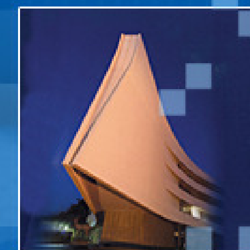
ERP 420

Research Project

Introduction & Network Structure



Dr A. De Freitas

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Administrative

	Name	Room number and building	Telephone number and e-mail address
Lecturer	Dr. A. De Freitas	Eng. 1, 15-18	(012) 420-4305 allan.defreitas@up.ac.za
Assistant Lecturer	Mr Llewellyn Strydom	Eng. 1, 13-26	u15012884@tuks.co.za
Secretary	Mrs. M. Ferreira	Eng. 1, 15-6	(012) 420-3736 mari.ferreira@up.ac.za

Administrative

- 12 x 2-hour lectures in Eng II 2-37 on Wednesdays 08:30-10:20.
- 12 x 1-hour tutorial sessions in Eng II 3-31 on Thursdays 14:30-15:20
- 12 x 2-hour practical sessions Netlabs A & B on Fridays 8:30-11:20.
- 12 x 6-hour self preparation per week (lectures, tutorials, practicals).

- Consulting hours will appear on ClickUP

Assessment schedule

Calculation of final mark	**Semester Mark: 50%** **Exam Mark: 50%**
Calculation of semester (year) mark **I = individual;** **G = group**	Semester test 1: 30% (I) Semester test 2: 30% (I) Assignment and/or class tests: 5%(I) Research Methodology: 15% (I) Laboratory work: 20% (I & G) (Students in each group must present their technical work (weight: 35%) and submit a clear report (weight: 65%)).

Assessment schedule

This module is presented at exit level for ELOs 4 and 5.

ELO 4: Investigations, experiments and data analysis

Demonstrate competence to design and conduct investigations and experiments. - *will be assessed in a research assignment and in specific question of a semester test.*

ELO 5: Engineering methods, skills and tools, including information technology

Demonstrate competence to use appropriate engineering methods, skills and tools, including those based on information technology. - *will be assessed in practical assignments.*

Assessment schedule

Admission to examination:

- In order to be admitted to the final examination in a module, a semester mark of at least **40%** is required.
- A final mark of at least **50%** must be attained for the laboratory work.
- The subminimum on ECSA ELO 4 is **50%** i.e., a student will not gain examination entrance if he/she does not attain at least **50%** for ELO 4.
- The subminimum on ECSA ELO 5 is at least **50%** i.e., a student will not gain examination entrance if he/she does not attain at least **50%** for the ELO 5 report.

Minimum examination mark:

- To pass a student must attain an examination mark of at least **40%** and a final mark of at least **50%.**

Research Project

- To develop knowledge and understanding of **queuing theory models** with regard to research, design and application.
- To develop a thorough understanding of queuing theory and Markovian chains and their solution methodologies in a research project.
- To do research and model a complex system using queuing theory.
- To design and implement a **queuing simulator** to perform experiments and data analysis.
- To analyse experimental data as well as compare queuing theory models and discuss the findings.

