INTRODUCTION TO NETWORKING

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1.0 INTRODUCTION TO NETWORKING

Networking is referred as connecting computers electronically for the purpose of sharing information. Resources such as files, applications, printers and software are common information shared in a networking. The advantage of networking can be seen clearly in terms of security, efficiency, manageability and cost effectiveness as it allows collaboration between users in a wide range. Basically, network consists of hardware component such as computer, hubs, switches, routers and other devices which form the network infrastructure. These are the devices that play an important role in data transfer from one place to another using different technology such as radio waves and wires.

There are many types of network available in the networking industries and the most common network are Local Area Network (LAN) and Wide Area Network (WAN).LAN network is made up of two or more computers connected together in a short distance usually at home, office buildings or school. WAN is a network that covers wider area than LAN and usually covers cities, countries and the whole world. Several major LAN can be connect together to form a WAN. As several devices are connected to network, it is important to ensure data collision does not happened when this devices attempt to use data channel simultaneously. A set of rules called Carrier Sense Multiple Access / Collision detection are used to detect and prevent collision in networks.

2.0 WHAT IS CARRIER SENSE MULTIPLE ACCESS (CSMA)

Carrier Sense Multiple Access is one of the popular ways to transmit information packets across networks. Packets is referred as data bits which are sent over a network. According to Wikipedia, Carrier Sense Multiple Access (CSMA)) is a “probabilistic Media Access Control (MAC) protocol in which a node verifies the absence of other traffic before transmitting on a shared transmission medium, such as an electrical bus, or a band of the electromagnetic spectrum”. In a simple word, CSMA will check to ensure the line is not being used before the data is sent, if it is in use, it waits until the line is idle before proceeding with transmitting.

Ethernet networks use this method to send information packets. One of the important purpose CSMA was developed is to minimize the chances of collision and improve the performance by preventing computers from exchanging information at same time. Collision occurs when computers attempt to send information to each other at the same time. Thus, the data does not reach its destination or destroyed. With CSMA, collision can be reduced as it will hold the data and wait until the line is clear before data is transmitted to the particular computer and user.

According to Wikipedia, "**Carrier Sense**" describes how transmitter uses feedback from a receiver to detect existence of encoded signal from any other station before trying to transmit. The chances of collision can be reduced if the station can sense the medium before it is used. Station should listen to medium about ongoing transmission in process before sending its own information. CSMA is based on the principle "sense before transmit" or "listen before talk".

"**Multiple Access**" means that more than one device can listen and waiting to transmit at a time. Multiple stations may share multiple access medium. This means every data bits transmitted by a station is generally received by all the stations using that medium.

CSMA actually uses several different methods where they wait for the medium to become idle, known as the persistence strategy. Persistence strategy defines the procedures for a station that senses a busy medium. Below are three persistent strategy in Figure 1.0 that have been developed :

i. 1-persistent method

In this strategy, the station will sense the channel and transmit packets immediately if the channel is sensed free. If the medium is busy it will wait until the channel becomes idle.Then it will send the data with probability of 1.

ii. **P-persistent method**

In P-persistent protocol, when the line is free the sender will transmit frame with probability *p*. If the medium is busy, it will wait until the line is free before sending the packet with probability *p*. If the station choose to hold back, it will not transmit with the probability *1-p*. The sender will wait and the process will be repeated until the frame are sent with the same probability *p* when the next time slot is available. The strategy are used in WiFi and packet radio systems.

