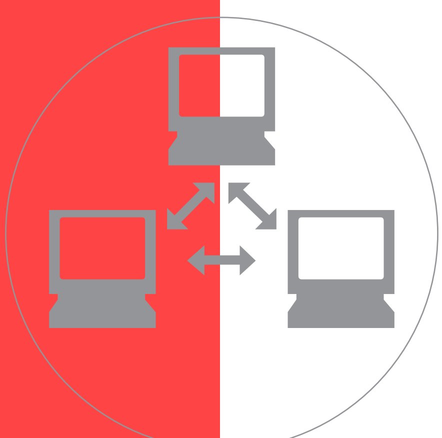
The Conversion Technology Experts

Collision Domains



Collision Domains

a white paper from Transition Networks, Inc.

Introduction

All communication protocols have a set of rules or specifications that govern their operation. It is these rules that determine both the performance and the limitations of each protocol. Both Ethernet and Fast Ethernet have, as a part of their protocol, a collision sensing standard. This is known as CSMA/CD (Carrier Sense Multiple Access/Collision Detection). This is the protocol that allows multiple devices to access a shared Ethernet or Fast Ethernet network.

Collision Domains

A collision domain is a group of Ethernet or Fast Ethernet devices that are directly connected by repeaters. Only one device may transmit at any one time inside of this collision domain. When a device is transmitting all other devices in the collision domain listen. The method by which this is accomplished is a simple means to guarantee that only one device is talking at a time. The construction of a network also will include such products as switches and routers. Collision domains are separated by these devices. These types of products also allow the separate collision domains to communicate with each other.

Media Access Protocol

When communications devices are sharing a network in any protocol, a MAC (Media Access Control) protocol is used to establish access to that network. As mentioned above, the CSMA/CD protocol is used by Ethernet and Fast Ethernet. The MAC resides in all data terminal equipment (DTEs) in the network. PCs, servers, bridges, and switches are typical DTE devices. Repeaters do not contain a MAC and operate with a simplified set of rules that will be explained below.

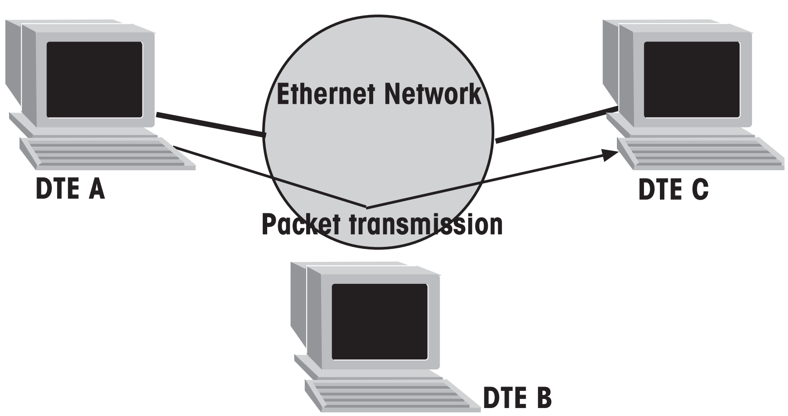


Illustration 1.1

To give an example of the operation of the Ethernet MAC layer, consider the following: On a network of Ethernet devices a DTE wishes to send a transmission to another DTE that is in the same collision domain. In this example DTE A wishes to transmit to DTE C (see Illustration 1.1). The MAC client will ‘listen’ to the network to determine if there is another DTE using the network. This is done by the CSMA protocol. If another device is currently transmitting it will not attempt to send its packet. Instead it will back off and wait until the network is clear. If no other signal is on the network, then the DTE proceeds to transmit the packet onto the network. When the packet completes transmission, the MAC client on the source DTE will consider the packet sent understanding that since no other device was transmitting, its packet transmission was good. If there is a need to send more than the single packet in this example, then the process in repeated.

The other half of this MAC client will determine the actions to take if two devices do transmit at the same time. Again, using the same example of a DTE wishing to send a packet to another device in the same collision domain, we will explore what happens to the network when collisions occur. The first DTE (DTE A) will follow the same steps as before. This time after beginning the transmission of a packet a different DTE (DTE B) also wishes to send a packet. DTE B will also use the CSMA to determine if there is current activity and make the decision to transmit or not. It is at this point that the issue of timing becomes important. As you know from the earlier example, DTE C will not transmit if it knows that DTE A is currently using the network.