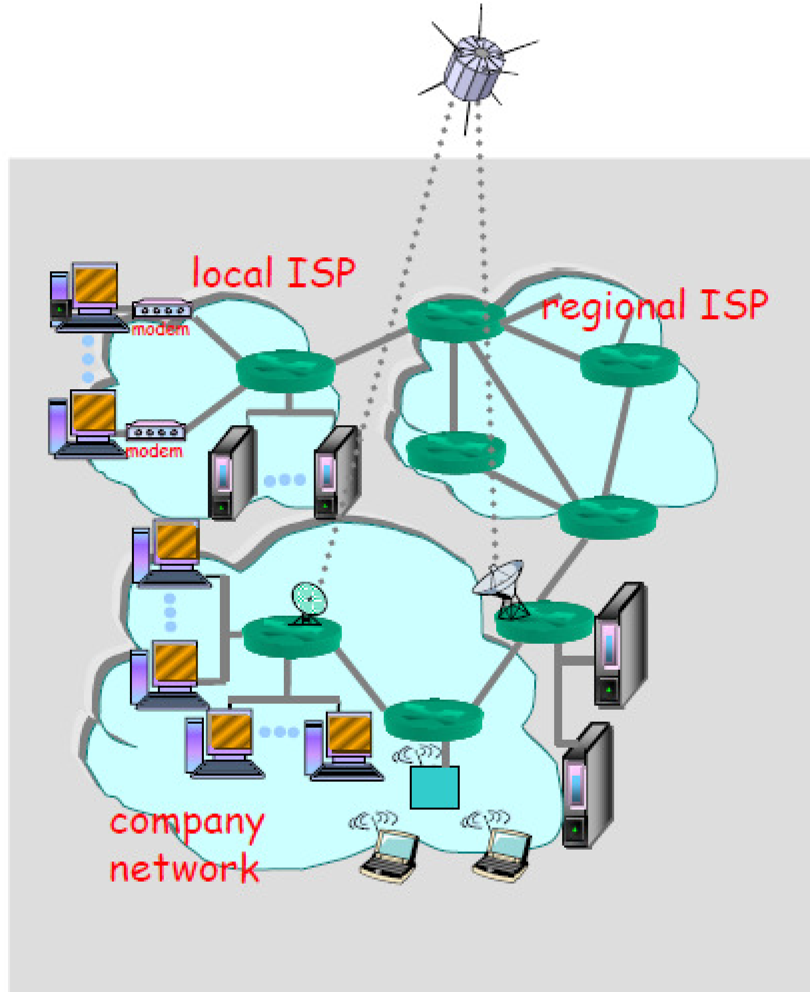
Outline

- Network Structure
    - Network edge
    - Network access and physical media
    - Network core

Reference: James F. Kurose, K. W. Ross, Computer Networking: A Top-Down Approach Featuring the Internet

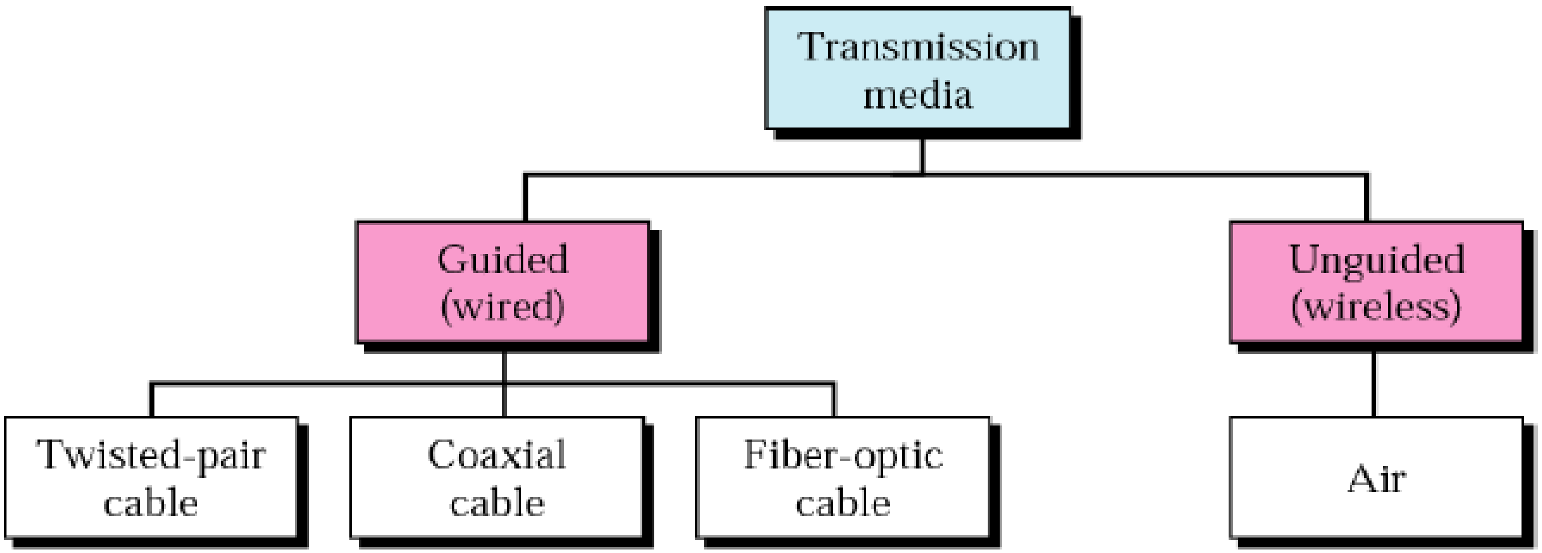
Network Structure

- network edge: applications and hosts, objects, sensors,…
- access, physical media:
  - communication links (bandwidth, latency)
- core:
  - routers



