PERFORMANCE INVESTIGATION OF FIBER DISTRIBUTED DATA INTERFACE IN NETWORKING

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Abstract—Token Rings and Fiber Distributed Data Networks, FDDI, are designed to have two data transmission paths which provide redundancy should one of the two paths become unusable. FDDI can be implemented as a higher speed version of a token ring and is designed to work over fiber. This standard is also designed primarily for peer-to-peer communications but can certainly be used for the polled traffic modem. The underlying principle of the token ring is that access to the communications ring is limited to one modem at a time: A single modem transmits its message around the ring. Then, once the message travels completely around the ring, the modem removes the data from the ring and passes control (the token) to the next modem in line. This method promises to be an effective method of distributing data. In this thesis we have analyzed the performance of the FDDI systems depending on the various parameters. Results shown in the last chapter conclude that efficiency of the FDDI network can be increased by controlling the ring latency and by minimizing it. Data reliability of the FDDI network can also be increased by adding some error detection/error correction information to the data packet being sent. FDDI adds a form of error detection in the frame check sequence field. The cost of the network depends on many factors such as the cost of the fiber and modems which are being used in the network. So, we can control the cost of the network by controlling the cost of the fiber and modems used. Also the other way of minimizing the cost is by using the modems which is having very low latency time. In this way we can analyse the performance of the FDDI networks and can produce a FDDI network with greater efficiency, larger reliability, lower cost and faster to operate.

Keywords— *Fiber Distributed Data Interface; Wavelength Division Multiplexing; Wide Area Network; Metropolitan Area Network**.**atting.*

I. INTRODUCTION

Fiber Distributed Data Interface (FDDI) is an optical standard for data transmission in a local area network (LAN). The logical topology is a ring based token network. FDDI, as a product of American National Standards Institute X3T9.5 (now X3T12), conforms to the Open Systems Interconnection (OSI) model of functional layering of LANs using other protocols [12]. In LAN, FDDI support thousands of users. It also support real-time allocation of network bandwidth and allows the use of wide array of different types of traffic. A FDDI network has two data transmission path. One is the primary path and other is secondary path. So it is called dual ring network. Due to some problem if primary ring fails then secondary ring is used for data transmission. Primary ring has the capacity of 100 Mbits/s carrying data but it extends upto 200 Mbits/s if the secondary ring is not in use. The frame size of FDDI is also larger than standard Ethernet, allowing better throughput. The FDDI is derived from the IEEE802.4 token bus timed token protocol. FDDI can be implemented as a higher speed version of a token ring and is designed to work over fiber. The basic principle of the token ring is that access of communication ring is limited to one modem at a time. Message from only a single modem is transmitted at a time. Then, once the message travels completely around the ring, the data from the ring is removed by the modem and control (the token) is passed to the next modem. This network uses optical fiber as a transmission medium. The fiber is made up of glass which is cheaper than other transmission mediums used like coaxial cables etc.

In this study work is done on the performance analysis of FDDI network. Then the performance of FDDI network analyzed on the basis of Efficiency, response time and network cost by using different values of ring latency and fixed target token rotation time (TTRT) and number of stations. All the work is done using MATLAB.

II. BACKGROUND

The copper cable can only be able to provide 100 Mbps of bandwidth over a 1 Km of area before regeneration of signal is required. In comparison to this, wavelength division multiplexing (WDM) technology is used by an optical fiber which can support a number of wavelength channels [11], the connection rate of 10 Gbps can be supported by each channel. Over a distance of several tens of kilometers good quality of optical signal can be delivered by Long-Reach WDM transmitters and receivers without regeneration of signal. Thus, the bandwidth of tens of Tbps (10^9) can easily offered by optical fiber. Rather than high bandwidth, the fiber is cheaper than other conventional transmission mediums such as coaxial cable because it’s made up of glass. Low attenuation is also provided by glass fiber. One more advantage of fiber is that it is not being affected by electromagnetic interference and failure of power. Fiber is thin and lightweight so it is also easy to install.

The fiber cables can replace an existing copper-based transmission infrastructure. In the fiber infrastructure, to make use of the fiber bandwidth WDM is considered as a parallel transmission technology with non-overlapping wavelength channels [11]. An individual optical transmission system consists of three components:

- The optical transmitter
- The transmission medium
- The optical receiver

To indicate pulse of light the transmitter use '1' bit and for absence of light it uses '0' bit. The electrical pulse is generated by receiver once the light is detected. The fiber uses a single mode transmission which requires a light to propagate along the center of fiber in straight line. The single mode fiber is used for long-distance transmission because it provide good quality of signal. A light ray may go through the internal reflection once it's entered in fiber at particular angle. A fiber with this quality is known as multimode fiber. In an optical network the basic optical transmission is used, which can be a local access network (LAN), a metropolitan local exchange network (MAN), or a wide area network (WAN)

An extraordinary bandwidth is provided by optical fiber that is larger than any other transmission medium. The total bandwidth of 25000 GHz is offered by a single thread of fiber. Viewing this huge potential of fiber, it is necessary to note that the total bandwidth of radio on earth is not more than 25 GHz. Rather than its huge bandwidth; additional advantages are provided by an optical fiber such as low attenuation loss. The high speed optical networks are building by using fiber links to interconnect geographically distributed nodes. How these nodes are interconnected are explained below.

