Modified Slotted Aloha Protocol For Increasing Throughput In WDMA Systems

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Under the supervision of

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CERTIFICATE

I hereby certify that the work which is being presented in the thesis entitled, in partial fulfillment of the requirements for the award of degree of Master of Engineering in Computer Science and Engineering submitted to Computer Science and Engineering Department of Thapar University, Patiala, is an authentic record of my own work carried out under the supervision of **Dr. Anil K. Verma** and refers other researcher's works which are duly listed in the reference section.

The matter presented in this thesis has not been submitted for the award of any other degree of this or any other university.

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ABSTRACT

This thesis proposes a new media-access protocol for high-speed packet-switched multichannel networks based on a broadcast topology - for example, optical passive star net-works using wavelength-division multiple accesses. The protocol supports connection-oriented traffic, with or without bandwidth reservation, as well as datagram traffic in an attempt to integrate transport-layer functions with the media-access layer. It utilizes the bandwidth efficiently while keeping the processing requirements low by requiring stations to compute their transmission and reception schedules only at the start and end of each connection. A simulator has been developed and there are the different characteristics of WDMA that have been simulated. These characteristics have been able to simulate and analyze for a single receiver and single transmitter. Further a modified algorithm has also been implemented in this simulator and the results shown an increase in performance by 10% to 20% in different cases.

Keywords: WDMA, Simulator.

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LIST OF ABBREVATIONS

WDMA: Wavelength Division Multiple access.

FDDI: Fiber Distributed Data Interface.

MAC: Media Access Control.

WEP: Wired Equipped Privacy.

WPA: Wi-Fi Protected Access.

WLAN: Wireless Local Area Network.

LAN: Local Area Network.

FDMA: Frequency Division Multiple Access.

AMPS: Advanced Mobile Phone Services.

TACS: Total Access Communication System.

CDMA: Code Division Multiple Access.

TDMA: Time Division Multiple Access.

RF: Radio Frequency.

AM: Amplitude Modulation.

FM: Frequency Modulation.

PTT: Push To Talk.

CSMA/CD: Carrier Sense Multiple Access/ Collision Avoidance.

DIFS: Distributed Inter Frame Space.

NAV: Network Allocation Vector.

RTS: Request To Send.

CTS: Clear To Send.

PSC: Passive Star Coupler.

M-WDMA: Multimedia Wavelength Division Multiple Access.

POTS: Plain Old Telephone Service.

CBR: Constant Bit Rate.

I-TDMA: Interleaved Time Division Multiple Access.

ISA: Interleaved Slotted Aloha.

VBR: Variable Bit Rate.

TR: Rapid Tunable Receiver.

FT: Fixed Tunable Transmitter.

FR: Fixed Tunable Receiver.

TT: Rapid Tunable Transmitter.

CHAPTER 1

INTRODUCTION

Wavelength division multi-access (WDMA). Offers a means of utilizing the vast bandwidth of the optical fiber to bid high-speed communication networks. In WDMA, multiple optical channels spaced apart in wavelength are used along with tunable optical components to provide switchable interconnections between any two ports. The path between any two stations is completely optical. WDMA avoids a fundamental limitations of single channel high-speed networks such as FDDI, Fasnet, Expressnet and Dnet namely in these networks, the rate at which the entire network can be operated is equal to the rate that can be supported by the electronics at one of the end-stations.

WDMA eliminates this bottleneck by using multiple channels, with each channel operating at moderate data rate that can be easily supported by end stations electronics. The aggregate throughput of the WDMA networks, thus growing linearly with the number of stations. In broadcast WDMA networks, the different channels correspond to different optical wavelengths that can be multiplexed onto a single fiber. Stations may transmit packets on different channels using a tunable-laser transmitter. The transmissions are broadcast to all of the stations. Stations may receive packets from different channels using a tunable-filter receiver.

These devices must be rapidly tunable to enable a station to transmit successive packets on different channels and receive successive packets from different channels. In conventional single-channel networks, for example Ethernet, a station sees traffic intended for many or all of the other stations in the network, which means that the electronics has to operate at the aggregate bit rate corresponding to this total traffic. WDMA offers the potential of relieving this electronic bottleneck by requiring each station to handle intended only for itself.

In many proposed MAC protocols for WDMA networks, there are many data channels and a single shared control channel. For each packet on the data channel, a packet header is transmitted on the shared control channel, and each station is required to process all the headers on the control channels. A fundamental issue that arises in dealing with multiuser optical system is that of multiiser access methods. We consider a user-network interface at which user traffic is broken into message. These messages, which could be generated in bursts, are then transmitted onto optical medium at the maximum rate allowed by the electrooptic bandwidth constraints of the interface. The multiuser access protocols determine when and how user messages are to be transmitted, and possibly retransmitted. The key issue here is the efficiency by which a given access protocol utilizes the optical medium's bandwidth.

This is particularly important in the optical data networks where the fraction of time during which a user is actually using any bandwidth is on average very small. Under these conditions, the use of scheduled-access schemes (e.g., fixed preassigned time division multiplexing or wavelength division multiplexing) would lead to a very inefficient use of available optical bandwidth. Hence, there has been a lot of interest in the design and performance analysis of random-access schemes for optical data networks. A number of random-access protocols were introduced and analyzed for a very high speed optical data network. We have limited our attention to the class of protocols whose performances are independent of the normalized propagation time of packets on the optical medium.

CHAPTER 2
WIRELESS NETWORK

Wireless networks have significantly impacted the world as far back as World War II. Through the use of wireless networks, information could be sent overseas or behind enemy lines easily and quickly and was more reliable. Since then wireless networks have continued to develop and its uses have significantly grown. Cellular phones are part of huge wireless network systems. People use these phones daily to communicate with one another. Sending information over seas is possible through wireless network systems using satellites and other signals to communicate across the world. Emergency services such as the police department utilize wireless networks to communicate important information quickly. People and businesses use wireless networks to send and share data quickly whether it be in a small office building or across the world. Another important use for wireless networks is as an inexpensive and rapid way to be connected to the Internet in countries and regions where the telecom infrastructure is poor or there is a lack of resources, like most Developing Countries.

Wireless networks allow you to eliminate messy cables. Wireless connections offer more mobility, the downside is there can sometimes be interference that might block the radio signals from passing through. One way to avoid this is by putting the source of your wireless connection in a place where the signal will have as little interference as possible. Sometimes nearby networks are using the same frequencies, and this can also cause interference within the network and can reduce its performance.

Compatibility issues also arise when dealing with wireless networks. Different components not made by the same company may not work together, or might require extra work to fix compatibility issues. To avoid this, purchase products made by the same company so that there are fewer compatibility issues.

Wireless networks, in terms of internet connections, are typically slower than those that are directly connected through an Ethernet cable. Though the speed is slower, most things will still move at the same speed except for things like video downloads. Though wireless technology continues to develop, it is now easier to get networks up and running cheaper and faster than ever before.

A wireless network is more vulnerable because anyone can try to break into a network broadcasting a signal. Many networks offer WEP - Wired Equivalent Privacy - security systems which have been found to be vulnerable to intrusion. Though WEP does block some intruders, the security problems have caused some businesses to stick with wired networks until security can be improved. Another type of security for wireless networks is WPA - Wi-Fi Protected Access. WPA provides more security to wireless networks than a WEP security set up. The use of firewalls will help with security breaches which can help to fix security problems in some wireless networks that are more vulnerable

2.1 Next generation wireless technologies

The next generation wireless networks are expected to converge into a ubiquitous architecture, which includes high-speed cellular networks, wireless local area networks (WLANs), mobile ad hoc networks, peer-to-peer networks; wireless metropolitan area networks (WMANs), etc. The increasing demand of wireless multimedia services has motivated the development of broad wireless access in the heterogeneous wireless networks. Mobile subscribers can enjoy the high bit rate, low cost, ubiquitous coverage, and secure connection. For the next generation wireless networks, further extensive investigation, experimentation and development are necessary, such as capacity analysis/ enhancement, quality-of-service (QoS) support, power saving, wireless routing, security and mobility management. on Broadband Networks .

2.2 Benefits of wireless networks

The popularity of wireless LANs is a testament primarily to their convenience, cost efficiency, and ease of integration with other networks and network components. The majority of computers sold to consumers today come pre-equipped with all necessary wireless LAN technology.

The benefits of wireless LANs include:

- **Convenience**: The wireless nature of such networks allows users to access network resources from nearly any convenient location within their primary networking environment (home or office). With the increasing saturation of laptop-style computers, this is particularly relevant.
- **Mobility**: With the emergence of public wireless networks, users can access the internet even outside their normal work environment. Most chain coffee shops, for example, offer their customers a wireless connection to the internet at little or no cost.
- **Productivity**: Users connected to a wireless network can maintain a nearly constant affiliation with their desired network as they move from place to place. For a business, this implies that an employee can potentially be more productive as his or her work can be accomplished from any convenient location.
- **Deployment**: Initial setup of an infrastructure-based wireless network requires little more than a single access point. Wired networks, on the other hand, have the additional cost and complexity of actual physical cables being run to numerous locations (which can even be impossible for hard-to-reach locations within a building).
- **Expandability**: Wireless networks can serve a suddenly-increased number of clients with the existing equipment. In a wired network, additional clients would require additional wiring.
- **Cost:** Wireless networking hardware is at worst a modest increase from wired counterparts. This potentially increased cost is almost always more than outweighed by the savings in cost and labor associated to running physical cables.

2.3 Techniques Of Multiple Access

2.3.1 FDMA (Frequency Division Multiple Access)

Overview

Frequency division is the original multiple access technique. Currently, most legacy public safety wireless networks use FDMA to improve spectrum efficiency. FDMA is used throughout the commercial wireless industry. Legacy commercial telecommunication networks (analog networks based on Advanced Mobile Phone Service [AMPS] and Total Access Communications System [TACS] standards) are built on a backbone of cellular base stations, using the FDMA[3] technology. However, due to increased spectrum efficiency of CDMA and TDMA systems, very few, if any, new cellular systems are using FDMA.

How it Works

FDMA systems separate a client's large frequency band into several smaller individual bands/channels. Each channel has the ability to support a user. Guard bands are used to separate channels to prevent interference. They are used to isolate channels from adjacent-channel interference.

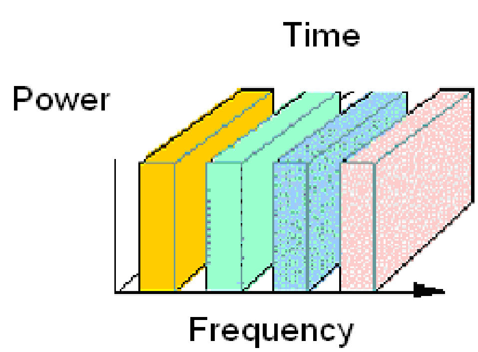

Figure 2.1: FDMA permits only one user per channel because it allows the user to use the channel 100 percent of the time. Therefore, only the frequency “dimension” is used to define channels. Each block represents a different user.

When the FDMA technique is employed, each user is assigned a discrete slice of the radio frequency (RF) spectrum, a "channel" of spectrum space that will vary in size depending on the type of signal being transmitted. In a given amount of spectrum space, the user is granted access to a small sliver of the overall allocation. As long as the user is engaged in "conversation," no other user can access the same spectrum space.

An example of this type of access is use of the spectrum by commercial radio broadcasters. In the commercial radio broadcast bands, 535–1705 kHz for amplitude modulation (AM) and 88–108 megahertz (MHz) for frequency modulation (FM)[3], each local broadcast station (user) is assigned a specific slice of spectrum within the frequency band allocated for that purpose. As long as the station broadcasts, no other radio station in the same area can use that radio frequency bandwidth to send a signal. Another broadcast station can use that same bandwidth only when the distance between the stations is sufficient to reduce the risk of interference.

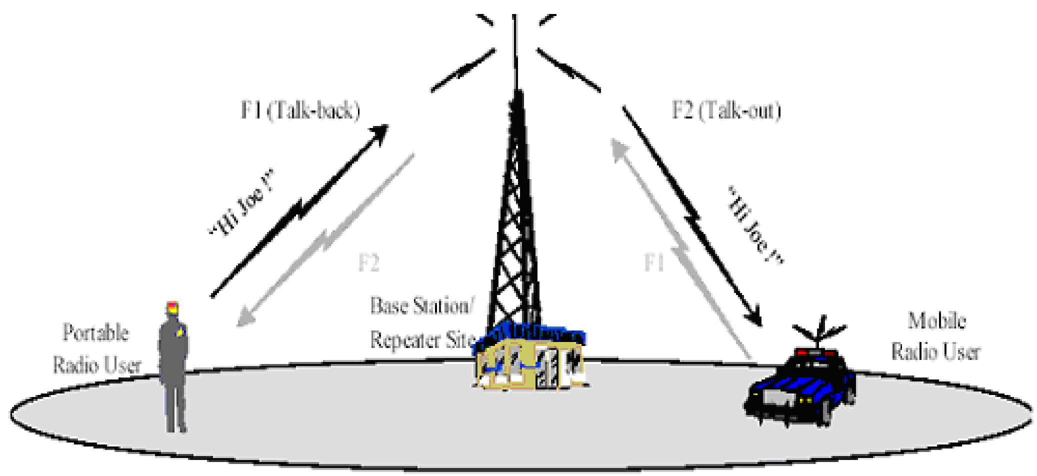

Figure 2.2: Single-Site Conventional System Configuration Operating in Half-Duplex

In a conventional two-frequency public safety radio system, one frequency is used to transmit and the other is used to receive. Each channel has its own center frequency and each channel has a bandwidth that is a fraction of the original allotted bandwidth. In this type of system, if an FDMA channel is in use, other users cannot use it until the "conversation" is complete. This is one of the inefficiencies of FDMA systems. Figure 2.2 graphically displays a two-frequency conventional system. The mobile and portable radio users transmit on frequency F1 to the repeater; the repeater then retransmits back to the users on frequency F2. In Figure 2, the F1 lightning symbol is an uplink to the repeater while the F2 lightning symbol is a downlink.

