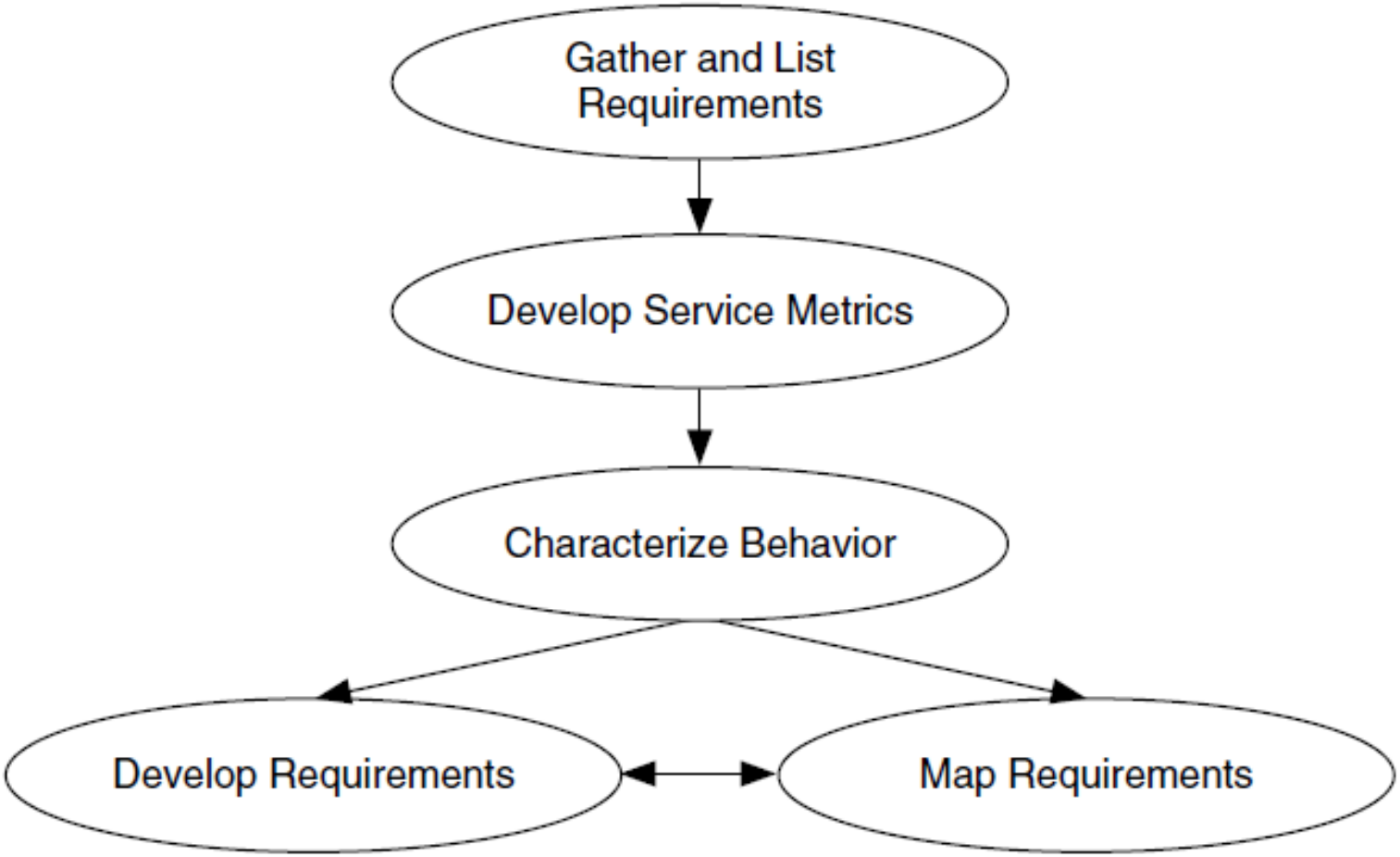
NETWORK

DESIGN & ANALYSIS

03 REQUIREMENT ANALYSIS

Contents

Req. Analysis Processes



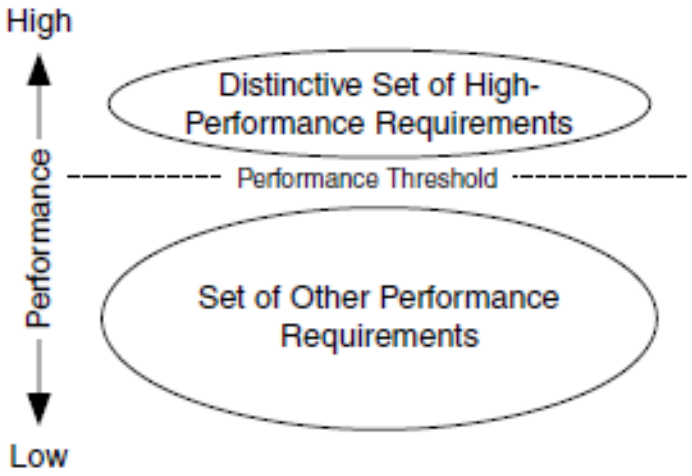
3.1 Gathering & Listing

Initial Conditions

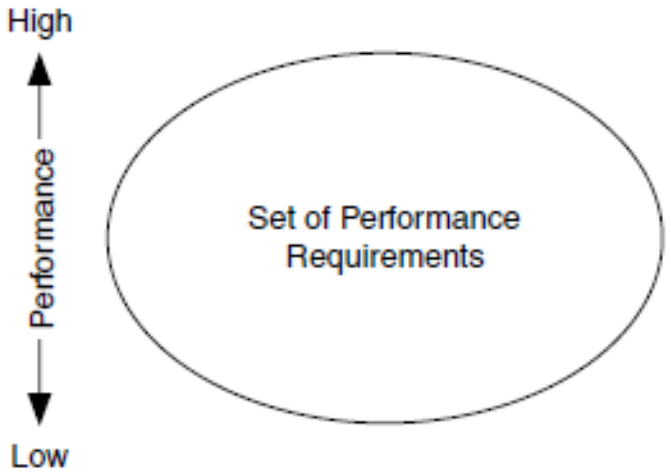
- *Initial conditions* consist of the type of network project, the scope of the architecture and design, initial architecture/design goals.
- It will influence the network architecture and design, and will often act as constraints.
- Part of the initial conditions of new network project may be determining its performance target: multi-tier performance or single-tier performance

3.1 Gathering & Listing

Multi-Tier Performance Network: Where one or a few applications, users/groups, and/or devices whose performance requirements are significantly greater than other performance requirements for that network



Single-Tier Performance Network: No distinctive set of applications, users, or hosts that have significantly greater performance requirements for that network.