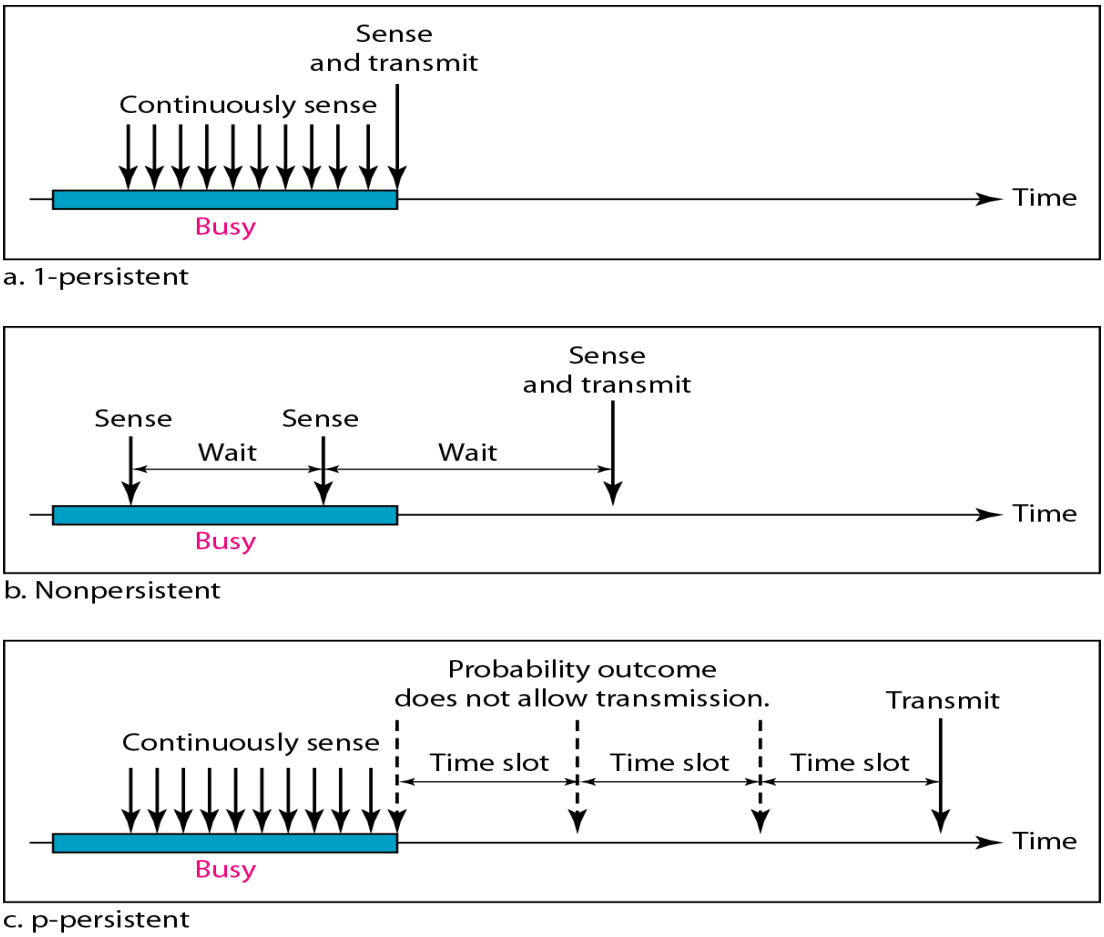

Figure 1.0 Behaviour of three persistent method

*Retrieved from :http://networking.khu.ac.kr/...03.../Chapter12%20**Multiple**%20**Access**.ppt*

iii. Non-persistent method

Station will sent immediately if the line is idle or the station will have to wait for a random amount of time and then sense the line again to check its status. The advantage of this strategy is that, it reduces the chances of collision since it is out of ordinary for two station to wait for the same period of time before retrying concurrently.

3.0 CARRIER SENSE MULTIPLE ACCESS WITH COLLISION DETECTION (CSMA / CD)

As described earlier, in CSMA data is transferred by sensing the channel. Possibility for collision happends is high when the computers try to send information one to another concurrently. This problem can be reduced if the station can detect if the data transmission deteriorate a collision during the transmission. Instead of randomly transmitting data which has collided with others, the collision can be detected by a station which could immediately halt the collided transmission to reduce the duration of collision. The protocol which perform this action is called Carrier Sense Multiple Access with Collision Detection or CSMA/CD. It is a protocol used to ensure only one network node are transmitted at one time in the Ethernet network. This is the technique used to access the 802.3 Ethernet network channel.

