# PERFORMANCE METRICS

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# ATTRIBUTION


- These slides incorporate material from:
  - Alex C. Snoeren, UC San Diego
  - Computer Networking: A Top Down Approach

# PERFORMANCE METRICS


- Bandwidth: number of bits transmitted per unit of time
- Latency = Propagation + Transmit + Queue
  - Propagation = Distance/SpeedOfLight(*)
  - Transmit = 1 bit/Bandwidth
  - Queue = Time waiting in switches/routers behind other traffic (traffic jam)
- Overhead
  - # secs for CPU to put message on wire
- Error rate
  - Probability P that message will not arrive intact

* In that particular medium

# BANDWIDTH VS. LATENCY

## 1 Byte Object

| | Latency: 1 ms | Latency: 100 ms |
|---|---|---|
| Bandwidth: 1 Mbps | 1,008 µs | 100,008 µs |
| Bandwidth: 100 Mbps | 1,000 µs | 100,000 µs |

## 10 MB Object

| | Latency: 1 ms | Latency: 100 ms |
|---|---|---|
| Bandwidth: 1 Mbps | 80.001 s | 80.1 s |
| Bandwidth: 100 Mbps | .801 s | .9 s |

# NETWORK PERFORMANCE MEASUREMENT UNITS

| Exp. | Explicit | Prefix | Exp. | Explicit | Prefix |
|---|---|---|---|---|---|
| $10^{-3}$ | 0.001 | milli | $10^{3}$ | 1,000 | Kilo |
| $10^{-6}$ | 0.000001 | micro | $10^{6}$ | 1,000,000 | Mega |
| $10^{-9}$ | 0.000000001 | nano | $10^{9}$ | 1,000,000,000 | Giga |
| $10^{-12}$ | 0.000000000001 | pico | $10^{12}$ | 1,000,000,000,000 | Tera |
| $10^{-15}$ | 0.000000000000001 | femto | $10^{15}$ | 1,000,000,000,000,000 | Peta |
| $10^{-18}$ | 0.000000000000000001 | atto | $10^{18}$ | 1,000,000,000,000,000,000 | Exa |
| $10^{-21}$ | 0.000000000000000000001 | zepto | $10^{21}$ | 1,000,000,000,000,000,000,000 | Zetta |
| $10^{-24}$ | 0.000000000000000000000001 | yocto | $10^{24}$ | 1,000,000,000,000,000,000,000,000 | Yotta |

# TERMINOLOGY STYLE

- Mega versus Mega, Kilo versus Kilo
  - Computer architecture: Mega → 2^20, Kilo → 2^10
  - Computer networks: Mega → 10^6, Kilo → 10^3
- Mbps versus MBps
  - Networks: typically megabits per second
  - Architecture: typically megabytes per second
- Bandwidth versus throughput
  - Bandwidth: available over link
  - Throughput: available to application
    - E.g. subtract protocol headers, etc.

# PERFORMANCE TOOLS

- Ping
  - Test if other side is “alive”
  - Measures round-trip latency
- Netperf/iperf3
  - Times how long it takes to send N bytes to the other endpoint
  - Used to calculcate bandwidth

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