3.1 Gathering & Listing

Customer Expectations

- It is important to begin to set customer expectations. This consists of:
  - a rapid, initial evaluation of the problem, and
  - estimating resources and schedule

- The intent is to inform customers, early in the process, when their expectations are unrealistic.

3.1 Gathering & Listing

Working with User

- There are some successful techniques that can be used:
  - developing a survey to email, FAX, or mail to users
  - following up on the survey with one-on-one telephone calls or conference calls
  - following up calls with face-to-face meetings with selected individuals or groups
  - whiteboard sessions to elicit ideas from users
  - spending time with users while they work

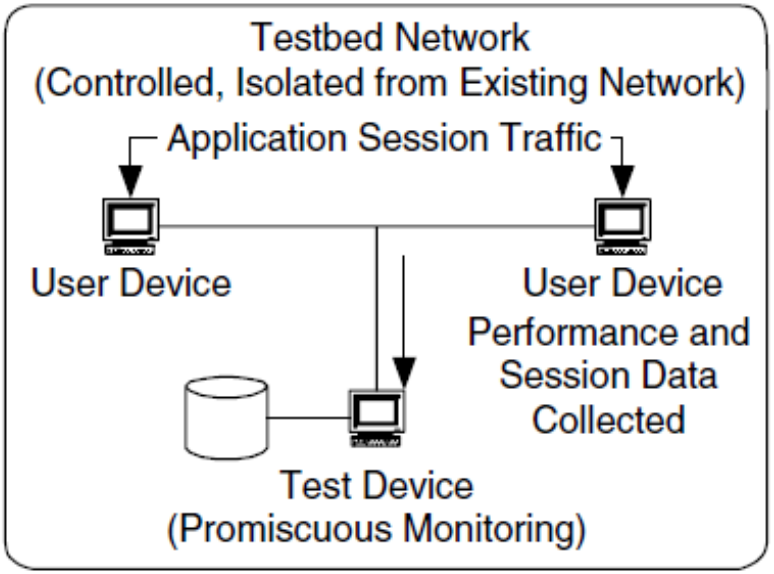
3.1 Gathering & Listing

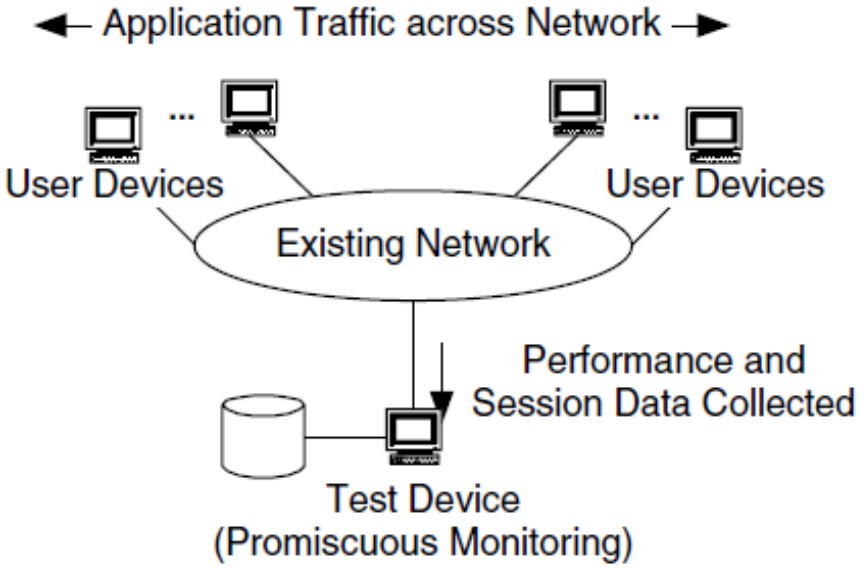
Performance Measurement

- It is helpful to measure performance levels of applications and devices that will be used in the planned network.

- Either by testing applications and devices on a separate, controlled network (e.g., testbed network) or by measuring their performance levels on the existing network.

3.1 Gathering & Listing





3.2 Service Metrics

- Next step is to analyze the requirements using performance thresholds and limits and performance characteristics.
- Performance thresholds and limits and performance characteristics are measured in the system with service metrics.
- Service metrics are either actual measurable quantities in the network or are derived from measured quantities.

3.2 Service Metrics

- Service metrics for RMA include:
  - Reliability, in terms of mean time between failures (MTBF) and mean time between mission-critical failures (MTBCF)
  - Maintainability, in terms of mean time to repair (MTTR)
  - Availability, in terms of MTBF, MTBCF, MTTR
  - Optionally, uptime and downtime (as a percent of total time)

3.2 Service Metrics

- Service metrics for capacity include:
  - Data rates, in terms of peak data rate (PDR), sustained data rate (SDR), and minimum data rate (MDR)
  - Data sizes, including burst sizes and durations

3.2 Service Metrics

- Service metrics for delay include:
  - End-to-end or round-trip delay
  - Latency
  - Delay variation
- As configurable and measurable quantities in the network, service metrics can be described in terms of variables in network devices.