Project 25's (P25) Phase I standard requires upgrades from standard analog technology with a 25 kHz bandwidth to digital technology with a narrower bandwidth of 12.5 kHz. Implementation of an FDMA[3] system would give each user access to two separate frequency allotments, each with a 12.5 kHz bandwidth. Under P25, this newer equipment is also required to be "backward compatible" to the legacy 25 kHz analog equipment to allow a smooth transition.3 Because adjacent channel interference is an important factor in channel quality, frequency planning is a key consideration when selecting fixed or base station locations. Frequency planning is complicated and difficult. Available frequency

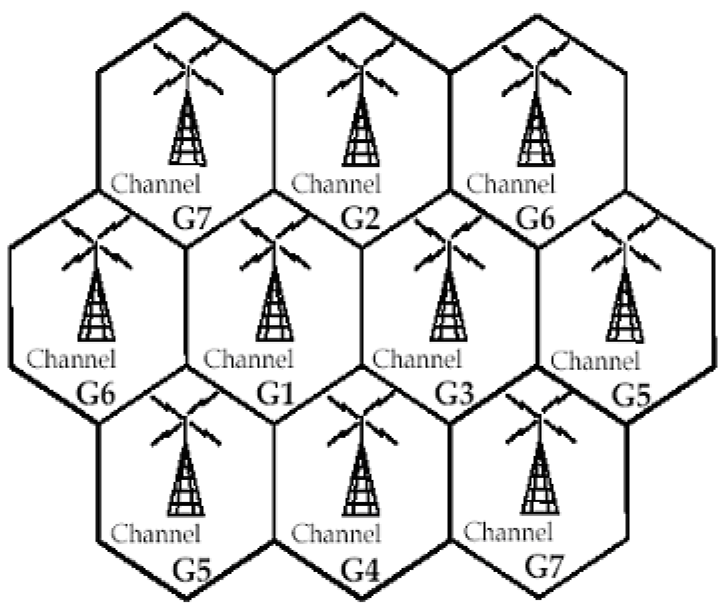

Figure 2.3: Channels F1-Fn are divided in 7 groups(G1-G7). Each site is assigned frequency group different from adjacent site to minimize co-channel interference.

bands must be researched and analyzed. Transceiver transmission strength affects fixed station range while antenna design affects its coverage patterns. These are also important factors in frequency planning. Figure 2.3 is a sample base station coverage scheme for a cellular system.

Advantages

- Simple to implement , from a hardware standpoint.
- Fairly efficient with a small base population and when traffic is constant.
- P25 equipment is backward compatible to legacy 25 KHz analog radio equipment.

Disadvantages

- Network and spectrum planning are intensive.
- In a conventional system, because channels are allocated for one user, idle channels add to spectrum inefficiency.
- Frequency planning is time-consuming.

2.3.2 TDMA—Time Division Multiple Access

Overview

As the frequency spectrum experiences more traffic, spectrum efficiency becomes increasingly important. TDMA systems were developed as FDMA system spectrum efficiency became insufficient. Not only do TDMA systems split users into an available pair of channels, but they also assign each user an available time-slot/cell within that channel. TDMA systems have the capability to split users into time slots because they transfer digital data, instead of analog data commonly used in legacy FDMA systems. Each of the users takes turns transmitting and receiving in a round-robin fashion. Frequency division is still employed, but these frequencies are now further subdivided into a defined number of time slots per frequency. In reality, only one user is (actually) using the channel at any given moment. Each user is transmitting and receiving in short "bursts." Because TDMA[3] systems do not transmit all of the time, their mobile phones have an extended battery life and talk time.

How it works

Similar to an FDMA trunked system, when a user depresses the Push-To-Talk (PTT) switch in a TDMA system, a control channel registers the radio to the closest base station. During registration, the base station assigns the user an available pair of channels, one to transmit and the other to receive. But, unlike an FDMA[3] system registration, a TDMA system registration also assigns an available time-slot within the channel. The user can only send or receive information at that time, regardless of the availability of other time-slots. Information flow is not continuous for any user, but rather is sent and received in bursts. The bursts are re-assembled at the receiving end and appear to provide continuous sound because the process is very fast.

In Figure 4, each row of blocks represents a single channel divided into three time-slots. Calls in a TDMA system start in analog format and are sampled, transforming the call into a digital format. After the call is converted into digital format, the TDMA system places the call into an assigned time slot. Figure 4 is also a graphical display of the efficiency of a TDMA system.The improved efficiency of TDMA over FDMA can be

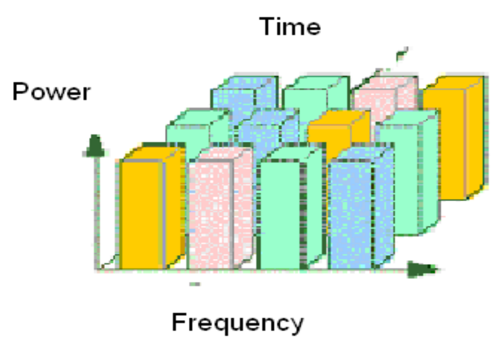

Figure 2.4: TDMA increases the number of users who have access to particular channel by dividing that channel into time-slots.

realized through a quick glance at Figures 2.1 and 2.4. In Figure 2.1, the FDMA system supports 2.4 users while in Figure 4, the TDMA system supports 12 users within the same bandwidth as the FDMA system. There are systems in place today that allow an increase of up to six times the capacity of FDMA alone.

Because TDMA systems also split an allotted portion of the frequency spectrum into smaller slots (channels), they require the same level of frequency planning as FDMA systems. The same careful steps in frequency planning must be taken in both FDMA and TDMA systems.

Advantages

- Extended battery life and talk time
- More efficient use of spectrum, compared to FDMA
- Will accommodate more users in the same spectrum space than an FDMA system which improves capacity in high traffic areas, such as large metropolitan areas
- Efficient utilization of hierarchical cell structures – pico, micro, and macro cells
- Can handle video and audio data efficiently

Disadvantages

- Network and spectrum planning are intensive
- Multipath interference affects call quality
- Dropped calls are possible when users switch in and out of different cells
- Frequency planning is time consuming
- Frequency guard bands add to spectrum inefficiency
- Too few users result in idle channels (rural versus urban environment)
- Higher costs due to greater equipment sophistication

2.3.3 CDMA—Code Division Multiple Access

Overview

CDMA is a spread spectrum technique used to increase spectrum efficiency over current FDMA and TDMA systems. Although spread spectrum's application to cellular telephony is relatively new, it is not a new technology. Spread spectrum has been used in many military applications, such as anti-jamming (because of the spread signal, it is difficult to interfere with or jam), ranging (measuring the distance of the transmission to determine when it will be received), and secure communications (the spread spectrum signal is very hard to detect).

How it works

With CDMA, unique digital codes (Walsh Codes)[3], rather than separate radio frequencies/ channels, are used to differentiate users. The Walsh codes are shared by the mobile phone and the base station, and are called “pseudo-Random Code Sequences.” All users access the entire spectrum allocation all of the time. That is, every user uses the entire block of allocated spectrum space to carry his/her message. A user's unique Walsh Code separates the call from all other calls. Figure 2.5 graphically shows each user simultaneously accessing the fully allotted frequency spectrum.

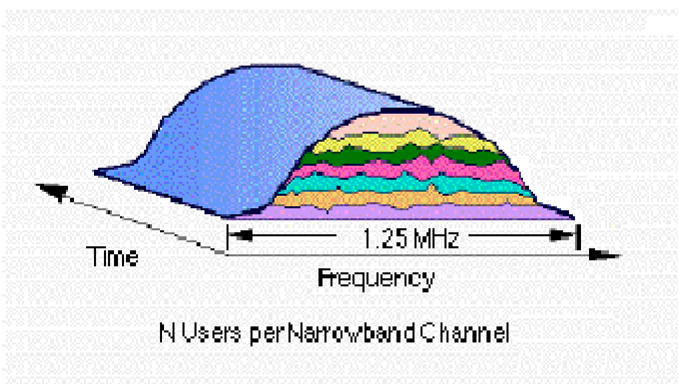

Figure 2.5: CDMA allows all users access to their entire allocated spectrum.

CDMA, being a “spread-spectrum” technology, spreads the information contained in a signal over the entire available bandwidth and not simply through one frequency. Due to the wide bandwidth of a spread-spectrum signal, it is very difficult to cause jamming, difficult to interfere with, and difficult to identify. It appears as nothing more than a slight rise in the “noise floor” or interference level, unlike other technologies where the power of the signal is concentrated in a narrower band making it easier to detect. Therefore CDMA[3] systems provide more privacy than FDMA or TDMA systems. These are great advantages over technologies using a narrower bandwidth.

CDMA channels can handle an unspecified number of users. There is not a fixed number. The capacity of the system depends on the quality of current calls. As more users are added, noise is added to the wideband frequency and therefore decreases the quality of current calls. Each user's transmission power increases the level of the frequency spectrum's "noise floor" and therefore decreases the overall call quality for all users. To help eliminate the "noise floor," CDMA mobile phones and base stations use the minimum amount of power required to communicate with each other. They use precise power control to decrease users' transmission power. By decreasing a user's transmission power, the mobile phone has added battery life, increased talk time, and smaller batteries.

Because CDMA is a spread spectrum technology, it requires less frequency planning. The full original spectrum is not divided into separate blocks/channels, like it is in FDMA and TDMA systems. Therefore, there is no need to plan for multiple frequency guard bands. Because all users have access to the entire spectrum at all times, frequency planning only needs to consider one frequency/channel. However, the channel requires relatively wide contiguous bandwidth.

Advantages

- Greatest spectrum efficiency: capacity increases of 8 to 10 times that of an analog system and 4 to 5 times that of other digital systems which makes it most useful in high traffic areas with a large number of users and limited spectrum
- CDMA improves call quality by filtering out background noise, cross-talk, and interference
- ”Soft handoffs”— Because of the multiple diversities in use, handoffs between cells are undetected by the user
- Simplified frequency planning - all users on a CDMA system use the same radio frequency spectrum.
- Engineering detailed frequency plans are not necessary.
- Frequency re-tunes for expansion are eliminated.
- Fewer cells are required for quality coverage
- Random Walsh codes enhance user privacy; a spread-spectrum advantage
- Precise power control increases talk time and battery size for mobile phones

Disadvantages

- . Backwards compatibility techniques are costly
- . Currently, base station equipment is expensive
- . Difficult to optimize to maximize performance
- . Low traffic areas lead to inefficient use of spectrum and equipment resources

2.3.4 Hidden/Exposed problem

Both of the access methods use a multiple access scheme based on carrier sensing with collision avoidance (CSMA/CA)[3]. Basically, each node senses the channel before transmitting the first frame of the handshake; if the channel is sensed idle for a certain period of time called DIFS(Distributed Inter Frame Space), the node starts transmitting the first frame of the handshake immediately. Otherwise the nodes waits for the channel to be idle for DIFS and draws a random additional back off time to avoid possible collisions when the channel gets free (Collision Avoidance).Even if 802.11 is the optical standard for Wireless LAN's both in infrastructure and in adhoc mode, originally it was devised only for a single Access Point scenario where all the nodes were within the transmitting range of one another. For this reason, many problems arise when we use 802.11 both in a pure ad hoc mode and in a infrastructure cellular-like scenario where we have different APs and mobile nodes moving around [3].IEEE 802.11 also employs a mechanism called virtual carrier sensing. Each transmitted frame brings the information about the duration of the ongoing communication. Every other node overhearing that frame is prevented from accessing the media for all the duration of the ongoing communications by setting its NAV (Network Allocation Vector).

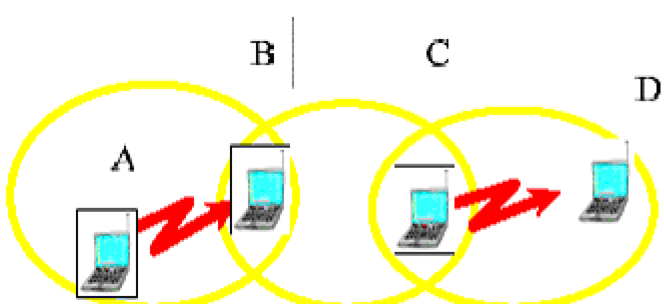

Figure 2.6: Hidden Terminal example

Well known problems in these environments are the hidden and the exposed terminal. Figure2.6 reports a typical hidden terminal situation where there's an ongoing communication between A and B. If C does not have any information about the communication between A and B, it can start transmitting to D causing a collision in B. In order to get rid of the hidden terminal problem, the standard has introduced the four way handshake procedure based on RTS and CTS. In the case of the figure, C overhears the CTS B sends to A and refrains from transmitting and colliding. In Figure 2 the exposed terminal problem is described. A node is exposed when is within the sensing range of the sender but out the interfering range of the receiver. In the case of the figure, supposing on ongoing communication between B-A, every communication involving Cis not feasible, since C is in the zone cleared by the RTS sent by B, even if C could transmit to D without causing any collision. The exposed terminal problem is still unsolved and can deeply affect the performances of multihop ad hoc networks based on IEEE 802.11 [28].Different solutions have been proposed to face such problem. Most of them are based on a wise sharing of the common resource between different communications based on the management of the numerous timers the IEEE 802.11 MAC level has [6, 7].In this technical report we propose a novel MAC layer for Wireless LAN which is able to extend the capabilities of the basic IEEE 802.11 to environments with high interference, both in adhoc and in infrastructure mode .

