Asian Journal of Information Technology 5(8): 848-853, 2006
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A Comprehensive Study on Data Networking Using Fiber Optical Backbone

[1]Md. Abu Yousuf, [2]Md. Monzurul Ahsan and [3]Md. Abu Sina
[1]Department of Computer Science and Engineering, Mawlana Bhashani Science and Technology University,
[2]Department of Computer Science, Daffodil International University,
[3]Department of Computer Science and Information Technology,
Internation Islamic University (IUT) Bangladesh

Abstract: The fast evolution of networks has been continuously driven by new advances in enabling technologies, as well as the growth of Internet traffic. All optical packet switching provides high throughput, rich routing functionalities and excellent flexibility. These characteristics make it an excellent candidate for next-generation metropolitan area networks, which will be much more dynamic and demanding than today's networks. This study proposes Dense Wavelength Division Multiplexing (DWDM) based data networking using fiber optical backbone in a Dhaka city of Bangladesh. DWDM is used in this study as a backbone controller from centralized location. Two DWDM devices are placed at the two important location of the Dhaka city. DWDM based optical infrastructure is a future demanded technology.

Key words: Dense Wavelength Division Multiplexing (DWDM), metronet, Information and Communication Technology (ICT), Metropolitan Area Network (MAN)

INTRODUCTION

Information and Communication Technology (ICT) related issues are drawing the attention of modern society. Almost all the countries in the world already made some forward steps toward the ICT by introducing it into their internal structures in last few years. However almost all of them are still far behind from achieving the desired level of ICT adaptation in everyday life. The ICT policy of Bangladesh aims at building an ICT driven nation comprising of knowledge based society. In view of this, a countrywide ICT infrastructure will be developed to ensure access to information by every citizen to facilitate empowerment of people. This study describes data networking[1] using fiber optical backbone in a Dhaka city of Bangladesh. Data networking is the exchange information between different networks using IP networking. IP networking[11] is a network that works with packet. It can travel voice, video and text simultaneously because it can send data as a packet.

BTTB and Bangladesh Railway have some fiber optical networks in district level with Dhaka. In Dhaka metro city, only MetroNet covers entire Dhaka city fiber optical backbone network but it misses Dense Wavelength Division Multiplexing (DWDM) based optical infrastructure. DWDM based optical infrastructure is very essential for future. We have design a future proof optical infrastructure for Dhaka city, which is DWDM based optical Ethernet backbone.

EXISTING FIBER OPTIC NETWORK

Present fiber optical network in Bangladesh: Establishment of fiber optic links in Bangladesh began in 1986, along with the installation of new digital switches. Starting with the optical fiber link between Dhaka's Maghbazar and Gulshan telephone exchanges, all intra-city inter-exchange connections are now established through short distance fiber optic links. The inter-city portions between the major cities started with the completion of the STM-16 fiber link between Dhaka to Chittagong in 2001 (STM is a standard of data transmission rate where STM-1 represents 155 Mb/s). Bogra to Joypurhat to Ragpur and Dinajpur in the north west of Bangladesh is already connected by STM-4 optical link while Dhaka to Bogra optical fiber link via the Jamuna Bridge is currently under construction[7]. In addition, there is a plan to connect Dhaka to Sylhet and Dhaka to Khulna on the optical fiber network. These are summarized in Fig 1.

Moreover, to cater for the increasing international traffic, Bangladesh has joined to the SEA-ME-WE-4 submarine cable network consortium. The 10Gbs bandwidth of this network is expected to serve

Corresponding Author: Md. Abu Yousuf, Department of Computer Science and Engineering, Mawlana Bhashani Science and Technology University, Bangladesh