3.2 Service Metrics

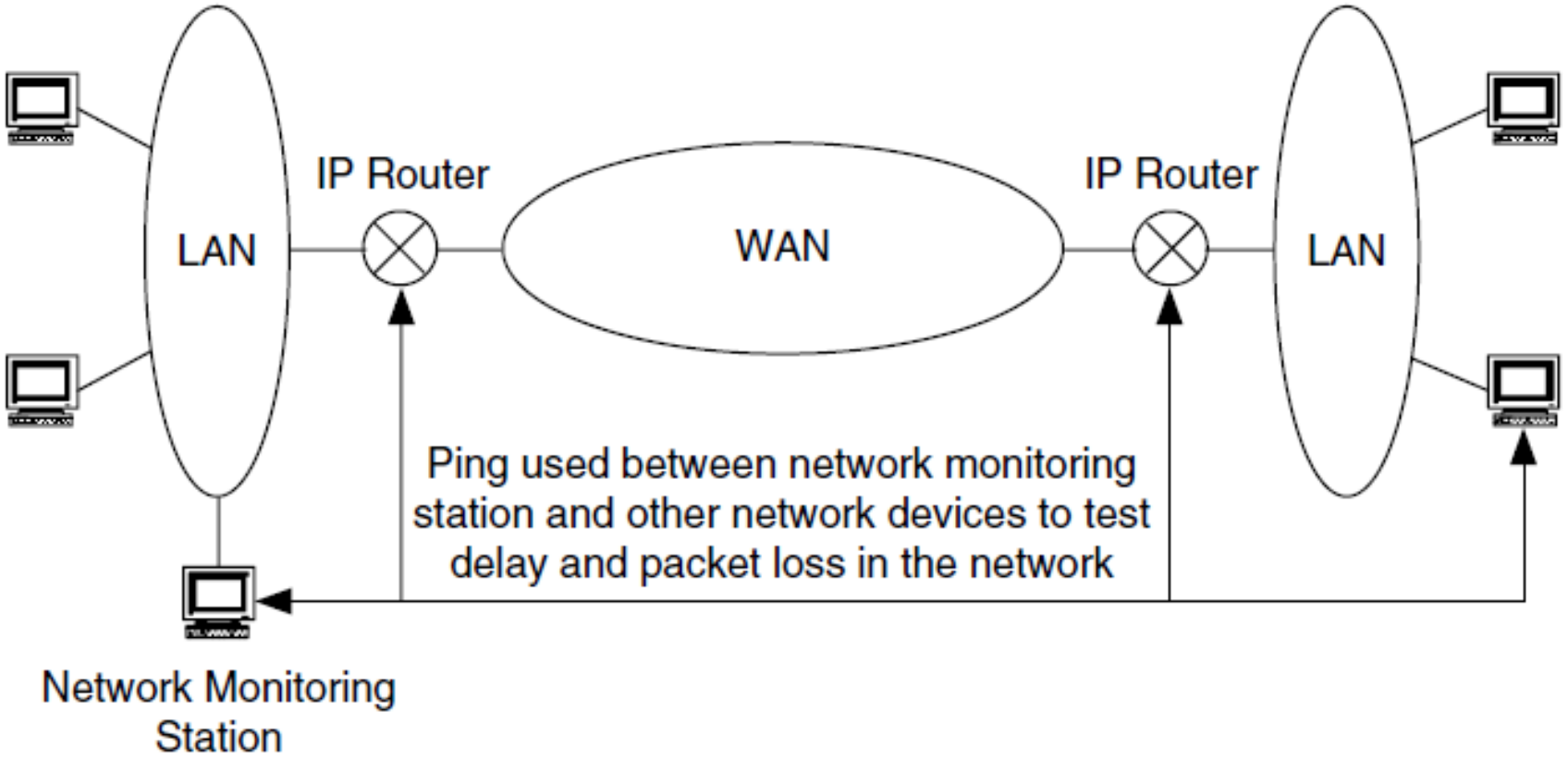
- Examples of variables used as service metrics include:
  - Bytes in/out (per interface)
  - IP packets in/out (per interface)
  - Dropped Internet control message protocol (ICMP) messages/unit time (per interface)
  - Service-level agreement (SLA) metrics (per user)

3.2 Service Metrics

3.2.1 Measurement Tools

- One such tool is the utility *ping*, which roughly measures round-trip delays between selected sources and destinations in the network.
- Another tool is *pathchar,* which combines round-trip delay and per-link capacity measurements with path traces, as does another popular utility *traceroute*.
- Another popular tool to analyze TCP traffic is *TCPdump*

3.2 Service Metrics



3.2 Service Metrics

Service Metric		Where Metric Will be Measured in System	Measurement Method
1	LAN Delay	Between NM Device and Each Router in LAN	Ping
2	Wan Delay 1	Between NM Device and Local Router Interface to WAN	Ping
3	WAN Delay 2	Between NM Device and Remote Router Interface to WAN	Ping
4	LAN Packet Loss	At Each Local Router	SNMP

3.3 Characterizing Behavior

- *Characterizing behavior* means representing how users and applications use the network.
- The types of behavior that we examine include:
  - User behavior
  - Application behavior
  - Network behavior

3.3 Characterizing Behavior

3.3.1 Modeling & Simulation

- To predicts, determines, or estimates requirements and data flows, behavior can be modeled or simulated.

- One clear benefit from having such models is that, once developed, they can be used again and again to help tune the system for optimal performance.