A collision occurs if DTE B begins transmitting before the signal from DTE A is heard by the CSMA/CD MAC of DTE B. If this is the case all DTE’s in the collision domain will ‘hear’ the collision and they send a collision signal onto the network. The two DTE’s that are transmitting will then stop their transmission and restart again later. Each MAC client has a unique timing value that will determine when to restart.

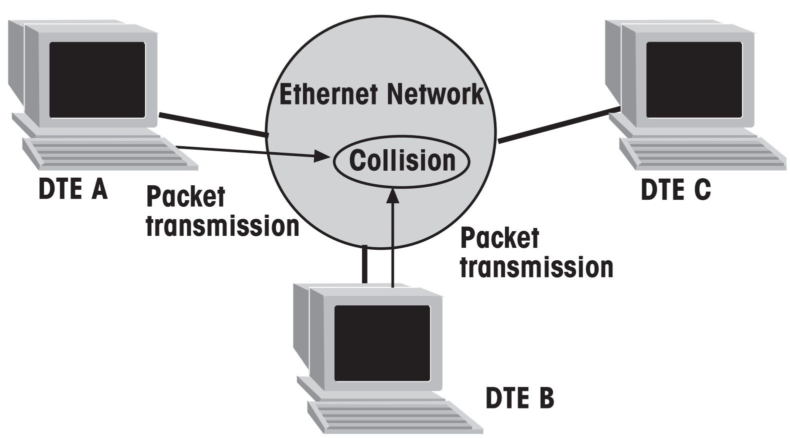


Illustration 1.2

The key is the time it takes for the first DTE's signal to reach the furthest DTE in the collision domain and for this DTE to return the collision signal. Remember that the first DTE will assume that it's packet was sent successfully if it does not hear a collision before it has completed transmission. This packet will then be discarded by the Ethernet MAC client. If transmission was completed before a collision was sensed, the packet is lost and requires a higher software layer to realize the packet is lost and then retransmit the packet. This is what is referred to as a late collision.

Collision Domain Diameter

The collision domain's diameter is limited primarily by this timing issue. The diameter of the collision domain is the distance between the two furthest nodes. Because of the potential for packet loss the dimensions are limited to reflect the example above. The maximum diameter of a collision domain is the total time it takes for the smallest packet to travel round trip between the two furthest DTE's in that domain. Because Ethernet and Fast Ethernet allow for variable packet sizes, the smallest packet size is used (64 Bytes). Another important consideration is that collision domains do not cross over bridges or switches. Every port on a switch represents a separate collision domain.

The limitations posed by the CSMA/CD protocol are important guidelines for designing a network. The signals that packets consist of take time to travel over the network. The time is doubled in the case of the collision signal returning to the transmitting source from the furthest node. With the 64 byte packet (512 bits) being the smallest packet size we can use the time it takes this size packet to travel the network serves as the measurement of a networks collision domain diameter. When using the 512 bit packet in this way and knowing that the signal travels over all media types in a finite fashion we can measure the maximum diameter by the 512 bit times for a round trip.

The goal of a network designer is to guarantee that a collision will occur in the first 512 bit times of transmission. If the collision occurs later than this, there is no certainty that the packet transmission on the network is successful. Limiting the collision domain diameter to 512 bit times ensures that all collisions do occur in an acceptable time frame. The table below demonstrates the statistics for both Ethernet and Fast Ethernet:

Table 1.1	**10Mbps Ethernet**		**100Mbps Fast Ethernet**	
Description	**Seconds**	**Bit times**	**Seconds**	**Bit times**
Bit time	100ns	1	10ns	1
Collision constraint	51200ns	512	5120ns	512
Round trip cable delay	27900ns	279	2337ns	234
Remaining budget	23300ns	233	2783ns	278
Maximum repeaters	4		2	

Table 1.2

Bit Time Delays

Item	Bit Times
Class I repeater	140
Class II repeater	92
DTE	50
1 meter UTP	1.1
1 meter fiber	1

The limitations on Fast Ethernet are the focus of this document. As you can see from the table above, distances in Fast Ethernet are limited to 1/10 the size of Ethernet. The design and layout of such a network must be carefully planned. While the round trip cable delay is easy to understand, it is helpful to see how these delay times affect the network's size.

The collision domain limitations will make it impossible to upgrade many networks from 10Mbps Ethernet to 100Mbps Fast Ethernet without making significant changes to the topology of the network. Even fiber optics will only give a marginal gain to total network size when used in a collision domain. Above and beyond the collision restrictions are the media imposed limitations of fiber optic cable and twisted pair wiring. Over multi mode fiber
2 km can be achieved in a full-duplex environment and the 100 meter limitation remains the same over copper wiring. The difference is attributed to the lower signal loss of fiber optic cables.

