CHAPTER 5

# CHARACTERIZING THE NETWORK TRAFFIC

**Expected Outcomes**

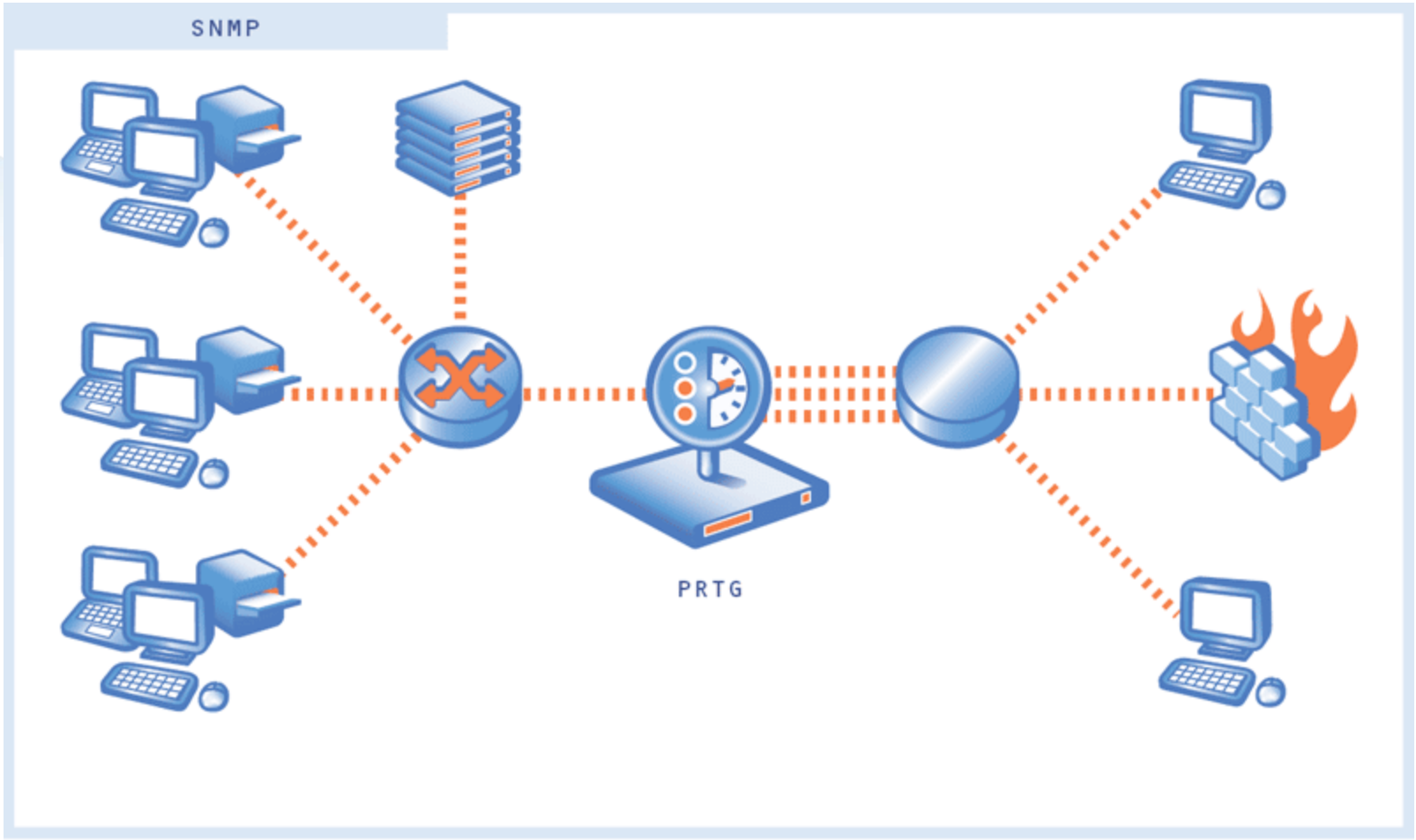
Able to analyse the network traffic

Able to use specific tools to monitor the network performance

# What is Network Traffic?

- “data in a network”
- In computer networks, the data is encapsulated in packets.

