WHITE PAPER

July 1996

Compaq Computer Corporation

Systems Division

Internetworking Products Group

CONTENTS

Smart Uplink Technology: Overcoming the Configuration Limitations of Fast Ethernet

Networks are becoming increasingly overloaded with users, services, and heavy bandwidth applications. This kind of traffic can cause networks to become ineffective in what they were originally intended to do- move data quickly. But emerging technologies, such as Fast Ethernet, have opened up new opportunities for performance enhancements.

The Compaq Netelligent strategy for bringing 100Base-T Fast Ethernet technology to the desktop is straightforward:

- *Compaq provides dual-speed 10/100 Ethernet adapters at a price comparable with single-speed 10Base-T adapters, making integration of shared 100 Mb/s onto the desktop an easy decision.*
- *Compaq provides managed and unmanaged 100Base-T repeaters at prices which are competitive with slower 10Base-T technology - thus offering a significant price:performance advantage over 10Base-T Ethernet.*
- *100Base-T protocols leverage the knowledge, software, and infrastructure established with 10Base-T Ethernet, while providing a ten-fold improvement in bandwidth.*

Implementation of 100Base-T Fast Ethernet into a network presents two obstacles that all 100Base-T vendors must face, however. The familiar guidelines used for designing and configuring legacy 10Base-T networks do not apply to 100Base-T network design. Specifically, the new configuration guidelines for 100Base-T networks:

- *Permit only two repeater hops along the data path while maintaining a 100 meter distance to the desktop*
- *Limit the distance between repeaters to a maximum of 5 meters (16.4 feet)*

This means that while 100Base-T can be easily deployed in a workgroup setting, in its current state it is not a 'drop-in' replacement for Ethernet in larger networks unless more expensive bridging and routing technologies are added to the equation.

Compaq has introduced a new technology called Smart Uplink which overcomes the configuration limitations for 100Base-T networks and brings them back into alignment with those of 10Base-T. With Smart Uplink, 100Base-T truly becomes a drop-in replacement for 10Base-T without violating the standards for Fast Ethernet and without introducing the need for additional bridges, switches and routers.

COMPAQ

NOTICE

The information in this publication is subject to change without notice.

COMPAQ COMPUTER CORPORATION SHALL NOT BE LIABLE FOR TECHNICAL OR EDITORIAL ERRORS OR OMISSIONS CONTAINED HEREIN, NOR FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES RESULTING FROM THE FURNISHING, PERFORMANCE, OR USE OF THIS MATERIAL.

This publication does not constitute an endorsement of the product or products that were tested. The configuration or configurations tested or described may or may not be the only available solution. This test is not a determination of product quality or correctness, nor does it ensure compliance with any federal, state or local requirements. Compaq does not warrant products other than its own strictly as stated in Compaq product warranties.

Smart Uplink Technology:
Overcoming the Configuration Limitations of Fast Ethernet

Version 1.0 (July 1996)

Document Number

084A/0796

WHY IS THERE A PROBLEM?

100Base-T looks like Ethernet on steroids – only the transmission speed has changed. Fast Ethernet, therefore, is the natural evolution of Ethernet. As market forecasts and buying trends indicate, there is a tremendous market for an Ethernet technology that provides a ten-fold increase in bandwidth. According to the Dataquest 1995 Worldwide Intelligent Repeater Market Forecast, over 49 million new Ethernet ports will be sold this year – each one of these is a potential candidate for 100Base-T.

However, 100Base-T is not exempt from the laws of physics. While the access method and packet sizes stay the same, increasing the transmission rate from 10 Mb/s to 100 Mb/s causes three adjustments to the well-understood configuration guidelines for 10Base-T Ethernet networks:

- Category 5 unshielded twisted pair (UTP) that was optional for 10Base-T networks is required for 100Base-TX networks (4-pair Category 3, 4 or 5 wiring is acceptable for 100Base-T4 networks).
- Network segments cannot span more than two repeater hops.
- The distance between repeaters decreases to 5 meters (16.4 feet), limiting the total (end-to-end) length of a 100Base-TX network segment to 205 meters (672.4 feet) when using UTP cable.

For Fast Ethernet to gain the same widespread acceptance as 10Base-T, its configuration guidelines should be at least as flexible. To understand how Smart Uplink technology makes this possible, we must take a look at the factors that shape these configuration guidelines.