CHAPTER 3

3.1 WDMA Architecture

With a single hop passive star coupled topology, N stations are deployed around a passive star coupler (PSC) and connected by optical fibers in the WDMA network as shown in Fig. 1(a). C wavelengths are dedicated to N network stations as channels, and channel sharing is imperative in the case of $N > C$. The transmission and reception of the three types of traffic are built on the fundamental packet service which is provided by the three corresponding sub-protocols in MAC[40] sub-layer. Due to broadcast and select characteristic one type of traffic stream from a station is broadcasted to all stations which determine to receive or discard it as a result of corresponding sub-protocol, and remaining two types of traffic streams are also processed in turn according to their corresponding sub-protocol. The processing time of M-WDMA is denoted as a frame which consists of TDM, RSV

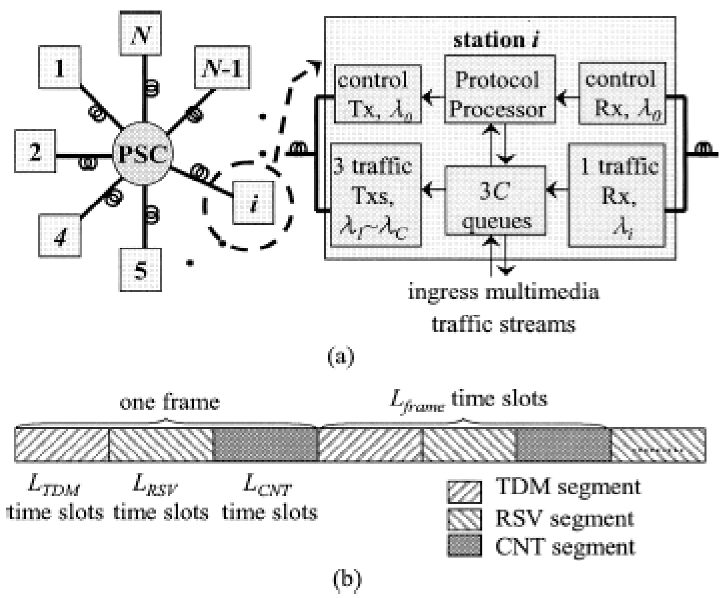

Figure 3.1: Architecture and time flow graph of WDMA network. (a) Block diagram of the WDMA network with a single hop passive star coupled topology. (b) Time flow graph of the WDMA network employing M-WDMA MAC protocol.

and CNT time segments as shown in Fig. 1(b). Each time segment is composed as multiple time slots. TDM, RSV and CNT time segments respectively consist of *LTDM*, *LRS V* and *LCNT[41]* time slots so that the number of time slots in a frame, Lframe, can be represented as *LTDM* + *LRS V* + *LCNT* .

3.2 Efficient Protocols for Multimedia Streams on WDMA Networks

A plethora of MAC protocols have been proposed for star coupled WDM networks (for more details, see [40]). However, most of these MAC protocols are not suited for an integrated services environment because they have been designed with just one *generic* traffic type in mind. As a result, they perform quite well for the traffic streams they have been designed for but poorly for other traffic streams with different characteristics. The purpose of this seminar is to combine the advantages of these various MAC protocols with

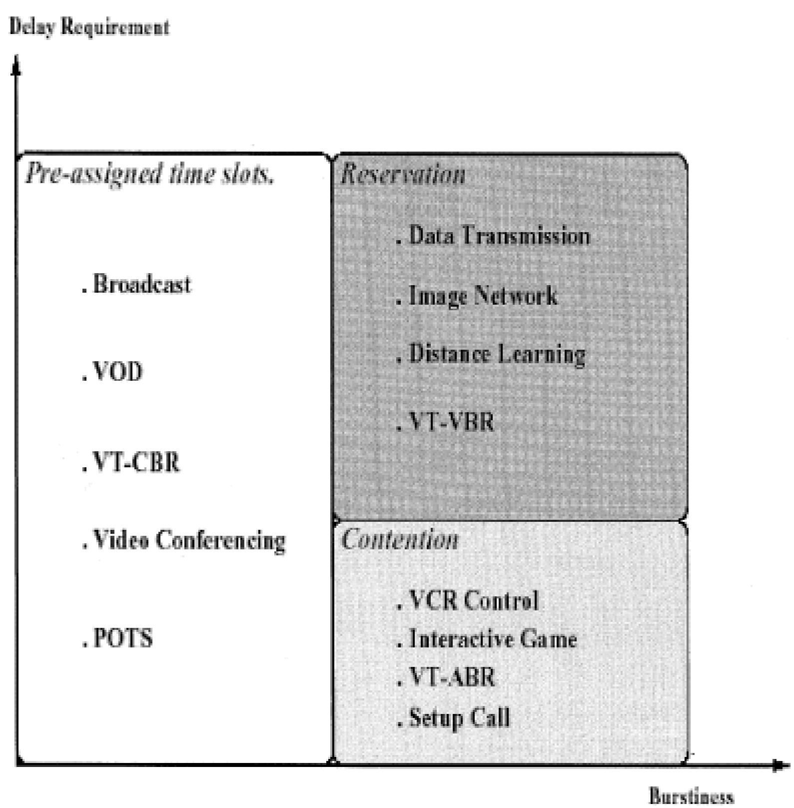

Figure 3.2: Multiple traffic stream features and their appropriate MAC protocols.

In a single framework so as to be able to efficiently serve a wide range of traffic streams typical in multimedia applications.

In particular, we propose a novel WDM MAC protocol that can integrate different types of MAC protocols into a single physical WDM network to efficiently support multimedia traffic streams. This MAC protocol is termed multimedia wavelength-division multiple-access (M-WDMA)[40,41]. The motivation behind integrating different MAC protocols into a single WDM network comes from the fact that different types of traffic streams have different characteristics. As a result, the traffic streams have different transmission and quality of service (QoS) requirements. We can classify multimedia traffic streams as a function of their data burstiness and delay requirements, as shown in Fig. 3.2. For example, video/audio streams and plain old telephone service (POTS)[40] have small data burstiness but require almost constant transmission delay and almost fixed bandwidth in order to guarantee their QoS. On the other hand, applications such as image networking and distance learning are less stringent in terms of their delay requirements, but their traffic streams are very bursty. Finally, there are other applications that require a very low delay while their traffic streams are bursty. Examples of this type of applications include control messages for video-on-demand systems or interactive games and network control and management.

These different traffic streams are better served by different MAC protocols. Video/audio data streams and other constant-bit-rate (CBR) traffic streams benefit best from prescheduled MAC protocols since they can guarantee that each node has a cyclic and fixed available bandwidth. The best MAC protocols for this purpose would be a simple round-robin time

division multiplexing access (TDMA)[3] scheme. In a WDM network, a TDMA MAC protocol is applied to each of the channels. The scheduling principle can be represented in a scheduling table that is arranged in such a way that every channel is cyclical allocated to every node in a prefixed order, and every channel is used by a pair of source and destination nodes at a time. This protocol is usually referred to as interleaved time-division multiple-access (ITDMA) protocols [3], [4], or WDM/TDM protocols [7]. A typical node configuration for the ITDMA protocols uses a fixed receiver and a tunable transmitter (FR-TT) or a tunable receiver and a fixed transmitter (TR-FT). One drawback of this class of protocols is that if the input load is non uniform or bursty, the TDMA protocol performs rather poorly.

On the other hand, reservation-based MAC protocols are very well suited for applications where the traffic streams are bursty or the traffic load of the nodes is unbalanced, since reservation- based MAC protocols schedule the transmission according to a particular transmission request. Before a transmission takes place, a node has to send a transmission request to the destination node or to a central controller. Then, the transmission can only start after the source node gets a positive acknowledgment (e.g., grant). Since a lot of detailed information about the transmission can be obtained before the transmission takes place, the transmission schedule can be very efficient and precise. As a result, these MAC protocols can be easily designed to consider tuning time, propagation time, packet processing time, deadline, and transmission cost, etc.

The disadvantages of the reservation-based MAC protocols are that reservation mechanism requires extra bandwidth and time to exchange the request and the acknowledgement information. In addition, the scheduling methods can be relatively complicated, hence, requiring more processing time. These drawbacks cause considerable additional delay and delay variation for packet transmission. Therefore, this type of MAC protocols usually does not perform well for CBR traffic streams or for applications requiring very small delays (for more details about reservation-based protocols, see [40], [7], and [25]). Finally, random access (contention) MAC protocols usually do not consider the status of the channels or the destination nodes. Once a transmission request emerges, the node starts the transmission almost immediately. This, however, leads to potential collisions between packets. That is, packets being transmitted in the same time slot will collide, and then they have to be retransmitted again. On the other hand, if the transmission succeeds, the packet transmission delay can be extremely low.

Thus, random access MAC protocols have the potential of meeting the delay requirements of very urgent messages. Some examples of these urgent messages (e.g., call setup) are listed in Fig.3.2. These applications may not generate a lot of traffic data when compared with the other applications. However, once certain traffic (message) is generated, they require a very low delay. A typical random access MAC protocol that has been proposed in WDM networks is Interleaved Slotted ALOHA (ISA) [37]. These protocols perform very well, especially with respect to packet delays when the traffic load is low. However, if the traffic load gets high, then packet collisions start to occur more frequently. As a result, the performance can be quite poor. As can be seen, none of these MAC protocols serves all types of traffic well. However, each one of them is ideal for certain types of traffic streams.

This observation leads us to propose an efficient scheme of integrating all these MAC protocols into a single MAC protocol for WDM networks. We denote this integrated WDM MAC protocol as M-WDMA. In an M-WDMA MAC[40] protocol, an ITDMA-like MAC protocol, a reservation based (using token passing)MAC protocol, and an ISA protocol are integrated into a single physical WDM network in an efficient way so that different types of traffic streams can use the most appropriate protocol. In our M-WDMA implementation, we consider the following as pects of the environment:

1) Three types of traffic streams: a CBR, a variable bit rate (VBR) with large burstiness (VBR1), and a VBR with longer inter arrival times (VBR2);

2) The importance of the deadline associated with each traffic stream;

3) A nonzero tuning time of the transmitters/receivers.

In addition, we design a dynamic bandwidth allocation strategy to further improve the utilization of our M-WDMA, which we call M-WDMA+ to distinguish it from the case where the channel bandwidth is allocated in a static fashion.

3.3 Efficient Communication Protocol for Multichannel Networks

This seminar presents a new media-access (MAC) protocol for high-speed packet-switched multichannel networks based on a broadcast topology, such as all-optical passive-star-based wavelength-division multi-access (WDMA) networks[10]. These networks are expected to support several hundred to a thousand nodes stations and high-speed applications requiring hundreds of Mb/s per node .The underlying philosophy behind this new protocol is two fold. First, we will design the protocol so as to minimize the processing requirements at each station. As a consequence of this design, the performance and operation of the protocol scale well with the number of stations in the network. Second, we will design the protocol to support different traffic classes, both connection-oriented and connectionless, as a first step towards creating a single integrated media-access/transport layer. None of the MAC protocols proposed so far performs this function. In broadcast WDMA networks, the different channels correspond to different optical wavelengths that can all be multiplexed onto a single fiber. Stations may transmit packets on different channels using a tunable-laser transmitter.

The transmissions are broadcast to all of the stations. Stations may receive packets from different channels using a tunable-filter receiver. These devices must be rapidly tunable to enable a station to transmit successive packets on different channels and receive successive packets from different channels. In conventional single-channel networks, for example, Ethernet, a station sees traffic intended for many or all of the other stations in the network, which means that its electronics has to operate at the aggregate bit rate corresponding to this total traffic. WDMA offers the potential of relieving this electronic bottleneck by requiring each station to handle traffic intended only for itself. In many proposed MAC protocols for WDMA networks, there are many data channels and a single shared control channel. For each packet on a data channel, a packet header is transmitted on the shared control channel, and each station is required to process all the headers on the control channel.

This creates an electronic processing bottleneck. For example, at 1 Gb/s transmission rate per channel, a 100 kb packet lasts 100 *ps.* If a station transmits on one data channel at a time, then it transmits at the rate of 10,000 packets/s; hence, a station must be able to receive and process 10,000 packets/s. This is around the limit for transport protocol processing rates today [14]. Therefore, in protocols that use a single common control channel as described, we have a severe electronic processing bottleneck because a station now has to process 10,000N headers/s, where N is the total number of stations.

3.3.1 Existing Protocol Schemes

We now summarize the features of schemes that have been proposed in the thesis. We shall use four metrics in evaluating these schemes.

- The processing requirements.
- Whether or not a station has to wait before transmitting a packet. (In reservation schemes, a station has to make a reservation and wait for at least one round-trip delay from the hub star before it can transmit a packet. Some protocols

have a feature where a station simply informs the destination that it is transmitting a packet and goes ahead and does so without waiting any further. This is a desirable feature in high-speed networks where the round-trip delays are much longer than the packet transmission times. We refer to this feature as "tell and go.")

- The network throughput or channel utilization.
- Whether or not the scheme requires network-wide synchronization.

.

Since in high-speed WDM metropolitan-area networks (MAN'S) the packet transmission time is much smaller than the end-to-end propagation delay, schemes that use carrier-sense multiple access (CSMA) perform poorly. In [4], [5], stations use ALOHA or carrier-sense multiple access on a common control channel to send the packet header, and again ALOHA or CSMA on one of several data channels for sending the actual packet itself. These random access protocols are simple, but make inefficient use of the bandwidth.

Each station has to look at all packets on the control channel, and hence the processing requirement is high. The throughput of these schemes is low due to collisions on the control as well as the data channels. However, an advantage of the schemes in [4] is that a station can transmit a packet as soon as it is received by its transmitter without having to wait one or more round-trip delays (which would be the case with reservation schemes). In [5], a station transmits the packet on the data channel only after determining whether its transmission on the control channel was successful. This improves the throughput, but increases the waiting time before packet transmission. Network-wide synchronization is not required. Among the other protocols, DT-WDMA [6] assumes that each station transmits on a unique fixed wavelength, different from the other stations, and uses a tunable filter to select one from among all of the different wavelengths for reception.

