Exploration: The Network Layer - Hardware Functions

Introduction

In this lecture we take a look inside the workhorse of the internet core: The router.

We will see how routing and forwarding are implemented functionally in routers and we will also take a detailed look at forwarding tables.

Routers are organized around two key functions: Routing and forwarding. Forwarding is the process of moving datagram data from an input port to the correct output port.

Routing determines the correct output port for forwarding. Routing algorithms produce forwarding tables. These tables map the datagram destination to an output port.

Sometimes the routing and management function is not handled in the router, but instead performed by specialized computers. The results (forwarding tables) will then be distributed to the routers and switches.

Let's follow the path of a datagram through the router. First the datagram comes over the physical media to the router input port, where it is processed. This involves error-checking, and unpacking the datagram for the Network layer. The Network layer, uses the IP address of the datagram and the router forwarding table to determine an output port. At that point, the datagram will be queued for forwarding at the switching fabric. In turn, the datagram will be forwarded to an output port, where it is again encapsulated by the lower layers and queued for transmission over the physical media.

It should be noted that there are two queuing operations involved in forwarding. If the input rate is greater than the switching rate, or the switching rate is greater than the transmission rate, then packet loss is probable.

Here is a look at a router forwarding table with the IPv4 address ranges given in binary form. We also see their mapping to an output port, that physically connects to the next hop in the datagram's path.

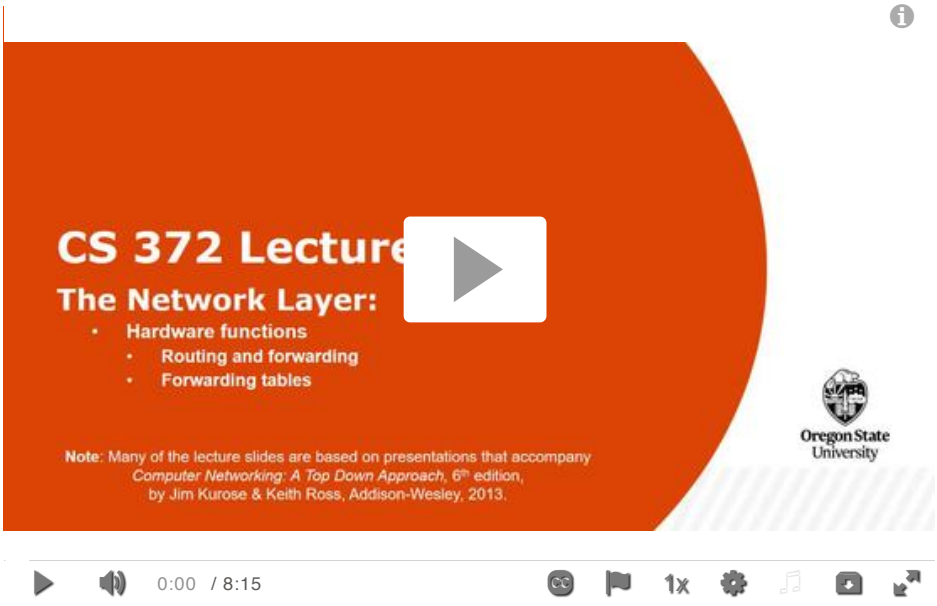
When matching the datagram's address to the forwarding table's address ranges, there can be more than one matching entry (starting at the left of the address, with the most significant digits). Where there is a more specific match, with more matching digits, that match will be preferred over others. The process of determining the most specific match for a datagram's IP address is known as "Longest Prefix Matching". Several examples are provided below:

For more on router function, including a description of several types of queuing issues, be sure to watch the video lecture, then test your knowledge with the Self-Check exercises.

Note for the lecture video below: there is reference to a buffer overflow in the video, when in reality the situation discussed is really referring to the fact that a buffer could get full and packets dropped, rather than an overflow in the sense of the common exploit where data is written beyond the boundaries of a buffer causing errors or possible exploitation.

Video Lecture

Router Hardware Functions



(PDF (https://oregonstate.instructure.com/courses/1798856/files/83165092/download?wrap=1) (https://oregonstate.instructure.com/courses/1798856/files/83165092/download?wrap=1) |PPT (https://oregonstate.instructure.com/courses/1798856/files/83165056/download?wrap=1) (https://oregonstate.instructure.com/courses/1798856/files/83165056/download?wrap=1))

Self-Check Exercises

What does a routing algorithm do? Where is the output of a routing algorithm stored?

Turn

Card 1 of 4

Given the following routing table: *Prefix Match Port:*

10001100 00011011 01011101 0

10001100 00011011 01011101 000 1

10001100 00011011 01011101 01 2

10001100 00011011 01011110 00100 3 Default 4

Use longest prefix matching to determine which output port is used for each IP address

Drag the words into the correct boxes

a. 140.27.93.25
b. 140.27.94.39
c. 140.27.95.32
d. 140.27.93.98
e. 140.27.93.156

Port#0 Port#4 Port#2 Port#1 Port#3

Reuse <> Embed

Resources

More on routers, including history and use:

- **Wikipedia Router (computing)** (https://en.wikipedia.org/wiki/Router_(computing))
  "Router (Computing)." In Wikipedia, February 27, 2020. https://en.wikipedia.org/w/index.php?title=Router_(computing)&oldid=942952433.