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# Optical Communication Performance a 10 Gbps Data Transmission Speed Ethernet Optical Network with Opnet Software

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**Abstract:** ***A present computing imposes heavy demands on the optical communication network. Gigabit Ethernet technology can provide the required bandwidth to meet these demands. However, it has also in volve the communication Impediment to progress from network media to TCP (Transfer control protocol) processing. In this paper ,present an overview of Gigabit per second Ethernet technology and study the end-to-end Gigabit Ethernet communication bandwidth and retrieval time. Performance graphs are collected using NetPipein this clearly show the performance characteristics of TCP/IP over Gigabit Ethernet. These indicate the impact of a number of factors such as processor speeds, network adaptors, versions of the Linux Kernel or opnet software and device drivers, and TCP/IP(Internet protocol) tuning on the performance of Gigabit Ethernet between two Pentium II/350 PCs. Among the important conclusions are the marked superiority of the2.1.121 and later development kernels and 2.2.x production kernels of Linux or opnet software used and that the ability to increase the MTU (maximum transmission unit) Further than the Ethernet standard of 1500 could significantly enhance the throughput reachable. The Metro Ethernet network (MEN) expands the advantages of Ethernet to cover areas wider than LAN. MENs running Ethernet Services as specified by the Metro Ethernet Forum (MEF) are known as Carrier Ethernet Networks (CENs). CENs can cover not only metro areas, but it can expand to cover global areas by connecting multiple MENs. Next-generation CENs are expected to support 100 GbE. With arising technologies for Ultra Long-haul (ULH) networks the bandwidth bottleneck of CENs is shifting to other areas like the transport layer protocol (such as the Transport Control Protocol or TCP) and the chip-to-chip channel capacity found at the network edge, which in general has an electrical backplane. Traditional TCP is well known to have difficulties reaching the full available bandwidth, due to its inefficient AIMD mechanisms under a high-delay-bandwidth-product environment. At the network edge, network equipment with electrical backplanes poses many problems including inductive-capacitive effects that limit its bandwidth. These are the two main issues addressed in this work. To resolve the transport layer issue, this work proposes a transport protocol that fully utilizes the available bandwidth while preserving TCP-friendliness and providing QoS support that is compatible with Ethernet Services. It can guarantee throughputs above the Committed Information Rate (CIR), which is specified in the Service Level Agreement (SLA). To resolve the physical layer limitations, a novel optical coupling technique is examined to encourage the use of optical backplanes for network-edge and core technology. The proposed technique consists of aligning the normal of the laser emission plane, waveguide plane and the normal of the photo detector active region plane with the purpose of reducing optical power loss caused by common methods of light manipulation. By addressing the shortcomings of both Traditional TCP and electrical backplane technology the overall throughput can be significantly increased. The OPNET software was used to simulate the different scenarios of the networks which clearly explain the way the data is transmitted and received. We also find a lot about different topologies and how subnets can be used to effectively connect nodes in a network. The easy-to-use and drag-and-drop nature of OPNET helped a lot in simulating networks in star topology, creating different types of servers for each department of a campus network. The papers on wireless networks were very enlightening, awakening us to different standards presently in use, like, 802.11, 802.16, etc.***

## 1. Introduction

Ethernet has come a long technique then its invention in the early 70s. Even still the frame arrangement, protocols and routing devices of today are very changed from those designed and implemented four periods ago the core of computer interconnection has been preserved. Ethernet started as a method to connect multiple computers to all other, this group of computers is called a local area network (LAN). With more advances the local area network finally grew to cover much larger zones such as metro areas, called metro area networks (MAN) and outside, referred to as wide area networks (WAN). Even today Ethernet keeps increasing not just in size but in speeds. Ethernet started from just lower than 3 Mbps transmission rate, which was the first recorded speed, and has grew to 10 Gbps. Now that we see where Ethernet come from the original question is: In which path is Ethernet headed to?