In addition, there is a common control channel shared by all the stations. A station transmits the packet header in its assigned time slot on the control channel, and follows this by transmitting the actual packet on its data channel. All stations listen to the control channel. The destination station, after listening to the packet header on the control channel, tunes its receiver to the appropriate channel to receive the packet. There is contention if two or more stations transmit to the same destination at the same time; the destination can then listen to only one of these packets. The throughput of this scheme for uniform traffic is 0.6, but the processing overhead on the control channel becomes a bottleneck. Moreover, either the data-packet length or the bit rate on the control channel has to scale in proportion to the number of stations in the network in order to retain the bandwidth efficiency.

Network-wide synchronization is required. Two other schemes [7], [8] use the same control-data channel format as DT-WDMA, but use reservations to schedule transmissions more efficiently, and in principle can realize a throughput of 1. However, these schemes require even more processing than DT-WDMA. Moreover, a station has to wait for at least one round-trip delay time from the hub before it can transmit a packet. In [4], *[5] ,* collisions can occur on the control channel as well as on the data channels while, in DT-WDMA [6], no collisions occur. Three other schemes [9]-[13] use Slotted ALOHA on the control channel to reserve a slot on one of the data channels. Thus, collisions occur on the control channel but not on the data channels. In addition, in [12] , nodes maintain sufficient state information so as to avoid receiver contentions. Again, a station has to wait at least one round-trip delay from the hub before it can transmit a packet. In another variant [13], a station uses Slotted ALOHA on the control channel to select one of the data channels, but immediately follows through by transmitting the packet on the data channel.

Thus, collisions occur both on the control and data channels, but a station does not have to wait before transmitting a packet. This is similar to [4] in performance. However, all of these schemes again require a lot of processing of information on the control channel, and also require network-wide synchronization. Our protocol uses multiple control channels to reduce the processing requirements. Similarly, in [141, the scheme proposed in [4] is extended to work with multiple control channels. In this scheme, there are *2N* channels for *N* stations.Each station receives control information on a fixed dedicated wavelength and transmits data on a fixed dedicated wavelength. For example, if station ***A*** wishes to send a packet to station *B,* it tunes to *B's* control wavelength and transmits the packet header. Station ***A*** then transmits the packet on its transmit wavelength. If B is idle, it listens to its control channel, receives the header (if it does not collide with other headers), and tunes to *A's* transmit wavelength to receive the packet.

This scheme has the advantage of being simple and easy to implement. A station does not have to wait before transmitting a packet and no network-wide synchronization is required.All of the schemes proposed support datagram (connectionless) traffic. In , fixed time slots are assigned for each source-destination pair, depending on the overall traffic matrix. These schemes are suitable for nonbursty traffic requiring guaranteed bandwidth. However, they do not accommodate bursty traffic efficiently; in addition, a means must be provided to change the slot assignment pattern dynamically as the traffic matrix changes.

3.3.2 Features of the MAC Protocol

We develop a protocol that makes efficient use of the available bandwidth, but with significantly less processing overhead than most of the schemes described here. The basic idea is to have not one, but several, control channels. By dedicating a separate control channel to each station, we ensure that a station has to process control packets intended only for itself and not for all other stations. Furthermore, each station maintains information related only to connections that it has with others, and not about all connections in the network.

This enables us to reduce the processing requirements at the stations, and avoids having to scale the data-packet length or the control-channel bit rate with the number of stations. Furthermore, addition and removal of stations from the network does not affect the operation of the protocol. Moreover, it may be possible to operate the control channels at moderate bit rates between 10-100 Mb/s using cheap off-the-shelf electronics. This protocol does require network-wide synchronization. Another important feature of our protocol is its ability to support many different traffic types. In high-speed lightwave networks, it has been conjectured that the entire protocol stack

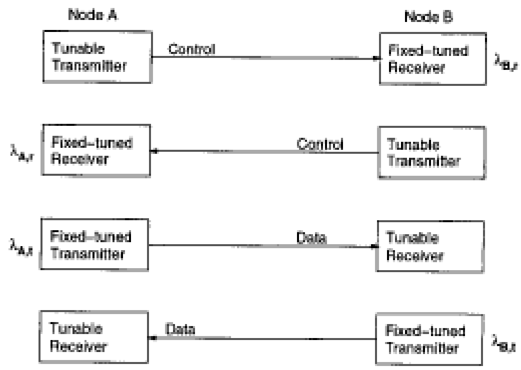

Figure 3.3: Organization of control and data transmission in the network

Ought to be much slimmer than in today's networks [14]. One instance where this is true is in a broadcast multichannel network of the type we consider here. Since the networking layer is essentially absent, it is desirable to combine the transport and media-access layers into a single integrated layer.

Among the functions of the transport layer [14], we consider only the connection setup and disconnect functions, support of different traffic classes, and the data transfer mechanism. Other functions such as flow control, error recovery, packet re-sequencing, segmentation, and reassembly are not considered here. One of our design objectives is to provide support of different traffic classes in the media-access protocol itself. This is not the case with any of the schemes proposed earlier. These support purely datagram traffic. It is likely that most of the high-speed traffic in the network is connection oriented, but in today's networks, there is also a lot of datagram (connectionless) traffic. Hence, our protocol is designed to support three different traffic classes:

Class I : Connection-oriented with guaranteed bandwidth, e.g., video. We believe most network traffic would be connection oriented, and those applications with real-time delivery constraints will require dedicated bandwidth.

***Class* 2**: Connection-oriented but bandwidth not guaranteed, e.g., file transfer. This corresponds to virtual-circuit like traffic. There is the notion of connections, but traffic on a connection is bursty. Thus, although many connections can be set up, only some of them will be active at any time.

Class 3: Datagram traffic, e.g., short transactions, control messages. For both class 1 and class 2, connection setup is implicit, i.e., the first packet belonging to a connection signals the start of the connection. Connections may either be full-duplex (two-way) or simplex (one-way). The remainder of this seminar is organized as follows. Section I1 describes our protocol, along with our assumptions on the underlying network. We also describe some extensions requiring less hardware, and show how we can reduce the number of channels required (bandwidth) by increasing the amount of processing. In we analyze the protocol and compute the blocking probabilities for class 1 and 2 traffic and the throughput for class 2 traffic. Concludes the seminar The Protocol for convenience, we will associate each channel with a wavelength. We propose that each station be provided a fixed-tuned transmitter (FT), a fixed-tuned receiver (FR), a rapidly tunable transmitter (TT), and a rapidly tunable receiver (TR). Each FT and FR in the network is assigned a unique wavelength. Hence, for a network of *N* stations, we need 2N wavelengths.

The TT's and FR's are used for control purposes, and will be denoted as control transmitters and control receivers, respectively. The FT's and TR's are used for data transmission and reception, and will be denoted as data transmitters and data receivers, respectively. Fig.3.3 illustrates this assignment. In Section 11-1, we show that this protocol can be implemented with anywhere from 1 to *N* control wavelengths, 1 to ***N*** data wavelengths (both at the cost of trading off processing against bandwidth), and with only a single TT and FR at each station. Consider a station in the network, say station *A.* On each channel, time is divided into frames of length *T.* The frame structure is shown in Fig. 2. A frame on the channel used by station *A's* control receiver is divided into *m* slots, numbered l , . . . , m . Up to *m* stations may simultaneously have connections established with station *A.* Every station in the network that has set up a connection with station A is assigned one of these *m* slots (at the time of connection setup).

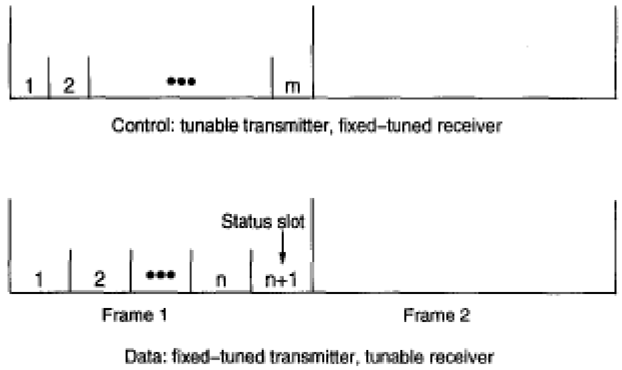

Figure 3.4: The frame structure on the control and data channel

A frame on the channel used by station *A's* data transmitter is divided into *n*+ 1 slots, numbered 1, . . . , *nS* 1. *n* of these slots, say 1, . . . , *n*, are used to transmit data. Usually, *n 5 m.* The idea is that many stations may have a connection setup with a station, but not all those connections are active simultaneously. In the remaining slot (slot *n*+ 1) on its data transmitter, station

A transmits the assignment of slots for its control receiver. We refer to this as the *status slot.* Network-wide frame and slot synchronization is assumed. **(A** slot is assumed to be long enough to accommodate a packet as well as the time taken to tune from one channel to another.

3.4 COMPARISON OF DIFFERENT MULTIPLE ACCESS TECHNIQUES

	FDMA	TDMA	CDMA	WDMA
Capacity (Spectrum Efficiency)	1	2	3	4
Security	1	1	3	4
Ease of Network Planning	1	1	2	2
Ease of Implementation	4	4	2	2
Cost of Implementation	3	3	3	4
Backwards Compatibility	4	3	1	4
Throughput	3	2	3	4
Processing Power Requirement	3	2	3	4

Excellent 4 3 2 1 0 Poor

CHAPTER 4

PROBLEM STATEMENT

4.1 Primary Objective

A number of random access protocols were introduced and analyzed for a very high speed optical data network based on a passive star topology. In our thesis a number of more efficient protocols for the same hardware architecture are presented. In particular attention is given to the most simple algorithm that are based on the Aloha protocol and do no require any kind of carrier sensing. The simulator we have designed have better throughput performance than the corresponding protocols for all the values of system parameters.

4.2 Justification

Each user simply transmits a newly generated control packets in the first control slot after the packet generation time, and immediately after, it transmits the corresponding data packets over one of the N data channels chosen at random. When a collision occurs on either the control channels or at the data channels, the user waits some random number of control slots before retransmitting the original control packets and the data packets.

$$S_d = \frac{L}{N} G e^{-G} \left[e^{-(G/N)} \right]^{2(L-1)} \qquad \text{eq.1}$$

Each user transmits a newly generated control packet in the first control slot after the packet generation time. If the control packet is transmitted successfully, then and immediately after it, the user transmits the corresponding data packet over one of the N data channels chosen at random. When a collision occurs on either the control or the data channel, the user waits some random number of control slots before transmitting the original control packet and the corresponding data packets for newly generated packets.

$$S_d = \frac{L}{N} G e^{-G} \left[1 - \frac{G}{N} e^{-G} \right]^{2(L-1)} \qquad \text{eq.2}$$

simple algebraic manipulation reveals that the throughput of the improved protocol given by eq.2 is larger than the original protocol given by eq.1 for all the reasonable values of the system parameters if L=2,N=2,G=0.2 then the throughput from eq.1=0.1839 and throughput from eq.2 is 0.2450.

CHAPTER 5
DESIGN AND DEVELOPMENT OF SIMULATOR

5.1 Simulator

A simulation is an imitation of some real things, state of affairs or process. The act of simulating something generally entails representing certain key characteristics or behavior of a selected physical or abstract system. Simulation is used in many contexts, including the modeling of natural system or human systems in order to gain insight into their functionality. Other context of include simulation of technology for performance optimization, safety engineering, testing, training and education. Simulation can be used to show the eventual real effects of alternative conditions and course of actions.

5.1.1 Types of Simulator

Many special purpose simulators exist to simulate very specific types of systems. Perhaps the simplest and most broadly used general purpose simulator is the **Spreadsheet.** The other general purpose tools exist that are better able to represent complex dynamics, as well as provide a graphical mechanism for viewing the model structure.

Discrete Event Simulator: These tools rely on transaction-flow approach to modeling systems. Models consist of entities, resources and control elements. Discrete simulators are generally designed for simulating processes such as call center, factory operations and shipping facilities in which the material or the information that is being simulated can be described as moving in discrete steps or packets. They are not meant to model the movement of continuous material or represent continuous system that are represented by differential equations.

Agent Based Simulator: This is a special class of discrete event simulator in which the mobile entities are known as agents. Where as in traditional discrete event model the entities only have attributes, agents have both attributes and methods. An agent-based model could for example simulate the behavior of a population of animals that are interacting with each other.

Continuous Simulators: This class of tools solves differential equations that describe the evolution of a system using continuous equations. These types of simulators are most appropriate if the material or information that is being simulated can be described as evolving or moving smoothly and continuously, rather than in infrequent discrete steps or packets. For example, simulation of the movement of water through a series of reservoirs and pipes can most appropriately be represented using a continuous simulator. Continuous simulators can also be used to simulate systems consisting of discrete entities if the number of entities is large so that the movement can be treated as a flow.

Hybrid Simulators: These tools combine the features of continuous simulators and discrete simulators. That is, they solve differential equations, but can superimpose discrete events on the continuously varying system.

5.2 Simulation Environment

In the simulator that we have designed, we make the standard set of assumptions for random-access networks. We are dealing with slotted aloha protocol system. All control packets are of same length and require one time unit (called control slot) for transmission. All data packets are of same length and require L time units (called a data slot) for transmission. If two or more users transmit a packet on the same channel during overlapping time slots, a collision occurs and all overlapping packets are destroyed. At the end of time slot, each user obtains a feedback specifying whether there was a collision in that slot. Each packet involved in a collision must be retransmitted in some later time slot. These are the same assumptions that are used in previous protocol because the use of same assumptions provides a fair framework for comparing the results present here in the graphs.

N= Number of channels in the system excluding the control channel.

L=Ratio of the length of a data packet to the control packet.

G= Average number of control packets transmitted per control slot on control channel.

Gd= Average number of data packets transmitted per data slot on data channel.

Ps= Probability that a given packet on a given data channel is successfully transmitted.

Sd= Average number of data packets successfully transmitted par data slot on a give data channel, fraction of time on a given data channel carrying successful messages, throughput per data channel, Gd*Ps.

St= Total System throughput NSd.

Figure 5.1: Shows the snapshot of the login page of Simulator.