3.3 Characterizing Behavior

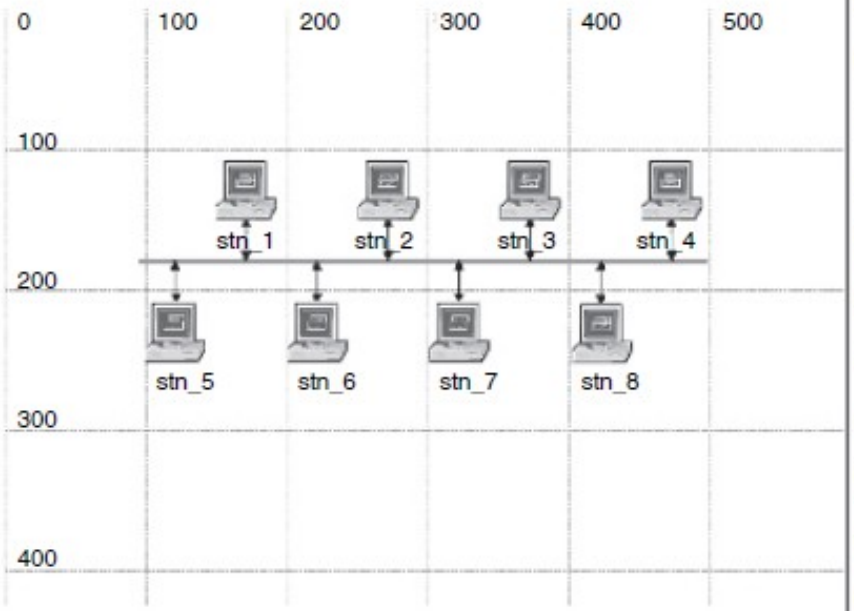
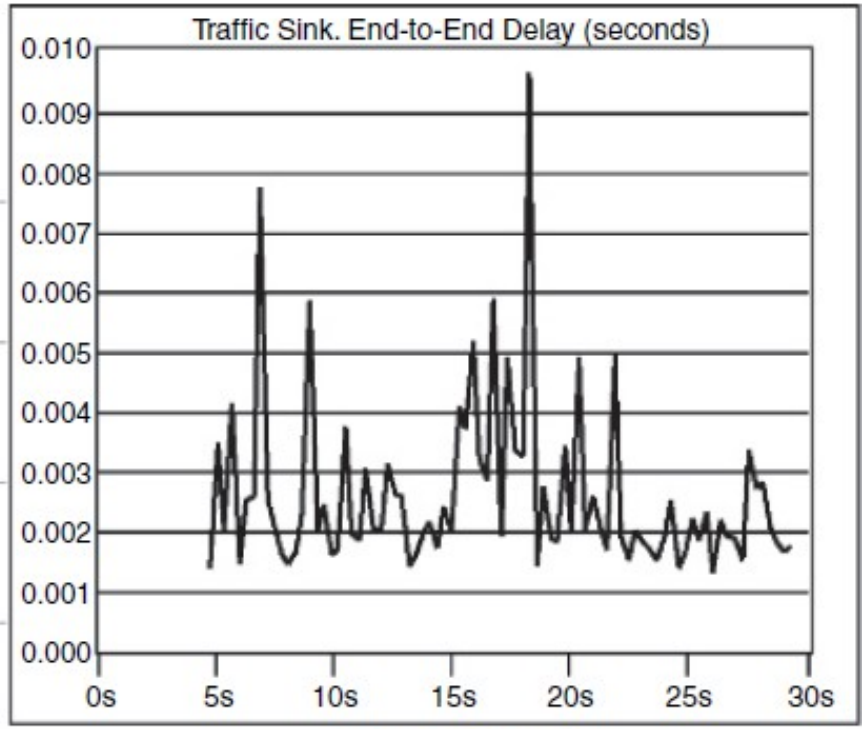
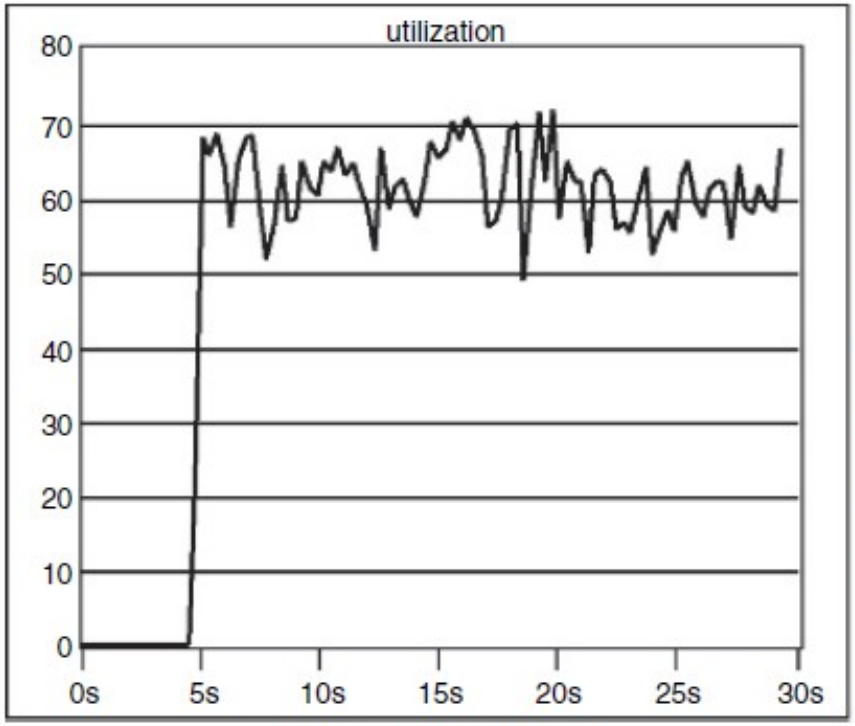