Collision Detection

Collision Detection means that when two devices try to send data simultaneously at the same time, they are able to detect this error. CSMA/CD operates in the same manner with CSMA except the moment collision is detected, the operation of data transmission will be aborted immediately. The collision that occurs on the shared media are detected when the devices in the listening mode. When a device is in listening mode, it can detect collision occurs on the shared media. The detection of a collision happen when there is increase of amplitude above the normal level. Once the increase in the signal amplitude detected all the transmitting devices will transmit to assure devices in network detect the collision.

Jamming Signal and Back off Algorithm

Once the collision is heard the sender will send jamming signal to announce other devices that the collision had happened and the devices should stop sending data onto the wire. After the jamming signal is sent, the sender will wait for a indefinite amount of time. This random time will ensure the devices which were involved in the collision do not transmit simultaneously again. This process is called back off algorithm which make sure traffic from two devices are not transmitted at the same time. The back off period is decided by collision counter of each node and usually generate random numbers. The possibility of repeated collision exist even after the back off when the nodes trying to transmit the data again. It can be reduces if each nodes back off at different time.

Retransmission

Final step in CSMA/CD data transmission process is retransmitting the frame that is corrupted or terminated because of a collision. The process of retransmitting is performed after a collision is detected, and the node backs off for a period of time. If the retransmission is successful, the node clears its collision counter.

The entire operation of the CSMA/CD can be described by flow diagram in Figure 2.0 The operation of CSMA/CD are same with CSMA before the collision detection starts as shown in the diagram. The transmission is successful if there is no collision is detected. In case of collision is detected, the transmission will be aborted. The jamming signal will be sent and all the station involved in collision will back off. The process will be repeated after the packets backs off.