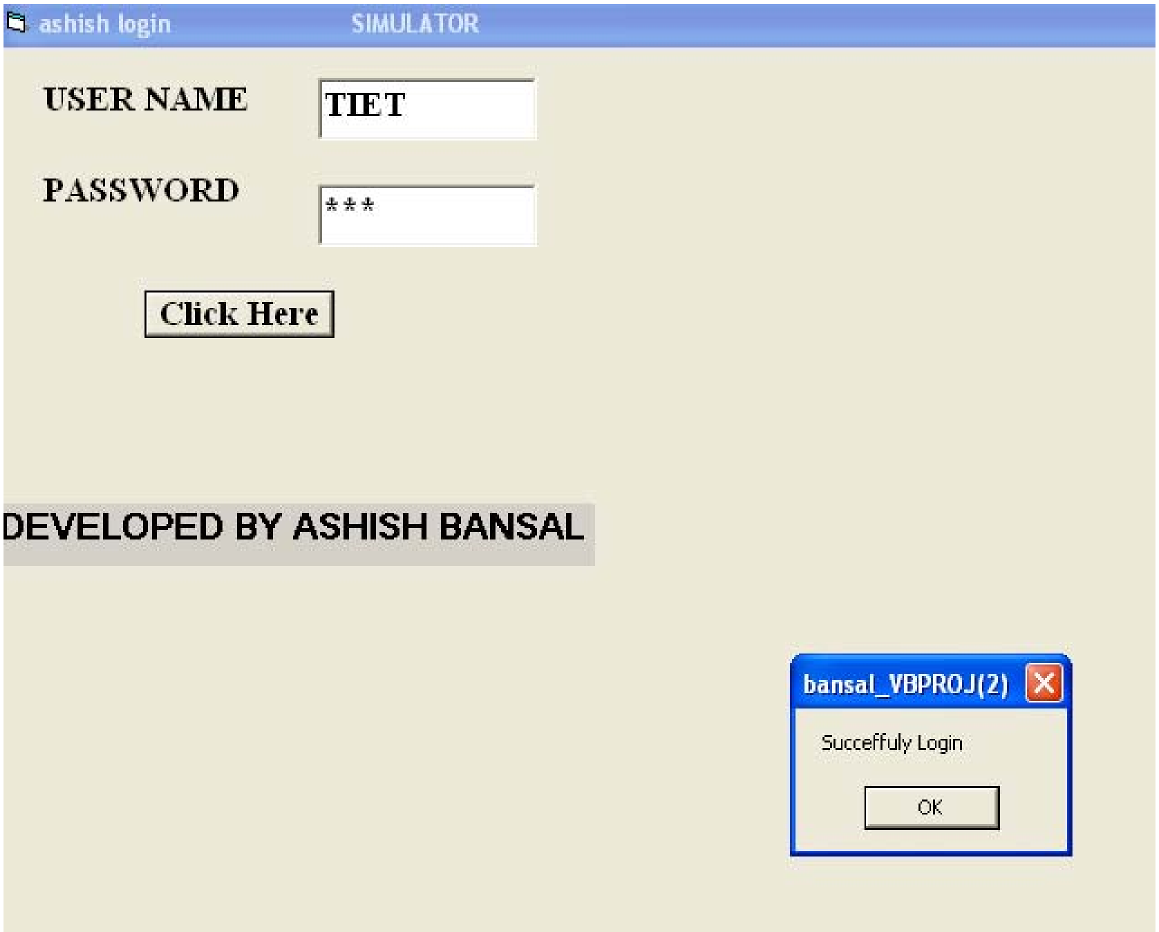

Figure 5.2: Shows the snapshot of the login page of Simulator. In which only valid user can login.

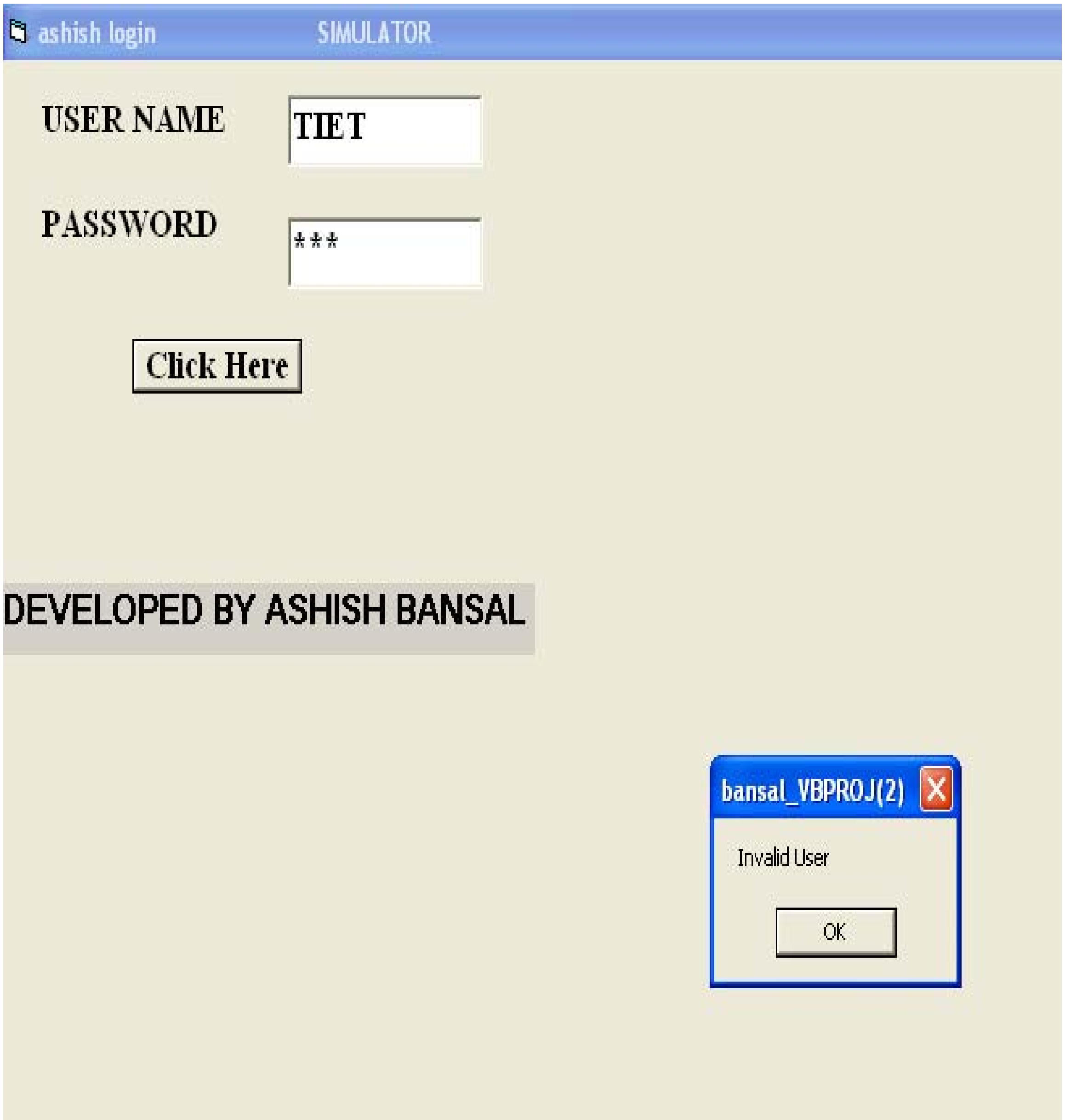

Figure 5.3: Shows the snapshot of the login page of Simulator. In which if there is invalid user can't login.

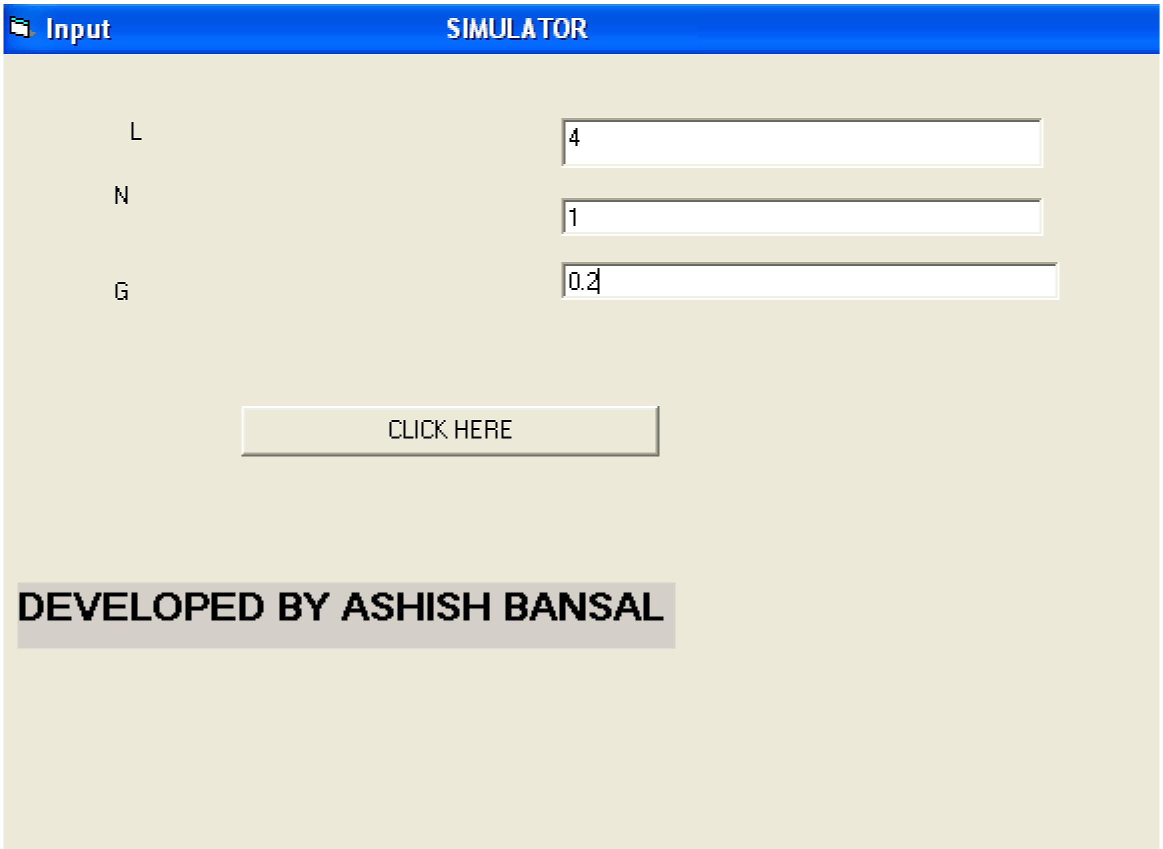

Figure 5.4: Shows the snapshot of the input page of Simulator.

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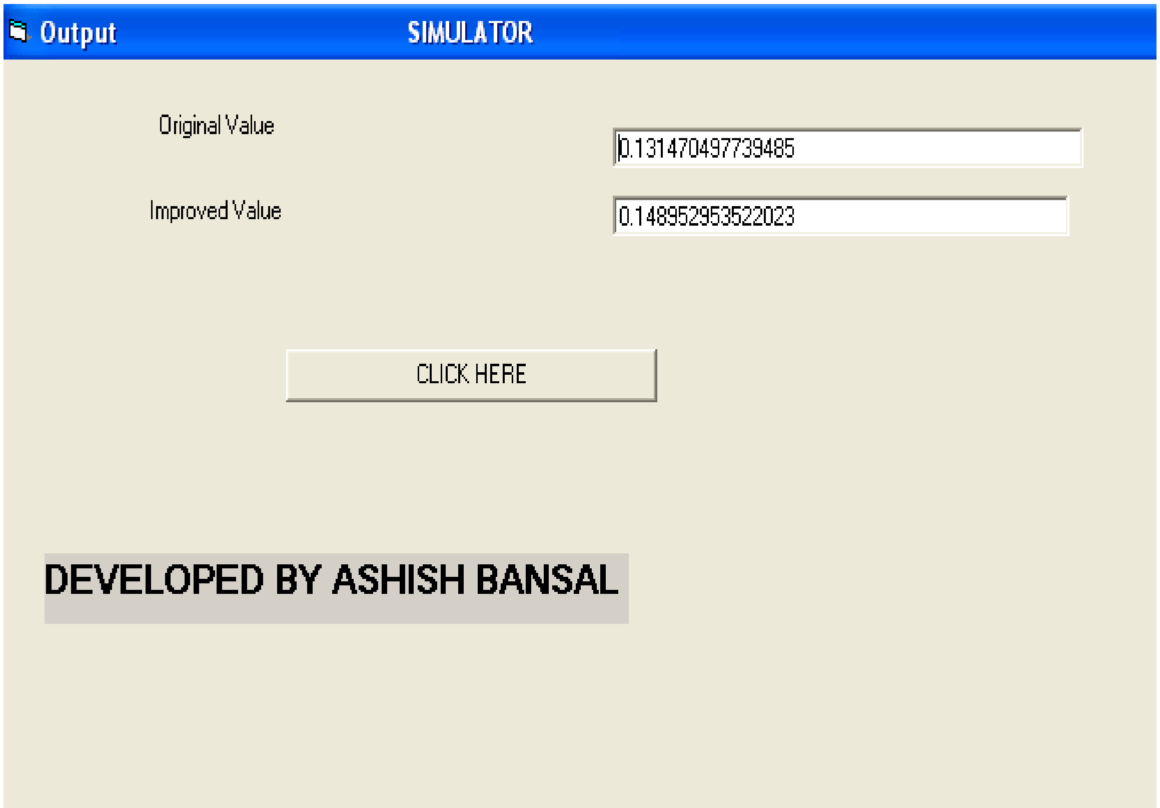

Figure 5.5: Shows the snapshot of the Output page of Simulator

		Per channel Throughput		Total System Throughput	
L	N	Original	Improved	Original	Improved
4	1	0.1989	0.2246	0.1989	0.2246
4	4	0.1489	0.2019	0.5956	0.8076
4	8	0.1286	0.1382	0.8236	1.1056
4	10	0.1045	0.1289	1.045	1.289
4	12	0.0796	0.1130	0.955	1.356

Table 5.1: **Per Channel Capacity and Total System Capacity of the original and improved protocol. When L=4 and value of N is changed**.