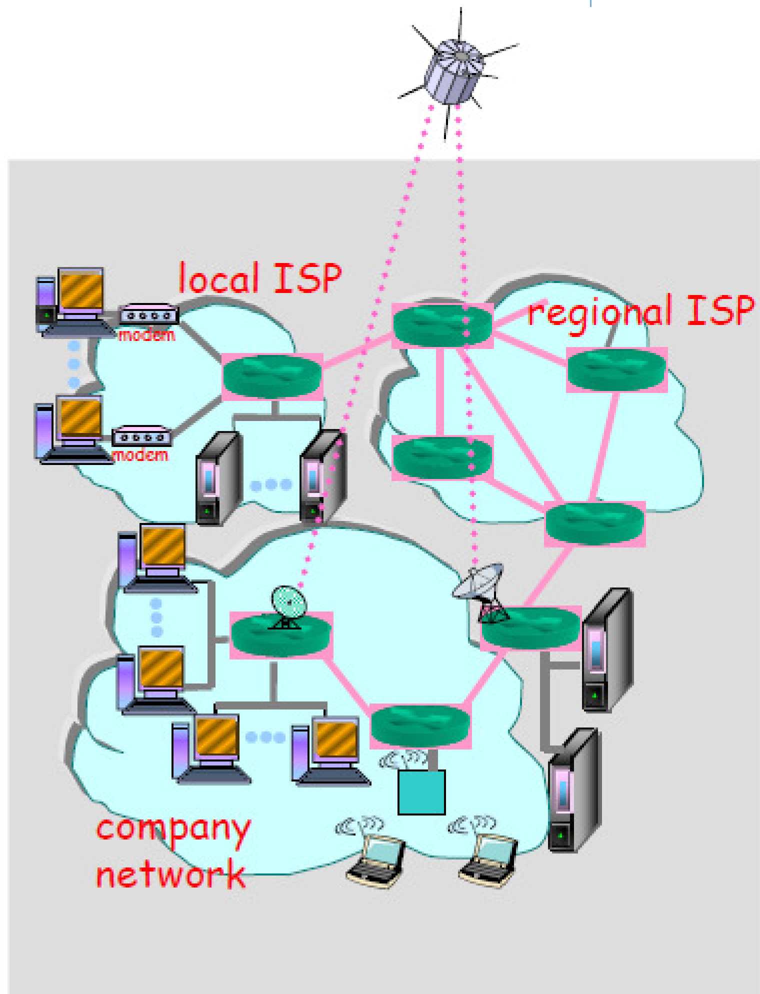
Network Access

Physical Media (link)



The Network Core

- Interconnection of routers (to route and forward packets to the receiver)
- question: how is data transferred through net?
  - circuit switching: dedicated circuit per connection: telephone net
  - packet-switching: data sent thru net in discrete segments



