Benha Faculty of Engineering
5th Year (Comm. & Comp.)
Examiner: Dr. Hatem ZAKARIA

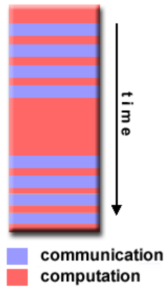
Electrical Engineering Department
Final Exam: 11 June 2014
Time allowed: 3 Hours

Distributed Processing (E521)

Model Answer

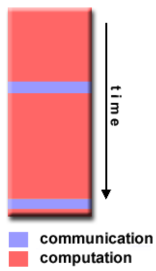
Question (1) (11 Marks)

a. **Fine-grain Parallelism**



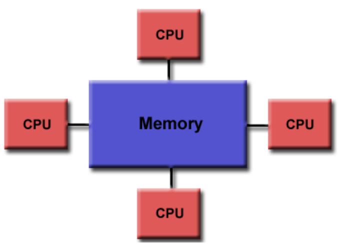
- Small amounts of computational work are done between communication events → low computation to communication ratio
- Facilitates load balancing
- Implies high communication overhead and less opportunity for performance enhancement

Coarse-grain Parallelism



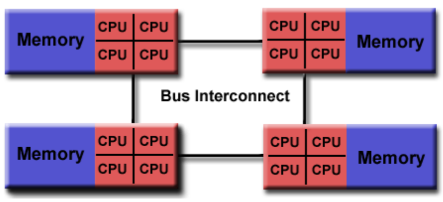
- Relatively large amounts of computational work are done between communication/synchronization events
- High computation to communication ratio
- Implies more opportunity for performance increase
- Harder to load balance efficiently

b. **Uniform Memory Access (UMA)**



- Shared memory is accessible by all processors in the same way a single processor accesses its memory
- Identical processors
- Equal access and access times to memory

Non-Uniform Memory Access (NUMA)



- Each processor has part of the shared memory attached (memory banks)
- NUMA systems include additional hardware or software to move data between banks.
- Memory access time depends on the memory location relative to a processor

- **Cache coherent means**: If one processor updates a location in shared memory, all the other processors know about the update.

c. T_{add} = 2ns and T_{com} = 1ns
No. of processors = 3
Total No. of add operations/clock cycle = |8/3| + |4/3| + |2/3| + |1/3|
= 3 + 2 + 1+ 1 = 7

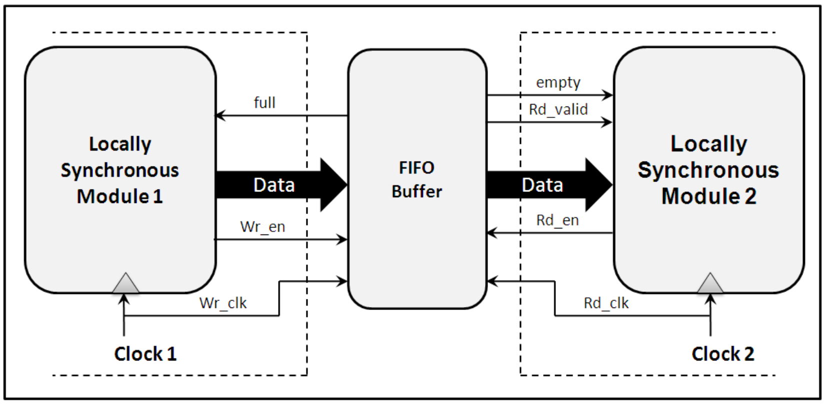
Execution time = 7*3 = 21 ns

<u>Question (2)</u> **(8 Marks)**

a. **<u>Synchronous communications</u>** require some type of "handshaking" between tasks that are sharing data. Synchronous communications →***blocking*** communications as other work must wait until the communications have completed.

<u>Asynchronous communications</u> allow tasks to transfer data independently from one another. Task 1 can prepare and send a message to Task 2, then immediately begin doing other work, while task 2 is receiving the data. Asynchronous communications → **non-blocking** communications as other work can be done while the communications are taking place. Interleaving computation with communication is the single greatest benefit for using asynchronous communications.

b.

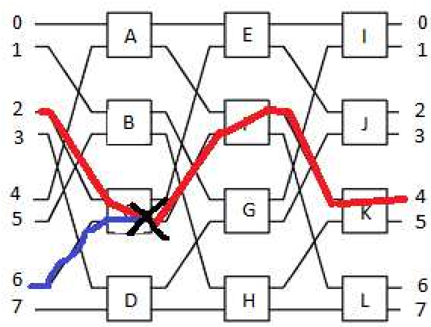


c.