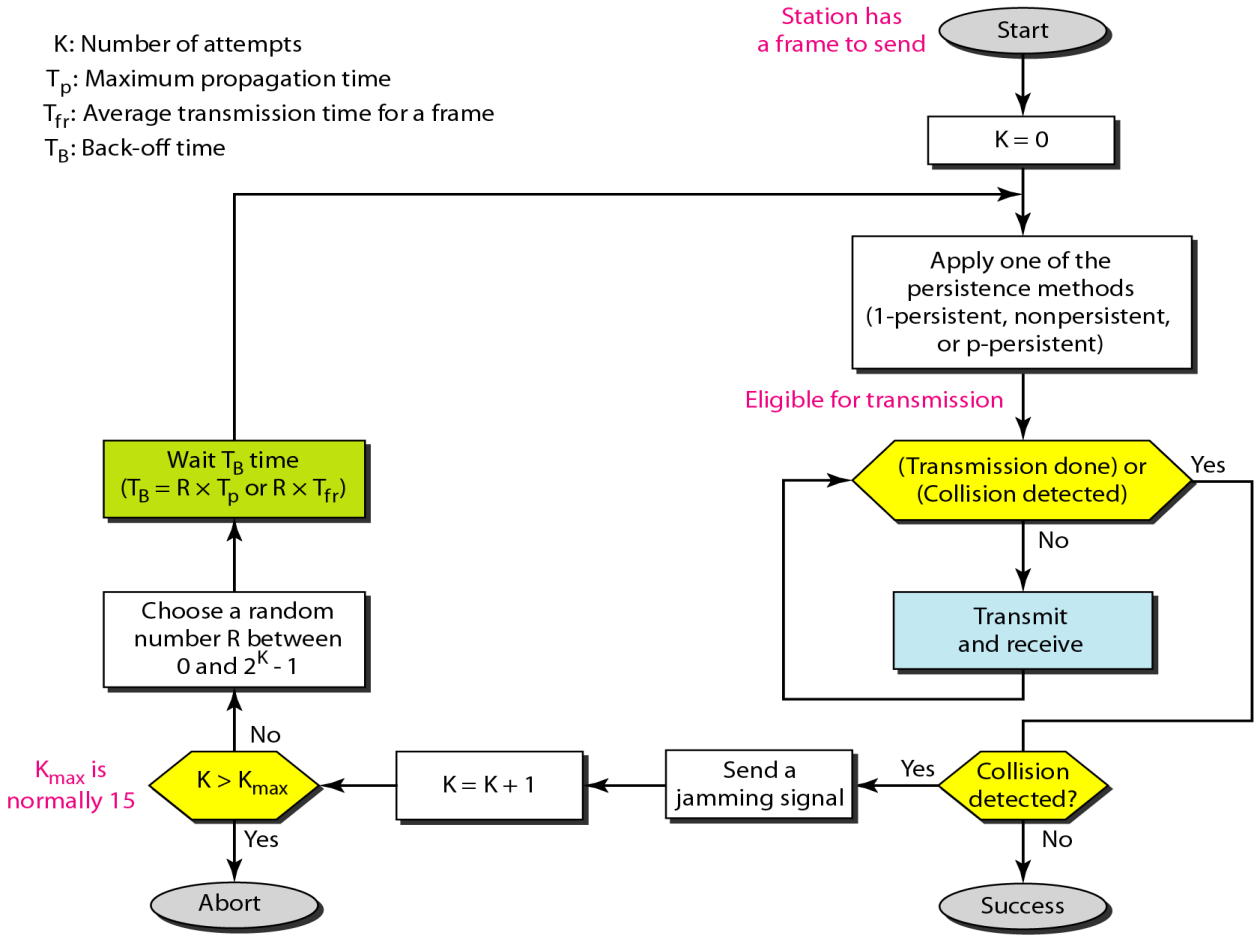

Figure 2.0 Flow diagram for the CSMA/CD

*Retrieved from :http://networking.khu.ac.kr/...03.../Chapter12%20**Multiple**%20**Access**.ppt*

As explained earlier we know that collisions occurs when two medium transmit at the same time and the collision is sensed based on increase of voltages of signals in the line. It happened when :

> Both medium found the line to be idle

> Both medium had been waiting to for a busy line to become idle to transmit

Figure 3.0 below is used to explain the process of CSMA/CD.