The timing constraints for Fast Ethernet will pose some interesting problems for network administrators. While it is easy to draw out a network on a sheet of paper, in real life there are numerous obstacles to overcome. In Fast Ethernet there are two classes of repeaters. These are divided according to the delay that they introduce into the network. The fastest of the two, the Class II repeaters must have no more than 92 bit times of delay. The second class, the Class I are restricted to 140 bit times or less. These two simple illustrations demonstrate two repeater classes' largest Fast Ethernet collision domains.

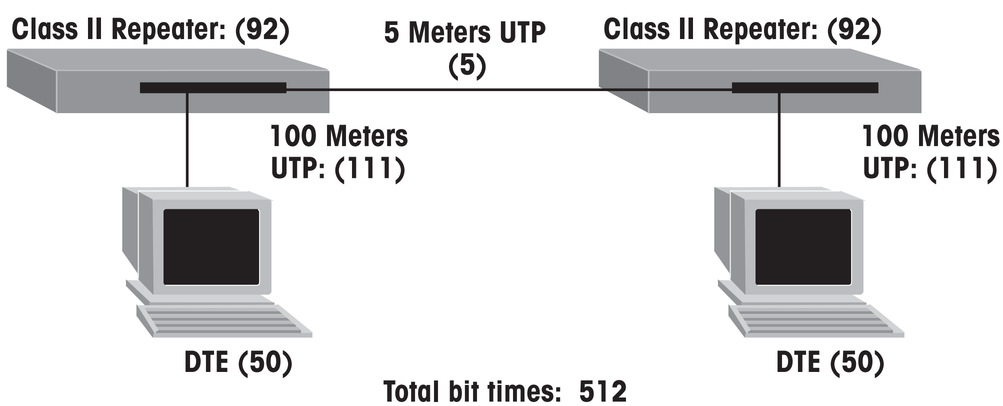


Illustration 1.3

This is the maximum network size for the Class II repeaters Class II repeaters are the most common type of Fast Ethernet repeater.

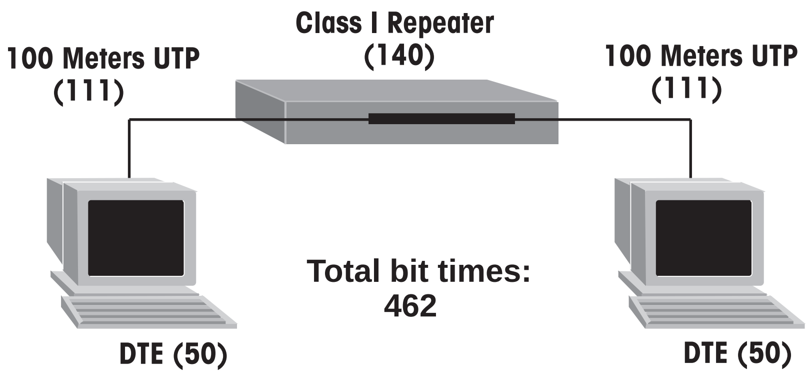


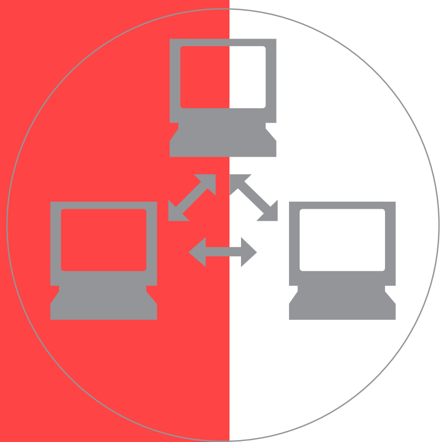
Illustration 1.4

Class I repeaters do not allow for the use of more than one repeater in a collision domain.

Summary

Collision domain size is a major consideration for any Fast Ethernet network. While Fast Ethernet shares the same CSMA/CD protocol as Ethernet, the distance limitations for collision domain diameter are one tenth as large. In the 10mbps Ethernet environment these distances are rarely pushed to the limit. However, as speeds increase the distances and repeater limitations will make using Fast Ethernet over existing cable plant a challenge. If you are planning to use Fast Ethernet in the future keep in mind the following guidelines.

- Fast Ethernet collision domain diameters are limited to 412 meters over fiber and 205 meters over twisted pair
- The collision domain timing limit is a round trip figure of 512 bit times
- To extend the distance limitation the collision domain must be separated or bridged



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