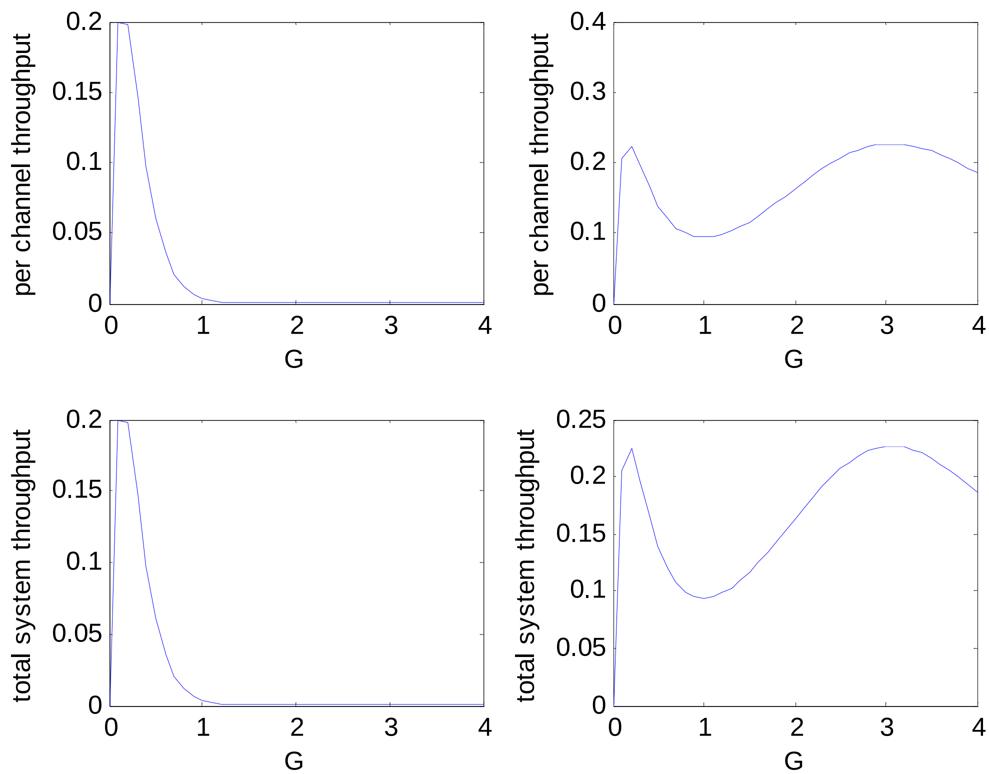

Figure 5.6: Shows the graphs of the valves that are been in the table 5.1. Where L=4 and N=1

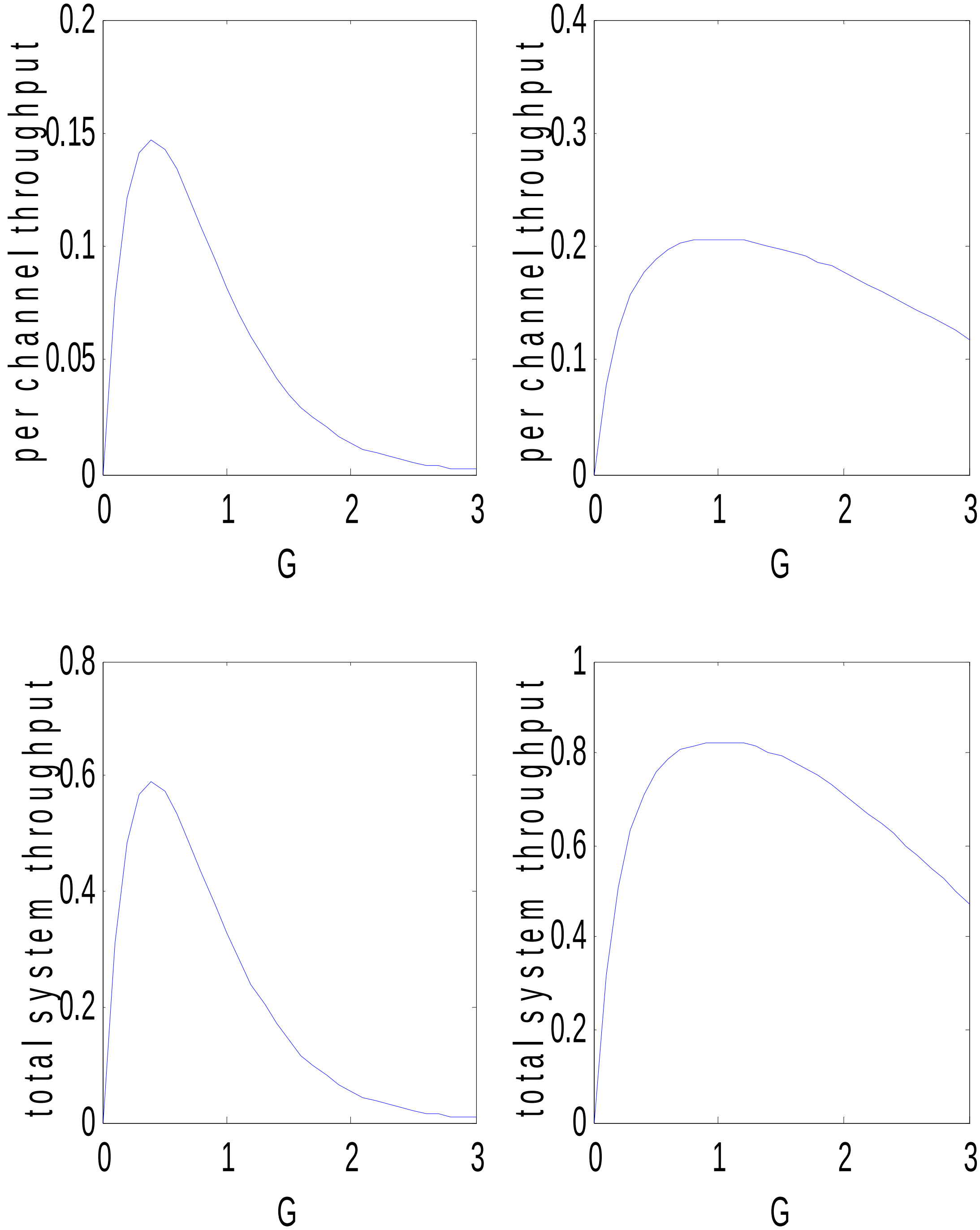

Figure 5.7: Shows the graphs of the valves that are been in the table 5.1

Where L=4 and N=4

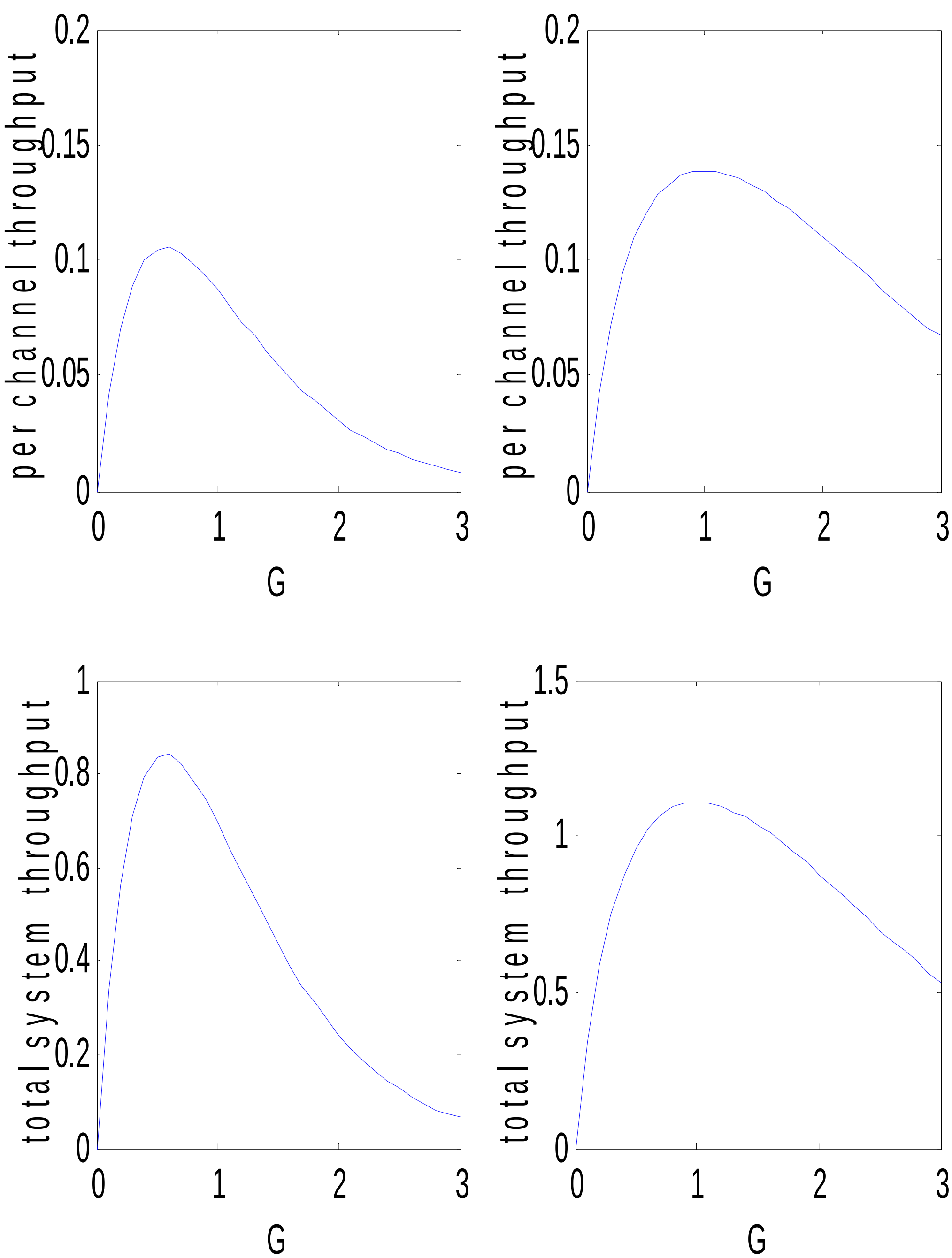

Figure 5.8: Shows the graphs of the valves that are been in the table 5.1

Where L=4 and N=8

		Per channel Throughput		Total System Throughput	
L	N	Original	Improved	Original	Improved
20	1	0.1732	0.1856	0.1732	0.1856
20	4	0.1694	0.1872	0.6776	0.7488
20	8	0.1622	0.1896	0.1279	1.5168
20	12	0.1476	0.1902	1.7712	2.2824

Table 5.2: **Per Channel Capacity and Total System Capacity of the original and improved protocol. When L=20 and value of N is changed**.

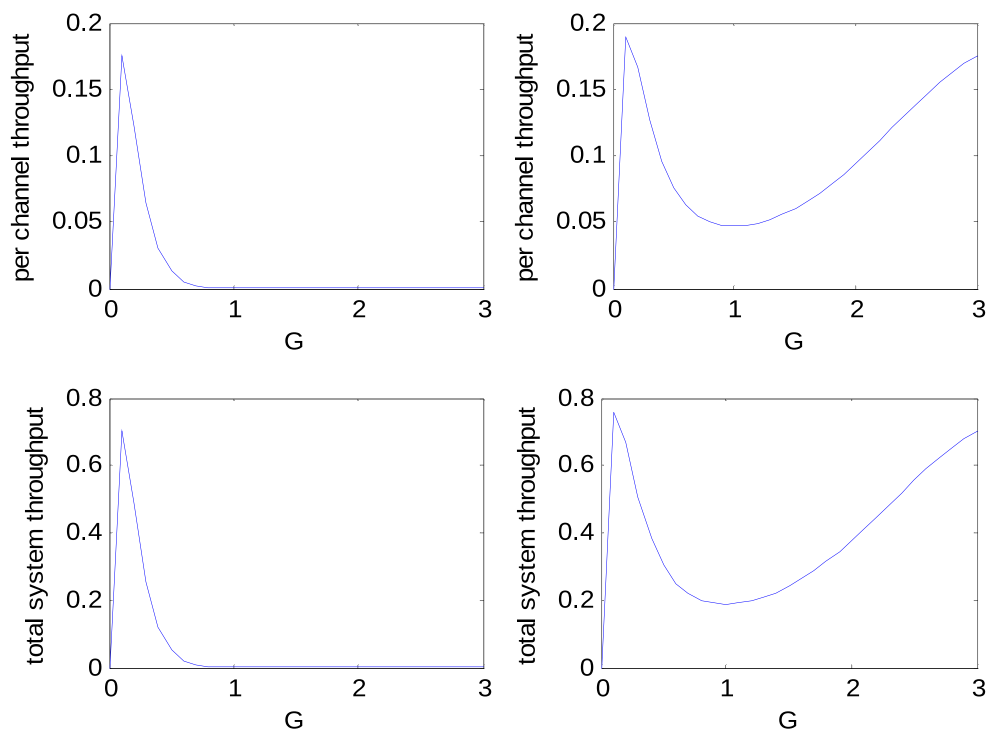

Figure 5.9: Shows the graphs of the valves that are been in the table 5.2 Where L=20 and N=4