Diagram of Network

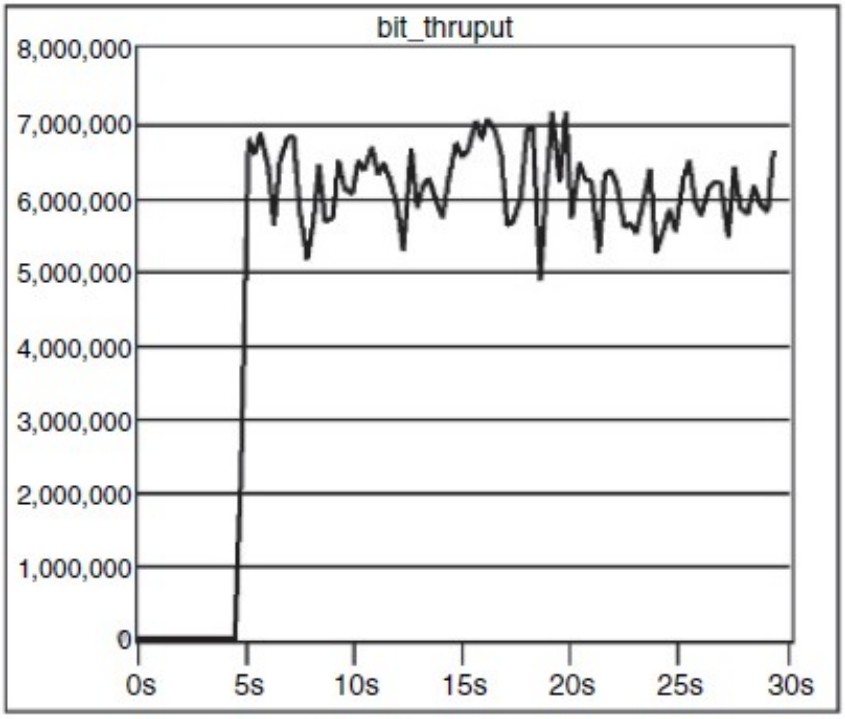


Delay Performance

3.3 Characterizing Behavior



Utilization Performance

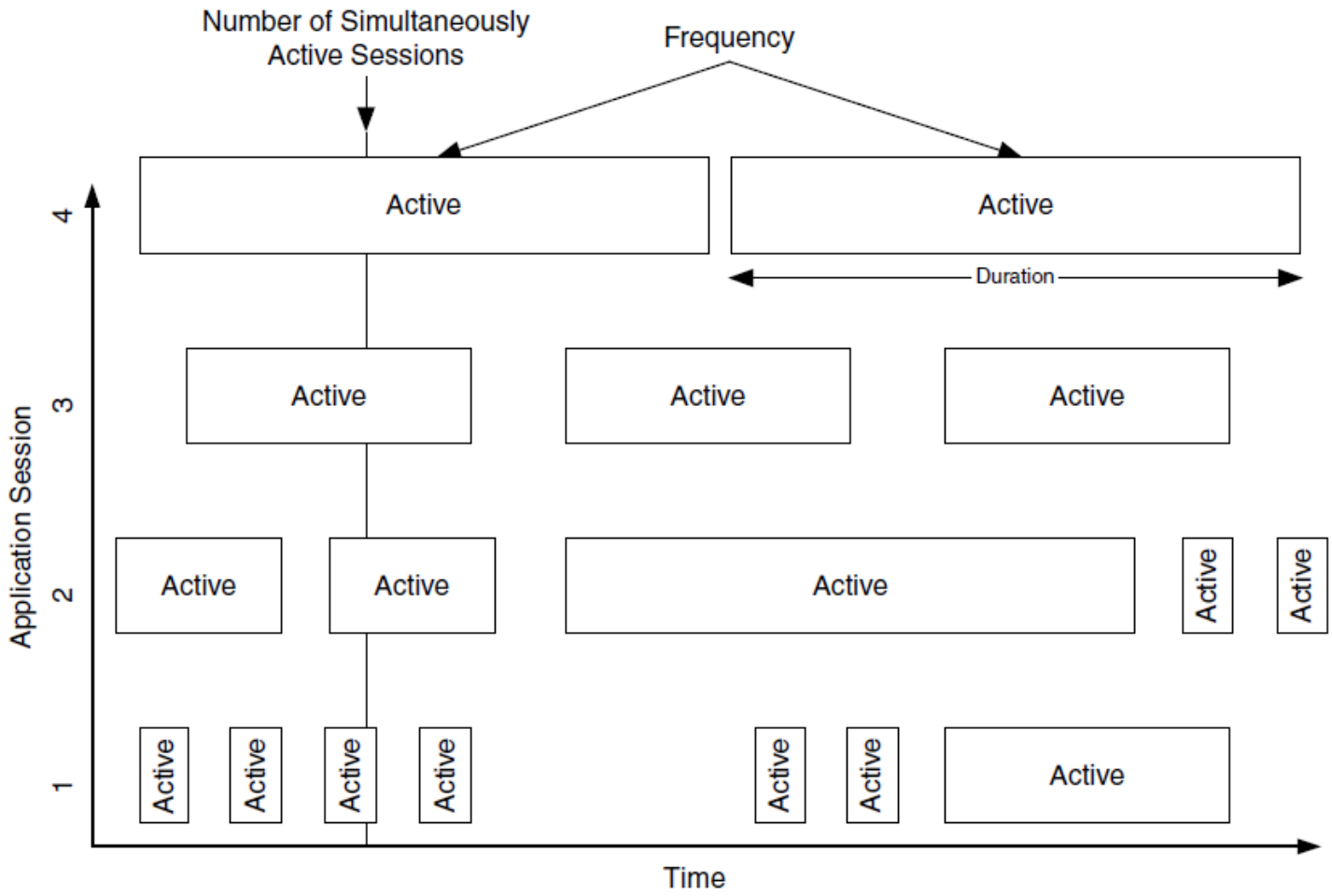


Capacity Performance (Throughput)

3.3 Characterizing Behavior

- 3.3.2 User Behavior
  - Simple usage patterns can include user work times and durations;
  - Figure below shows the characteristics of how a user uses an application.
  - This is an example of a simple, first-order approximation of user and application behavior.

3.3 Characterizing Behavior



3.3 Characterizing Behavior

3.3.3 Application Behavior

- Application behavior can be used to modify performance requirements.
- Characterizing application means to consider:
  - the data sizes that the application will be processing and passing across the network;
  - the frequency and time duration for data to be passed across the network;
  - any traffic flow characteristics such as flow directions (e.g., from client to server);

3.4 RMA Requirements

3.4.1 Reliability

- Reliability is a statistical indicator of the frequency of failure of the network and its components and represents the unscheduled outages of service.
- One measure of reliability is mean time between mission-critical failure (MTBCF), usually expressed in hours.

3.4 RMA Requirements

- A related measure is the mean time between failure (MTBF), which considers all failures, regardless of their significance at the time of failure, and is a conservative approximation, useful in simple systems.
- MTBF is computed as the inverse of the failure rate, which is estimated through testing or analysis in terms of failures per hours of operation.

3.4 RMA Requirements

3.4.2 Maintainability

- Maintainability is a statistical measure of the time to restore the system to fully operational status, once it has experienced a fault.
- This is generally expressed as mean time to repair (MTTR).

3.4 RMA Requirements

3.4.3 Availability

– Availability (also known as operational availability) is the relationship between the frequency of mission-critical failure and the time to restore service.

$$A = \frac{MTBCF}{MTBCF + MTTR} = \frac{MTBF}{MTBF + MTTR}$$

3.4 RMA Requirements

- Analyzing a network's availability gives us the ability to schedule preventive maintenance and replace.
- Other measures of availability include
  - uptime,
  - downtime,
  - error, and
  - loss rates.

3.4 RMA Requirements

Uptime and Downtime

- A common measure of availability is expressed in terms of percent of uptime or downtime.
- For example, a request for proposal (RFP) from a potential customer may state a required uptime of 99.999% (commonly known as “five nines”).

