**Processing Delay**: Time to examine packet's header, determine where to direct the packet, check for bit-level errors in the packet, etc.

**Queuing Delay**: Packet waits to be transmitted onto link. Depends on number of earlier packets. Queuing delay is 0 if queue empty. be zero. Queuing delay long if traffic heavy.

**Transmission Delay**: Length of the packet = $L$ bits, transmission rate of the link from router A to router B = $R$ bits/sec, Transmission delay is $\frac{L}{R}$.

**Propagation Delay**: Time for bit to propagate from start of link to other router. Depends on medium of link.

**Traffic Intensity**: Average rate packets arrive at queue = $\alpha$ packets/sec. Transmission rate (bits pushed out of queue) is $R$ bits/sec. All packets consist of $L$ bits. Average rate bits arrive at queue is $L\alpha$ bits/sec. Assume queue can hold infinite bits, $\frac{L\alpha}{R}$ is traffic intensity.

**End-to-End Delay**:
$d_{end-end} = N(d_{proc} + d_{trans} + d_{prop})$, $d_{trans} = \frac{L}{R}$ where $L$ is packet size.

**Internet Protocol Stack**

**Application Layer**: Support data exchange. FTP, SMTP, HTTP.

**Transport Layer**: Handle delivery reliability, multiplex within host. TCP, UDP.

**Network Layer**: Forward packets from source to destination. IP, routing protocols.

**Link Layer**: Transfer data between directly connected network elements. Ethernet protocol.

**Physical Layer**: Bits "on the wire".