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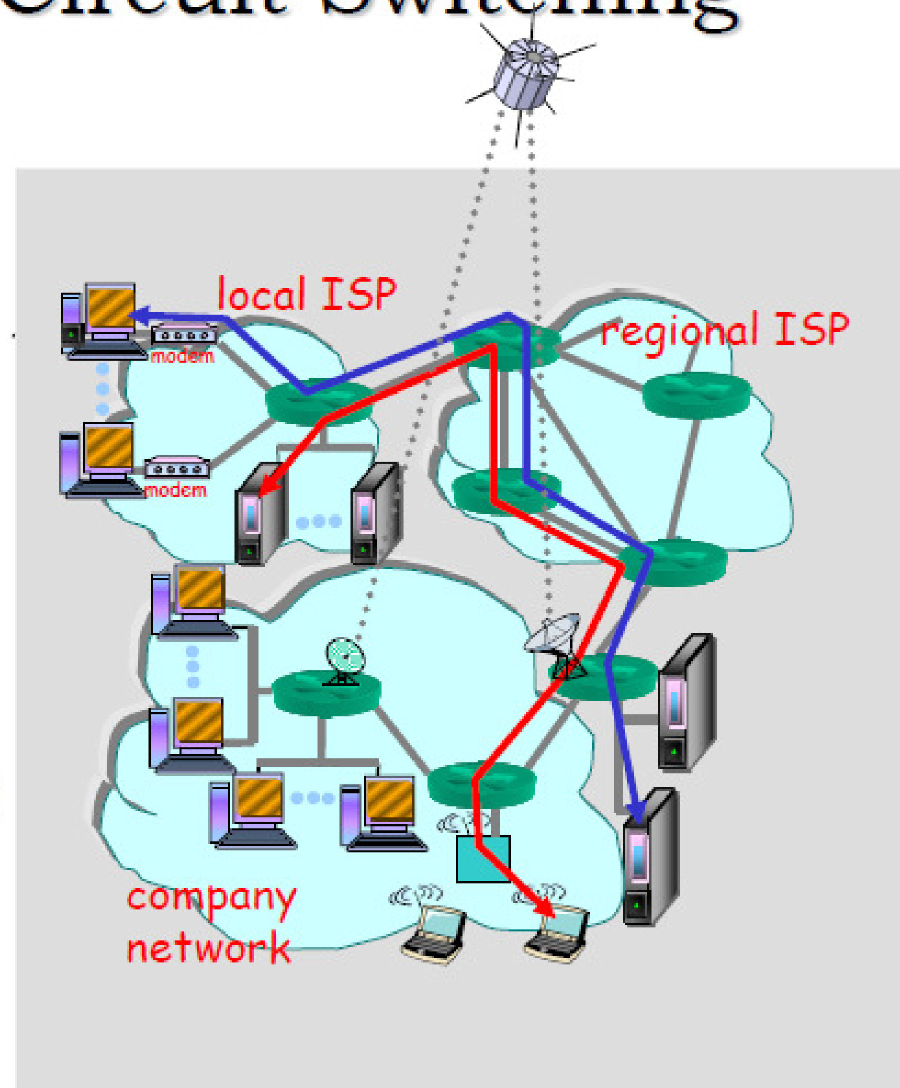
Network Core: Circuit Switching

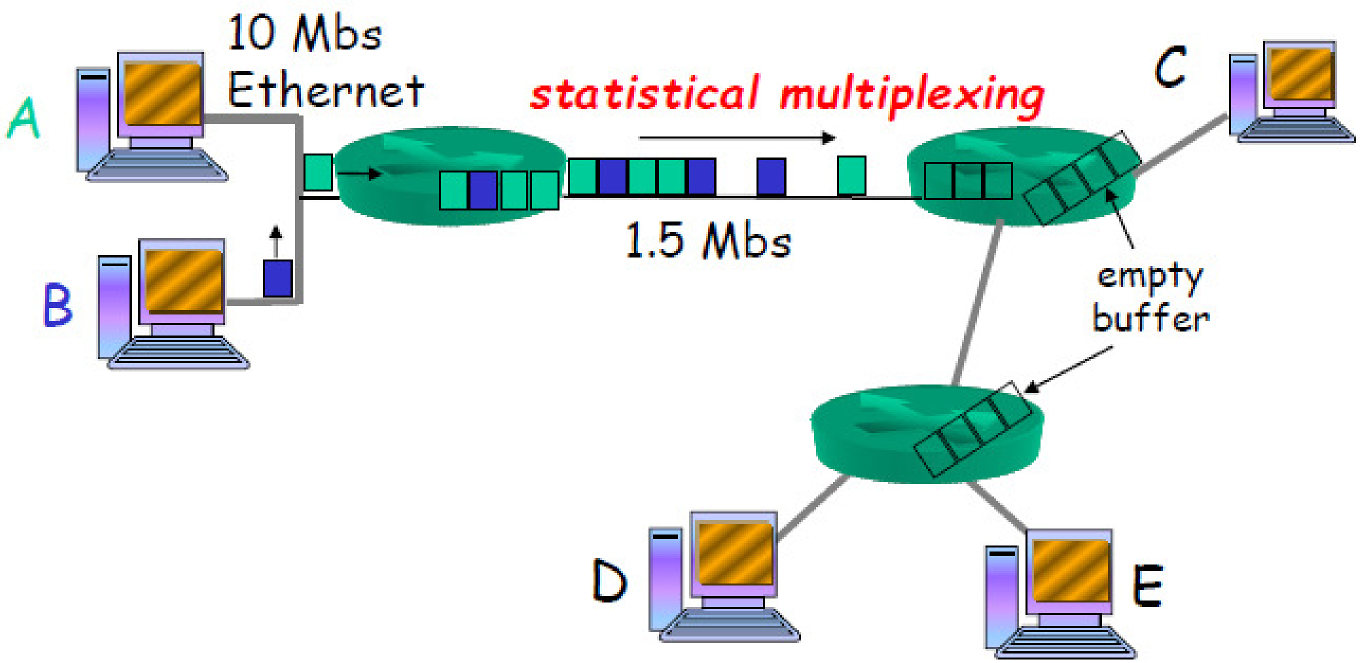
*Connection setup
  setup required

*End-to-end
  resources reserved for each "connection"