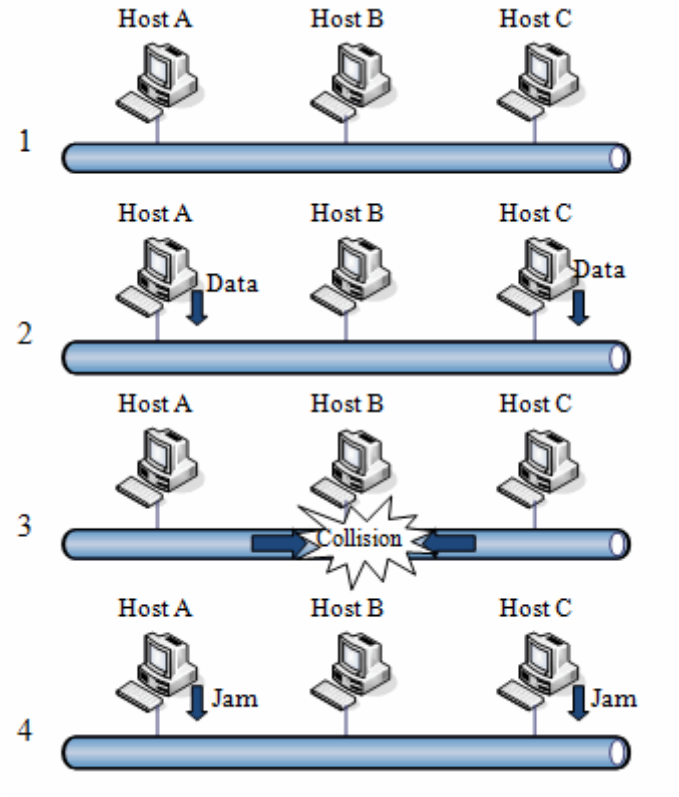

Figure 3.0 Principle of CSMA/CD

1. Host A, Host B and Host C which wants to send data will "listens before transmit" to ensure the line is free and ready to send data.
2. Since there the line is idle, Host A and host C on shared network tries to send frames.
3. Both Host A and Host C are listening and transmitting at the same time which cause a collision to occurs.
4. The collision is detected by Host A and Host C and send out "jamming" signal to other host for not sending data at this time. The data need to be retransmitted by both Host A and Host C but need to assure it don't happen at the same time again. To avoid collision, host A and host B that involved in collision will back off before attempting to start the entire process again by listening to the wire.

3.1 Advantages and Disadvantages of CSMA/CD

Advantages

- CSMA/CD is reliable because it detect collisions and packets are re-sent. Data lost does not happen.
- A computer does not take turn or have to wait for its turn to transmit data so it makes data transmitting relatively fast.
- CSMA/CD control software is simple and less expensive.
- It work best on a bus topology with burst transmission.

Disadvantages

- The collision detection system limit the cable length that can be used where it is limited to 2500 meters
- The collision cause network slow down due to retransmission process so it is not suitable for large networks
- The protocol not suitable for channels with controlling automated equipment where certain control needs over channel access

4.0 THE SLOTTED RING

Slotted ring is a control strategy used to increase transmission capacity in a ring networks. Transmission capacity in other ring networks, for example token ring is wasted since the packets needs to travel on every link. Slotted ring is possible to increase transmission capacity twice the capacity or higher throughput because it is based on empty slot principle. Slotted ring is widely used for wide area network (WAN) when need to cover a large distance or a high transmission speed is involved. Development of slotted ring was done in University of Cambridge so it is also known as Cambridge ring.

The slotted ring consists of a number of fixed length slots which circulate continuously on the ring. The principle of slotted ring is it should have one or more circulating slot or minipackets where each slots have a bit that point out which slot is empty or full. Every slot has an access contol field used for bus access control and data segment field which used for packet transmitting. In the beginning all the slots are marked empty. Station which wants to send data must divide the data into fixed length packets called 'minipackets'. Empty slots which arrives will be marked full and minipackets will be inserted to that slot as the empty slot goes by. The full slot will make a complete round trip around the ring from the source to destination and back to the source. During this period the station is not allowed to send another minipacket.

The operation of slotted ring is illustrated in the Figure 4.0. Operation of the slotted ring starts at monitoring station which presents on all slotted rings. The monitor station monitor slots as the ring is running and decides how many minipackets the ring should contain. As the slots circulate continuously in the ring from station to station, each station will controls the data in the slot before it is forwarded to the next station. The slots have a fixed predefined format where it consists of 40 bits. 16 bits used for data, 8 bits for control purposes, 8 bits for the transmitter and the balance 8 bits for receiver address.

Data is transmitted if there is an available slots. Any station wants to transmit data must wait for the available slot. Later it will sets the full/empty bits, clears the monitor bit and fill the slot with addresses and user data. Besides that, it also sets the response bit ignored (11) on the condition . The receiving station detects and read the data sent based on the destination address. If the station able to read the data, it will sets the bit to answer (01), if the data couldn't be read it will sets to rejected (10) and busy mode (0) if the data overloaded. The ignored state will be remains if the station is not ready (inoperable). The transmitting station will detects the slot and response if the the data was transferred correctly based on the full/empty bit. Originating station will set the monitor passed bit to 1 as it transmit the full slot which means this is a first time pass. It will change the monitor pass to 0 as the slot are passed on. If the sending station fails to remove the full packet, it will circulate round to the monitor station for a second time. It will be identified as lost packet and the monitor will remove it and sends out a new empty slots. The two control bits at the end of a slot is unimportant for media access as it is reserved for other protocol layers use.

