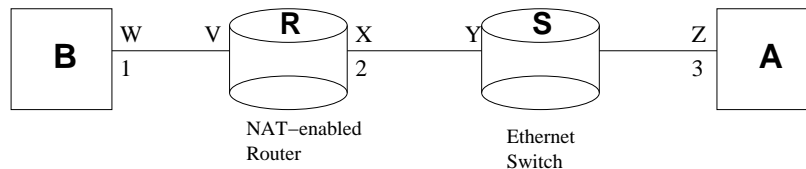


1. (CS2105 Final, April 2006) The following diagram shows a LAN with two hosts, A and B. B is behind a NAT-enabled router R and has a private IP address. The router has a public IP address, and is connected to a switch S. The following tables show the (simplified) MAC addresses and IP addresses of the interfaces/ports/adaptors of the nodes shown in the diagram.



Interface	MAC address
B to R	W
R to B	V
R to S	X
S to R	Y
A to S	Z

Interface	IP address
B to R	1
R to S	2
A to S	3

Suppose A runs a Web server. B initiates connection to A, sends an HTTP request m to A. A replies with an HTTP response m' . The following questions concern the IP datagrams and Ethernet frames that encapsulate the messages m and m' .

- (a) What is the destination IP address of the datagrams sent from B? How does B obtain this destination IP address?

Solution: 3. Use DNS.

- (b) What is the destination MAC address of the Ethernet frames sent from B? How does B obtain this destination MAC address?

Solution: V. Use ARP.

- (c) What is the destination IP address of the datagrams sent from A? How does A obtain this destination IP address?

Solution: 2. From the src IP address of datagram received.

- (d) What is the destination MAC address of the Ethernet frames sent from A? How does A obtain this destination MAC address?

Solution: X. Use ARP.

2. (KR, Chapter 5, Problem 15) Suppose two nodes, A and B, are attached to opposite ends of a 900 m cable, and that they each have one frame of 1,000 bits (including all headers and preambles) to send to each other. Both nodes attempt to transmit at time $t = 0$. Suppose there are four hubs between A and B, each inserting a 20-bit delay. Assume the transmission rate is 10 Mbps, and CSMA/CD with back-off intervals of multiples of 512 bits is used. After the first collision, A draws $K = 0$ and B draws $K = 1$ in the exponential back-off protocol. Ignore the jam signal and the 96-bit time delay.

- (a) What is the one-way propagation delay (including repeater delays) between A and B in seconds? Assume that the signal propagation speed is 2×10^8 m/sec.

Solution:

$$= \frac{900m}{2 \times 10^8 m/sec} + 4 \times \frac{20bits}{10^7 bps} = 12.5 \mu s$$

- (b) At what time (in seconds) is A's packet completely delivered at B?

Solution: At time $t = 0$, both A and B transmit. A detects collision at time $t = 12.5 \mu s$. A picks $K = 0$ and (ignoring jam signal) waits for the channel to be idle. The channel becomes idle at time $t = 25 \mu s$. This is the time last bit from B arrives at A . A retransmits at $t = 25 \mu s$ (ignoring 96-bit time delay). A finishes transmission at time $t = 125 \mu s$. Last bit from A arrives at B at time $137.5 \mu s$.

- (c) Now suppose that only A has a packet to send and that the hubs are replaced with switches. Suppose that each switch has a 20-bit processing delay in addition to a store-and-forward delay. At what time, in seconds, is A's packet delivered at B?

Solution: Each switch introduces additional 1000-bit store-and-forward delay and 20-bit processing delay. Total delay introduced is 4080-bit time or $408 \mu s$. Transmission delay is 1000-bit time or $100 \mu s$. Propagation delay is $4.5 \mu s$. A's packet reaches B at time

$$408 + 100 + 4.5 = 512.5 \mu s$$