III. LITERATURE SURVEY

There are number of researchers working on the FDDI. The detailed literature review of the FDDI is covered in this section.

The system Terra Link laser communication (lasercom) was developed by Isaac I. Kim et. al. [1] as a high-bandwidth, cost effective, wireless alternative to fiber optic transmission. One of the main advantage of using lasercom over fiber optic is that lasercom is primarily economic. They suggest that however, free space lasercom is subject to atmosphere effects, like scintillation and attenuation, by which some problems arise like reduction of link availability and burst error which are not seen in fiber transmission. The Terra Link transceivers use some techniques like multiple transmit beams to reduce the effects of scintillation. By implementing the lasercom in effective way, a bit error rete (BER) of 1029 can be achieved. Since they designed the Terra Link transceivers to be eye-safe at the transmit aperture, range of each system is limited. For the Terra Link systems link power budgets were presented and link margin data were shown that quantitatively describe how the efficient laser link range varies in diverse weather conditions

How evolutions of complex technologies and networks of innovators affect the development of emerging innovations was investigated by Pek-Hooi Sohet [2]. Building upon the theories of technological evolution and socio-organizational dynamics, they developed propositions to examine the stability and change of networks punctuated by successive technological changes. They argued that incumbents who are early advocates of standards in complex technological environments are more likely to survive via alliances. Based on 150 firms and 319 alliances in the US data communications industry from 1985 to 1996, they found support for their propositions and the characteristics of central-periphery structure best describe the patterns of industry networks.

The overview of the FDDI and suggested some of the research actions was covered by William R. Hawe, Richard Graham and Peter C. Hayden [3]. The impact of various design decisions on the error detection capability of the protocol was analyzed by Raj Jain [4]. In particular frame error rate, undetected rate and token loss rate are measured by him. He also discussed number of characteristics of the 32 bit frame check sequence polynomial, which is also used in IEEE 802 LAN protocols. It was shown that by every noise event two code bit error is resulted, which may produce upto four data bits errors. The FCP can detect up to two noise events. He justified the enhancements by quantifying their effect.

The communication is a very important factor affecting distributed applications was suggested by Saurab Nog and David Kotz [5]. It is critical to understand overall application performance by taking a close view on network performance. Some benchmarks are settled using two sets of experiments, first is roundtrip and second is data hose. Some tests were performed to measure a combination of network bandwidth, latency and contention. The test is repeated for two protocols (TCP/IP and MPI). The performance results provided attractive insights into the behaviour of these networks beneath different load conditions and the software overheads associated with an MPI implementation (MPICH).

Everyone knows that FDDI token ring network provides a guaranteed throughput for synchronous message and a bounded medium access delay for each node/station was suggested by Qin Zheng [6]. He said that many real-time applications that need the timely delivery of each critical message are not effectively support by this fact. The main reason behind this was that the FDDI make sure that a medium access delay bound to nodes. The message-delivery delays may go beyond the medium-access delay bound even if a node transmits synchronous messages at a rate not larger than the guaranteed throughput. He solved this problem by developing a Synchronous Bandwidth Allocation (SBA) scheme which calculated the synchronous bandwidth necessary for each application to satisfy its message-delivery delay requirement. The results obtained were necessary for effective use of the FDDI token ring networks in supporting such real-time communications as digital video/audio transmissions and distributed control/monitoring.

The performance of the Wireless and Wired computer networks through simulation has been attempted using OPNET as simulating tool was analysed by Rahul Malhotra et. al. [7].

They investigated the delay and throughput performance parameters for wired networks by using changeable transmission links and load balancer. They analyzed the load balancing through parameters like analysis or traffic sent and traffic received. On the other hand for wireless networks the parameters like throughput, retransmission attempt and delay have been estimated with varying physical characteristics and buffer size. From the results of above parameters, it was noted that the performance of wired network is good if high speed Ethernet links and server-load balancing policy are used. On the other hand the performance of wireless network can be improved by properly choosing the WLAN parameters and by fine tuning. The performance was observed to be better with wireless network using infra-red type physical characteristics

A dynamic programming based three phase algorithm that solved the Delay-Constrained Minimum Cost Loop Problem (DC-MCLP) was proposed by Yong-Jin Lee et. al. [8]. This study deals with the DC-MCLP. In this study work is done on finding of several loops from a source node. The set of minimum cost nodes is founded to link end nodes to a source node. These minimum cost nodes satisfying the traffic requirement at end nodes. The objective function of DC-MCLP was to minimize the total link cost in the SONET network.

Fiber optic LAN topology, access protocols and standards are discussed by Gerald Herskowitz et. al. [9]. They described and compared various topology and access protocols in terms of the number of nodes, bandwidth utilization and transmission medium. They also discussed transport and access delay. In addition, for fiber optic, the industry standards that are developed are also discussed.

The Medium Access Control (MAC) protocols for current generation of multiple-access networks were developed by A. Bondavalli et. al. [10]. They discussed the problems that arise in developing MAC protocols for new long distance, high speed MANs. In this study a family of protocols that are used in dual-bus network are discussed, and the performance of network was evaluated through simulation. This paper shows the effect of protocol design on the performance of the network. They also discussed that some protocol provide very good transmission speed over a long distance and improve the overall performance of network while preserving the inherent fairness of cyclical access method.

