Networking Quick Reference

1 second = 1,000 milliseconds (msec)
1 second = 1,000,000 microseconds (μsec)
1 second = 1,000,000,000 nanoseconds (nsec)

1 bps = 1 bit per second
1 Kbps = 1,000 bits per second
1 Mbps = 1,000,000 bits per second

1 Hz = 1 cycle per second
1 KHz = 1,000 Hz
1 MHz = 1,000,000 HZ

Speed of light (c)
in vacuum: 3×10^8 meters/sec
in copper wire: 2.3×10^8 meters/sec
in optical fiber: 2×10^8 meters/sec

Well-known Ports
7 – echo
20 – FTP data connection
21 – FTP connection-control
23 – telnet
25 – SMTP
53 – DNS
79 – finger
80 – HTTP daemon
110 – POP3
143 – IMAP

Well Known Ports range: 0 - 1023
Registered Ports range: 1024 - 49151
Dynamic and/or Private Ports range: 49152 - 65535

IEEE Network Standards
802.3 – Uses Length field instead of Type
Ethernet – (DIX Ethernet or Ethernet II) uses Type field instead of Length
802.5 – Token Ring
802.11 – Wireless
802.11a – Uses OFDM
802.11b – Uses HR-DSS
802.11g – Enhanced 802.11b using OFDM
802.15 – Bluetooth (physical and data link layers)
802.16 – Wireless MAN

OSI Reference Model
Application
Presentation
Session
Transport (segments, datagrams)
Network (packets)
Data link (frames)
Physical

Networking Equations

- Propagation delay = distance traveled / propagation speed
- Transmission delay = # of bytes to transfer / transmission speed (or bandwidth)

- Signal-to-noise ratio (dB) $= 10 \log_{10} (S/N)$
- Attenuation in decibels $= 10 \log_{10}$ (Transmitted power/received power)
- Nyquist Theorem : Maximum data rate $= 2 H \log_2 V$ bits/sec where H is in Hz and V is # of levels
- Shannon's Result : Maximum number of bits/sec $= H \log_2 (1+S/N)$ where H is in Hz
- **Pure ALOHA** throughput $T = Ge^{-2G}$ Max throughput occurs at G = 0.5

  T = throughput per frame time e = 2.718
  G = attempts per packet time

  Throughput in bits per sec = T x transmission speed

  Vulnerable period = 2 x frame transmission time
- **Slotted ALOHA** throughput $T=Ge^{-G}$ Max throughput occurs at G = 1
- **TCP round-trip time**

  $RTT = \alpha RTT_{OLD} + M(1 - \alpha)$ RTT_{OLD} = previously observed round-trip time
  α = smoothing factor
  M = observed round-trip time (actual time to receive an ACK)

  $D = \beta D_{OLD} + (1 - \beta) \cdot |RTT - M|$ D_{OLD} = previously observed standard deviation
  β = smoothing factor (may be α)

  TCP Timeout = RTT + 4D
- **Ethernet / IEEE 802.3** (p. 280)

  Channel efficiency = t / (t + 2G/A)

  t = ave time to transmit a frame
  G = end-to-end propagation time (time for frame to traverse entire Ethernet network)
  2G = duration of each time slot
  A = probability that some station acquires channel in a particular contention slot
  $= kP(1 - P)^{k-1}$
  k = # of stations ready to transmit
  P = probability that each station transmits during a contention slot

  Channel efficiency = 1/(1 + 2BLe/cF)

  B = network bandwidth c = signal propagation speed
  L = cable length F = frame length
  e = contention slots per frame (2.718)

  Maximum throughput = channel efficiency x transmission speed

  Minimum frame length = 2 x propagation delay x transmission speed (data rate)
  * 802.3 minimum frame length = 64 bytes

ARQ Protocol	Channel Utilization	Window Size W_s (Sender)	Window Size W_R (Receiver)
Stop-and-Wait		1	1
Go-Back-N	Maximum channel utilization with no errors:   if $W_s >$ 	$2^m - 1$	1
	 if $W_s <$ 		
Selective-Repeat	 if $W_s >$ 	2^{m-1}	2^{m-1}
	 if $W_s <$ 		

Maximum throughput (data rate) = channel utilization x transmission speed

f = frame size
BW = channel transmission rate (bandwidth)
RTT = round trip propagation delay
ct = bandwidth-delay product
a = round trip propagation delay / transmission delay = *BW* x *RTT* / 2*f* = number of frames to fill the channel one way
P = probability of transmission error
m = # of bits in sequence #