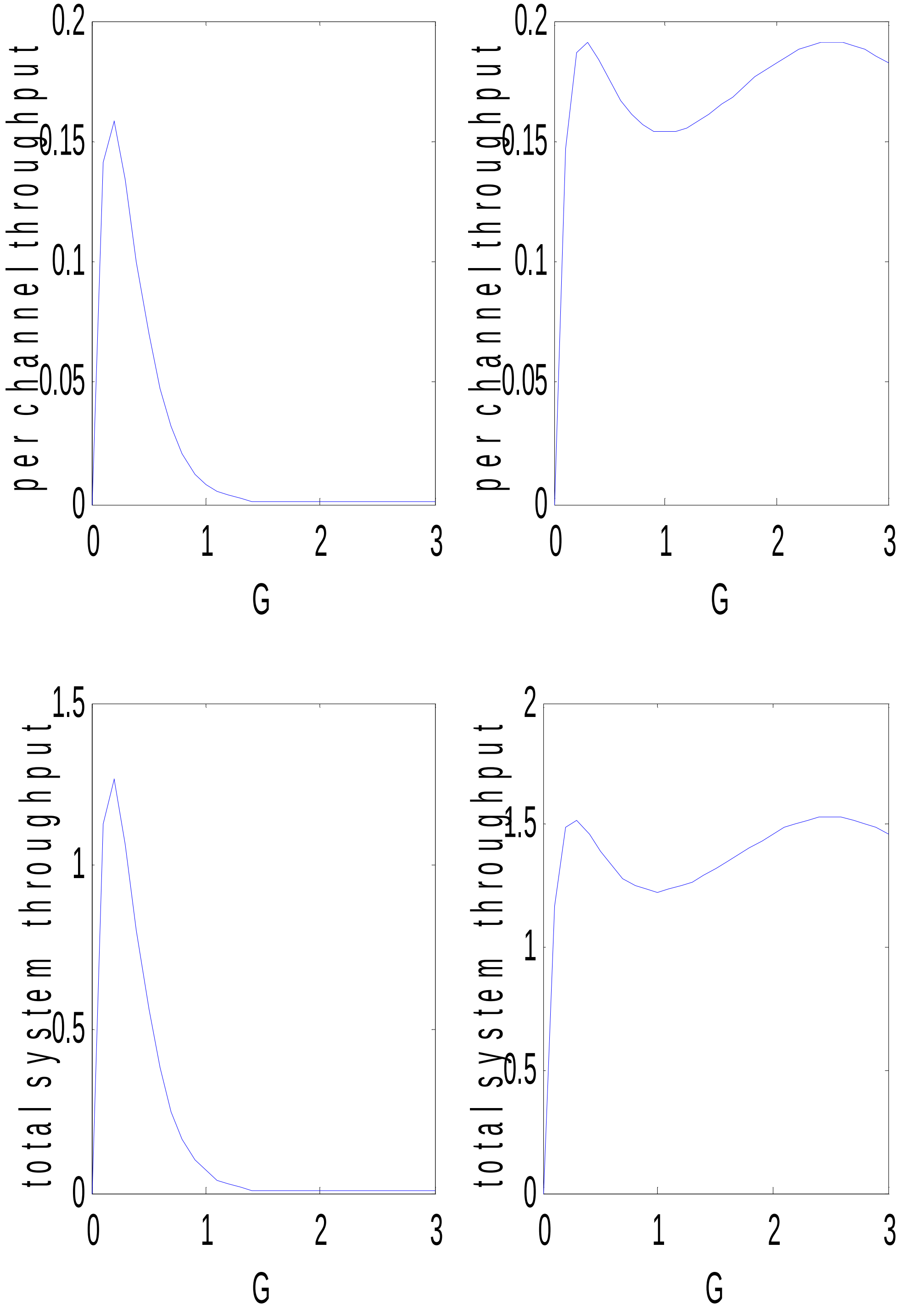

Figure 5.10: Shows the graphs of the valves that are been in the table 5.2
Where L=20 and N=8

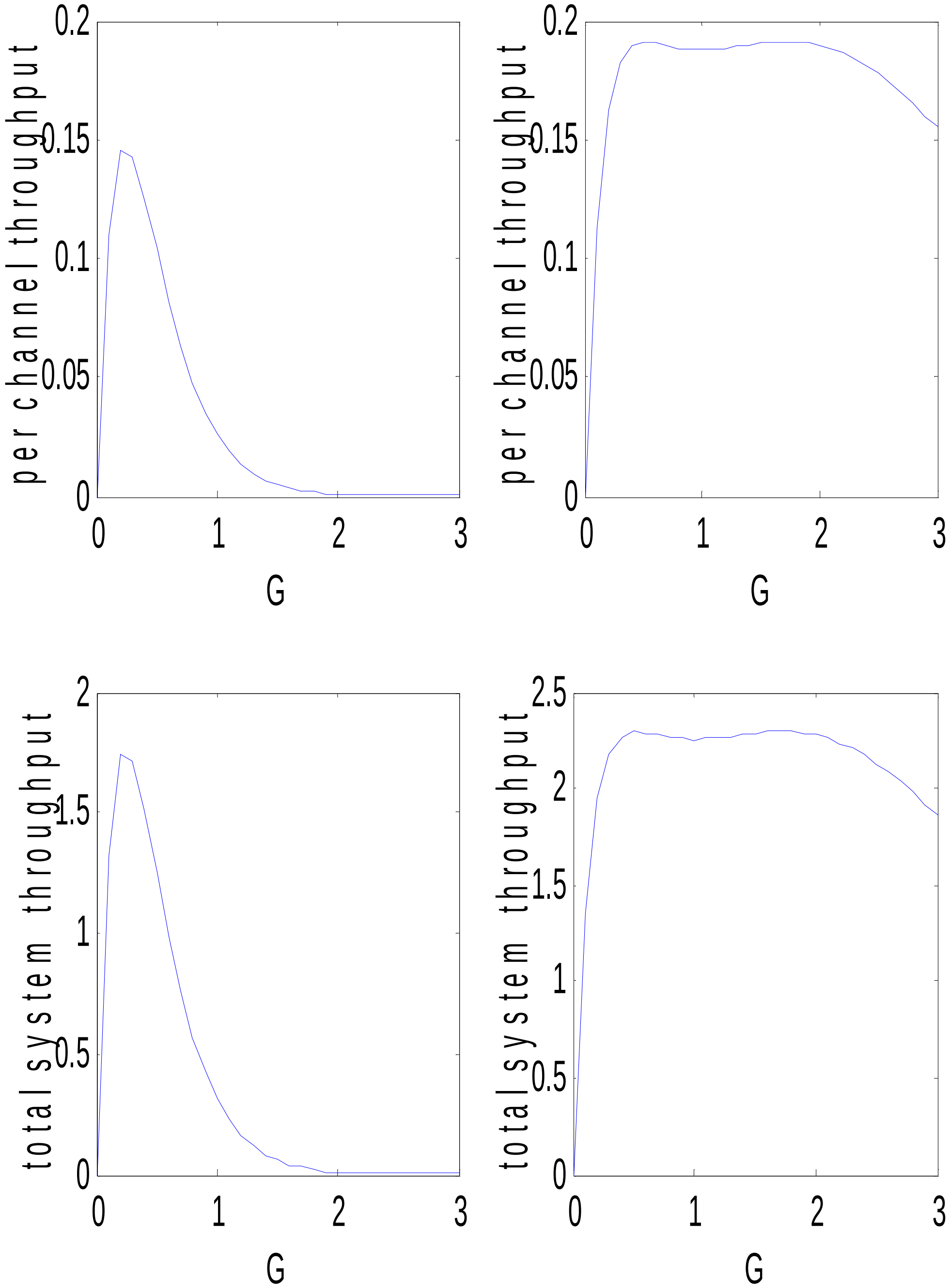

Figure 5.11: Shows the graphs of the valves that are been in the table 5.2

Where L=20 and N=12

		Per channel Throughput		Total System Throughput	
L	N	Original	Improved	Original	Improved
50	1	0.0267	0.0746	0.0267	0.0746
50	4	0.0986	0.1198	0.3952	0.4792
50	8	0.1648	0.1742	1.3184	1.3936
50	12	0.1656	0,1886	1.9872	2.2632

Table 5.3: **Per Channel Capacity and Total System Capacity of the original and improved protocol. When L=50 and value of N is changed**.

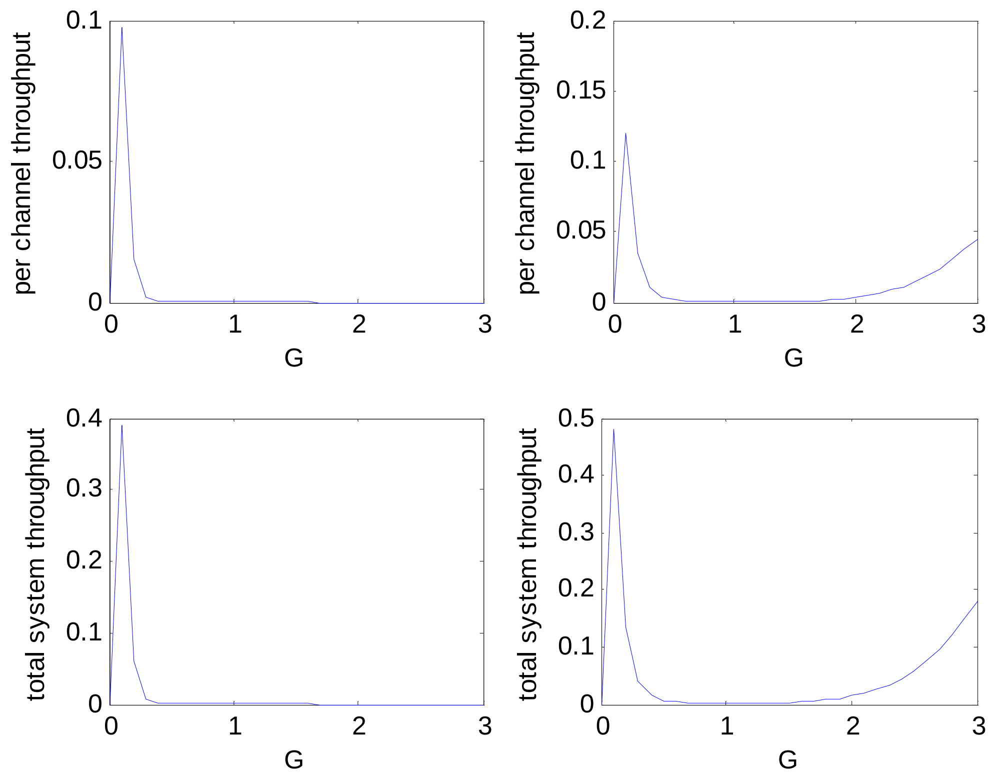

Figure 5.12: Shows the graphs of the valves that are been in the table 5.3 Where L=50 and N=4