A multichannel medium access control protocol suitable for implementation on a wavelength division multiplexed optical fiber LAN was discussed by S.D. Cusworth et. al. [11]. In this study emphasis was placed on the mean delay against network throughput. The performance of the network while using token passing arbitration policy protocol was compared with alternative conventional approaches. They also show that the performance of network is improved with token passing arbitration policy.

The Fiber Distributed Data Interface as a standard specially designed for use with fiber optic media was discussed by Harry Yuklea [12]. He also suggested that FDDI is based on the X3T9.5 ANSI standard. The topology used by FDDI is dual counter rotating ring which provide security, availability and reliability. Using fiber optic as a medium the network provides 100 Mb/s of throughput. The maximum distance allowed between two nodes of multimode network is upto 12 km and in single mode is 20 km. FDDI is used as a backbone to connect computers and workstations for exchanging data with each other. FDDI also support front-end and back-end applications. For specific applications bridging method such as translation and encapsulation were also valid that need the corresponding technique.

An HSLAN of their own OPERNET was demonstrated and developed by Ghassan Semaan [13]. In this study he discussed that HSLANs were used by variety of applications like backbone network, high speed graphic and video transmission. Therefore asynchronous and isochronous traffic are well handled by these HSLANs. Both asynchronous and isochronous transfer performance of the above network is also compared.

The possible concepts using both rings under normal working conditions was described by Peter Domschitz and Martin Siegel [14]. They discussed the fault-tolerance provided by ring reconfiguration around error situations without losing. Some drawbacks for management and system structure were also discussed. The main focus was put on the broad spectrum of standard-conformant possibilities of FDDI topologies and modes. In the end of study they have presented their concept which uses both rings for an FDDI and the related station management.

FDDI (Fiber Distributed Data Interface) is a token ring network which provides 100 Mbit/s of throughput. This network use two counter rotating optical rings. In this paper R Radhakrishna Pulai et al. [15] considered various possible faults (like lost token, link failures, etc.) and how the faults are detected and in the case of failure the process of recovery and the reliability of a network. Using parameters queue length and average delay simulation was done and the performance improvement as compared to existing fault detection and ring recovery was calculated. They also suggest some modifications to make the network more reliable. It was shown that, even when some link failure occurs, full connectivity was maintained among the stations. For link reconfiguration a distributed algorithm was also purposed in modified FDDI network when many successive as well as simultaneous link failures occur. Through simulation the performance of modified FDDI network was studied for link failure and compared with existing FDDI network.

The performance of the Synchronous Optical Network (SONET) protocol when it is receiving traffic from a Fiber Distributed Data Interface (FDDI) network was explored by Paul D. Stigall et. al. [16]. The NETWORK simulation program was developed by simulation using a simple model for exploration. Simulation was done on three functions. Firstly for producing frames simulation was done on a traffic generator, secondly an extended bridge and thirdly for an entity which represent the operation of an interface to SONET communication line. From the simulation results, they measure the adequacy of the model and discussed the performance of the SONET.

A new MAC protocol for ring-topology Metropolitan Area Networks (MANs) was defined by Andrea Bondavalli et. al. [17]. First of all ring topology network and MANs are analysed and from analysis some guidelines are derived for the definition of high performance MAC. By using these guidelines the DSDR (Destination Stripping Dual Ring) protocol was defined. The dual ring topology and destination stripping capability were its key characteristics, which together with slotted operation, multiple tokens and other details give very high performance. This high performance is given by DSDR in terms of total throughput, guaranteed throughput per station and maximum access delay. The guaranteed throughput on each of two rings, with bounded access delay is close to twice the medium capacity under the worst case hypotheses. On the other hand total throughput can be close to four times the medium capacity under realistic hypotheses. The maximum interval can be as low as N/2 slot times between accesses by the same station, with N stations on the network. This network also support multicast and the cost is also same as LAN and MANs.

In high speed LANs and MANs to preserve integrity, error-detection cyclic redundancy codes were often used at the Medium Access Control (MAN) level. Single CRC code is used by high speed LAN like FDDI. Three different CRC codes are employed by high speed networks like the DQDB MAN and the orwell ring. After the study of this, the design and application of a programmable high-speed parallel CRC implementation were described by Jesper Birch et. al. [18]. The execution was based on VLSI architecture with 8 kbits of embedded RAM. The CRC checksum was generated by the programmed architecture corresponding to any generator of any degree between 1 and 32. It was also possible the generation and verification of two different CRC checksums with the same VLSI architecture for any pair of generator polynomials of degree uo to 16. In this study a example of an 800 Mbit/s and a 160 Mbit/s CMOS semi-custom VLSI realization of the architecture were also presented.

A design solution to implement an FDDI dual attachment station on a PC-AT interface card was provided by Manohar Rao Mahavadi [19]. The AMD's SUPERNET chip set was used in implementation for the MAC and PHY controller and it provide very good results for end station applications like low cost and low power interface card.

The aim of A. Di Stefano et. al. [20] was to analyze the MAC sub layer and to find the possibility of using FDDI in it. For a distributed process control system MAC sub layer are used as a backbone network. By simulation the delay and throughput was evaluated, for the considered solution this shows good overall behavior. The quantitative performance was also given by this network which could be used as a support for the design of the network.