# ../What is Network Traffic?




The **Simple Network Management Protocol (SNMP)** is the basic method of **gathering bandwidth and network usage data.** It can be used to monitor bandwidth usage of routers and switches port-by-port as well as device readings like memory, CPU load etc.

# Chapter Outline

- Traffic flow
- Location of traffic sources and data stores
- Traffic load
- Traffic behavior
- Quality of Service (QoS) requirements

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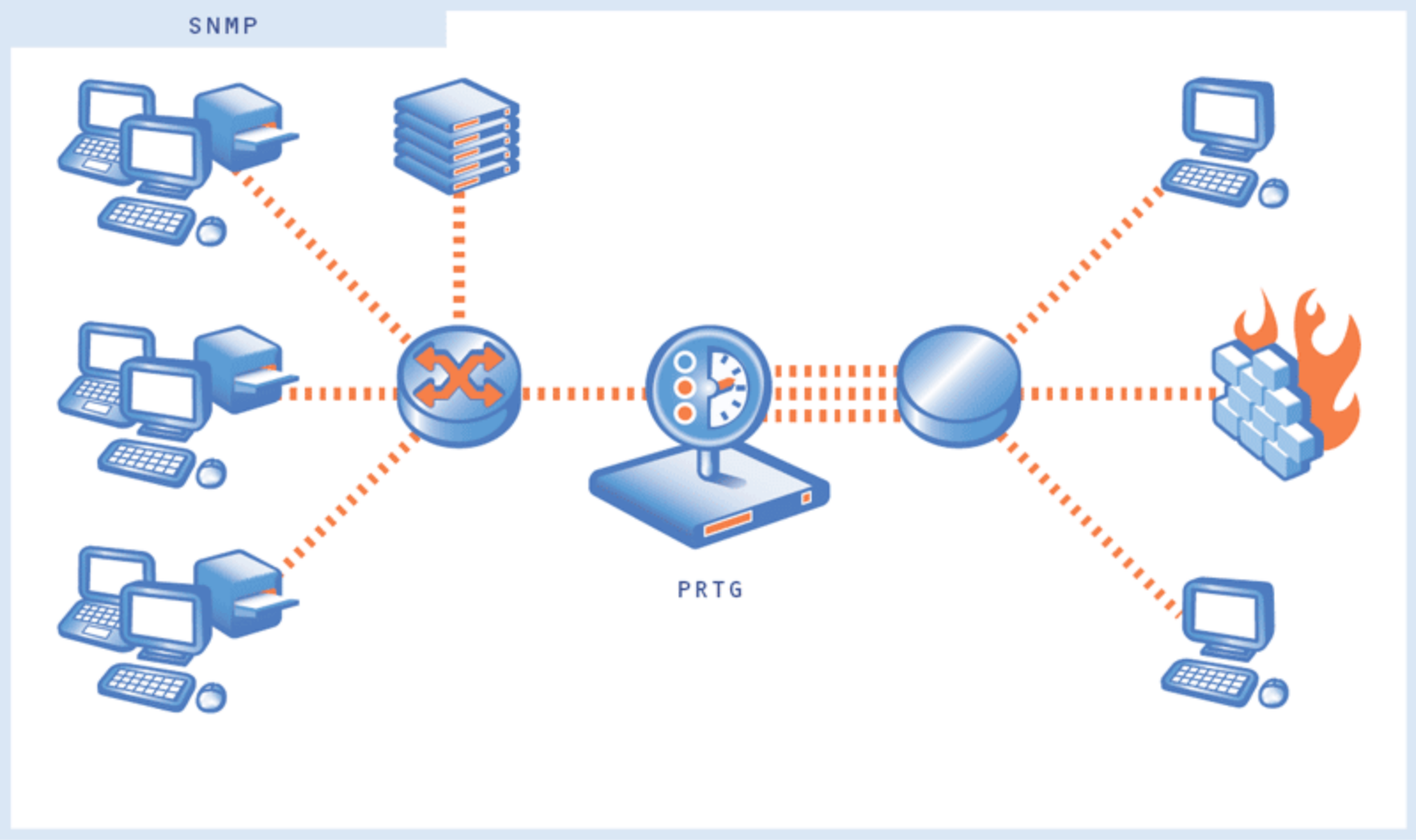


