Networking Cheat Sheet

Key Variables

```
R: Bandwidth in bps (bits per second)
L: Packet size in bits
d: Distance in meters
s: Propagation speed (≈ 2 × 10^8 m/s, unless specified)
k: Number of active users
n: Total number of users
p: Probability a user is active (e.g., 0.1 if active 10% of the time)
rB: Required bandwidth
tB: Total bandwidth
```

Fundamental Formulas

```
Transmission Delay (d_trans): d_trans = L / R
Propagation Delay (d_prop): d_prop = d / s
Bit Time: T_bit = 1 / R
Bit Width (spatial length of one bit): W_bit = s / R
Total Transmission Time: T_total = (L / R) + (d / s)
```

Probability & Users

```
Binomial Probability: P(k) = (n choose k) * p^k * (1-p)^(n-k)
Expected Active Users: E[k] = n * p
Variance of Active Users: Var(k) = n * p * (1-p)
```

Bandwidth Allocation

```
Required Bandwidth (per user): rB ≈ R (depends on context)
Total Bandwidth: tB = n * rB
Statistical Multiplexing (average required): rB_avg = n * p * rB
```

Extra Useful Formulas

```
Utilization (U): U = (d_trans) / (d_trans + d_prop)
Throughput: min(R, Window Size / RTT)
Delay-Bandwidth Product: D * R (measures 'in-flight' data)
RTT (Round Trip Time): RTT = 2 * d / s
Efficiency (Stop-and-Wait): U = 1 / (1 + 2 * d_prop / d_trans)
```