It was well known that the non-timed-token protocol and timed-token protocol are two classifications of token protocols (TTPs). The queuing model was included by non-TTP and for a long time mathematical analyses have been studied and from these analyses significant results have been obtained. The TTP was studied that how the developments are took place in Fiber Distributed Data Interface (FDDI) in MAN. For the TTP the system models was built by Zhaoyi Lu et. al.

It was a known fact that the timed token networks such as Fiber Distributed Data Interface (FDDI) have been widely used. However the transmission of synchronous message is allowed by the medium Access Control (MAC) of FDDI up to at most one-half of the total bandwidth of network. Shin and Zheng have proposed a modification to the FDDI MAC protocol, called FDDI-M, the ring ability of network could be double by these modifications in supporting synchronous traffic. As everyone knows FDDI timed token protocol and this protocol guarantee synchronous message deadlines, this was very dependent on the synchronous bandwidth allocation (SBA) schemes used. In this study Edward Chan et. al. [22] compared the ability of FDDI-M to support synchronous traffic under different SBA schemes with that of FDDI. A new taxonomy of SBA schemes was used by them which are based on the strategy used to partition the synchronous bandwidth and as performance metric the worst case achievable utilization (WCAU) are used and it present an analytical study of the timing properties of the FDDI-M protocol. For MPEG video traffic performance of FDDI-M is also simulated. From simulation the conclusion is obtained that FDDI are outperformed by FDDI-M significantly at heavy load. Under the heavy load conditions the effect of SBA was also shown to be relatively minor, the actual performance of SBA local schemes is better than global schemes.

Analysis of an FDDI network supporting stations with single-packet buffers was presented by Izhak Rubin et. al. [23]. In this study a non symmetric multiple priority token ring network was analysed with single packet buffer that employ medium access control of Fiber Distributed Data network (FDDI) network under timed token protocols. For describing the queuing operation the single packet buffer model was employed characterizing typical user terminal. The limiting state distribution is computed by using an iterative procedure which embedded Markov chains representing the system state process. The distribution of the token rotation time, mean packet waiting time and the normalized throughput was obtained by them. The number of transmitted and deferred packets in a token rotation cycle was calculated by using a counting process. The simplified analysis of a symmetric network was presented by them which contain a large number of stations. Through numerical examples they illustrate the application of the analytic approach, by which FDDI network system was represented operating under various traffic loading conditions.

A new topology for high-speed ring networks: the spiral ring was presented by Wlodek Dobosiewicza and Paweł Gburzynski [24]. MAC-level protocol was also described by them, called Distributed Spiral Multiple Access (DSMA), which was best suitable for the spiral ring topology. Rather than transmission rate and network size, the DSMA protocol was based on token passing. The medium access delay approach to zero, under the normal light load. On the other side when load is heavy, the guarantee was provided by the medium access delay that starvation will not occur. The proposed protocol was able to handle synchronous traffic of varying intensity. The pre-allocation of bandwidth are not required for the synchronous part of traffic unlike other protocols. Provision for a graceful dynamic reconfiguration and costless protocol recovery after a lost token was another property of DSMA.

FDDI (Fiber Distributed Data Interface) standard and IEEE 802.4 are high speed MAC protocols which employ a timer control token passing mechanism for LAN/MANs, called timed token protocol. It was used to control station access to the shared media. The class to which MAC protocols was belonged is timed token protocols support synchronous and real time applications. J.P.C. Blanc et. al. [25] showed the versatility of the PSA technique to evaluate the station buffer occupancy. To represent the behavior of several LAN/MANs MAC protocols they use delay distribution of a very general model, among which the timed token MAC protocols. Mainly, they focused on the solution of an almost exact model of the IEEE 802.4 MAC protocol. Since they proposed the model and numerical solution of model by exploiting the PSA technique was an approximate model of FDDI MAC protocol, comparison between performance measures was also reported by them obtained for this model and simulation results are also represented by them for the corresponding model of FDDI.

The stability of two types of timed-token rings: the existing Fiber Distributed Data Interface token ring protocol and a new variant of the FDDI was analysed by Eitan Altman et. al. [26]. Two classes of traffic was supported by FDDI: synchronous and asynchronous. The transmission delay of synchronous traffic was guaranteed by the time constraint mechanism of FDDI : a Target Token Rotation Time (TTRT) being fixed, this was make sure by FDDI protocol that the token rotation time is always bounded above by twice TTRT. The stability of asynchronous traffic was considered by them, for both FDDI and new proposed protocol, for which the time of token rotation was bounded by twice TTRT. The sufficient an necessary conditions was obtained by them, which indicates that how the stability of system was affected by choice of parameters. They have also show that the new protocols were weak in stability. As this protocol require less time so it is easy to implement.

The issue of achieving useful and fair prioritization from the SAE LTPB LAN when applied in future military avionics networks was considered T Burrage and S Ward [27]. When the time token prioritization mechanism was applied to practical asymmetrical-loaded networks, the lack of fairness was identified as a key problem: a problem which also arise with FDDI. Based on adaptive timer a performance control mechanism was described. It was demonstrated by simulation results that the mechanism can induce fairness for packets in the form of equal delays of a given priority over the network or node position regardless of load distribution.