3.4 RMA Requirements

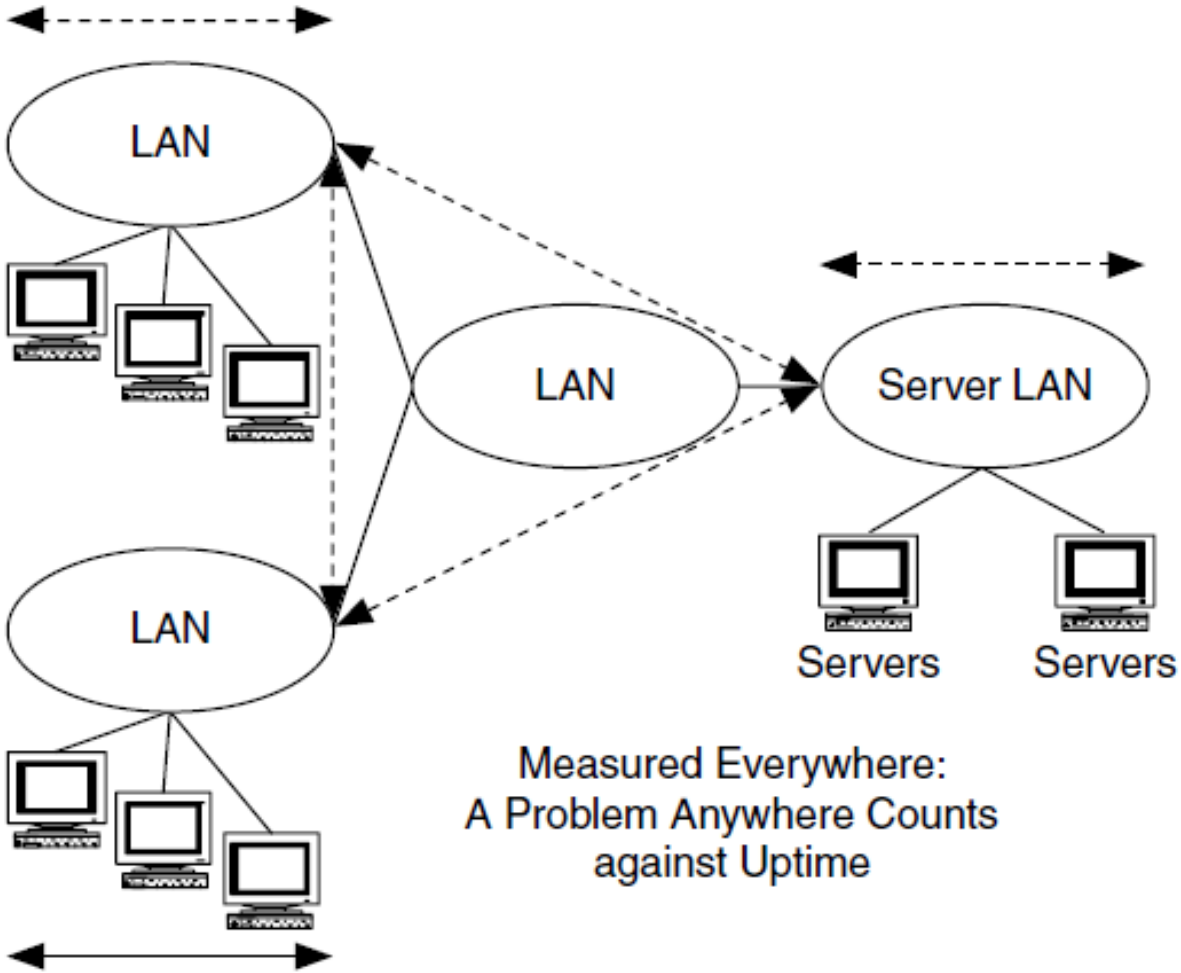
% Uptime	Amount of Allowed Downtime in Hours (h), Minutes (m), or Seconds (s) per Time Period			
	Yearly	Monthly	Weekly	Daily
99%	87.6 h	7.3 h	1.68 h	14.4 m
99.9%	8.76 h	44 m	10 m	1.4 m
99.99%	53 m	4.4 m	1 m	8.6 s
99.999%	5.3 m	26.3 s	6 s	0.86 s

3.4 RMA Requirements

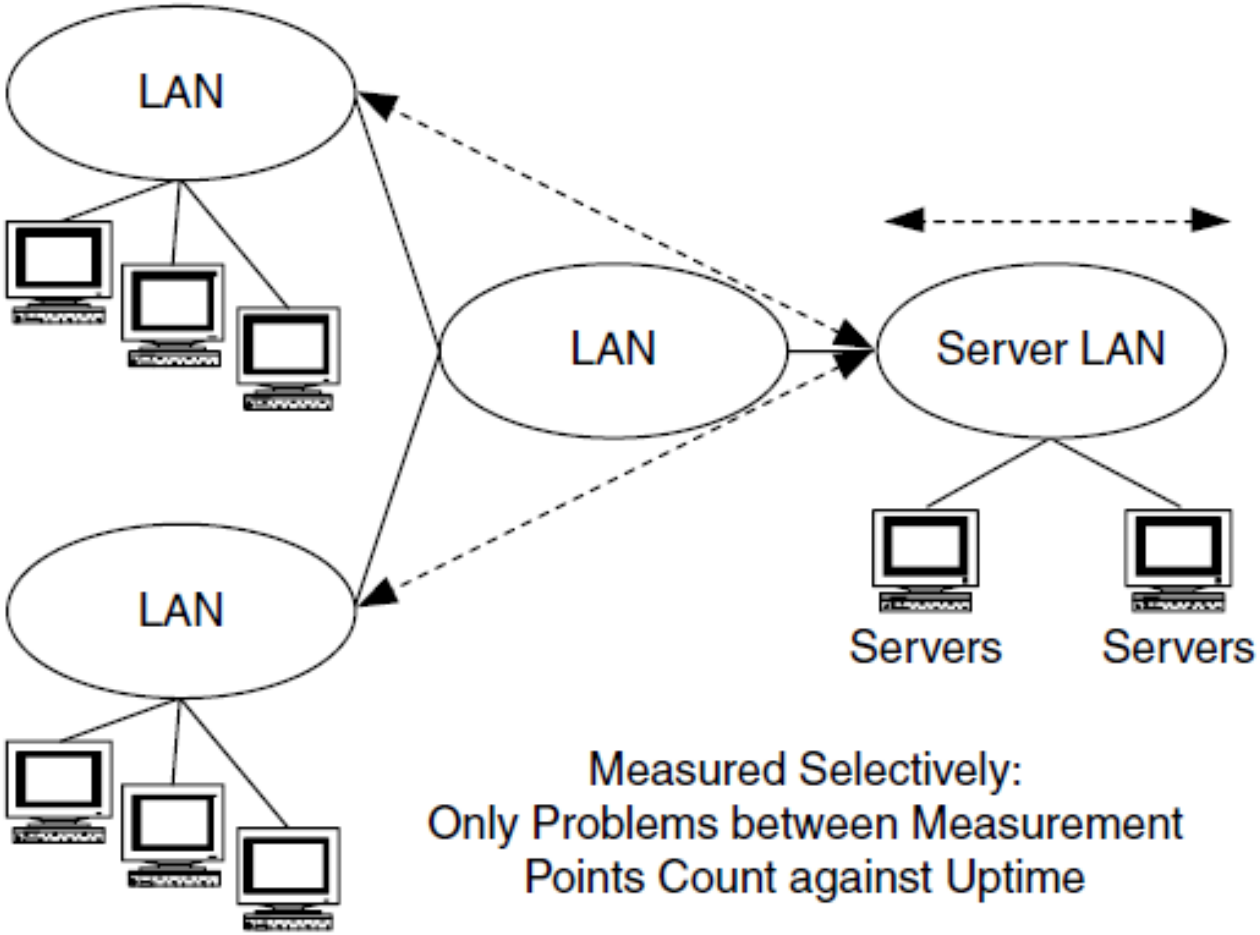
- It can be measured anywhere in the network or measured selectively in certain place of the network.