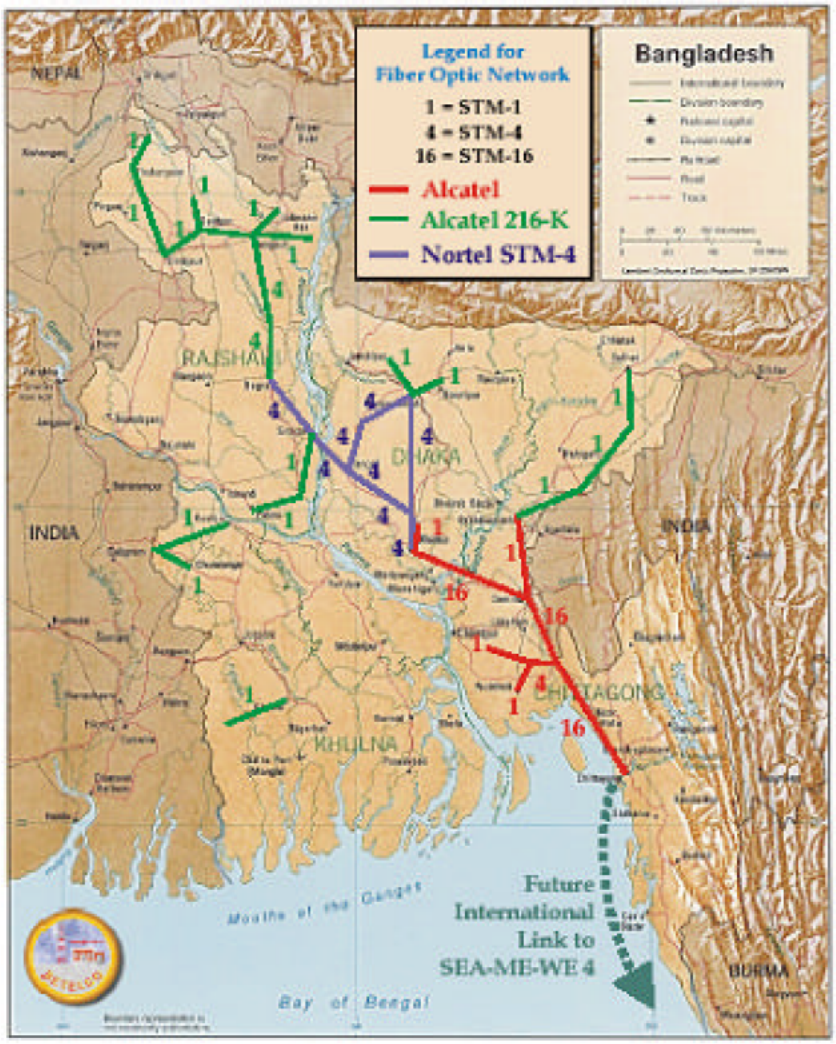

Fig. 1: Map of the existing fiber-optic network in Bangladesh

Lanka, Pakistan, UAE, Saudi Arabia, Egypt, Italy and France.

Present fiber optical network in dhaka city: At present only MetroNet covers entire Dhaka city with fiber optical backbone[2]. MetroNet coverage of Dhaka city is shown in Fig. 2. The whole of their network is optical ring network. Optical ring network has some drawbacks. When one access point occurs some problem then other few stations may not works until that access point is recovered. But MetroNet do not implement DWDM based infrastructure. For future development DWDM based optical network infrastructure is very essential.

PROPOSED NEW NETWORK MODEL

Why fiber optic networks: In this study we propose Dense Wavelength Division Multiplexing (DWDM) based data networking using fiber optical backbone in a Dhaka city of Bangladesh. Fiber optic networks offer very high bandwidth[3] necessary for Bangladeshi nations to catch up with the new global information technology. For example, fiber cables today can have capacity up to 2 Tbps-an equivalent of millions of simultaneous voice channels per cable. This is far from the reach of any anticipated satellite system, which is less than 1 Gbps-lower than our own SAT-3/WASC/SAFE undersea cable system.

Real time transmission and very low bit error rate offered by fiber optic networks are among the advantages of fiber over satellite. Satellite communications add a delay to communications making interactive data transmission difficult and subject the quality of transmission to external factors.