- Resources such as: link bandwidth, switch capacity, router queue



Packet Switching: Statistical Multiplexing



In circuit switching, we have connection and resources will be assigned to each connection.

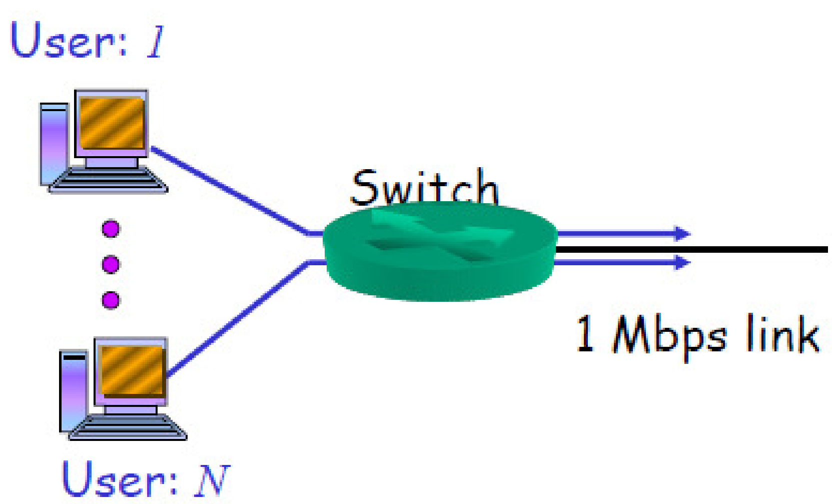
In packet switching, we have segments and resources will be assigned to packets from different senders.

Packet switching versus circuit switching

We have N-user:

- At each time only 10% of users are active
- Each sends 100 kbps when "active"

Q: How many users can use this link (with bandwidth: 1 Mbps) in circuit-switching & Packet-switching ?



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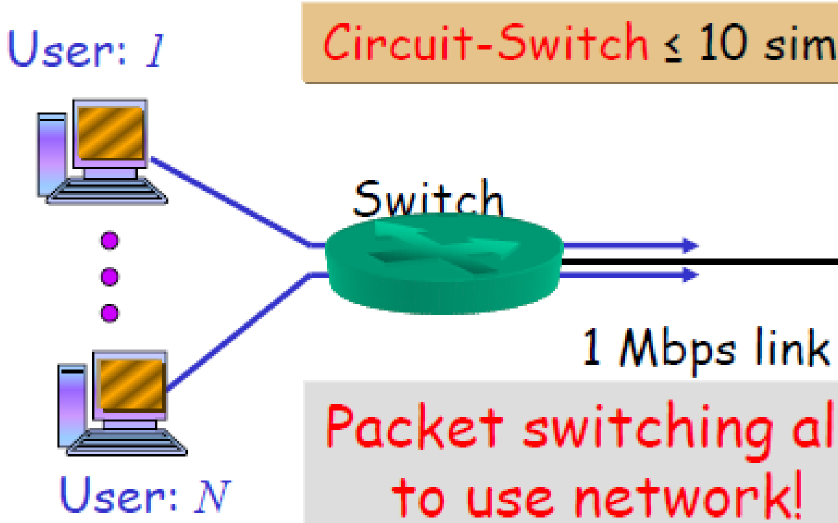


Circuit-Switch ≤ 10 simultaneous users

Packet switching allows more users to use network!

How many Users?

