, *X*, the translation table will contain multiple entries for *X*, and NAT will not be able to route incoming datagrams. Basic NAT also fails in situations when two or more applications running on a given host at a site attempt simultaneous communication with different destinations on the Internet.

The most widely used variation of NAT handles both problems: it allows a site to have arbitrary numbers of applications running on arbitrary hosts, all communicating simultaneously with arbitrary destinations throughout the Internet. Although it is technically known as *Network Address and Port Translation (NAPT)*, the mechanism is so popular that most networking professionals assume the term *NAT* means *NAPT*.

The key to understanding NAPT is to recall that applications use *protocol port numbers* to distinguish among services. In particular, Chapters 25 and 26 describe the UDP and TCP transport protocols that each use port numbers. In addition to keeping a table of source and destination addresses, NAPT uses port numbers to associate each datagram with a TCP or UDP flow. That is, instead of stopping at the IP-layer, NAPT operates on transport-layer headers. As a consequence, entries in the translation table used by NAPT contain a 4-tuple of source and destination IP addresses and protocol port numbers.

For example, consider the translation table that might result if a browser on computer 192.168.0.1 and a browser on computer 192.168.0.2 each use local port 30000, and each forms a TCP connection to a web server at port 80 through a NAPT device that uses address 128.10.24.6. To avoid a conflict, NAPT must choose an alternative TCP source port for the connections. Figure 23.13 shows one possibility.

Dir.	Fields	Old Value	New Value
out	IP SRC:TCP SRC	192.168.0.1:30000	128.10.24.6:40001
out	IP SRC:TCP SRC	192.168.0.2:30000	128.10.24.6:40002
in	IP DEST:TCP DEST	128.10.24.6:40001	192.168.0.1:30000
in	IP DEST:TCP DEST	128.10.24.6:40002	192.168.0.2:30000

**Figure 23.13** An example NAPT translation table for two TCP connections to the same web server.