The past of Ethernet starts from the Aloha packet radio network. Aloha was established at the University of Hawaii to make it thinkable to communicate between computers through the Hawaiian Islands. By the basic ideologies of Carrier Sense Multiple Access with Collision Detection (CSMA/CD) from Aloha technology, Ethernet local area networking technology was established in the mid-1970s at the Xerox Palo Alto Research Center (PARC).

The progress of Ethernet has made digital sharing simpler, earlier and more economical. This has various companies travelling their services from other network types to Ethernet. This conversion is not forthright as Ethernet in its raw form is not carrier-grade. For this purpose an organization called the metro Ethernet forum (MEF) has taken the assignment of organizing, configuring and standardizing Ethernet to make it carrier-grade, and this fresh version of Ethernet is known as Carrier Ethernet. The newest Carrier Ethernet specifications are designed to work at 100 Gbps and cover areas worldwide. With 31 service suppliers and 76 network kit makings companies certified by the MEF, revenues in the hundreds of dollars per year [47], and calculations stating billions of dollars in revenues by

2012 [48], it is attractive more and more marked that the resulting generation of Ethernet is controlled toward the Carrier Ethernet Network (CEN).

### 1.1 Basic of Ethernet

Ethernet LAN topology is presently the most mutual network design. Ethernet topologies are commonly bus and/or bus-star topologies. Ethernet setups are passive, which means Ethernet hubs do not recycle or modify the signal sent by the involved devices. Ethernet technology customs transmission topology with baseband signaling and a control method known as Carrier Sense Multiple Access/Collision Detection (CSMA/CD) to transfer data. The IEEE 802.3 standard describes Ethernet procedures for (Open Systems Interconnect) OSI's Media Access Control (MAC) sub layer and physical level network characteristics. The IEEE802.2 standard describes protocols for the Logical Link Control (LLC) sub layer. A solid appreciative of Ethernet basics is necessary for all network persons.

Communication may be recognized through a collection of different media, general choices include copper cables and fiber optics. Excluding for the material connection a diversity of principles is used to allow an operational communication channel. These principles are required for hardware configurations such as bit rate and signal amplitudes, as well-as to describe the sense of the signal array that is to be approved over the channel. Ethernet is a set of such values used to explain a well-known and used structure. This group defines a range of values about different ways of signaling over different mediums. The principles are used to encode an array of bits to transmittable signals. A order of bits or information is called a frame which is illustrated in Figure1.1. The duration/Type field defines the quantity of data or if the data should be interpreted according to a different protocol such as IP [2].

There are four different structure formats used in Ethernet world. These are Ethernet IEEE 802.3, Version 2, Snap IEEE 802.3 and Novell Proprietary. The most common Ethernet structure type today is the Version 2 or Ethernet II structure, the so called DIX frame (named after DEC, Intel, and Xerox). Ethernet title info contains basis MAC address (SA), Destination MAC address (DA), EtherType and Payload. See Figure 1.1 Ethernet II structure arrangement is used in this job for Ethernet packets.

Figure 1.1: The most common Ethernet Frame format

### 1.1.1 Ether Type

Ether Type is a title field in the Ethernet structure. It is used to designate which protocol is being transported in an Ethernet structure. Registering a latest Ether Type value goes through IEEE Ether category Field Registration Authority. A community list of previously registered Ether category values can be found from IEEE website. The rate for one Ether Type field value is $2500.

### 1.1.2 Ethernet Packet

Ethernet package consists of an up-to 1500 byte consignment and an 18 byte Ethernet title. This we can see also from the Figure 2-2. The unique 1518 byte MTU limit for Ethernet was used because of the high mistake charge and low speeds of communication. The limit is useful for 10 Mbit/s Ethernet and 100 Mbit/s speedy Ethernet, but not required for the faster Ethernet connections. Today we don't require this border anymore for those reasons and there has been several improvements on the packet size.