- MIN with 2×2 switches, the cost of each switch is proportional to 2^2
- There are $1024/2$ ($\log_2$ 1024) total switches
- There are Log_2 1024 stages of *1024* unidirectional links per stage from the switches plus *1024* links to the MIN from the end nodes.
- $\text{cost(crossbar)}_{switches} = 1024^2$, $\text{cost(crossbar)}_{links} = 2048$
- $\text{Relative\_cost}(2 \times 2)_{switches} = 1024^2 / (2^2 \times 1024/2 \times \log_2 1024) = \mathbf{51.2}$ → 2 Marks
- $\text{Relative\_cost}(2 \times 2)_{links} = 2048 / (1024 \times (\log_2 1024 + 1)) = 2/11 = \mathbf{0.182}$ → 2 Marks

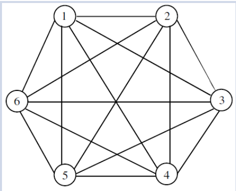
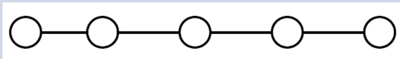
<u>Question (3)</u> **(12 Marks)**

a. **Routing**: 0 means use upper output and 1 means use lower output



- The two connetcion can not be established simultaneosly. The 2nd connetcion is blocked by switch C.
- MINs Network has the property of being *blocking.*

Contention is more likely to occur on network links where paths from different sources to different destinations share one or more links b.

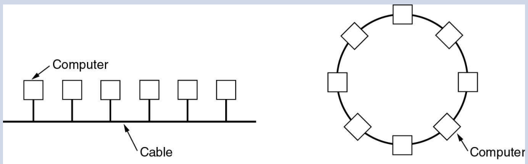
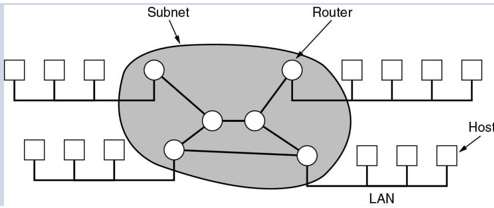
Aspect	Completely Connected Network	Linear Array Network
Architecture		
Link Cost	*N(N-1)/2*	*N*-1
Worst Delay	1	*N*
Degree	*N-1*	2
Symmetry	Yes	No
Diameter	1	*N*-1

c. ***Answer:*** $BW = M(1-(1-(\rho/M))^n) = 4(1-(1-(0.5/4))^4) = 1.66$

d. **Answer:** The condition is expressed as follows: $0.5*f + (1-f) * 0.5 *N > 20$ (1 mark)
For f = 20% → 0.5*0.2 + (1 - 0.2)*0.5*N > 20 → N = 50 processor (1 mark)
$S(n)$ = N/[1+f(N-1)] = 50 / [1 + 0.2 (50 - 1)] = 4.63 (1 mark)
Maximum speedup factor = 1/f = 1/0.2 = 5 (1 mark) Efficiency η = s(n) / N = 9.3 % (1 mark)

<u>Question (4)</u> **(15 Marks)**

a.

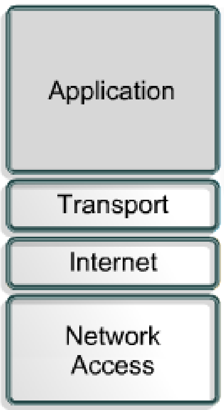
Aspect	LAN	WAN
Architecture		
Scaling	*Single building or campus (up to few kilometers)*	*Span large geographical area (country or continent)*
Connections	Connect PCs and workshops in company offices and factories to share resources (e.g. Printers) and exchange information	*- Contains a collection of machines "hosts" intended for running user programs* *- Hosts are connected by a communication subnet* *- The subnet carry messages from host to host*
Transmission Technology	*Broadcasting*	Point to Point
Topology	Various possible forms (Bus, Ring, …)	Various possible forms (Star, Complete, …)
Transmission Media	Twisted Pair	Fiber Optics

Issue	Datagram Subnet	VC Subnet
Circuit Setup	Not required	Required
Addressing	Each packet contains the full source and destination address	Each packet contains short VC number
Routing	Each packet is routed independently	All packets follow the same chosen rout
Effect of router failure	None except for packet lost during the crash	All VCs that passes through the failed router are terminated
Congestion Control	Difficult	Easy if enough buffers can be allocated in advance for each VC

b. **Resource sharing**: All programs, equipment and data are available to anyone on the network. No regard to the physical location of the resource "*server*" and the user "*client*".
High Reliability: Multiple CPUs, If one goes down, the other may be able to take over its work.
Cooperative Computing: The main problem can be divided into sub-problems. Each processor solves a certain part of the problem.
Communication Medium: 2 or more people who live far apart can write a report together. A change to an online document can be seen by the immediately.
Saving Money: Small PCs have a much better price/performance ratio than large ones. Mainframes are a factor of 10 faster than small PCs, but have very high cost. Designers build systems consisting of PCs, with data kept on one or more shared file server machine

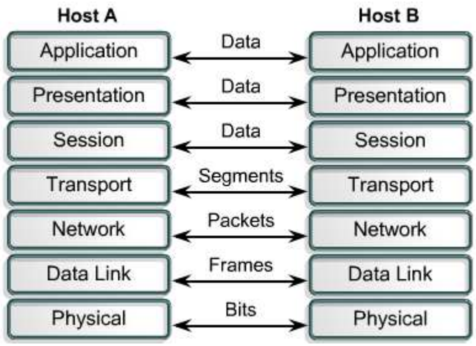
c. **Generator G(x) = 10011** **Checksum CS = 1110**
Transmitted Frame T(x) = 11010110111110

d. **TCP/IP (*Transmission Control Protocol / Internet Protocol).*** It's a framework (guideline) for network implementation and troubleshooting. Divides complex functions into 4 simpler components (layers).



