CS 456
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Chapter 4.2 What's Inside a Router

4.2.1 Overview of Router Architecture

- A high-level view of a generic router architecture can be found on **slide 4-11**.
- The center of the router contains a **high-seed switching fabric**. It is connected bidirectionally to a **routing processor**. The switching fabric is also connected to a number of **router input ports** and **router output ports** unidirectionally.
- The routing processor is in the *control plane* while the switching fabric and the I/O ports are in the *forwarding plane*.

4.2.2 Input Port Functions

- The input port contains mechanism for three functions. They are lined up sequentially.
- The **line termination** is first. It receives bits. It is in the *physical layer*.
- The **link layer protocol** is up next. It is in the *data link layer*.
- Finally is the lookup, forwarding, and queueing. Its goal is to complete input port processing at *"line speed"*. If datagrams arrive faster than the forwarding rate into the switch fabric, the datagrams will be placed into a queue.
- After acquiring the output port from the header, one of two forwarding methods is used:
  - **Destination-based forwarding**: Forward based only on the destination IP address. This is the traditionally-used method.
  - **Generalize forwarding**: Forward based on any set of header field values.
- A chart showing destination-based forwarding is shown on **slide 4-14**.
- **Longest prefix matching** is used when looking for a destination address. That is, use the *longest* address prefix that matches the destination address. An example can be seen on **slide 4-15**.
- Longest prefix matching is often done using *ternary content addressable memories (TCAMs)*.

4.2.3 Switching Fabrics

- The **switching fabric** transfers packets from the input buffer to an appropriate output buffer.
- **Switching rate** refers to the rate at which packets can be transferred from inputs to outputs. It is often measured as a multiple of I/O line rate. For N inputs, a switching rate of N times line rate is desirable.
- A visual of different switching fabrics can be seen on **slide 4-17**.
- If the fabric is slower than the input ports combined, then queueing may occur at the input queues, which may result in loss due to buffer overflow.

4.2.4 Output Ports

- The output port uses the same three functions as the input port (also sequentially), but in reverse order.
- Buffering will happen if datagrams arrive from the fabric faster than the transmission rate, which could, once again, cause packet loss.
- **Scheduling discipline** chooses among the queued datagrams the best one to use for transmission.
- The *RFC 3439 rule of thumb* is that the average buffering is equal to "typical" RTT times link capacity C. With N flows, the buffering is equal to $\frac{RTT \cdot C}{\sqrt{N}}$.

4.2.5 Scheduling Mechanisms

- **Scheduling** chooses the next packet to send on link.
- **FIFO scheduling** sends packets in order of arrival to the queue.
- **Priority scheduling** sends the queued packet with the highest priority. Priority can be determined by the class of the packet, which depends on marking and other header info (such as *IP source/destination, port numbers, etc...*).