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# Characterizing Traffic Flow

How to characterize the direction and symmetry of traffic flow on an existing network and analyzing flow for new applications.

1. Identifying Major Traffic Sources and Stores
   - first identify user communities (table 4-1) and data stores (table 4-2) for existing and new applications.
2. Documenting Traffic Flow on the Existing Network
   - Identifying and characterizing individual traffic flows (table 4-3) between sources and stores -> important in measuring traffic flow behavior
3. Characterizing Types of Traffic Flow for New Network Application
   - Characterized by its direction and symmetry.
   - To classify applications as supporting one of a few well known flow types eg. terminal/host traffic flow, client/server, peer-to-peer, etc.
4. Documenting Traffic Flow for New and Existing Network Application
   - Use table 4-4 to document traffic flow for new (and existing) network applications

# User Communities

| User Community Name | Size of Community (Number of Users) | Location(s) of Community | Application(s) Used by Community |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

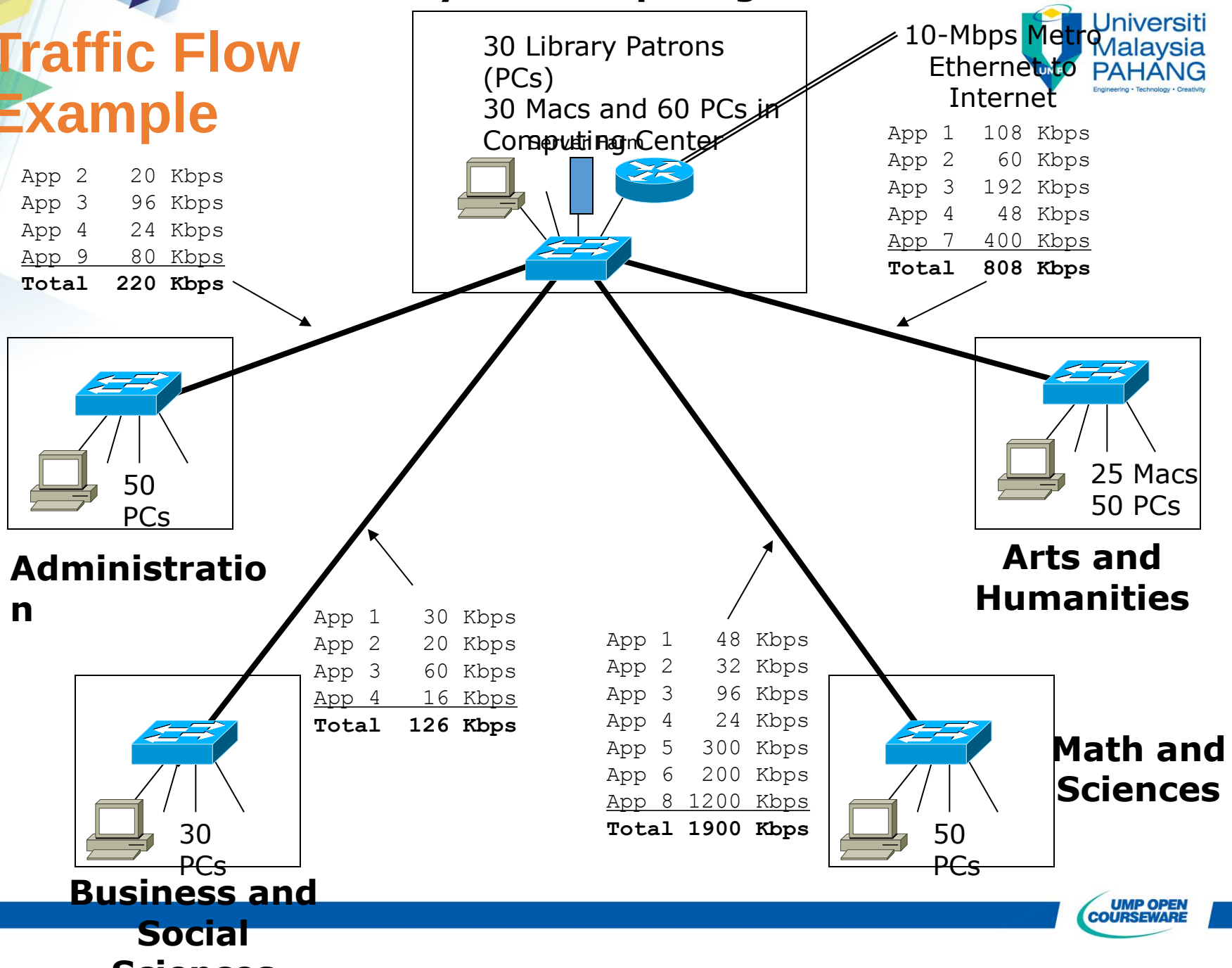
# Data Stores

| Data Store | Location | Application(s) | Used by User Community(or Communities) |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

# Traffic Flow

| Destination MB/sec | Destination 1 MB/sec | Destination 2 MB/sec | Destination3 MB/sec | |
|---|---|---|---|---|
| Source 1 | | | | |
| Source 2 | | | | |
| Source 3 | | | | |
| Source *n* | | | | |

# Traffic Flow Example



# Network Applications Traffic Characteristics

| Name of Application | Type of Traffic Flow | Protocol(s) Used by Application | User Communities That Use the Application | Data Stores (Servers, Hosts, and so on) | Approximate Bandwidth Requirements | QoS Requirements |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