ETHERNET PROPAGATION DELAY

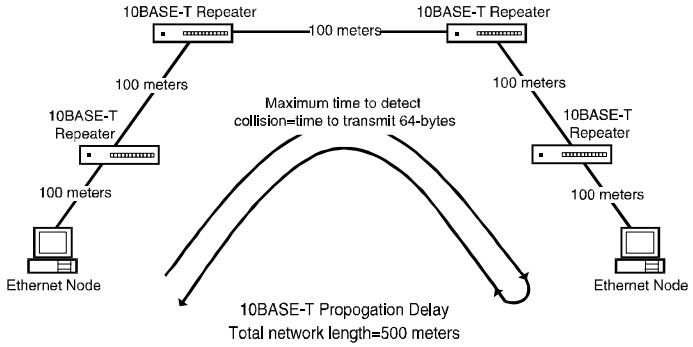
Ethernet and Fast Ethernet use a method of accessing the network called Carrier Sense Multiple Access with Collision Detection (CSMA/CD). CSMA means that Ethernet devices listen to the network to ensure that the line is idle before transmitting. When two or more stations transmit simultaneously, an error condition, called a collision, occurs. To ensure that the network would recover from this condition, the Ethernet specification included a recovery scheme called Collision Detection (CD).

With the Collision Detection scheme, a sending station listens to the network while transmitting data. If two stations transmit at the same time, the collision is detected and a jamming signal is broadcast. When this happens, the sending stations back off, wait a random period of time, and begin the listen and transmit procedure again.

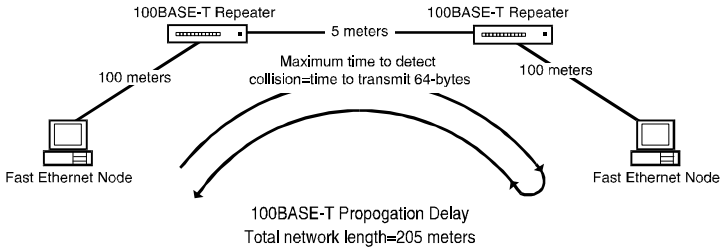
The amount of time it takes for data to reach the other end of the network (including wire and repeater delays) is called its *propagation delay*. When an error occurs, there is an additional delay for the jamming signal to reach the sending station. For the Ethernet collision detection scheme to work, the time it takes to detect a collision (which can be up to twice the propagation delay) must never exceed the time it takes to transmit a complete Ethernet packet. Otherwise, it would be possible for a sending station to transmit a valid Ethernet packet before it received notification that a collision occurred.

At the higher transmission speed of 100Base-TX, the time it takes to transmit a complete packet is much shorter. We can adjust several factors, including the number of repeaters in the data path and the length of the network segment, to accommodate this shortened transmit time. Holding the distance between a node and the repeater constant at 100 meters (328 feet), the IEEE 802.3 committee adjusted both the distance between repeaters and the maximum number of repeaters to fall within these specifications.

Maximum 10BASE-T Network Configuration



Maximum 100BASE-T Network Configuration



As this figure shows, the resulting changes limited 100Base-T networks to two repeaters in the data path and limited the distance between the repeaters to 5 meters (16.4 feet). Therefore, the total network length of 2,500 meters (8200 feet) for 10Base-T networks was reduced to 205 meters (672.4 feet) for 100Base-T networks within a single collision domain.

CLASSIC SOLUTION TO THE PROBLEM

The conventional approach to building larger networks (and networks with a greater number of ports) is to use bridges, switches, and routers to interconnect independent Fast Ethernet segments. Using a bridge, switch, or router, you can interconnect isolated 100Base-TX segments into a larger internetwork as shown in the figure below.

However, there are drawbacks to the bridging, switching, and routing approach:

- Bridges, switches, and routers introduce latency in the network, negating some of the performance benefits.