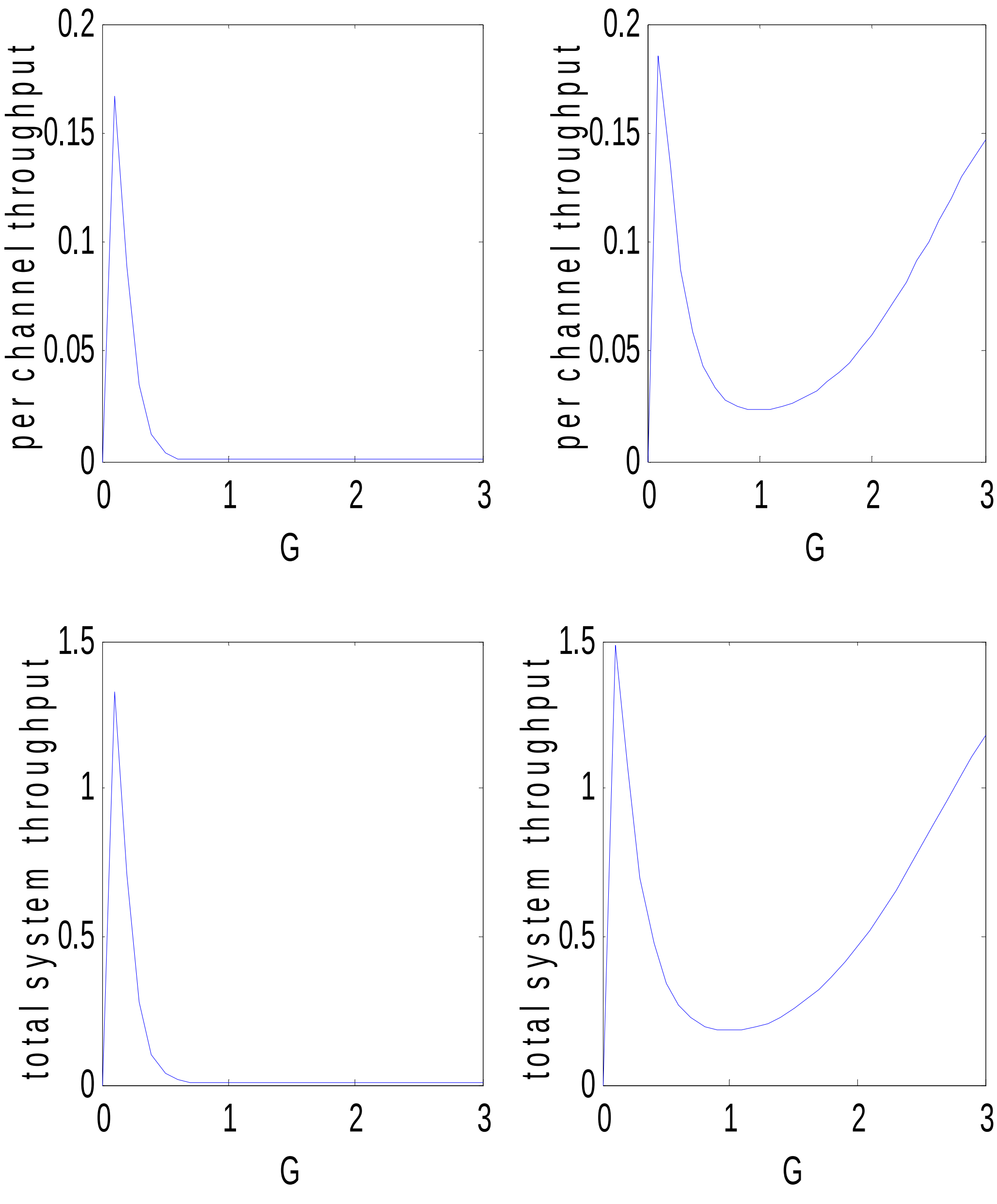

Figure 5.13: Shows the graphs of the valves that are been in the table 5.3

Where L=50 and N=8

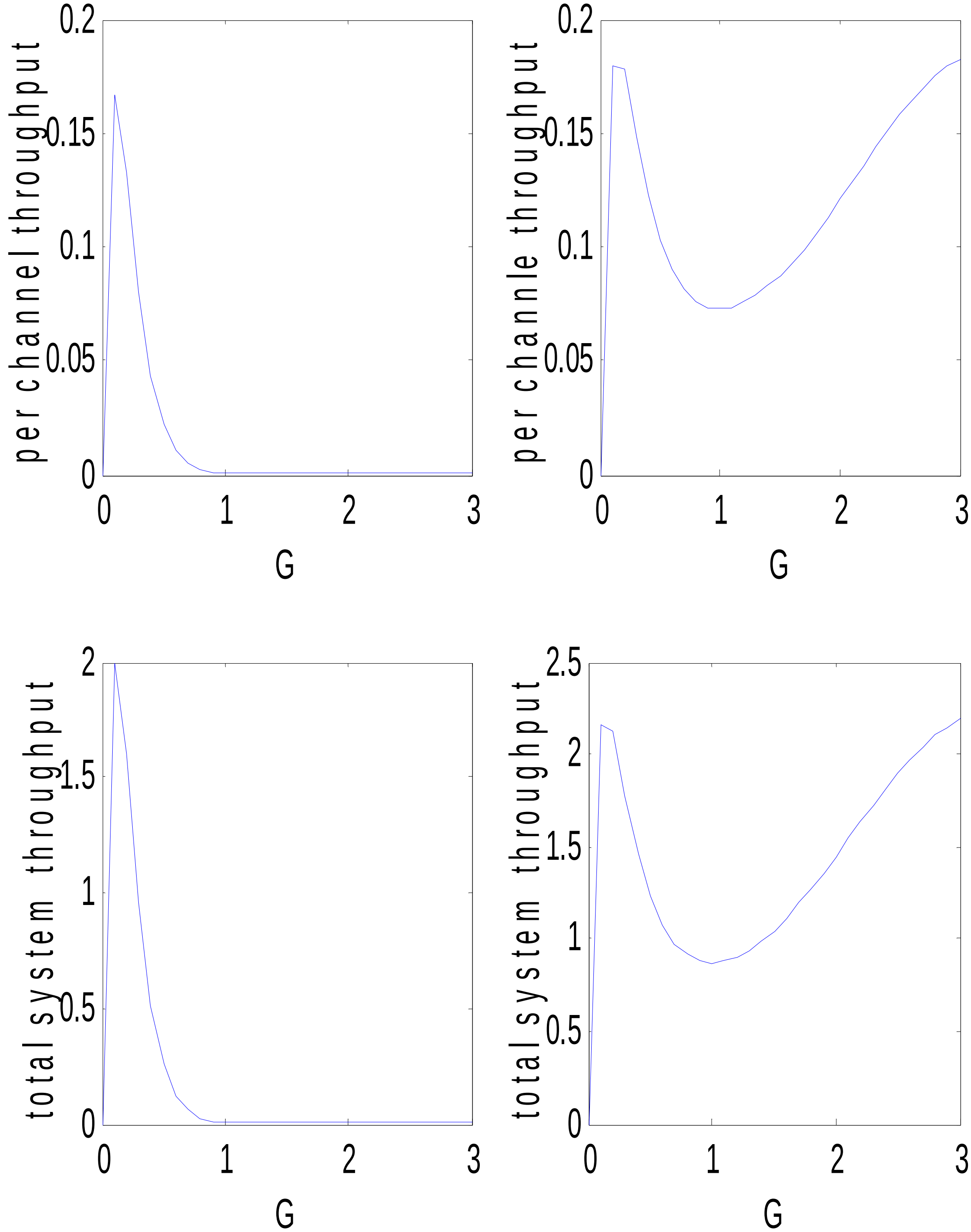

Figure 5.14: Shows the graphs of the valves that are been in the table 5.3

Where L=50 and N=12

CONCLUSION AND FUTURE SCOPE

Wireless networks are the future of communication. There are different accesses methods used for communication in wireless networks. We have developed simulator for WDMA, which is a discrete event simulator. We are able to simulate the characteristics of WDMA based upon some standard parameters like N (number of channels in the system excluding the control channel.), L(Ratio of the length of a data packet to the control packet), G(Average number of control packets transmitted per control slot on control channel), Gd(Average number of data packets transmitted per data slot on data channel), Ps(Probability that a given packet on a given data channel is successfully transmitted), Sd(Average number of data packets successfully transmitted par data slot on a give data channel), St(Total System throughput NSd) .this has also been implemented by the use of modified algorithm and the results shows that throughput increases by 10-20%. One of the limitation of our simulator is that they require one receiver and one transmitter per user. This simulator is first of its kind and we are hopeful that this simulator can be used by the research fraternity to study and compare the different characteristics of WDMA.Further the simulator can be enhanced to include characteristics of WDMA such as delay analysis, traffic control, processing requirements.

REFERENCES

[1] N. K. Cheung, G. Nosu, and G.Winzer, Eds., Special Issue on Dense WDM Networks, *ZEEE J . Select. Areas Commun.,* vol. 8, Aug. 1990.

[2] N. R. Dono, P. E. Green, Jr., K. Liu, R. Ram swami, and F. F.Tong, "A wavelength division multiple access network for computer communication," *ZEEE J . Select. Areas Commun.,* vol. 8, pp. 983-994,Aug. 1990.

[3] Public safety Radio Frequency Spectrum: A Comparison Of Multiple Access Techniques.

[4] A. N. Netravali, W. D. Roome, and K. Sabnani, "Design and implementation of a high-speed transport protocol," *ZEEE Trans. Commun.,* vol. 38, pp. 2010-2024, Nov. 1990.

[5] I. M. I. Habbab, M. Kavehrad, and C.-E. W. Sundberg, "Protocols for very high speed optical fiber local area networks using a passive star topology," *J . Lightwave Technol.,* vol. LT-5, pp. 1782-1794, Dec. 1987.

[6] N. Mehravari, "Performance and protocol improvements for very high speed optical fiber local area networks using a passive star topology," *J . Lightwave Technol.,* vol. 8, pp. 520-530, Apr. 1990.

[7] M. S. Chen, N. R. Dono, and R. Ramaswami, "A media-access protocol for packet-switched wavelength-division metropolitan area networks,"*ZEEE J . Select. Areas Commun.,* vol. 8, pp. 1048-1057, Aug. 1990.

[8] M. Chen and T.4. Yum, "A conflict-free protocol for optical WDMA networks," in *Proc. GLOBECOM,* 1991, pp. 1276-1281.

[9] R. Chipalkatti, Z. Zhang, and A. S. Acampora, "High-speed communication protocols for optical star networks using WDM," in *Proc.Infocom'92,* 1992.

[10] J. Lu and L. Kleinrock, "A wavelength division multiple access protocol
for high-speed local area networks with a passive star topology,"*Performance Eval.,* vol. 16, pp. 223-239, Nov. 1992.

[11]J. B. Jeon and C. K. Un, "Contention-based reservation protocols in multiwavelength optical networks with a passive star topology," in *Proc. ICC' 92, pp. 1473-1477*

[12] F. Jia and B. Mukherjee, "The receiver collision avoidance (RCA) protocol for a single-hop WDM lightwave network," in *Proc.* ZCC'92,1992, pp. 6 1 0 .Aug 1991

[13] G. N. M. Sudhakar, N. D. Georganas, and M. Kavehrad, "Slotted Aloha and reservation Aloha protocols for very high-speed optical fiber local area networks using passive star topology," *J . Lightwave Technol.,* vol. 9,pp.1411-1422, oct 1991.

[14] P.A. Humblet. R.Ramaswami, K.N. Sivarajan "An efficient communication protocol for High-Speed Packet –Switched Multichannel Networks.,vol 2 no. 4 may 1993

[15] I. Chlamtac and A. Ganz, "Design and analysis of very high speed network architectures," *IEEE Trans. Commun.,* vol. 36, pp. 252-262, Mar. 1988.

[16] A. Ganz and I. Chlamtac, "Path allocation access control in fiber optic networks," *ZEEE Trans. Comput.,* vol. 38, pp. 1372-1382, Oct. 1989.

[17] P. E. Green, Jr., "The future of fiber-optic computer networks," *IEEE Computer,* vol. 24, pp. 78-89, Sept. 1991.

[18] W. Doeringer, D. Dykeman, M. Kaiserswerth, B. Meister, H. Rudin, and R. Williamson, "A survey of light-weight transport protocols for high-speed networks," *ZEEE Trans. Commun.,* vol. 38, pp. 2025-2039, Nov. 1990.

[19] W. Feller, *An Introduction to Probability Theory and Its Applications.* New York Wiley, 1984.

[20] H. Kobrinski and K.-W. Cheung, "Wavelength-tunable optical filters: Applications and Technologies," *ZEEE Commun. Mag.,* vol. 27, pp. 53-63, Oct. 1989.

[21] T. P. Lee and C.-N. Zah, "Wavelength-tunable and single-frequency lasers for photonic communication networks," *ZEEE Commun. Mag.,* vol. 27, pp. 42-52, Oct. 1989.

[22] S. Murata, I. Mito, and K. Kobayashi, ''Tuning ranges for 1.5 pm wavelength tunable DBR lasers," *Electron. Lett.,* vol. 24, no. 10, pp.577-578, 1988.

[23] F. Heisman *et al.,* "Electrooptically tunable narrow-linewidth InGaAsP- Ti/LiNh03 external cavity laser," in *Proc. OFCIZOOC,* Jan. 1987,

[24] W. Warzanskyj, F. Heisman, and R. C. Alfemess, "Polarization-independent electro-optically tunable narrow-band wavelength filter," *Appl. Phys. Lett.,* vol. 53, pp. 13-15, July 1988.

[25] R. C. Alfemess *et al.,* “Widely tunable InGaAsPDnP laser based on a vertical coupler intracavity filter,” in OFC‘92 *Tech. Dig.,* Postdeadline Paper, PD2, Feb. 1992, pp. 321-323.

[26] V. Jayaraman, D. A. Cohen, and L. A. Coldren, “Extended tuning rangein a distributed feedback InGaAsP laser with sampled gratings,” inOFC’92 *Tech. Dig.,* no. WL12, Feb. 1992, p. 165.

[27] S. C. Liew and K.-W. Cheung, “A broad-band optical network based on hierarchical multiplexing of wavelengths and RF subcarriers,” *J . Lightwave Technol.,* vol. 7, pp. 1825-1838, NOV. 1989.

[28] R. Ramaswami and K. N. Sivarajan, “A packet-switched multihop light-wave network using subcarrier and wavelength-division multiplexing,” IBM Res. Rep., RC 16743, 1991.

[29] J. Medhi, *Stochastic Models in Queueing Theory.* New York Academic, 1991.

ZCC‘92, 1992, pp. 1473-1477.9, pp. 1411-1422, Oct. 1991. 577-578, 1988.

[30] D. Bertsekas and R. Gallager, Data Networks Englewood Cliffs, NJ: Prentice-Hall, 1987, pp. 209-210.

[31] N. R. Dono, P. E. Green, Jr.. K. Liu, R. Ramaswami, and F. F.-K.Tong, “A wavelength division multiple access network for computer communication,” IEEE J . Selecr. Areus *Cornrnun.,* this issue, pp

[32]A. S . Acampora. “A multi-channel multihop local lightwave net-work.” in Pror. GLOBECOM 1987, Tokyo. Japan, 1987, pp. 37.5. I-37.5.9.

[33]C. A. Brackett, “Dense wavelength division multiplexing net-works: principles and applications,” IEEE JSAC, vol. 8,pp. 948-964, Aug. 1990

[34]T. E. Darcie, “Subcarrier multiplexing for multiple-access light-wave networks,” IEEEIOSA J. Lightwave Tech., vol. LT-5,pp. 1103-1110,1987.

[35]N. K. Shankaranarayanan, S. D. Elby, and K.-Y. Lau,“WDMA/subcarrier-FDMA lightwave networks: limitations due to optical beat interference,” IEEE/OSA J. Lightwave Tech., vol. 9, no. 7, pp. 931-943,1991.

[36]M. M. Choy, S. M. Altieri, and K. N. Sivarajan, “A 200 Mb/s packet-switched WDM-SCM network using fast RF tuning,”

[37] G. N. M. Sudhakar, N. D. Georganas and M.Kavehrad, "Slotted ALOHA and Reservation ALOHA Protocols for High-speed Optical Fiber Local Area Networks Using Passive Star Topology," *IEEE J. Lightwave Technology,* Vol. 9, pp. 141 1-1422, Oct. 1991.

[38] Wonhong Cho, Sang-Bae Lee, "Performance Analysis of Slotted ALOHA Protocols for High-speed Optical Fiber Local Area Networks Using WDM Passive Star Topology," *Proceedings of JCCI 93,* Korea, pp.27- 31, April 1993

[39] Wonhong Cho, Sang-Bae Lee, "Protocols for High-Speed Optical Fiber Local Area Networks Using WDM Passive Star Topology," *Proceedings of JTC- CSSS 93,* Japan, July, 1993.pp.520-530, April 1990

[40] L.Wang,M. Ma,and M. Hamdi, "Efficient protocols for multimidea streams on WDMA networks," *Lightware techno..,* vol 21,no. 10 .pp.2123-2144, oct 2003

[41] IEICE TRANS. COMMUN., VOL.E90–B, NO.1 JANUARY 2007. LETTER. Analysis of Throughput in M-WDMA MAC Protocol for WDMA. Networks.

[42] www. Google.com