# Types of Traffic Flow

- Terminal/host
- Client/server
- Thin client
- Peer-to-peer
- Server/server
- Distributed computing

# Traffic Flow for Voice over IP

- The flow associated with transmitting the audio voice is separate from the flows associated with call setup and teardown.
  - The flow for transmitting the digital voice is essentially peer-to-peer.
  - Call setup and teardown is a client/server flow
    - A phone needs to talk to a server or phone switch that understands phone numbers, IP addresses, capabilities negotiation, and so on.

# Characterizing Traffic Load

Purpose:

- To avoid a design with any critical bottleneck.

To avoid bottleneck:

- Research for application usage patterns, idle times between packets and sessions, frame sizes, and other traffic behavioral patterns for application and system approach.
- Give large amounts of bandwidth at a problem.
  - LAN bandwidth is extremely cheap, Gigabit Ethernet also most organizations can afford.

# Characterizing Traffic Load cont…

1. Calculating Theoretical Traffic Load

- To calculate whether capacity is sufficient, you should know:
  - The number of stations
  - The average time that a station is idle between sending frames
  - The time required to transmit a message once medium access is gained

2. Documenting Application-Usage Patterns

- Few data obtained during characterizing traffic flow -> user communities, number of users in communities, and the applications that users employ.
- Additional information required:
  - The frequency of application sessions (number of session per day, week, month, or whatever time period is appropriate.
  - The length of an average application session
  - The number of simultaneous users of an application.

