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Ethernet Applications in Traffic Control

Demand for Bandwidth Makes Ethernet the Preferred Protocol

A White Paper

by

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Overview

Video cameras are an attractive new tool for traffic control and management. Video cameras can provide immediate full-motion feedback as traffic hotspots unfold, as well as offer better information for emergency vehicles, pedestrian and vehicular safety, public security, and other control and management functions that are the outgrowth of increasingly congested traffic conditions. Live video is driving a revolution in traffic control communications because the data bandwidth required for video is up to 100 times greater than the capacity of traditional serial communications lines that typically run out to the intersections themselves.

The second impact of new higher-bandwidth technologies is the increased difficulty of getting the huge flow of data up to the Traffic Operations Center (TOC). A highly centralized network topology is required for centralized traffic control operations. Fiber is the transport medium of choice because it is noise resistant and can carry data over long distances. A large proportion of traffic control networks have been designed using fiber cable and layered switches for connecting multiple traffic control sites, however the choices of the communications protocol to run over the fiber lines are broad.

Ethernet is emerging as the protocol of choice for incorporating video cameras at traffic intersections and for connecting to cameras monitoring interstate highway traffic. With the introduction of the new 1 Gigabit (Gb) Ethernet standard over the last couple of years, it is also a strong contender for carrying huge amounts of data back to the TOC. The scalable Ethernet standard encompasses a variety of bandwidths and, with the unlimited bandwidth capacity of fiber optic media, promises inexpensive and relatively painless upgrade paths for systems as traffic control technology evolves.

Communications Protocol 101

A centralized traffic control network topology is comprised of two major pieces. The edge portion of the network connects devices in intersections into the intermediate local collection points. The edge bandwidth, typically 25 to 100 Mb with live video, needs to support one intersection or a subnet consisting of several intersections. The backbone portion carries the traffic from intermediate local collection points to the TOC. Bandwidth is heaviest here, running from 100 Megabit (Mb) to 1 Gb, and outages cannot be tolerated.

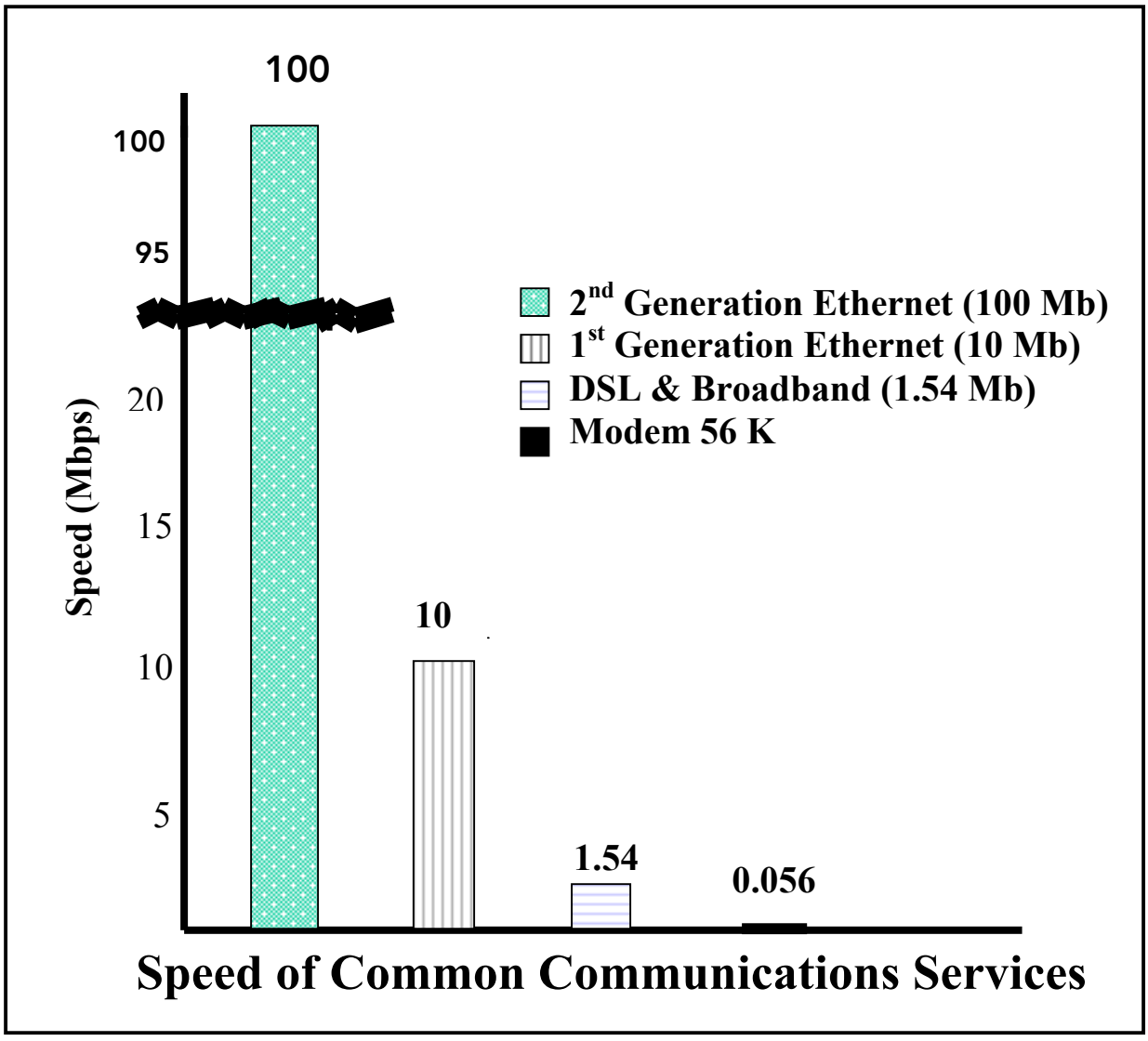
In both edge and backbone applications, the traditional practice in traffic control has been to follow telecommunications' lead. Telecommunications solutions have focused on serial connections, reliability, and outdoor-hardened equipment – and these were readily available. However, as bandwidth demands increase and options become available that provide both lower cost and higher performance, trends are moving toward newer packet-oriented standard solutions.