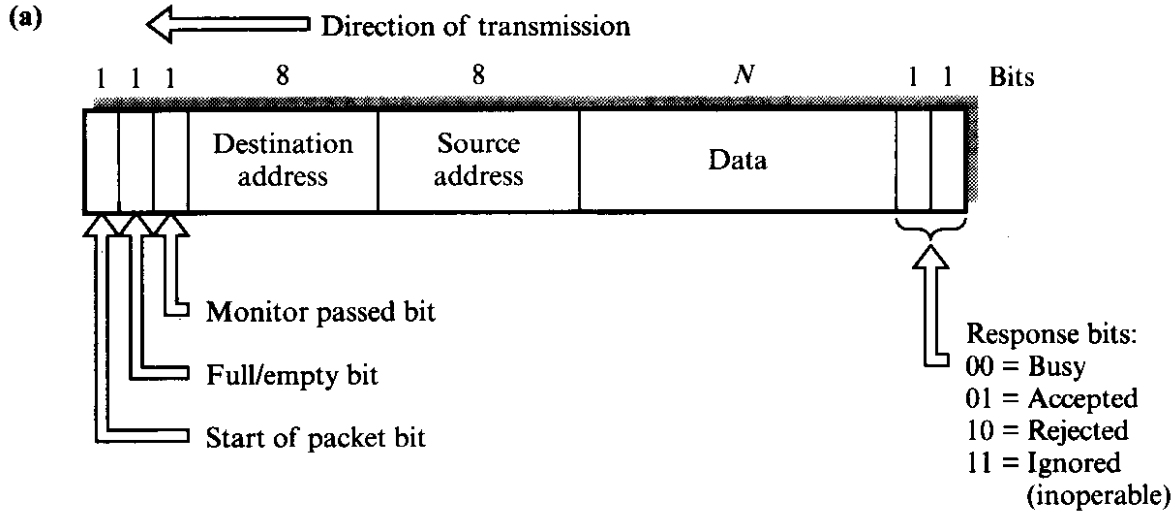

Figure 4.0 The slotted ring

The advantage of slotted ring operation can be determined as below :

i. The slotted ring technique ensure the station does not monopolize the channel and there is fairness among station in sharing the channel bandwidth.

ii. The monitor stations make sure the slot structure is maintained even with various ring errors.

iii. The multiple values for the response field in the minipackets allow the sender to know if the packets is received and provide basic flow control for ring stations with various speed to work together.

5.0 WHAT IS A TOKEN PASSING?

Token passing is a Media Access Control protocol which decides when and how a stations can transmit data to the network. A special frame called a token usually generated by station and transmits it to the network. This electronic token move around the network or electrical ring on token ring, token bus, and Fiber Distributed Data Interface (FDDI) networks. The function of token is to grant rights for stations to transmit data on a shared medium. The node that holding the token can transmit the data. The node will taking turn to transmit data and the token is passed from one node to another in a logical ring. Medium that attached to the shared network can capture the token as it circulates on the ring. The station continuously send data until it is expires. When the token is captured and when it expires, data sending process will be stopped and the station send a new token to the network. The new token may captured by the next station or the station simply repeat the token. The process continues until the token has made a complete trip around the ring. Each network only has one token so only one computer able to send messages at a time. Since only the station which hold the token can transmit data, computer on a token-based networks do not attempt to access the network on their own. There are several token passing protocols used in a local area network which is known as *Token Ring Network* and *Token Bus Network* which will be explained in detail on coming topics.

6.0 TOKEN-RING NETWORK

Token ring was invented by Olof Soderblom in the late 1960s. Token ring becomes popular in the mid 1980s when IBM released its token ring architecture based on active multi-station access units (MSAUs or MAUs) and the IBM Structured Cabling System. It was used and promoted by IBM in their networking standard and later standardized by The Institute of Electrical and Electronics Engineers or IEEE as 802.5 standard. In OSI model, token ring is exist at the data link layer (DLL). It is built in a star wired ring topology where the token travels uni-directionally around the ring. Nodes and the device called Multistation Access Unit (MSAU) are physically connected by wires in token ring network. Originally, token ring operates in the

speeds of 4Mbps before it was upgraded to 1Gbps and have been standardized by the IEEE 802.5 working group.

