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 = α 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".

IPv4 a.b.c.d/x: **#bits**: x, **#endpoint addr**: 2^{32-x}, **net addr**: a.b.c.d, **net mask**: leading x 1s the rest 0s, **broadcast addr**: (addr | (∼mask))

Routing Table: Match prefix to outgoing link. Exists on every host and router. **Longest Prefix Matching**: Longest net addr prefix with net mask. Routing table next-hop.