- Often, uptime is measured end-to-end, either between user devices (generic computing devices) or between network devices (routers, switches, or network security/monitoring stations).

3.4 RMA Requirements



3.4 RMA Requirements

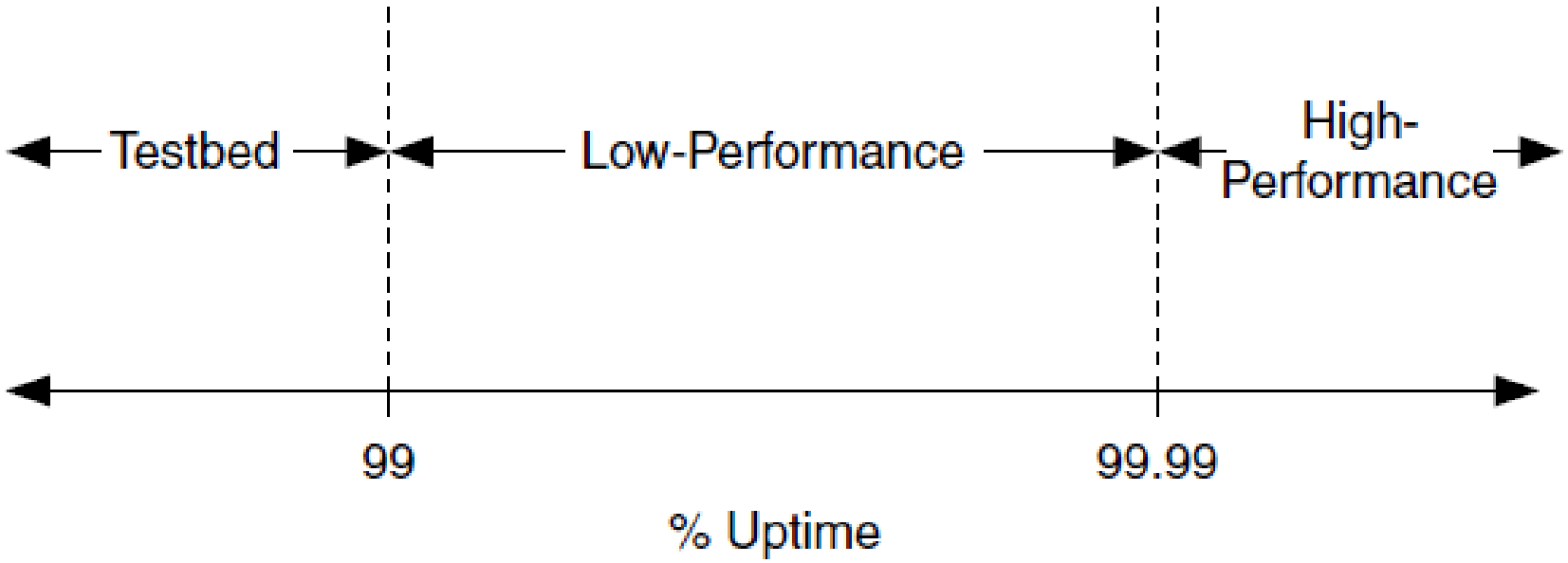


3.4 RMA Requirements

3.4.4 Thresholds & Limits

- RMA requirements may include descriptions of thresholds and/or limits.
- An example of a general threshold for RMA is for uptime.
- In general, requirements for uptime that are greater than or equal to 99.99% are considered to be high performance, those that are less than 99.99% are low performance.

3.4 RMA Requirements



3.5 Delay Requirements

- For applications that have delay requirements, we use the terms
  - *end-to-end delay,*
  - *round-trip delay*, and
  - *delay variation*

  as measures of delay in the network.

3.5 Delay Requirements

- Begin by introducing some useful general thresholds and limits for delay: interaction delay, human response time, and network propagation delay.

- These thresholds and limits are helpful in distinguishing low- and high-performance delay requirements for your network.

3.5 Delay Requirements

- *Interaction delay* (INTD) is an estimate of how long a user is willing to wait for a response from the system during an interactive session.
- The interaction delay depends on
  - user behavior,
  - the user's environment, and
  - the types of applications