Bandwidth management in high speed networks required to be as less dependent on the medium propagation delay as possible. At heavy load, token rings are usually very efficient and at a less or moderate load it were less efficient especially in short packet environment. Ahmed E. Kamal [28] proposed a solution to the token ring inefficiency under the aforementioned conditions: multiple tokens used by a medium access protocol. In a distributed way how the medium access can be managed using two tokens were also shown by them. The overhead of network was kept to be minimum. It was shown that, under the light to medium loads, the performance of this network was superior to that of the single token ring protocol, while it was light worse at heavy loads. Then the number of tokens was increased arbitrarily, it was shown the performance of network at light load improve when the number of tokens was increased. It was not just a improvement over the token ring protocol. This protocol was a general suite of protocols of which token ring is a well known special case.

The accomplishment of high throughput and availability were addressed by multi-connected and regular mesh topologies as required by high speed communication networks. Shuffle Net (SN) and Bidirectional Manhattan Street Network (BMSN) were multi-connected topologies. These topologies implement the logical layout of so called multichannel metropolitan area network. An issue was open by broadcasting in multichannel MAN's. M. Decina et. al [29] proposed two simple distributed techniques to deliver broadcast traffic in BMSN and SN. On the basis of delay and throughput result obtained from simulation the two techniques were compared. With respect to the failures the robustness of the proposed broadcasting was also considered.

For high-speed local and metropolitan area networks (LANs and MANs) the performances of several proposed topologies and access protocols were compared using simulation by M. Ajmone Marsan [30]. First in a uniform traffic scenario several networks like, FDDI (Fiber Distributed Data Interface), DQDB (Distributed Queue Dual Bus), CRMA (Cyclic Reservation Multiple Access), and CRMA-II were compared. Second, for DQDB and CRMA the slot reuse technique was studied, by which remarkable gains were shown in performance could obtain, only for non-uniform traffic distributions. Finally, focusing on Manhattan Street Networks (MSNs) the meshed topologies that allowed further exploitation of spatial reuse were considered. In terms of user access delay and throughput to be obtained, the massive exploitation were shown by numerical results of spatial reuse permits significant advantages, with node complexity comparable to that of bus or ring topologies.

The Manhattan Street Network (MS Net) was introduced by Jack Brassil et. al. [31] and for a high speed Metropolitan Area Network (MAN) it was shown to be a strong candidate by them. The comparison of the MS Net to other MAN architectures was done, especially for DQDB and FDDI, and MS Net was superior in terms of throughput, reliability and privacy of communication. The failure recovery mechanism was also discussed by them in each of these networks and the operation of networks under multiple failures. Under non-uniform and uniform scenarios the throughput performance of networks were compared. Also the abilities of these three networks were also compared to provide secure service and privacy. Finally, number of outstanding problems was discussed by them in the MS Net and the proposed solutions for them.

The spatial bandwidth reuse and fairness was provided by basic Meta Ring architecture. Meta Ring architecture is a full duplex ring. Simultaneous transmission over disjoint segments was enabling by concurrent access and spatial bandwidth in the bidirectional ring. Therefore the potential throughput was increased in each direction, by a factor of four or more. Yoram Ofek [32] overviewed the Meta Ring principles: (1) Distributed global fairness algorithm, a simple and robust mechanism based on a single control signal (i.e., one bit of information) that regulates the access to the ring. (2) Protocol for service integration of: (i) synchronous or real-time traffic which is periodic and requires a connection set-up and which will have guaranteed bandwidth as well as bounded delay, and (ii) connectionless or asynchronous traffic with no real-time constraints that can use the remainder of the bandwidth. Integration was an important function for multimedia applications. (3)Protocol and requirements for multi-ring and dual-bus Meta Ring networks. (4) Principles and requirements for interconnecting Meta Ring with wide-area networks (WANs). They showed that (i) the WAN-to-ring interconnection requires a separate queue for asynchronous traffic and relies on the use of the fairness mechanism for internal flow control, whereas (ii) the WAN-to-dual-bus configuration of the Meta Ring network was simpler, since it does not require any buffering and does not rely on fairness mechanism for internal flow control further more; it is fault tolerant and has better synchronous traffic performance.

To construct multi-service networks including high-speed LANs and MANs as well as access networks for Broadband ISDN an ATM-based high-speed slotted ring (ATMR) protocol was proposed by Kazuo Imai [33]. The main features of the ATMR protocol were: (1) an ATM-compatible access scheme for a slotted (cell-streamed) shared medium, (2) a destination release (i.e., cell re-use) scheme to increase efficiency and (3) fair and Quality of Service (QOS) guaranteed access based on a distributed cycle-reset access control scheme. Using its basic control parameters the QOS conditions and throughput could be described well in ATMR using: window size and reset period. Using these parameters, under multi service environment the QOS control schemes were discussed and their efficient access performance was demonstrated, QOS for all service classes was also guaranteed. For high-speed, multi-service access networking ATMR was shown to be a key component.