A geostationary satellite link has a transmission delay of up to 600 milliseconds

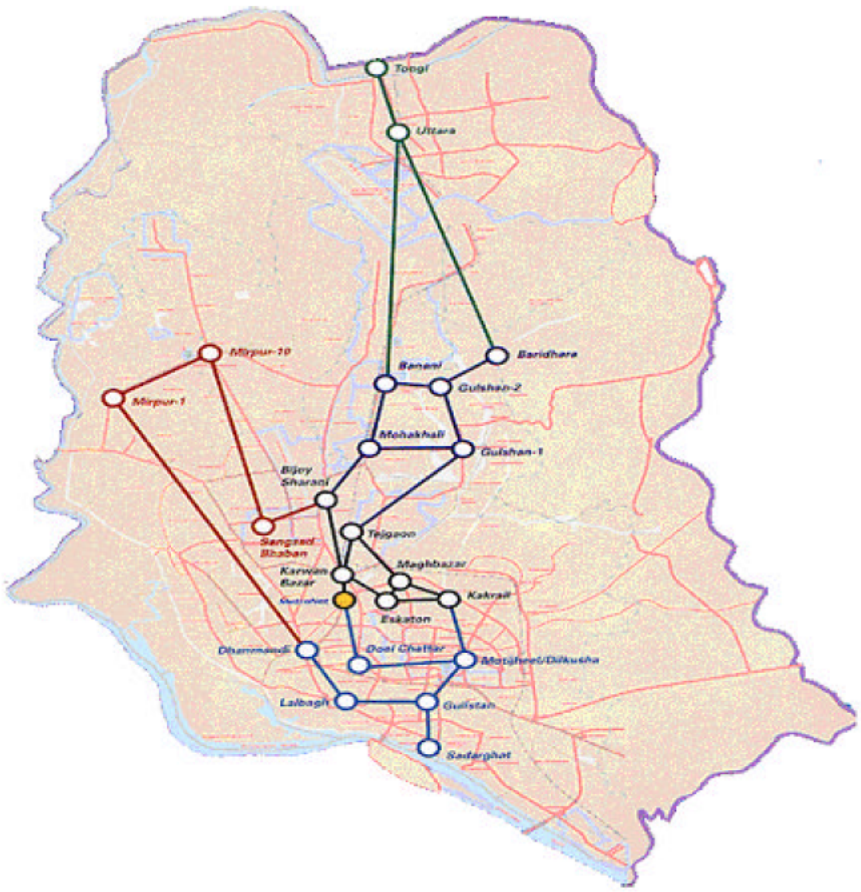

Fig. 2: Metronet coverage of Dhaka city

compared to 100ms for a combination of fiber and coaxial cable networks.

Dense Wavelength Division Multiplexing (DWDM): DWDM is used in this study as a backbone controller from centralized location. We place two DWDM devices at the center of the Dhaka city. From which our main backbone cable is configured.

Dense Wavelength Division Multiplexing (DWDM) is a fiber optic transmission technique that employs light wavelengths to transmit data p arallel-by-bit or serial-by-character.

A DWDM based optical transmission infrastructure has been proposed to increase the carrier capacity of the backbone, to facilitate flexible bandwidth provisioning and to support a number of transport technologies. The DWDM system allows SONET/SDH, Gigabit Ethernet and 10Gigabit Ethernet etc. to coexist on the same infrastructure, which is crucial in this ever-changing field. Optical DWDM equipments are available from the major manufacturers that are capable of supporting up to 192 optical channels using C (1530 to 1570 nm) and L (1570 to 1610 nm) bands. In the future the number of optical channels can be upgraded to 240 channels using the S (1450 to 1490 nm) band also. Currently DWDM channels are capable of synchronous bit rates of up to 40 Gbps (STM-256). With optical power control on each wavelength and in-fiber amplification, point-to-point links of up to 4500 km are possible without the need for regeneration. To build a future proof national backbone the DWDM infrastructure is must. At the heart of the DWDM infrastructure are the Optical Add-Drop Multiplexers (OADM) and the Optical Cross Connect (OXC). The devices provide transparent transmission of optical signal over the optical channels. OADMs today have evolved onto Re configurable OADM (ROADM), in which the wavelength add/drop and cross connect features can be configured from a centralized operations center. ROADM can be configured in both point-to-point and multipoint-to-multipoint configurations[4].