3.5 Delay Requirements

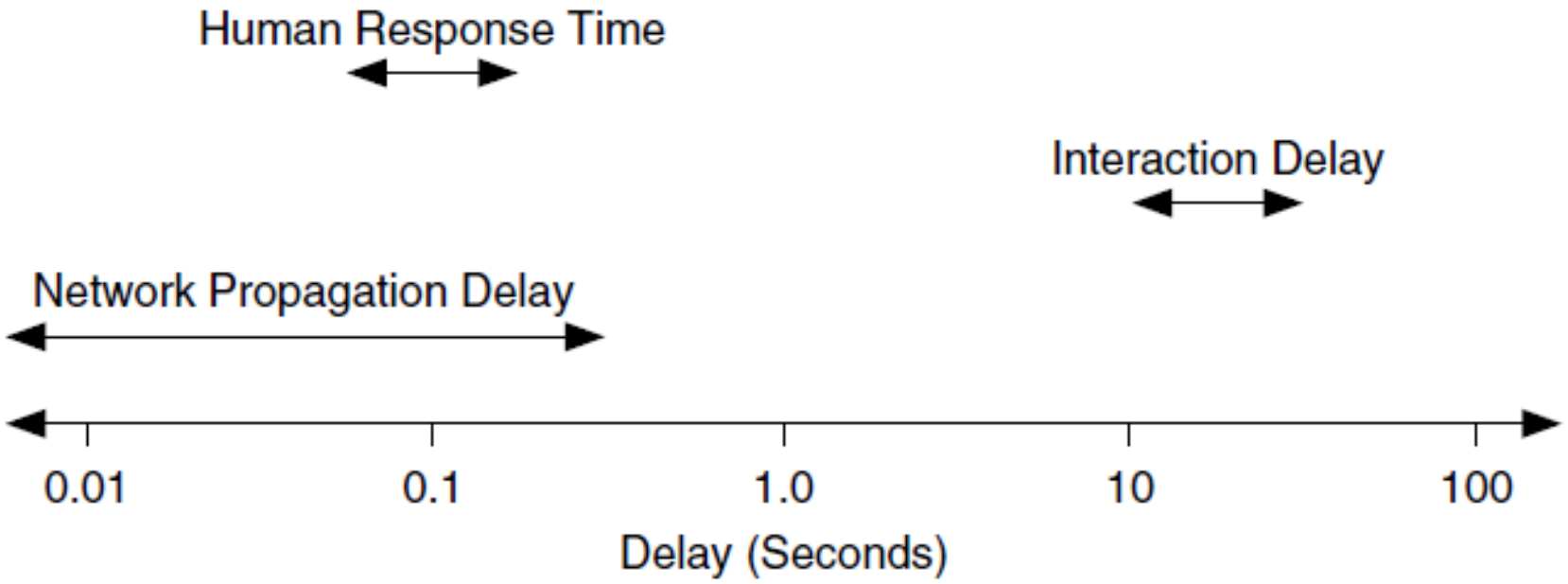
- *Human response time* (HRT) is an estimate of the time threshold at which users begin to perceive delay in the system.

- A good estimate of HRT, based on experience and observation, is approximately 100 ms.

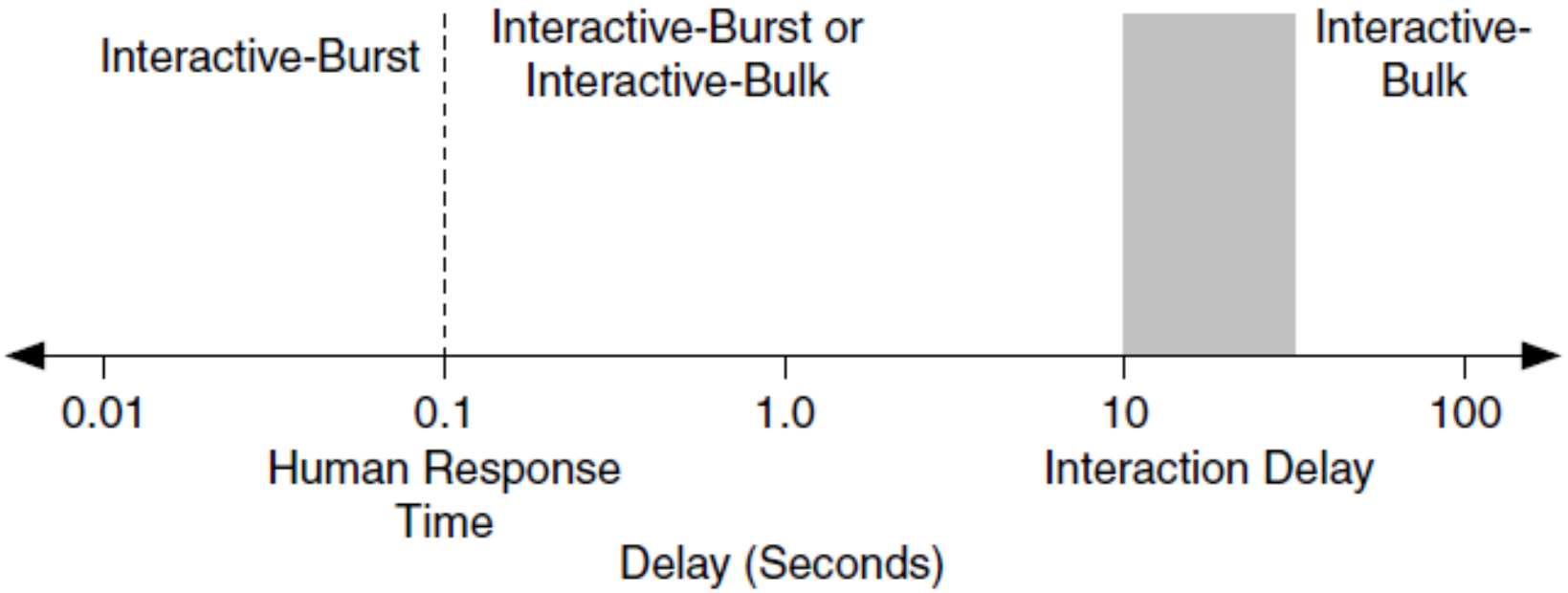
3.5 Delay Requirements

- *Network propagation delay* is an estimate of how long it takes for a signal to cross a physical medium or link.
- This provides a lower limit to the end-to-end and round-trip network and system delays.
- Propagation delay is dependent on distance and technology.

3.5 Delay Requirements



3.5 Delay Requirements



3.5 Delay Requirements

3.5.1 End-to-End & Round Trip Delay

- End-to-end and round-trip delays are composed of many sources of delay, including
  - propagation,
  - queuing,
  - transmission,
  - I/O,
  - switching, and
  - processing.

3.5 Delay Requirements

- Delay variation is often coupled with end-to-end or round-trip delay to give an overall delay performance requirement for applications that are sensitive to the inter-arrival time of information.

3.6 Capacity Requirements

- Estimating a data (or maybe more accurately, information) rate is based on transmission characteristics (e.g., traffic flow).
- Commonly used data rates include:
  - peak data rate (PDR),
  - sustained data rate (SDR),
  - minimum data rate (MDR), or
  - combinations of them.

3.6 Capacity Requirements

Application	Average Completion Time (Seconds)	Average Data Size (Bytes)
Distributed Computing (Batch Mode)	10^3	10^7
Web Transactions	10	10^4
Database Entries/Queries	2–5	10^3
Payroll Entries	10	10^2
Teleconference	10^3	10^5

3.6 Capacity Requirements

- 50 Kb/Iteration
- 40 Iterations/Second
- 6 ms Processing Time/ Iteration