### 1.1.3 MAC Address

Media Access Control (MAC) addresses are used in networks for identifying the devices in the system. They are exclusive identifiers for each network adapter (NICs). In various cases it can also be locate by hand for positive reasons. The identifier layout is called EUI-48 or improved identified as MAC-48 address. The standard layout for printing EUI-48 addresses in human-readable media is six groups of two hexadecimal digits in broadcast order. They can be separated by hyphens (-) orby colons (:), e.g. 01-23-45-67-89-ab or 01:23:45:67:89: ab.The MAC address contains a three-octet Organizational Unique Identifier (OUI)part, which is generally the vendor identifier. The last three octets are used for identifying the correct tool. For illustration MAC address 00:0d: 93:b0: ad: aa contains OUI part 00:0d: 93, which tells that the retailer is Apple Computer. This shows that MAC addresses do not contain any ladder in the addresses. The lack of ladder lowers the scalability of MAC address usage to minor networks. International networks require having hierarchy in addresses for efficient routing to be possible.

- **MAC Address Scalability Issues:-**Layer 2 switches restore occasionally their resource MAC address tables in shortened network. In a container where the number of MAC addresses is actually large,MAC address learning could generate broadcast storms or latency troubles. Even splitting the system into separate domains by VLANs, some clients might have a group of Ethernet NICs reach all over the WAN. Capable methods to optimize the MAC address learning are required. This 48-bit address gap contains potentially $2^{48}$ or 281,474,976,710,656 probable MAC addresses. The IEEE expects the EUI-48 gap to be bushed no faster than the year 2100; EUI-64s are not predictable to run out in the expected opportunity. So using either EUI-48 or EUI-64 solves the exhaustion of addresses. From this we can observe that the address gap is large enough to range for the required of Internet but the ladder is absent from the necessary MAC address.

- **Address Translation:-**Address Resolution Protocol (ARP) is a procedure used for mapping a network sheet address to a hardware address like IP address to MAC address. There is also a undo ARP (RARP), which maps a hardware address to a network-layer address.

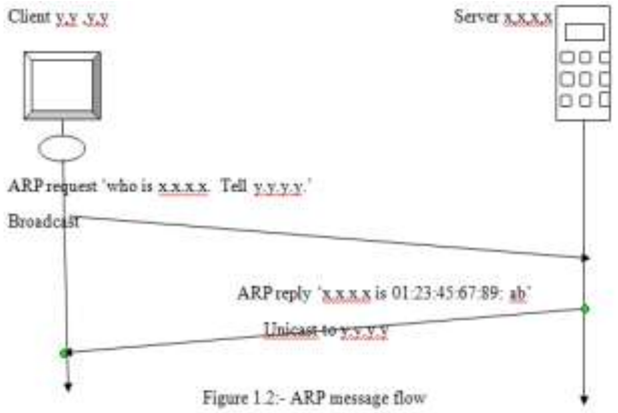


**Figure 1.2:** shows the messages used in ARP

When a client needs to send a package to one more host, it wants to primary find out the MAC address of the extra host. This is complete with ARP request message, which issent using the Ethernet broadcast address and Ether category value 0x806. This ensures that all devices in the similar impact area (LAN) will collect the message. The X.X.X.X and Y.Y.Y.Y are both IP addresses, where the X.X.X.X is the target host and Y.Y.Y.Y is the basis host. When the target host receives the message it will respond with an ARP reply message and all the additional devices will remove the packet. The ARP respond from the target host to the basis host contains the MAC address of the target host. This message is sent directly as a uncast to the basis host by its IP address. There is no requiring for the target host to do the same for the basis host, because it got the source host's MAC address from the ARP request. They require for these two addresses comes from the worldwide Internet. Steering with MAC addresses does not work in larger networks like Internet. The reason for this is the absent hierarchy. IP addresses carry the hierarchy part for steering purposes.

## 1.2 Ethernet Origins and History

Ethernet topology is based on bus and bus-star material configurations. It is now the mainly frequently configured LAN network structural design. A bus is a common pathway (regularly copper wire or fiber cable) among various devices such as computers. A bus is commonly used as a back bone devices. It is a skill that has been developing forover 25 years and is still developing to get together at all times growing and changing wants of the internet operational community.