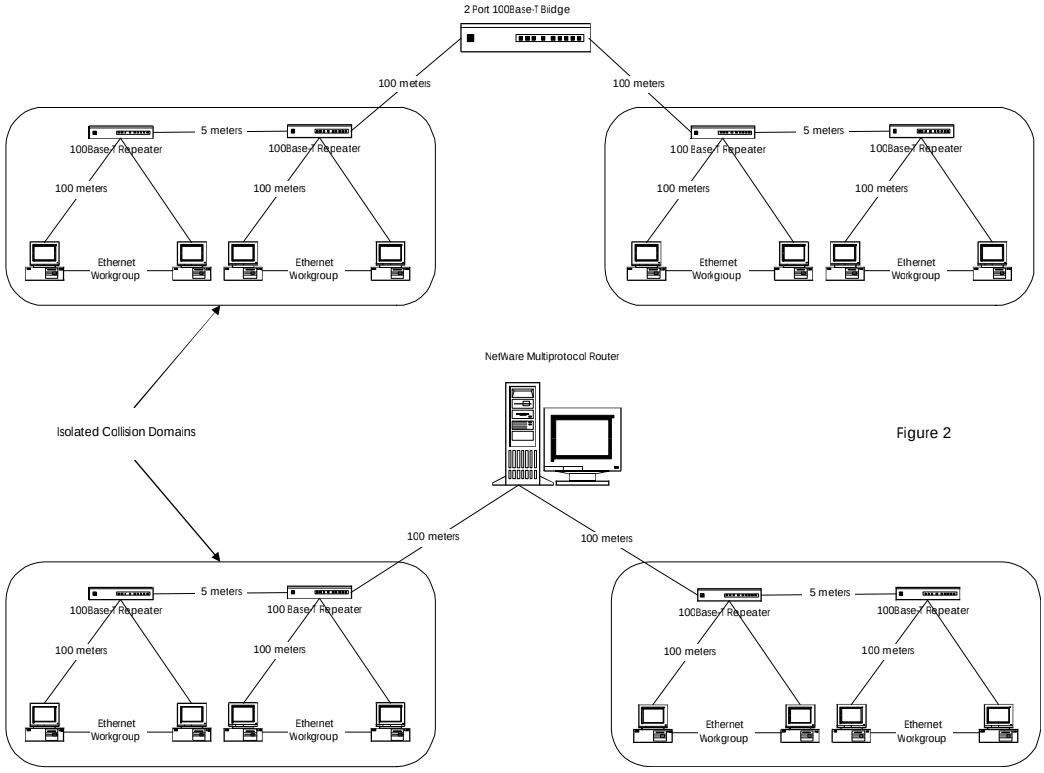
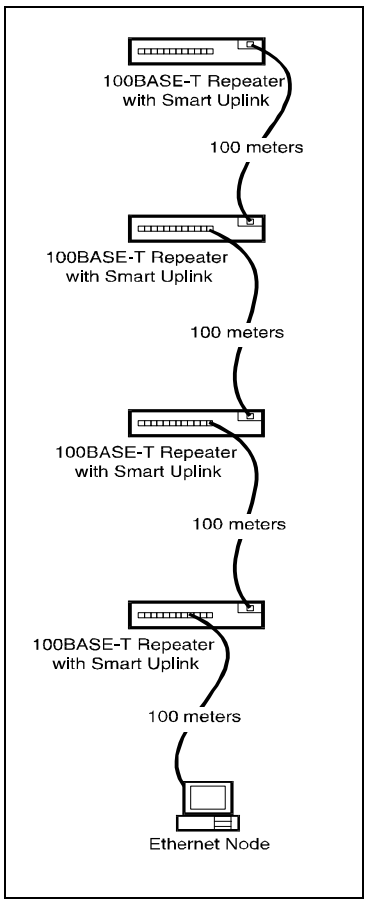


Figure 2

- When bridges, switches, and router buffers overflow, they drop packets. This causes time-outs at the sending nodes, significantly reducing the network's performance.
- Bridging, switching, and routing also introduce significant additional costs to the network, for purchase, configuration, and maintenance of network equipment.

THE SOLUTION WITH SMART UPLINK TECHNOLOGY

Smart Uplink technology makes it possible to expand 100Base-T networks beyond the two-repeater limit and extend the distance between them to 100 meters (328 feet) fiber optic cabling allows the distance to grow up to 412 meters (1351.4 feet). This brings the configuration guidelines for 100Base-T back in line with those of traditional 10Base-T networks.

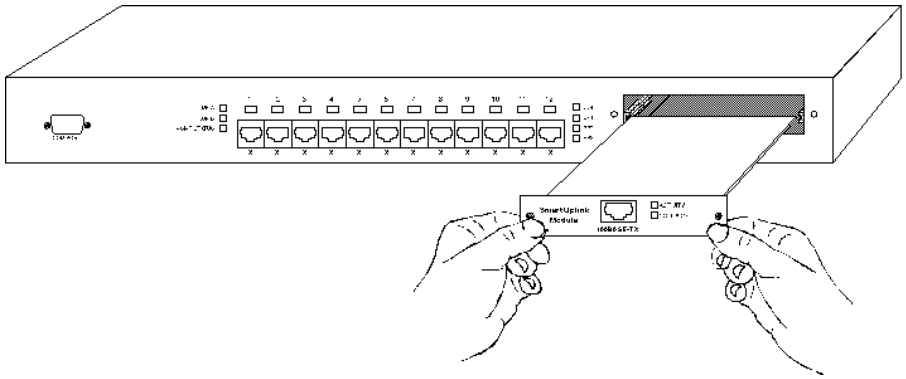


In fact, using Smart Uplink, you can configure hierarchical networks that span any number of repeaters. With the greater distances permitted between repeaters, Smart Uplink makes it feasible to build 100Base-T networks that are larger than those possible with 10Base-T.