Fiber, the Preferred Medium

The data transport medium is as critical as the protocol in creating a reliable system. Backbones do the heavy hauling, and are almost always fiber-based. Fiber has emerged as the backbone medium of choice because it provides unlimited bandwidth and it is relatively immune to electrical noise, contaminants, and other intrusions of the outdoors into a communications medium environment. With a range of 20 Km for 100 Mb standard single-mode fiber implementations, it provides secure transport within the typical range of a TOC. Today fiber's distance capability, noise immunity and reliability are making it the medium of choice at the edge as well.

Ethernet at the Edge

Voice-grade and T1 serial lines have previously been the edge protocols of choice for installation at the intersection for managing traffic lights, pedestrian crosswalk signals, traffic counters, and other light duty activities. Today, however, live video and other new technologies promise more information and more responsive traffic control – but at the cost of greatly increased bandwidth. Modems running at 56 Kb and T1 lines running at 1.544-3.152 Megabits per second (Mbps) cannot keep up.



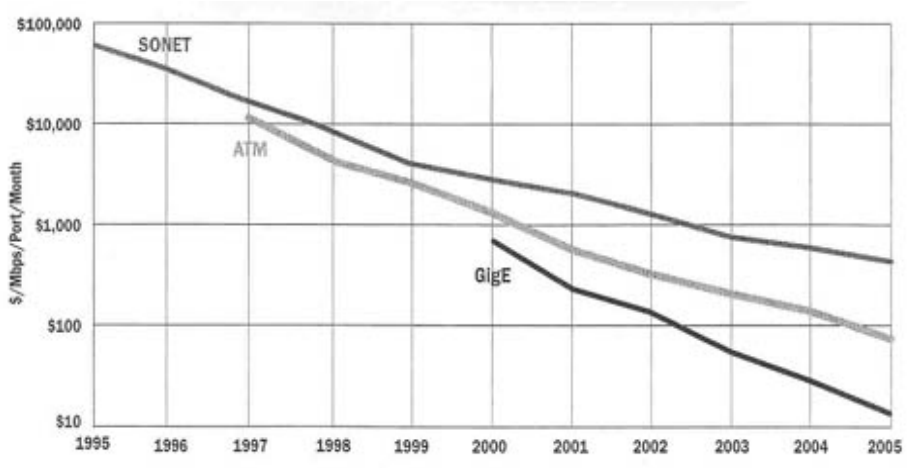
With more than 80 percent of all traffic intersections wired for data transmission, traffic control designers and managers across the nation are considering upgrades to higher performance communications systems. Ethernet is the new protocol of choice. Ethernet has always had both bandwidth and cost advantages over serial telecommunications lines, however, office-grade Ethernet products are designed for clean, air-conditioned environments. The heat, humidity, dirt, and electrical interference common to traffic control boxes and other outdoors applications were incompatible with delicate office systems. As Ethernet's performance and cost advantages were recognized in other markets, such as telecommunications and industrial control, new Ethernet boxes hardened for outdoor use became available. They have metal cases that are sealed to keep out contaminants, and they use premium components rated for temperature extremes along with special thermal design techniques. Combining the hardy features of the fiber medium with Ethernet product designs that could withstand extended temperatures and particulate contamination extended the benefits of Ethernet to other markets.