In order to support service integration a MAC protocol named E-DCP which provides additional mechanisms to the already designed DCP MAC protocol was described and analysed by M. Conti [34]. Two service classes were provided by E-DCP: synchronous and asynchronous. A pooling algorithm was used for both classes to manage the acquisition of transmission rights. Each time the start of a new synchronous cycle observed by node, the certain quota of slots was allotted for synchronous traffic transmission and for asynchronous traffic the unused bandwidth is fairly divided among all the nodes. Certain properties were exhibited by the access scheme for synchronous traffic which has been exploited to define a methodology to derive bounds on the QOS parameters relevant to real time traffic.

The demand for larger networks is increased which provide higher capacity and additional services. FDDI as a new LAN generation is widely accepted. 100Mbit/s of data rate is provided by FDDI which make it suitable for connecting super computers and powerful workstations. This also supports new, more demanding applications. Although FDDI is still going through standardization, many products were becoming available on the market today. In order to achieve reliable, high performance and cost effective communication systems the problem of product design and installing strategies for FDDI networks become more important. Both the basic concepts implemented in the protocol and the practical use of FDDI was the topics of this contribution by Peter Davids et. al. [35].

Performance analysis of FDDI was done by Raj Jain [36]. The performance FDDI ring network was affected by many parameters; the performance of the network was controlled by the key parameter that is target token rotation time (TTRT). The effect of another parameters like the total number of stations, the number of active stations and frame size was also analyzed.

IV. RESULTS AND DISCUSSION

The FDDI standard specifies a number of rules that must be followed for setting TTRT which should be taken into consideration. These rules are [36]:

1. The token rotation time can be as long as two times the target. Thus, a synchronous station may not see the token for $2 \times T$. Therefore, synchronous stations should request a TTRT value of one half the required service interval.
2. TTRT should allow at least one maximum size frame along with the synchronous time allocation, if any. That is:
   $$TTRT \geq RingLatency + Token\ Time + Max.Frame\ time + Synchronous\ allocation$$
3. The maximum size frame on FDDI is 4500 bytes (0.360 ms). The maximum ring latency is 1.773 ms. The token time (11 bytes including 8 bytes of preamble) is 0.00088 ms. This rule, therefore, prohibits setting the TTRT at less than 2.13 ms plus the synchronous allocation. Violating this rule, by over allocating the synchronous bandwidth, results in unfairness and starvation.
4. No station should request a TTRT less than T_{min}, which is a station parameter. The default maximum value of T_{min} is 4 ms. Assuming that there is at least one station with T_{min}=4 ms, the TTRT on a ring should not be less than 4 ms.
5. No station should request a TTRT more than T_{max}, which is another station parameter. The default minimum value of T_{max} is 165 ms. Assuming that there is at least one station with T_{max}=165 ms, the TTRT on a ring cannot be more than this value.

In addition to these rules, the TTRT values should be chosen to allow high-performance operation of the ring.Keeping the above point into consideration we have calculated some results shown in figure 1.1 – 1.9. At first point we have fixed the value of maximum value TTRT to165; number of stations is fixed to 100 and the ring latency of the system is varied as 10, 50, 100, 150 ms. Further, we have calculated the relationship between propagation time and group velocity; Transmission delay and bandwidth.

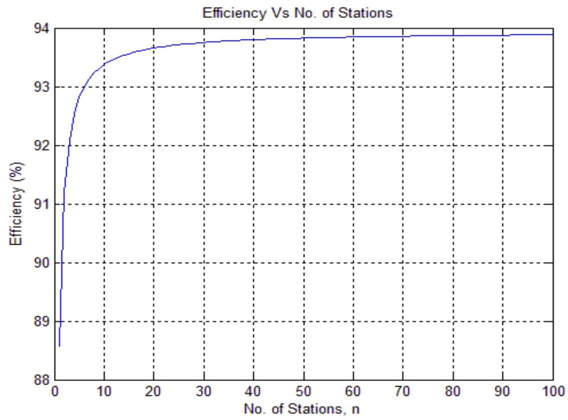

Figure 1.1: Efficiency Vs. No. of Stations for ring latency =10ms.

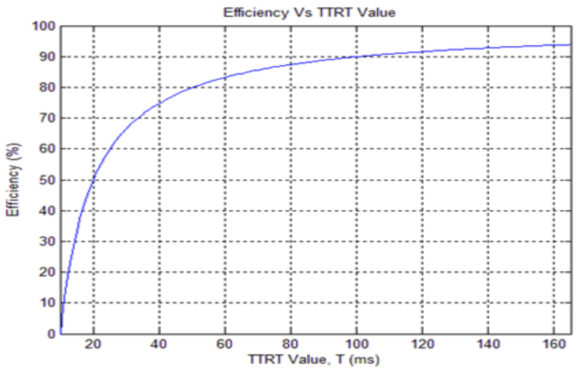

Figure 1.2: Efficiency Vs. TTRT Value for ring latency =10ms.

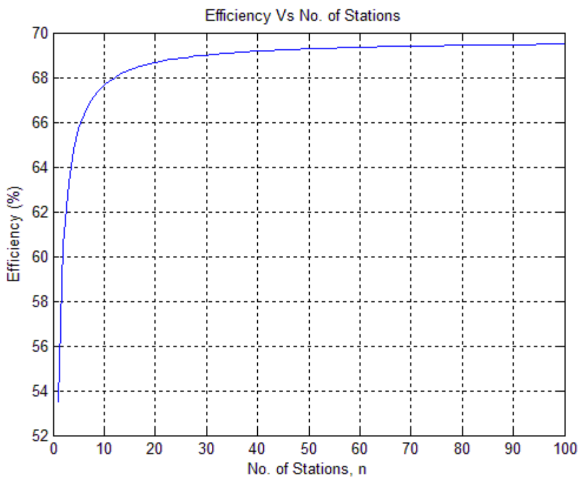

Figure 5.3: Efficiency Vs. No. of Stations for ring latency =50ms.