# Characterizing Traffic Load cont…

3. Refining Estimates of Traffic Load Caused by Applications

- Need to research the size of data objects sent by applications, the overhead caused by protocol layers, and any additional load caused by application initialization.
- Table 4-5 shows some estimates for object sizes

4. Estimating Traffic Load Caused by Routing Protocols

- At this point of designing process, you might not have selected routing protocols for new network but you should have identified routing protocols running on the existing network.
- Use table 4-7 as guidance that shows the amount of legacy distance-vector routing protocols.

# Size of Objects on Networks

- Table 4-5 : Approximate Size of Objects that applications Transfer across networks

| Type of Objects | Size (Kbytes) |
|---|---|
| Terminal screen | 4 |
| Simple e-mail | 10 |
| Simple web page | 50 |
| Spreadsheet | 100 |
| Word processing document | 200 |
| High-quality image | 50,000 |
| Database backup | 1,000,000 |

# Bandwidth used by Legacy Routing Protocols

Table 4-7: Bandwidth used by Legacy Routing Protocols

| Routing Protocol | Default Update Timer (sec) | Route Entry Size (Bytes) | Routes per packet | Network & Update Overhead (Bytes) | Size of full packet |
|---|---|---|---|---|---|
| IP RIP | 30 | 20 | 25 | 32 | 532 |
| IP IGRP | 90 | 14 | 104 | 32 | 1488 |
| AppleTalk RTMP | 10 | 6 | 97 | 17 | 599 |
| IPX RIP | 60 | 8 | 50 | 32 | 432 |

# Characterizing Traffic Behavior

1. Broadcast/Multicast Behavior

- Broadcasts
  - Broadcast frame = frame that goes to all network stations on a LAN
  - All 1s in binary data-link layer destination address
    - FF: FF: FF: FF: FF: FF
  - Doesn't necessarily use huge amounts of bandwidth
  - But does disturb every CPU in the broadcast domain
- Multicasts
  - Multicast frame = frame that goes to a subset of stations.
  - First bit sent is a one
    - 01:00:0C:CC:CC:CC (Cisco Discovery Protocol)
  - Should just disturb NICs that have registered to receive it
  - Requires multicast routing protocol on internetworks

# Characterizing Traffic Behavior cont…

2. Network Efficiency

- Efficiency refers to whether applications and protocols use bandwidth effectively.

Efficiency is affected by:

- Frame size
- Protocol interaction (refer to page 114 of text book for examples)
- Windowing and flow control
- Error-recovery mechanisms

# Characterizing QoS Requirements

- Besides information about load, you also need to know if the requirements is flexible or inflexible.
- Two techniques in analyzing QoS requirements: (you might need to read your text pg 119 – 126)