Today Ethernet appears to be the ideal protocol for the particular needs of edge traffic control systems. Ethernet provides the high bandwidth necessary to support live video and other applications that can help manage the overcrowded traffic environments of this decade. With the emergence of hardened outdoor Ethernet products, Ethernet is finally practical for traffic control. Traffic control devices such as cameras, wireless access units, and Model 2070 Controllers come with an Ethernet interface built in. Ethernet hardware is as affordable as T1 equipment, and the fiber optic media costs the same whether used for Ethernet or for serial data. In addition, the easy upgrade path as bandwidth requirements continue to spiral, makes it advantageous for cost-conscious traffic management planners.

Ethernet in the Backbone

Backbone protocol choices have traditionally been SDH, SONET and ATM. With the recent introduction of the 1 Gb (1999) and 10 Gb (2002) Ethernet standards, IP data traffic running over Ethernet now provides the backbone bandwidth required. In a traffic control network with video, over 95 percent of the data moves from the edge to the TOC; very little flows down. Networks based on IP packets are well suited to this unbalanced load. In addition, where SDH, SONET and ATM systems normally are heavily oversubscribed, Ethernet networks can more readily pass all the data through the backbone, making an Ethernet-based traffic control network more responsive under peak activity (i.e. emergency situation) conditions. Best of all, Ethernet offers a much more attractive cost structure.

Cost to Deliver Bandwidth over Time



Source Business Communications Review

With bandwidth over SDH, SONET or ATM protocols being metered, per telecommunications tradition, the price increases as the bandwidth demands increase. Ethernet's commercial orientation provides virtually free bandwidth once it is installed. Complexity is reduced because, with an all-Ethernet network, costly routers are minimized or eliminated. It is becoming evident that, unless SONET or ATM is already installed and paid for, planning for an IP-switched Ethernet backbone is the best strategy for the future.

Government Support for Ethernet

With the emergence of the Department of Transportation's Intelligent Transportation Systems (ITS) initiative, there has been increasing focus on interoperability. With the modern dependence on highways for local and long-haul transportation, and the potential for 20-mile or longer backups and disasters that can tie up freeways and surrounding surface streets for hours, traffic management has to improve.

A recent incident on the Capital Beltway required coordination among emergency services from two states and the District of Columbia, and some federal agencies were involved. Without a basic level of interoperability to allow services from different jurisdictions to "speak" to each other, communications snafus added to the mess.

As a part of the ITS initiative, interoperable Ethernet-ready traffic control devices, such as the Model 2070 Advanced Traffic Controller, are emerging. This recognition of Ethernet as a valuable protocol for traffic control reinforces a trend that has been gaining momentum for some time.

Emerging from the office environment in the days when personal computers were connected by the "Adidas net" (i.e., carrying a floppy disk from one system to another), Ethernet has over 20 years of practical history in

creating and nurturing a level of interoperability that makes possible the interconnection of multiple systems from multiple vendors without a hitch. Ethernet in LANs has swept away ARCnet, Token Ring, AppleTalk, and ATM. With cost-effective interoperable equipment readily available from multiple suppliers, Ethernet is the choice in government networks today.

As Ethernet has matured, it has become a valued protocol in the high-availability, high-reliability telecommunications market. With the introduction of hardened Ethernet products, Ethernet is rapidly displacing proprietary protocols in the industrial market as well. Almost all new industrial controllers are built with an integral Ethernet port today. Small low-cost serial-to-Ethernet converters are simplifying the transition from old serial lines to Industrial Ethernet. Even though bandwidth requirements are modest, fiber media is dominant in industrial networks, and the universality of Ethernet makes it a winner.

It stands to reason that Ethernet will become the edge protocol of choice in the traffic control market – and that it will also become a popular and cost-effective backbone protocol as well. It is time for traffic systems to move out of the telephone age (serial lines) into the Internet age (IP packet data).

Sample Implementation: Video Systems for Traffic Control

Live video offers the capability to provide instant traffic information for real-time management, but the data bandwidth required is up to 100 times greater than the capacity of traditional serial communications lines. In addition, reliability and redundancy are issues. In congested traffic conditions, a failure at any intersection can have widespread repercussions.