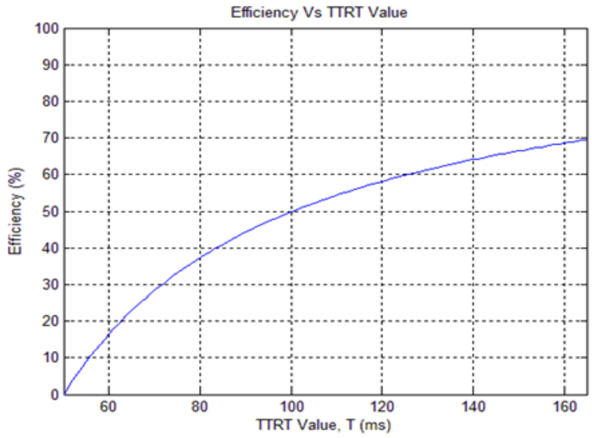

Figure 1.4: Efficiency Vs. TTRT Value for ring latency =50ms.

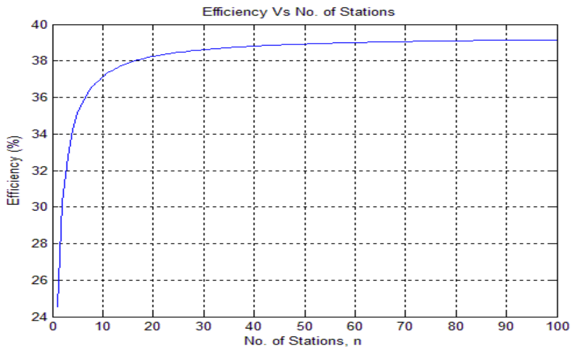

Figure 1.5: Efficiency Vs. No. of Stations for ring latency =100ms.

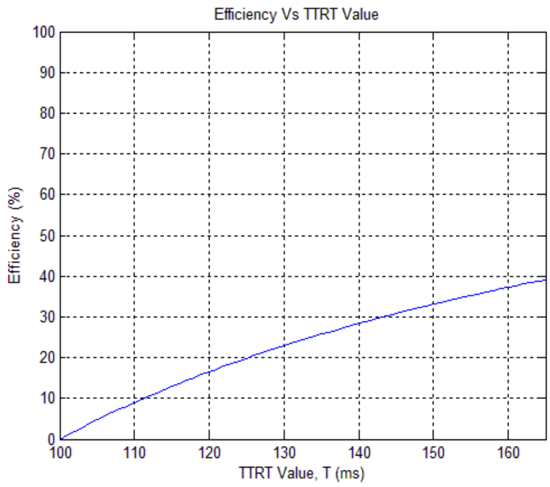

Figure 1.6: Efficiency Vs. TTRT Value for ring latency =100ms.

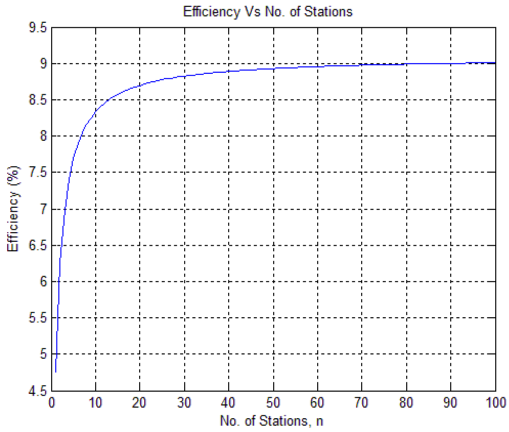

Figure 1.7: Efficiency Vs. No. of Stations for ring latency =150ms.

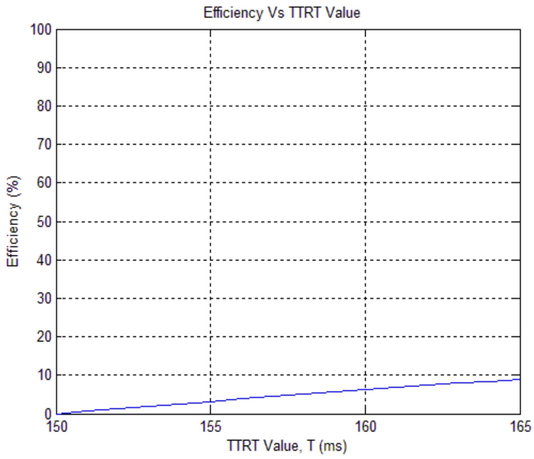

Figure 1.8: Efficiency Vs. TTRT Value for ring latency =150ms.