1. Application Layer used by the router → File Transfer 'TFTP, NFS, ..', E-mail, Remote Login, Network Management, Name Management DNS
2. Transport Layer → TCP 'Connection oriented', UDP 'Connectionless'
3. Internet Layer → IP and routing protocols, ARP, ICMP
4. Network Access → Ethernet, Token ring, point to point, ATM

e. **Protocol Data Unit (PDU)** - The form that a piece of data takes at any layer. At each stage of the process, a PDU has a different name to reflect its new appearance. PDUs are named according to the protocols of the TCP/IP suite.
Data - The general term for the PDU used at the Application layer



Segment - Transport Layer PDU
Packet - Internetwork Layer PDU
Frame - Network Access Layer PDU
Bits - A PDU used when physically transmitting data over the medium

<u>The MAC address</u> unique on every Network interface device and is embedded in the circuitry of the NIC card.
<u>The IP address</u> assigned by a DHCP server or manually configured in the device when it is connected to the network, and can be changed

<u>Question (5)</u> **(14 Marks)**

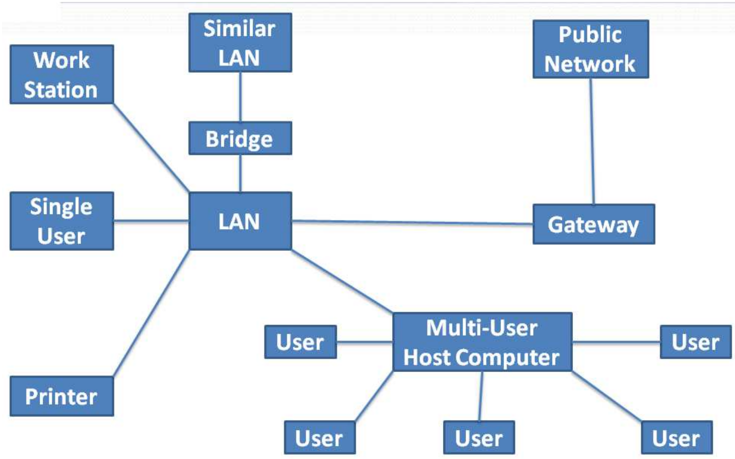
a. NIC inserts into the system bus of a computer and makes the connection between running software processes on the computer and physical media. The NIC is not solely a physical entity, however. Software associated with the NIC enables the NIC to perform its intermediary functions of preparing data for transmission and encoding the data as signals to be sent on the associated media.

   Fiber Optics Advantages:

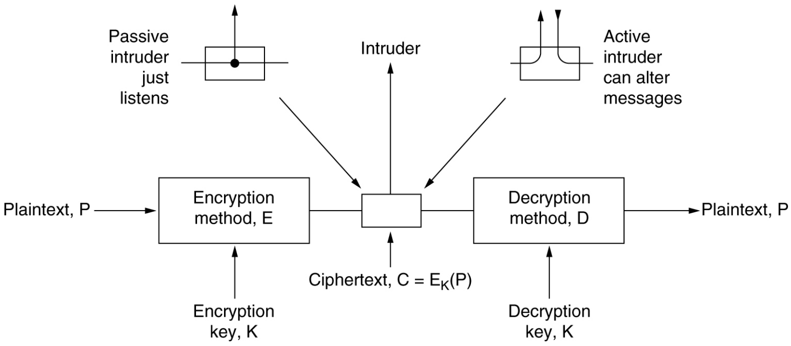
   (1) It is not affected by power surges or failures
   (2) It is not affected by corrosive chemicals in the air
   (3) It is thin and lightweight
   (4) It does not leak light and it is quite difficult to tap → Excellent against potential wire tappers
   (5) Photons in a fiber do not affect one another and are not affected by photons outside, while electrons in a wire affect one another and are affected by electrons outside
   (6) Fiber interfaces cost more than electrical interfaces

b. **<u>Passive Wiretapping</u>**

   An intruder simply monitors at some point without interfering with the information flow. Such unauthorized observation of information is referred to as ***release of message content***. When the message content is not available, the wire tapper can examine the quantities, lengths, and frequencies of the message transmission. These types of passive attacks are referred to as ***traffic analysis*** "i.e. learn about the character of the data being exchanged" c.



d.



e. Model answer: Plaintext is "ELSIE HAS PART OF THE TREASURE"

(Good Luck)