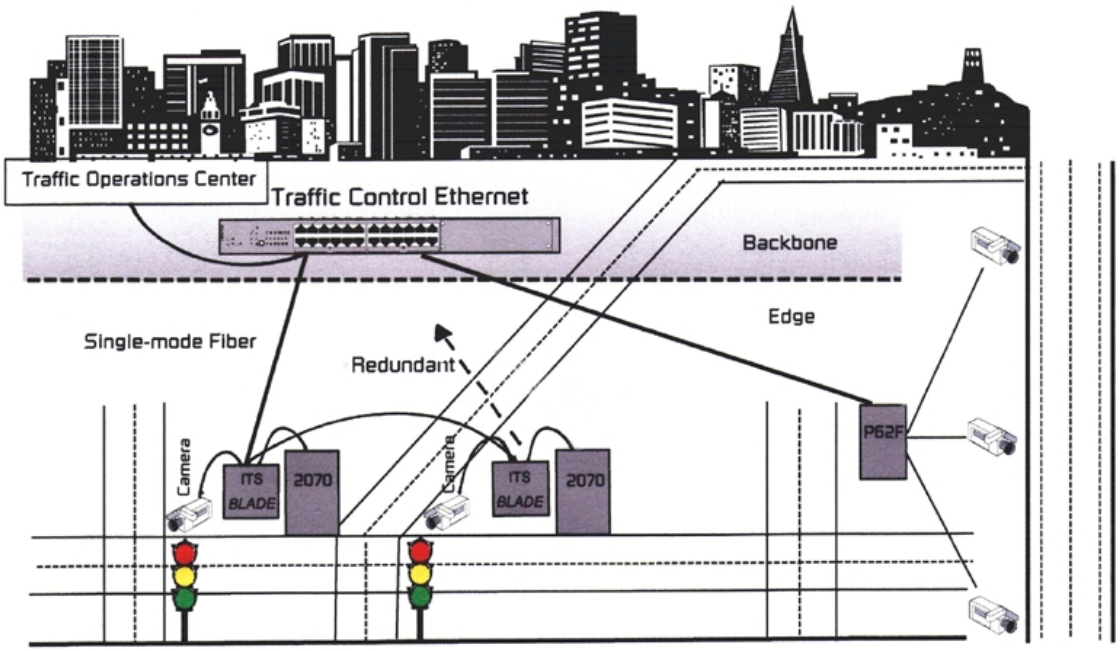
To install up to four cameras at an intersection, allowing complete surveillance of traffic conditions, requires bandwidth of up to 25 Megabits per

second per intersection. However, the cost would prove prohibitive using a traditional telecommunications high-bandwidth solution.

The environment in the traffic control boxes at intersections requires special hardened communications equipment to support the operational temperature ranges, dust and dirt, and fog and humidity to which it would be exposed in a traffic control box. Outdoor-hardened Ethernet devices are a preferred solution because the equipment itself is 10 percent or less of the cost of the alternatives for the same bandwidth. In addition, Ethernet provides an upgrade path that promises lower cost in the future, as well as today.

A sample edge solution is GarrettCom's new ITS *Blade* Ethernet switch-on-a-card that saves space in the tight confines of a traffic control box, occupying one A1 or A2 peripheral slot inside the Model 2070 Traffic Control Chassis. It supports up to six 10/100 copper ports to connect to the Ethernet-ready video cameras and to the 2070 CPU card and local nodes, plus two single-mode 100 Mb Ethernet fiber ports built-in for high bandwidth data transport upstream in the traffic control network hierarchy. The Model 2070 Controller connects to the traffic signal lights, traffic counters and sensors, pedestrian signs and switches. A redundant mesh of fiber cables and intermediate Ethernet switches connects the Ethernet card at each intersection with the TOC.

A Magnum P62F Hardened Switch connects multiple traffic cameras on a freeway and ties into the same TOC using a fiber built-in port.



The active hardware in a complete Ethernet IP-switched network solution is roughly one-half the cost of a combination T1 and SONET or ATM solution, and provides about 10X greater bandwidth for the video data as well.

About GarrettCom, Inc.

GarrettCom, Inc., Fremont, Calif., is a leading provider of Ethernet products designed to meet the requirements of specialized markets. Today the company is known for its broad, modular, highly reliable and cost-effective lines of Magnum Ethernet LAN products targeted to the telecommunications and industrial control markets, featuring fiber ports built-in. In 2002, GarrettCom launched an initiative to provide Ethernet Outdoors products for the traffic control and management market, which enable traffic control designers to take advantage of Ethernet's strengths and benefits in this market. Working with Naztec, Inc., Sugar Land, Tex., and others, the company developed the first board-level product designed to fit in a peripheral slot of the Ethernet-ready Model 2070 Traffic Controller.

GarrettCom's unique technical background, which combines experience in the demanding Carrier and the Industrial Ethernet markets with a pioneering presence in fiber-built-in Ethernet switches and hubs, gives the company a strong position from which to create innovative products for the traffic control market. Ethernet products for traffic control systems from GarrettCom include Outdoor Switches, ITS Blade Switches for use in 2070 chassis, Managed Fiber Switches, and Outdoor Media Converters.

GarrettCom markets its products through a network of resellers, OEMs, system integrators, and international distributors. For more information on GarrettCom and its Magnum products for Ethernet Outdoors, visit **www.GarrettCom.com**, or contact the company at 47823 Westinghouse Drive, Fremont, CA 94539, telephone 510-438-9071, fax (510) 438-9072, email mktg@garrettcom.com.