
Topic / Issue: Fast Ethernet Design

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Overview

100Base-TX (Fast Ethernet) is ideally suited for customers who desire high performance on their network.

Using the same CSMA/CD protocol as used in standard 10Base-T networks, Fast-Ethernet provides a easy, cost effective migration from 10Mbps to 100Mbps. It provides the ability to group file servers in one location , allowing greater security and easier management. Existing 10Mbps Workgroups can be maintained while Fast-Ethernet backbones and high performance workgroups are added on around the network. Alternatively, upgrade the existing workgroups to switched 10Base-T for greater performance while maintaining the current 10Base-T wiring and hardware structure.

Switching Concepts

Ethernet Switches increase network performance by decreasing the amount of traffic and collisions on individual segments attached to the switch. Broadcasts are generally propagated throughout the LAN while packets within the LAN are only retransmitted within their desired segment. Switches break up collision domains, and therefore allow the creation of much larger networks.

When a packet is received by a switch its header is checked to see which segment the packet should be switched through to. If it is destined for the originating segment then the packet is ignored. This can be done in two ways : Cut-Through and Store&Forward.

Cut-Through switching basically reads the first few bytes of a packet to identify the destination address and then attempts to pass the packet directly through to the correct segment. This causes very little delay within the switch. But the switch can pass invalid packets because in general it does not store and check the complete packet for errors before forwarding the packet on.

With Store and Forward switching packets are received, stored , checked for errors and then forwarded to the correct destination. These switches impose a small delay over throughput, but are less likely to propagate packets with errors than the Cut-Through method

Design 100Mbps Networks

When designing a Fast-Ethernet LAN there is a limitation on the round trip signal delay time allowed between two DTE type devices. This is termed the "Collision domain". This maximum delay time allows the collision detection mechanism to remain valid.

A DTE type device can be one of the following :

- Any Switching device.
 - Any Network card (End Transmission / receive device)
 - A Bridge
 - A Router
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The interconnecting network components that exist between these devices will all introduce delays. These devices can be Hubs , Repeaters , Converters , and even the connecting cable . In a 10Base-T LAN these delays were of less consequence due to the slower bit rate . But within 100Base-T LANs the delays become much more important to correct operation of a collision domain. The collision domain for 100Mbps is 512 Bit times. The 512 Bit time originates from the fact that the smallest packet permitted on a Ethernet network is 64 bytes or 512 bits. Basically the transmitting device must be able to receive its own first bit before the last bit has been transmitted . This ensures that a collision free transmission has occurred. (CSMA/CD)

To understand why a switch can be an end device within a Collision domain but not a Hub, you must understand that a collision occurs when two devices transmit at approximately the same time. Because a Switch can store packets until it is able to transmit them with no collision, remembering it only retransmits to the required segment (not all segments as a Hub would), the switch will always be able to eventually retransmit the packet. This allows the initialising segment to continue processing other packets while the switch negotiates the re-transmission of the original packet. If a switch's buffer is full and a packet arrives that the switch must act on, it simply forces a collision on the initiating segment, which allows the switch time to transmit some of its buffered packets, while the initiating device times out from the collision.

To calculate a round trip delay time within a segment the Worst-Case path must first be located. This will be the path between two DTE's (Workstation, server or switch) that passes through the largest number of repeaters and the longest cable runs. If there is more than one path, take note of all paths that are likely to be Worst-Case paths. If any of the Worst-Case paths exceed the maximum round trip time, then the segment must be redesigned or the offending path be shortened.

The following table shows the delay values introduced by network components when operating at 100Mbps. Note these are not valid within a 10Mbps LAN.

Component	Max Bit-time delay
Two TX/FX DTE's	100
Two T4 DTE's	138
One T4 and one TX/FX DTE	127
Category 3 Cable	1.14 / meter
Category 4 Cable	1.14 / meter
Category 5 Cable	1.112 / meter
Shielded Twisted-Pair Cable	1.112 / meter
Fiber Optic Cable	1 / meter
Class 1 repeater	140
Class 2 repeater	92
Class 2 repeater with T4	67

There are two definitions for repeater type devices. Class I and Class II. A Class I repeater is allowed larger timing delays, and supports translation internally for 100Base-TX/FX and 100Base-T4 support on the one device. A Class II repeater is restricted to smaller timing delays and can connect only to segment types using the same signalling techniques .

From the previous table you can see that the minimum required components ie 2 Workstation , will decrease the maximum cable length to 412 bit times. This case is only possible with fiber.