Token ring network adopt the whole process of token passing protocol to transmit data. As explained in the earlier section, the token circulates in a ring network even without data being transmitted. Each station will access the data and past to next station. Every stations wait for the token before attempting to access the network. Each token contains data, source and destination address. Token frame is converted to data frame when there involve a data transmission. The node which get the token will assign the token with these information and send it to next node. The data frame will travel around the ring until it reaches the destination node. The destination node will load the data into its buffer and return acknowledgement to data frame. This data frame will travel back to the source node which will check for the acknowledgement to ensure data was transmitted correctly. If the data has been transmitted successfully, the source node will send a new token to network.

Using Figure 5.0 the process of data exchange in token ring can be explained as below:-

i) There are 4 computer in the diagram which is A,B,C and D. Control token travel around all the computers as in (a).It may not contain any data to transmit

ii) Computer B receives the token and transmits a data frame as in (b). This data frame is circulated to C, D and finally to A.

iii) Data in data frame is received by computer A and attaches its message before retransmit to computer B as illustrated in (c).

iv) Computer B will verify the acknowledgement and knows that the data frame has been received correctly.

v) Computer B generates a new token to the network to be used by computer as shown in (d). The new token will circulate around the ring before captured by any computer for data transmit.

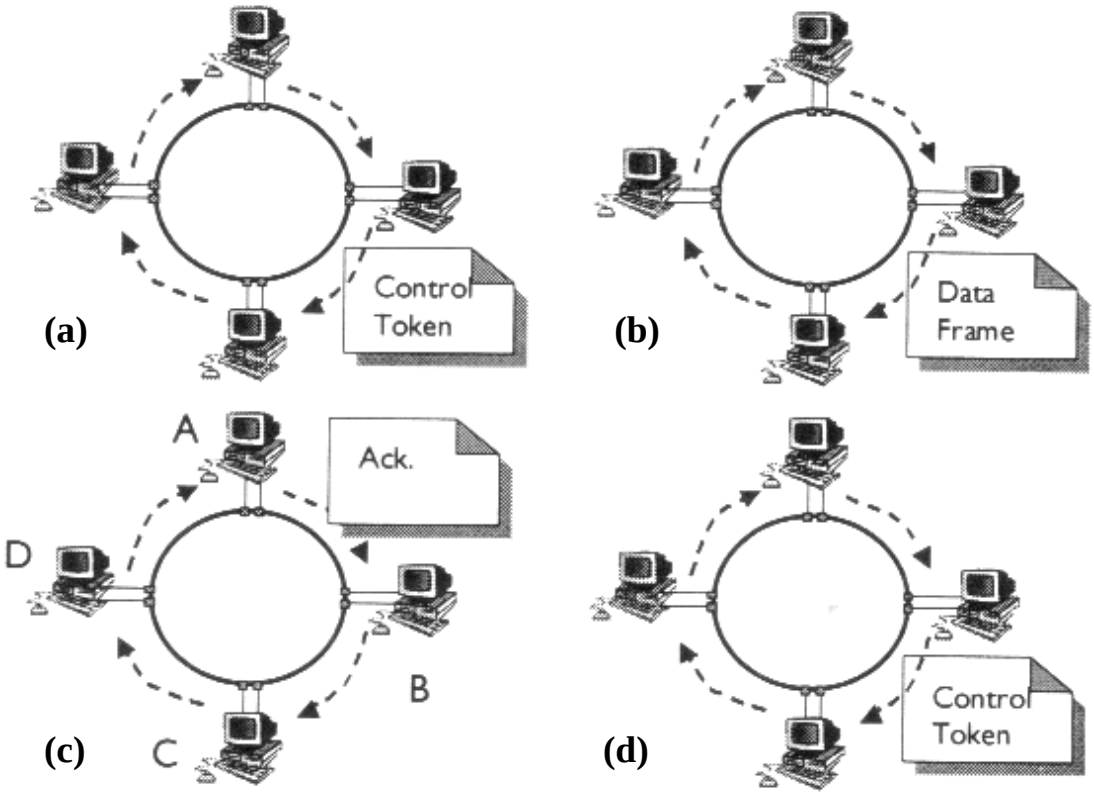

Figure 5.0 Data exchange in Token Ring Network

Retrieved from: http://homepages.uel.ac.uk/u0306091/TOKEN_RING.htm

7.0 TOKEN-BUS NETWORK