Digital Equipment Xerox (DIX) worked mutually to expand the primary Ethernet principles. These principles are the DIXE internet principles and are still in applying at present. As Ethernet topology became additional popular, industry-wide philosophy became mandatory. The IEEE adopted the present Ethernet standards in 1985. These standard sare called the IEEE 802.2 and 802.3 principles. They change slightly from the DIX standards, but both explain the protocols for the material and data link layers of the OSI Model. These principles comprise cabling specifications between outline format and network access conventions.

Ethernet is a passive and contention-based broadcast technology and that uses base band signaling. Baseband signaling uses the full bandwidth of a cable for a single broadcast. Single signal can be transmitted at a time and each device on the mutual network hears broad cast transmissions. Passive skill means that there is no individual tool controlling the system. Contention based means that each device must compete with every their tool for access to the mutual network. In other words the devices take turns. They can broadcast only when no more devices is transmitting.

Ethernet status is an effect of several factors. Ethernet technology is:
- Economical
- Easy to establish, maintain, troubleshoot and develop
- A extensively accepted industry standard, which means compatibility and equipment access are less of an issue
- Structured to permit compatibility with network operating systems (nos)
- Very reliable

### 1.2.1 Ethernet History

Ethernet was firstly planned to generate a network in a small region known as a Local Area Network (LAN); these networks are in region that are comparatively small and can be linked without a service provider or third party. They are normally deployed to maintain areas like a small group of building, office and home. Until recently, IT departments had to apply different technologies when linking many high performance office LANs mutually across slower Wide Area Networks (WANs) such as Leased Lines, Frame Relay and ATM.

In common, Leased Lines and Frame Relay do not present sufficient bandwidth to manage with a dynamic combine of real time interactive and folder transfer bulk traffic that makes up the greater part of LAN users require an everyday basis. Desktop connectivity has evolved as of 10 Mbps half duplex in the 1980s to 100 Mbps and still 10 Gbps full duplex at present; these increases are primarily suitable to the escalated apply of immediate video, tone of voice and data networking applications. Service providers require accommodating a result ready with the bandwidth to take larger documents efficiently and impeccably.

Regularly, and currently extra Predominantly, Ethernet skill has evolved so it not single connects networks that are in a secure radius but now can connect networks approximately the world, creation users thousands of miles apart sense as if they are in adjoining offices. These features create it simple for companies international to appear to Ethernet as the present and future standard for delivering WAN services.

While Ethernet is suitable the usual for WAN services, Ethernet facilities themselves are not identical. In detail, there are some mechanisms a package provider can use to align their Ethernet

**OPNET software**

The OPNET software was used to replicate the different scenarios of the networks which obviously explain the way the information is transmitted and received. We also get a lot about different topologies and how subnets can be used to successfully attach nodes in a network. The accessible and drag-and-drop nature of OPNET helped a set in simulating networks in star topology, creating different types of servers for every branch of a campus network. The papers on without wire networks were very informative, development us to different principles currently in use, like, 802.11, 802.16, etc. The OPNET modeler is a complicated work-station based location for the modeling and reproduction of communication systems, protocols and networks. It has a hierarchical, object-based modeling arrangement. It also has a graphical edge which displays the individuality of different personality parameters in comparison with the extra parameters.

This software is comparatively simple to use; a projection of the network can be performed. But the time for imitation of big networks can be some. It has a drag-and-drop system for location up networks. A network editor provides us with the workplace to work with. The system is subdivided into subnets. It consists of graphical symbol of network topology. It also consists of worldwide, node and link models. OPNET simulator is an instrument to reproduce the performance and presentation of any type of system. The most important difference with other simulators lies in its power and adaptability. This simulator makes achievable working with OSI model, from layer 7 to the adjustment of the most necessary physical parameters.

Service, with Virtual Private LAN Service (VPLS), Ethernet Virtual private Line (EVPL), /Ethernet Private Line (EPL)Hybrid WAN VPLS/IP VPN, Multi-Protocol Label Switching (MPLS)/VPLS and the usage of E-Access to Internet Protocol allowed Virtual Private Networks (IP VPNs).