Packet-Switch

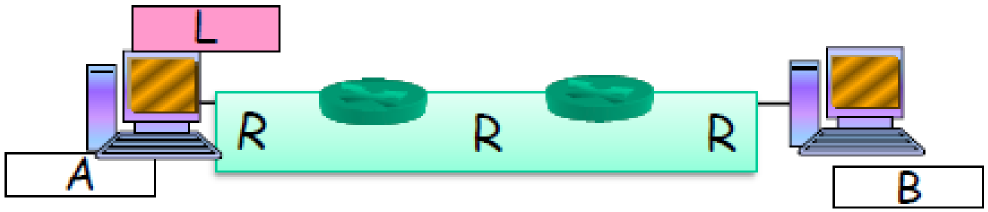
- if N=35 users,
  for active users > 10
  there is:
  probability < 0.0004
  (check this answer?)
- for active users <= 10
  there is:
  probability > 0.9996

binomial distribution:
The probability that k users be active together:

$$P(k;N,p)=\binom{N}{k}p^k(1-p)^{N-k}$$

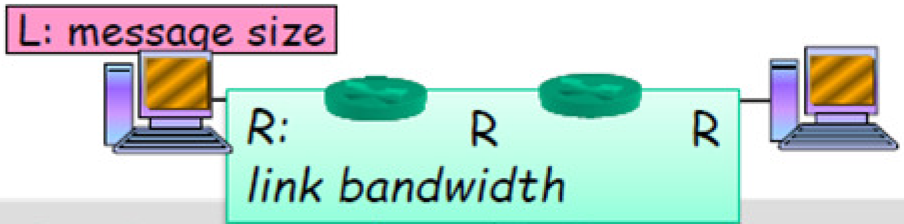
$$in\ which:\binom{N}{k}=\frac{N!}{k!(N-k)!}$$

Packet-switching: store-and-forward



- **What is Store and Forward concept:Entire packet must arrive at router before it can be transmitted on next link (routers have queue for this purpose)**
- Q: Transmission time in circuit switch & packet switch based on L(message length), and R(Bandwidth) ?

Packet-switching: store-and-forward



- **What is Store and Forward** concept: Entire packet/segment must arrive at router before it can be transmitted on next link (routers have queue for this purpose)
- delay = nL/R

Example:

- L = 7.5 Mbits; message size
- R = 1.5 Mbps; link bandwidth n=3
- message transmission time (CIRCUIT SWITCH) = L/R = 5 sec
- Delay(PACKET SWITCH) = 3L/R = 15 sec

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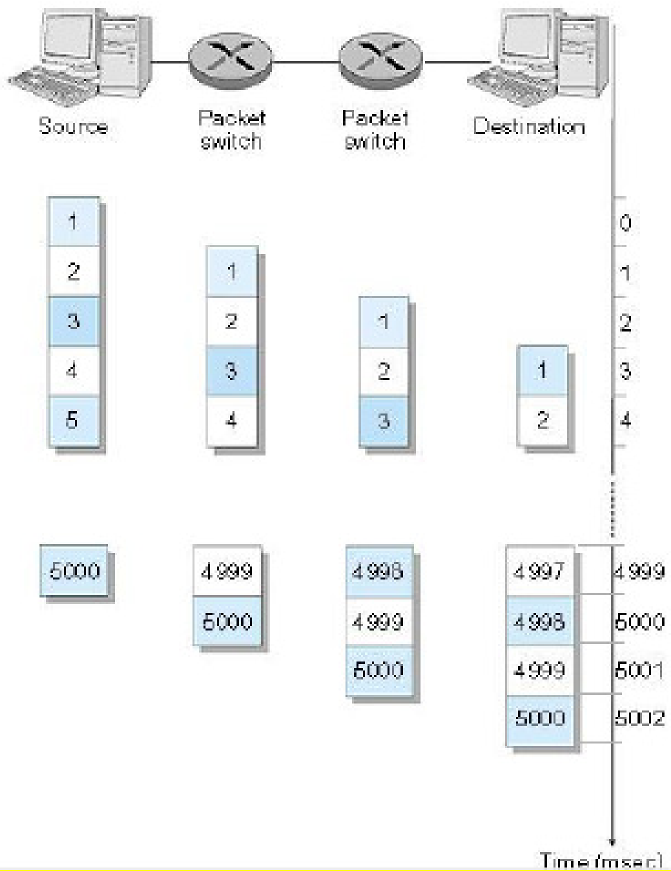
Packet Switching: Message Segmenting



message with size 7.5 Mb breaks up into 5000 packets

- Bandwidth is1,5 Mbps
- Delay for packet switching is ([3*(7.5/1.5)]=15 sec) and for circuit switching is 5 sec

Packet switching allows more users to use network!, while, it has more delay than circuit switching