Token bus network have a same concept as token token ring network where token is needed for each station to access the network transmission medium. It is a Local Area Network for broadband networks and stations form a logical ring in the network. Topology of bus network consist of a group of workstations connected by long trunk cables and branch out in a star configuration where the network has both a bus and star topology. A token bus network is different from token-ring network because the ends of the bus do not meet to form a physical ring. In bus network the physical location of the computers is not important as all the computers have different sequence addresses which the token and data have to pass through.

Stations with a control token are able to transmit data frames based on time allowed by network. Token are released when the stations complete transmitting data or time limit has expired. Token that has been released are now available to the next station in the logical sequence and acquired by the station with the highest number in the sequence.

Token passing in bus network are shown in Figure 6.0. Token and frames of data transferred from one station to another station based on the numeric sequence of the station addresses. Because stations are addressed by numeric sequence, token transferred in a logical ring and not a physical ring. The last station in numeric order which has control of token will pass the token back to the first station. The sequence address of the computers is important as it decides next destination of the token. Since the token does not follow the arrangement of workstation, stations might be dispersed in a logical ring and location of stations can be at anywhere in the bus. For example, station 1 might be at one end of the cable, station 3 could be in the middle and station 2 located in another end of cable. Token bus is suitable for some manufacturing environments and distributed group of users by some distance.

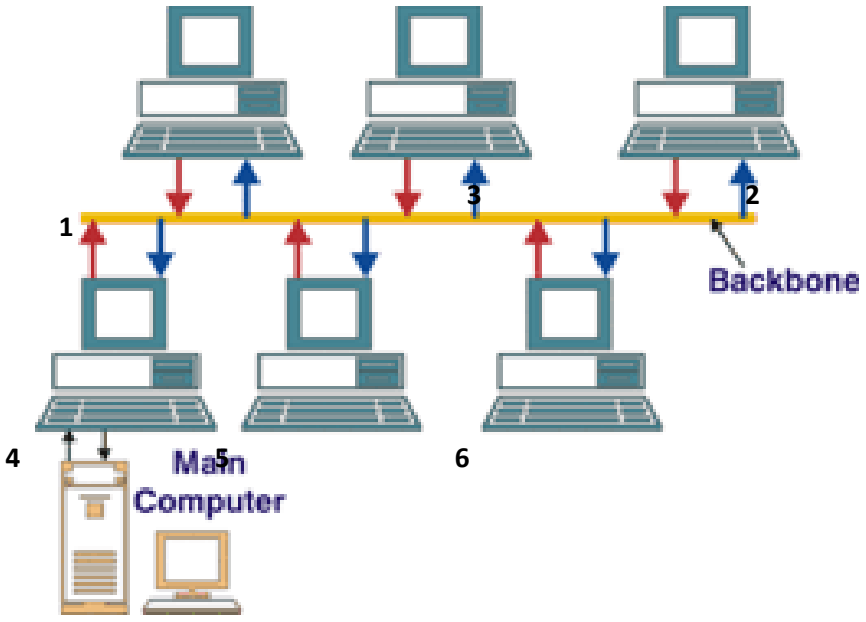

Figure 6.0. Bus Network Topology.

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ATTACHMENT

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