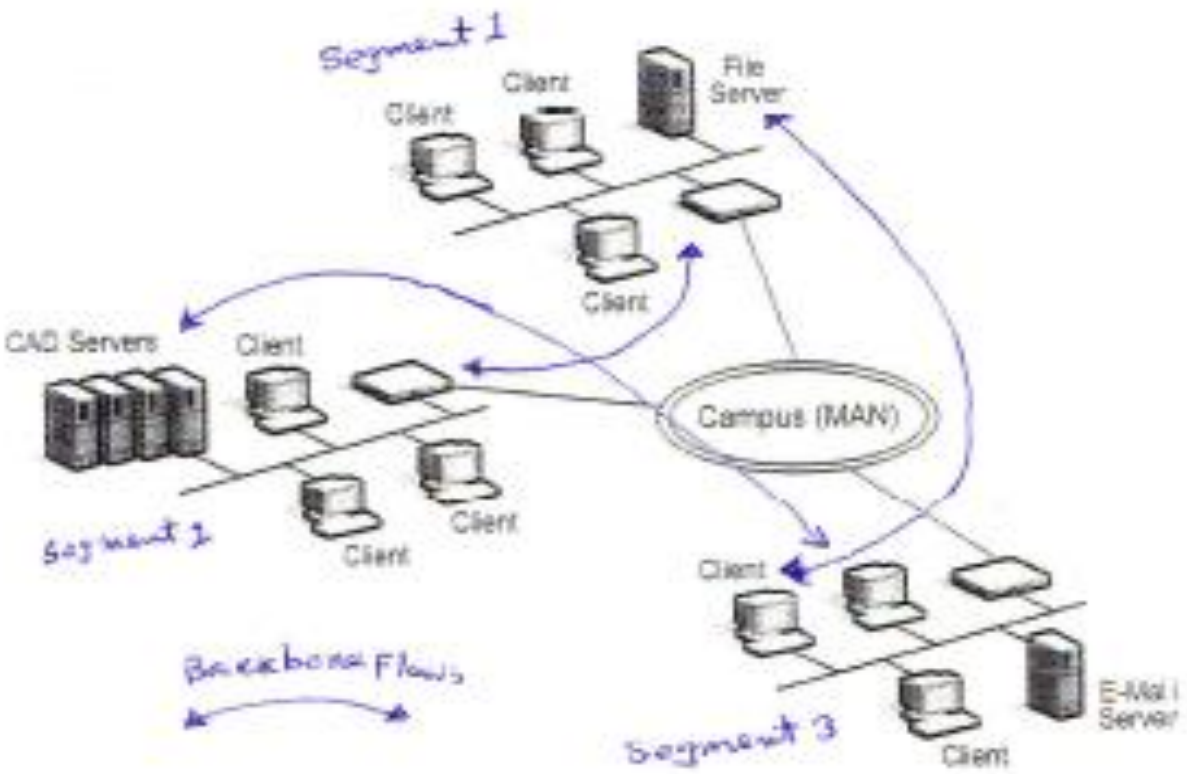
1. ATM service specifications
   - Constant bit rate (CBR)
   - Realtime variable bit rate (rt-VBR)
   - Non-realtime variable bit rate (nrt-VBR)
   - Unspecified bit rate (UBR)
   - Available bit rate (ABR)
   - Guaranteed frame rate (GFR)

# Characterizing QoS Requirements cont…

2. IETF integrated services working group Specifications
   - Controlled load service
     - Provides client data flow with a QoS closely approximating the QoS that same flow would receive on an unloaded network
   - Guaranteed service
     - Provides firm (mathematically provable) bounds on end-to-end packet-queuing delays

# Practical Analysis

# Campus (MAN) network with three segments and backbone flows




Backbone Flows

# Traffic Table for Campus (MAN) Network

| Application | % Distribution per segment (1/2/3) | No. of simultaneous sessions | Average Transaction / Packet size | **Estimated** total Capacity required (bps) | Backbone Capacity required for **SEGMEN-1** (bps) | Backbone Capacity required for **SEGMEN-2** (bps) | Backbone Capacity required for **SEGMEN-3** (bps) | **TOTAL** Backbone Capacity Required (bps) |
|---|---|---|---|---|---|---|---|---|
| E-mail | 33/33/33 | 540000/hour | 3 Kilo Byte (KB) | | | | | |
| CAD Server | 0/50/50 | 650/hour | 4 Mega Byte (MB) | | | | | |
| File Server | 25/25/50 | 100.8/hour | 2.5 MB | | | | | |

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|---|---|---|---|---|---|---|---|---|
| E-mail | 33/33/33 | 540000/hour | 3 Kilo Byte (KB) | 3.6 Mbps | 1.2 Mbps | 1.2 Mbps | 1.2 Mbps | 3.6 Mbps + 5.8 Mbps + 0.56 Mbps = 9.96 Mbps |
| CAD Server | 0/50/50 | 650/hour | 4 Mega Byte (MB) | 5.8 Mbps | 0 | 2.9 Mbps | 2.9 Mbps | |
| File Server | 25/25/50 | 100.8/hour | 2.5 MB | 560 kbps | 140 kbps | 140 kbps | 280 kbps | |