There are exceptions to these rules:

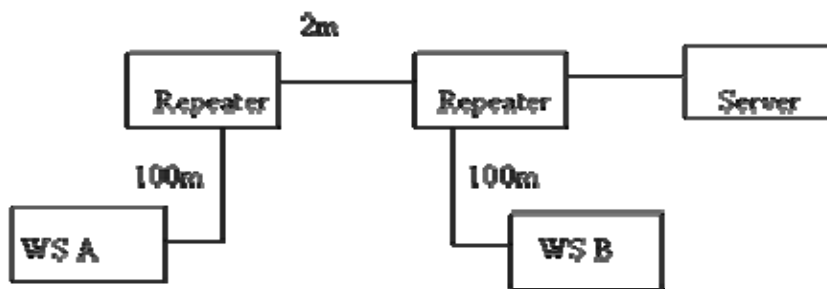
Full duplex fiber from a DTE to DTE can run up to 2 Km.
Proprietary devices quite often do not follow these guidelines.

KEY 100BASE-T TOPOLOGY RULES.

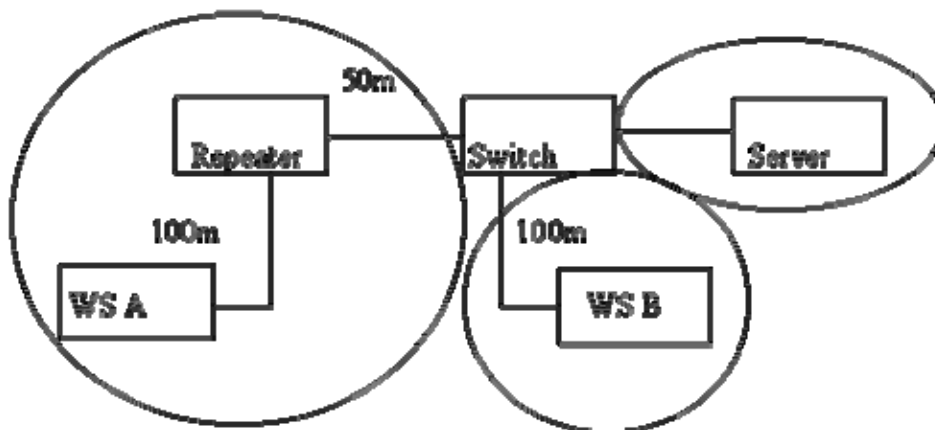
- * The maximum UTP cable length between hub and desktop is 100 meters.
- * In two-repeater topology's, a total 205 meters of UTP cable is allowed.
- * A hub connected to a switch with UTP cable should not exceed 100 meters.
- * 512 bit times round trip delay is allowed within the collision domain.

Note: 100 Base-TX standard includes a Media-independent interface (Much like a AUI).
This is a form of interface direct between the CSMA/CD MAC layer and any of the three media types (TX,FX or T4).

Single collision domain:



Worst case path in this situation is from Workstation A to Workstation B. The total bit time for this segment being 508.6. But if the two Repeater's needed to be separated by 50 meters. The best solution would be to place a switch such as the NS-16 in place of the second Repeater (Shared Media hub). Multiple collision domains:



The Worst Case path would now exist between Workstation A and the new Switch. The total Bit time would be 358. and 3 collision domains would now exist, all within the Bit time limitations, effectively creating Less Collisions, More Throughput and Greater Flexibility.

The easiest way to overcome collision domain limitations is to install a Switch.

What you Need to Know when Planning a LAN

There are several things you need to understand before planning a 100Base-T or 100/10 Mbps LAN. The Following are some of the required info.

- **Number of nodes to be connected.**
- **Distances between nodes.**
- **Building layout**
- **Location of servers**
- **Expected traffic utilisation within Workgroups (Peer to Peer)**
- **Expected traffic utilisation to File Servers.**
- **Expected growth within the company/department. (Try to get a idea on what will be required in 1-2 years for the company.)**
- **A Basic Budget the end user is happy with.**

Guidelines on Where to Switch and Where to Share

Switched 10 /100 Mbps

Great for implementing into existing LANs . Will give the performance boost of Switched 10Mbps to either the workgroup or Workstation while also creating 100 Mbps pipes to Servers or as a backbone to other Switches.

Shared 100 Mbps

Perfect for Peer to Peer as with Win95, or for high end workgroups connected back via a Fast Ethernet Switch. The stacking option, allows for workgroup growth while maintaining the one logical stack (additional Stacked Hubs do not add Additional Bit-time restrictions)

Switched 100 Mbps

**Probably most useful as the backbone for larger LANs
Full Duplex Server links down to Shared 100Mbps Hubs or 10/100 Switches.**

Distance will have a major effect on the design of a LAN , in some cases it will necessitate the need for switching, in others it may make switching redundant.

One important note is that when introducing switches, the whole switched network becomes one logical network. All Broadcasts will be propagated and all devices need to be bound to the same segment name

**Summary:
(If required)**