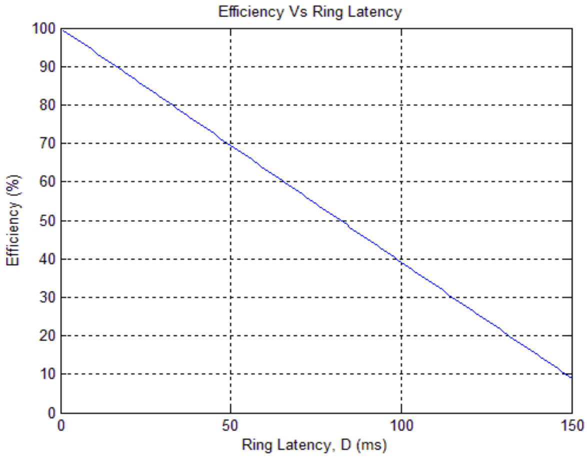

Figure 1.9: Efficiency Vs. Ring latency for n=100 &

TTRT=165

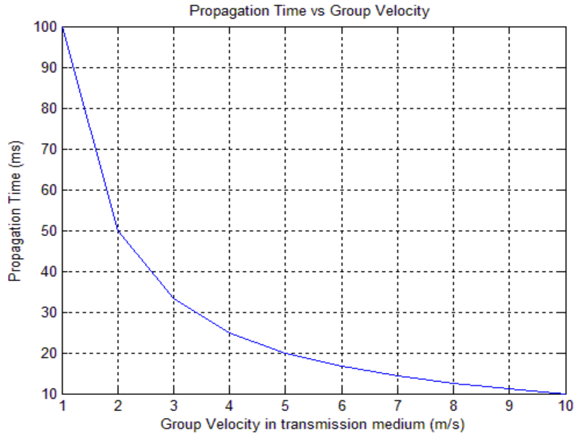

Figure 1.10: Propagation Time Vs. Group Velocity

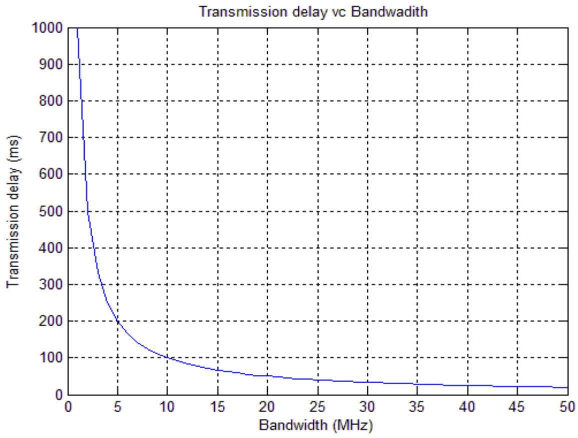

Figure 1.11: Transmission delay Vs. Bandwidth.

Result shown in figure 5.9 show that the propagation time decreases with increase in group velocity and figure 5.10 show that Bandwidth decrease with increase in transmission delay.

The results shown in figure 5.1 – 5.9 prove that the efficiency of the FDDI systems can be increase if we can control the ring latency and fix it to a minimum value. So in this way we can improve the performance of the FDDI systems.

As was explained in the last chapter of the thesis the response time of the FDDI systems is dependent upon the transition delay and propagation delay. The results shown in figure 5.11 and 5.12 prove that the transition delay can be decreased by increasing the bandwidth and propagation delay/time can be decreased by increasing the group velocity.

Data reliability of the FDDI network can also be increased by adding some error detection/error correction information to the data packet being sent. FDDI adds a form of error detection in the frame check sequence field. The cost of the network depends on many factors such as the cost of the fiber and modems which are being used in the network. So, we can control the cost of the network by controlling the cost of the fiber and modems used. Also the other way of minimizing the cost is by using the modems which is having very low latency time. In this way we can analyse the performance of the FDDI networks and can produce a FDDI network with greater efficiency, larger reliability, lower cost and faster to operate.

V. Conclusion

Token Rings and Fiber Distributed Data Networks, FDDI, are designed to have two data transmission paths which provide redundancy should one of the two paths become unusable. FDDI can be implemented as a higher speed version of a token ring and is designed to work over fiber. This standard is also designed primarily for peer-to-peer communications but can certainly be used for the polled traffic modem. The underlying principle of the token ring is that access to the communications ring is limited to one modem at a time: A single modem transmits its message around the ring. Then, once the message travels completely around the ring, the modem removes the data from the ring and passes control (the token) to the next modem in line. This method promises to be an effective method of distributing data. In this thesis we have analyzed the performance of the FDDI systems depending on the various parameters. Results shown in the last chapter conclude that efficiency of the FDDI network can be increased by controlling the ring latency and by minimizing it. The response time can be improved by decreasing the transition delay and propagation delay. The results shown in figure 1.10 and 5.11 prove that the transition delay can be decreased by increasing the bandwidth and propagation delay/time can be decreased by increasing the group velocity.

Data reliability of the FDDI network can also be increased by adding some error detection/error correction information to the data packet being sent. FDDI adds a form of error detection in the frame check sequence field. The cost of the network depends on many factors such as the cost of the fiber and modems which are being used in the network. So, we can control the cost of the network by controlling the cost of the fiber and modems used. Also the other way of minimizing the cost is by using the modems which is having very low latency time. In this way we can analyse the performance of the FDDI networks and can produce a FDDI network with greater efficiency, larger reliability, lower cost and faster to operate.

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