When determining service supplier to use for Ethernet facilities, single may need to consider the technology the service supplier is using as it does affect the quantity of management/control the operator is capable to leverage on their side. Several technologies need extra configurations and are extra automated while others are very relaxed to implement and are fewer automated. But, maximum value of the configuration occurs on the Service supplier's side and minimally affects the user if at all.

### 1.2.2 Ethernet Configuration and Communication:-

- **Ethernet Configuration**

Ethernet is a broadcast topology in communication and that may be designed as a physical star and physical bus through a logical bus for hardware configuration.

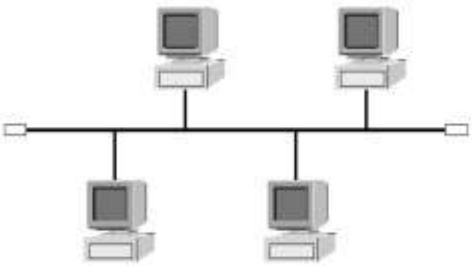

**Figure 1.3:** Ethernet Physical Bus Topology

The physical star using a logical bus is generated with the use of a hub or concentrator.

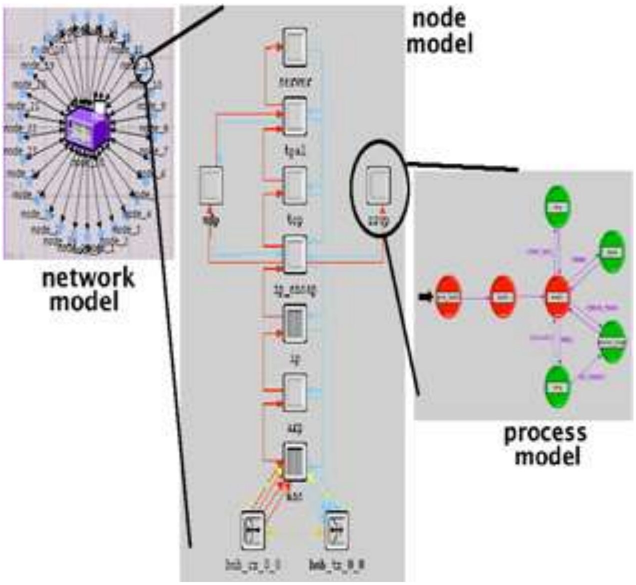


**Figure 3.1** OPNET Simulator

## 2. Result Analysis

We present the simulation setup and performance evaluation results of our proposed start-network based intra-communication. This setup represents simulation results which are obtained from Opnet network simulator. Additionally, for the purpose of this paper, we are interested in how network adaptors and processor speeds affect gigabit throughput, how TCP/IP performs on Gigabit Ethernet networks, what is the impact in terms of delay and device drivers have on Gigabit Ethernet throughput, and what is the maximum attainable throughput and minimum latency that can be achieved for our system configuration. The throughput graph is plotted using throughput versus transfer block size. Throughput is reported in megabits per second (Mbps) and block size is reported in bytes since they are the common measurements used among vendors. The throughput graph clearly shows the throughput for each transfer block size and the maximum attainable throughput. The throughput graph combined with application specified requirements will help programmers to decide what block size to use for transmission in order to maximize the achievable bandwidth. Another important network performance measure is latency.

In Opnet the latency is determined from the signature graph. This graph is plotted using throughput per second versus total transfer time elapsed in the test. The network latency coincides with the time of the first data point on the graph. In the remainder of this section, we present a detailed investigation of Gigabit Ethernet performance on the tested described earlier.