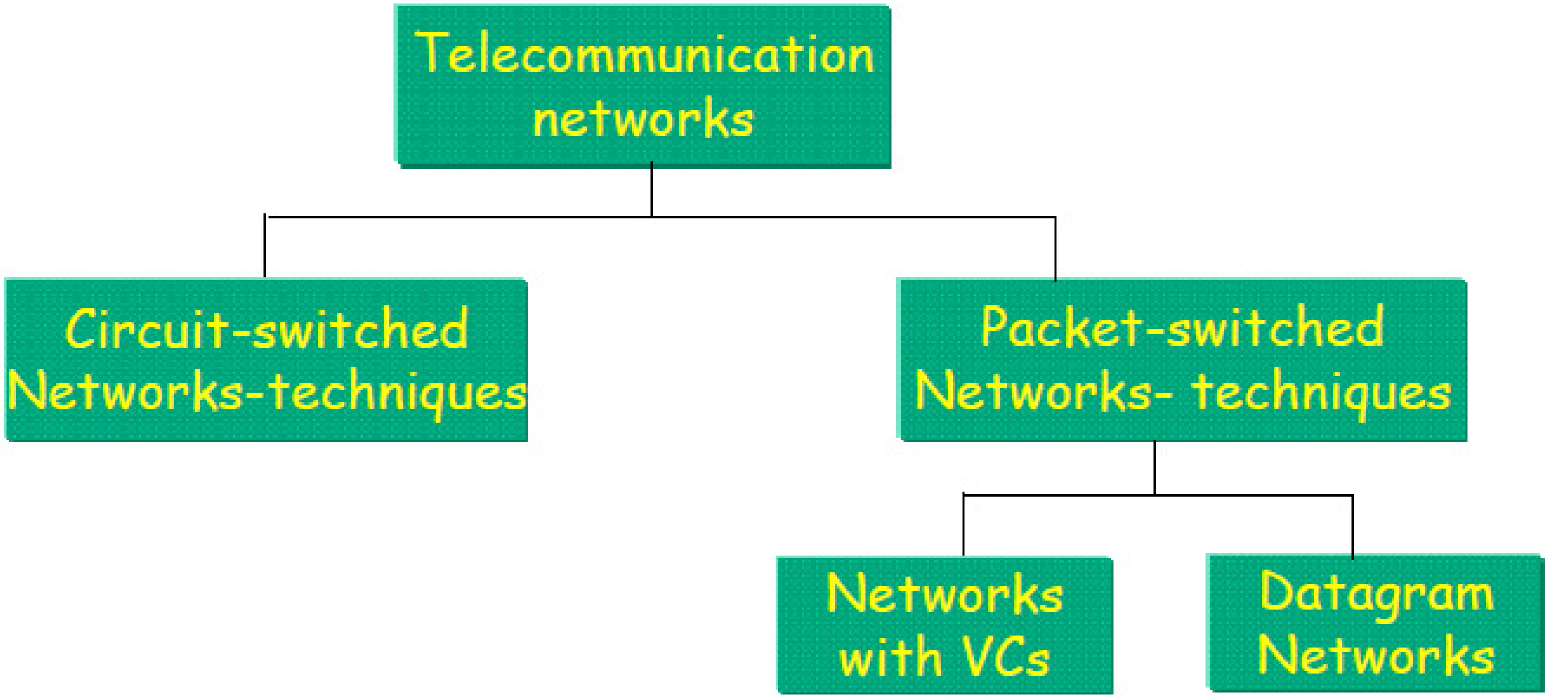
Advantages and disadvantages of Packet switching

- Advantage:
- resource sharing
- no connection setup to reserve the resources in advance.
- Disadvantage:
  - packet delay (because we have store and forwarding) and loss (because we do not have a dedicated route between source & receiver)
  - protocols needed for reliable data transfer, congestion control (packet are routed independently).

Two Packet-switched networks techniques in packet forwarding

- datagram network (Router):
  - *Routers check content of packets to find next hope*
  - *destination address* in packet determines next hop
  - routes may change during session
- virtual circuit network (Connection set up: **this connection set up is not only for one user, any other users can use this path**)
  - each packet carries tag (virtual circuit ID), tag determines next hop
  - fixed path determined at *call setup time*, remains fixed thru call
  - *routers maintain per-connection state*

Network Taxonomy



- Internet provides both connection-oriented (TCP) and connectionless services (UDP) to applications.