Smart Uplink is implemented as a user-installable module that serves as a point of connection between 100Base-T repeaters or 100Base-T repeater stacks. Smart Uplink Modules are available in two versions:

- SMARTUP-TX: for 100Base-TX Category 5 UTP networks
- SMARTUP-FX: for 100Base-FX multimode fiber networks.

Smart Uplink Modules fit into the Compaq Netelligent 3512/3612 100Base-T repeater.

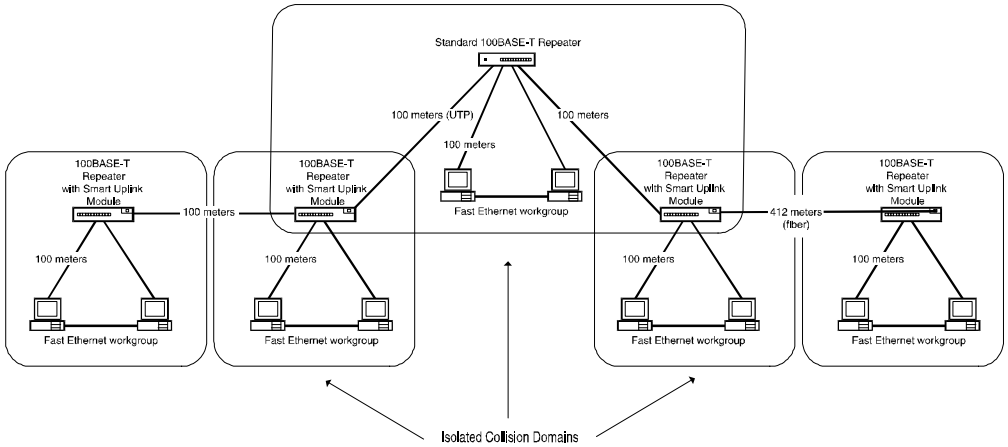


SMART UPLINK MODULE THEORY OF OPERATION

The Smart Uplink Module interconnects its host repeater and another 100Base-T repeater while keeping the host repeater isolated within its own collision domain. The Smart Uplink Module permits the collision domain of its host repeater to be isolated from the collision domain of the connected 100Base-T repeater by providing full-duplex, cut-through forwarding capabilities between these two collision domains. This means that the Smart Uplink Module forwards Ethernet frames with only a minimum delay to ensure collisions are not propagated between the segments.

Smart Uplink has buffering capabilities in case the destination domain is busy. As its buffers reach saturation, the Smart Uplink Module can prevent packet loss by throttling back stations in either domain until it has room to receive more packets. In this way, the Smart Uplink Module can help eliminate the dropped packets associated with bridging and routing.

Isolation of its local collision domain also permits the Smart Uplink to overcome the configuration limitations of 100Base-T. Since traffic originating in one domain is forwarded to the next domain by the Smart Uplink Module, the sending node is not forced to contend with the propagation delay of the entire network. A sending node needs only to contend with propagation delay within its local domain.



The Smart Uplink Module does not require any configuration. It is a Plug and Play device that provides the benefits of bridging without the associated purchase, configuration, and maintenance costs. In addition, Smart Uplink technology eliminates problems such as latency and dropped packets often associated with bridging, switching, and routing technologies.

COMPAQ FAST ETHERNET TECHNOLOGY LEADERSHIP

Compaq is committed to making Fast Ethernet technology efficient, affordable, and flexible. Smart Uplink technology overcomes the configuration limitations for 100Base-T networks and enables it as a drop-in replacement for 10Base-T. Smart Uplink technology is “plug compatible” with Compaq or third-party 100Base-T repeaters and repeater stacks. When combined with low-cost manageable 100Base-T ports and 10/100 adapter cards, Smart Uplink technology makes Fast Ethernet the obvious choice for bringing 100 Mb/s to the desktop.