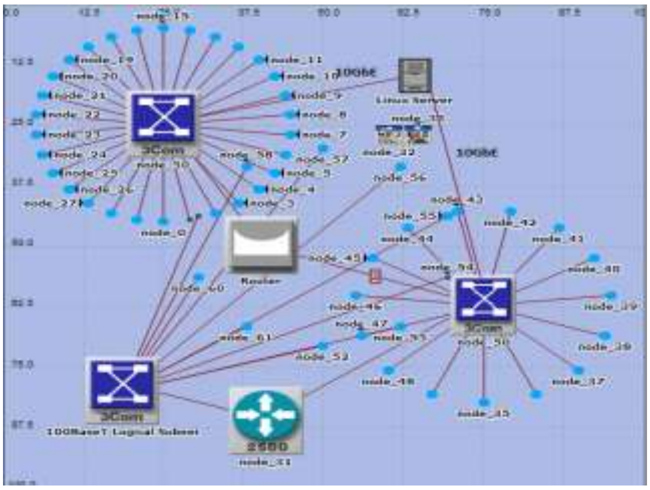


**Figure 6:** Simulation setup for high speed optical communication through 100BaseT Ethernet

It provides accurate and useful information to reveal the network performance for each different block size. Opnet increases the transfer block size from a single byte to large blocks until transmission time exceeds 1 second. This allows examination of block sizes that are possibly slightly smaller or larger than an internal network buffer. Opnet clearly shows the overhead associated with different protocol layers, in particular TCP. Opnet was also slightly modified. This improved the robustness of the code with experimental drivers. Star-network based simulation is shown Figure 1 with high speed Ethernet (we use 100BaseT).

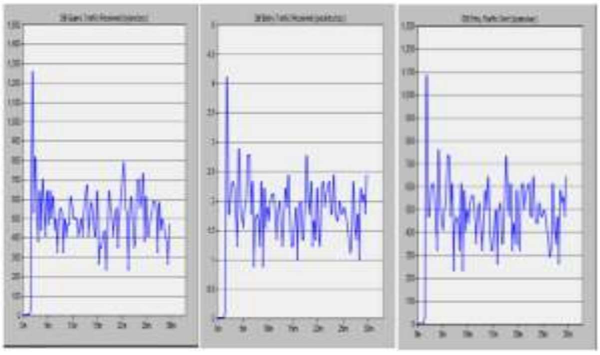

**Figure 7:** Globally1: Comparison (a) Ethernet delay and (b) RIP

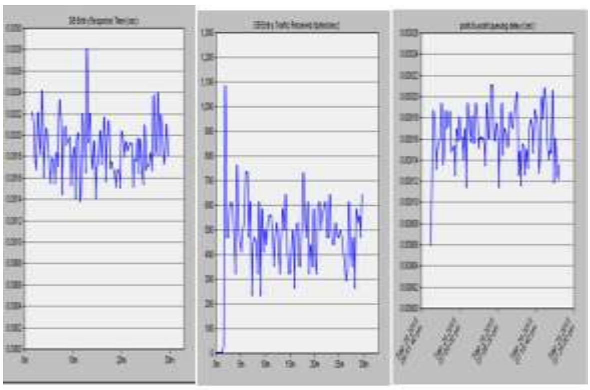

**Figure 8:** Globally2: Comparison (a) Ethernet delay and (b) RIP

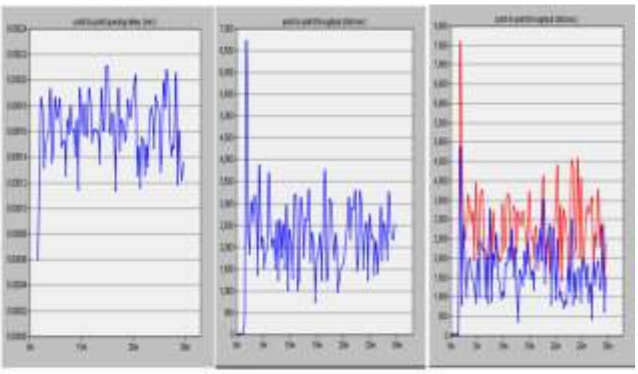

**Figure 9:** Globally3: Comparison (a) Ethernet delay and (b) RIP

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