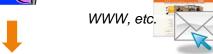# Networking Technologies at-a-Glance

## Application
*WWW, etc.*

**Provides the high-level services to the user**
- Built on a collection of functions and protocols that allow programs to access an internal environment
- Provides access to key functions like DNS, email, WWW

**Key Elements:**
- Application Program Interfaces (APIs) allow programs to access internal environment
- Protocols: Telnet, FTP, SMTP, SNMP, DNS, many, many, many more...

## Transport
*TCP, UDP, etc.*

**Delivers End-to-End reliable byte stream**
- Provides services that establish, use and release connections
- Handles all the service primitives, manage connections/timers, allocates credits.

**Key Elements:**
- Forms packets, adds headers with source/destination info
- Protocols: TCP, UDP (connectionless), RDP
- TCP version varies by Operating System

## Network /Internet
*Routers, etc.*

**Moving Packets to the Destination**
- Datagrams (connectionless) and Virtual Ckts (connection oriented) routing
- Congestion and quality of service features

**Key Elements:**
- Routing Algorithms – decide what links to send packets on
- Protocols – IP, ICMP, ARP, RARP, OSPF, BGP

## Link /DataLink Incl. MAC SubLayer
*Ethernet, etc.*

**Make the channel "appear" reliable to Network**
- Framing – Adds control bits/bytes; Introduces problem of telling data from flags
- Error Control – Hamming, CRC, Checksum, etc.
- Flow Control (MAC) – Manage multiple users

**Key Elements:**
- Nyquist Limit (noiseless): $2H \log_2 V$ bits/sec
- Shannon's Limit: $H \log_2 (1+SNR)$ bits/sec
- Hamming : $2d+1$ (correct) and $d+1$ (detect)
- Protocols: PPP, Ethernet, SONET

## Physical
*Modems, etc.*

**Getting Bits on the channel**
- The physical layer transmits raw bits over a communication channel (copper, fiber, wireless, etc.)
- Bits are converted to signals - voltages or flashes of light
- Maximize precious bandwidth/spectrum through modulation and multiplexing techniques

**Key Elements:**

**Modulation-** Converting bits to symbols & signals for transmission:
- Change the phase, frequency, amplitude using NRZ, AMI, Manchester, QAM, etc.

**Multiplexing –** Maximize channel capacity using: Frequency (FDM), Time (TDM), Wavelength (WDM), Code (CDM), etc..Remember the crowded airport lounge?

**Channel: Copper, COAX, Fiber, Wireless Spectrum, Satellite**