During the depression of the optical network market, flexibility and upgradability are the most important characteristics for metropolitan platforms. Metro DWDM can enable the traditional equipment to deliver comprehensive data services. Thus it is the only way to decrease the system cost and manage the system easily at

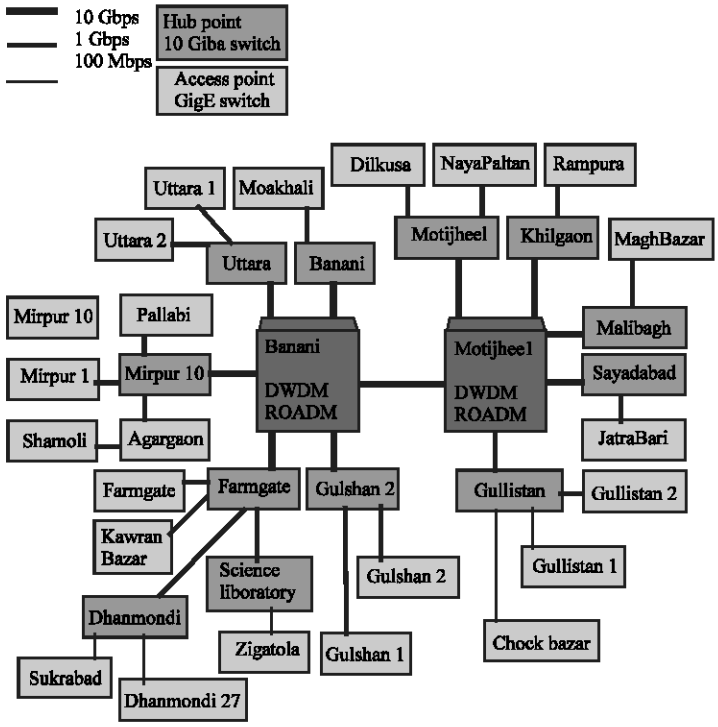

Fig. 3: Physical topology of the proposed optical fiber backbone

present. Therefore, it will definitely become an important part of the broadband MAN solution.

Value of DWDM in the Metropolitan Area Network (MAN): DWDM is the clear winner in the backbone. It was first deployed on long-haul routes in a time of fiber scarcity[5]. Then the equipment savings made it the solution of choice for new long-haul routes, even when ample fiber was available. While DWDM can relieve fiber exhaust in the metropolitan area, its value in this market extends beyond this single advantage. Alternatives for capacity enhancement exist, such as pulling new cable and SONET overlays, but DWDM can do more. What delivers additional value in the metropolitan market is DWDM's fast and flexible provisioning of protocol- and bit rate-transparent, data-centric, protected services, along with the ability to offer new and higher-speed services at less cost.

The need to provision services of varying types in a rapid and efficient manner in response to the changing demands of customers is a distinguishing characteristic of the metropolitan networks. With SONET, which is the foundation of the vast majority of existing MANs[6], service provisioning is a lengthy and complex process. Network planning and analysis, ADM provisioning, Digital Crossconnect System (DCS) reconfiguration, path and circuit verification and service creation can take several weeks.

Potential providers of DWDM-based services in metropolitan areas, where abundant fiber plant already exists or is being built, include Incumbent Local Exchange Carriers (ILECs), Competitive Local Exchange Carriers (CLECs), Inter-Exchange Carriers (IXCs), Internet service providers (ISPs), cable companies, private network operators and utility companies. Such carriers can often offer new services for less cost than older ones. Much of the cost savings is due to reducing unnecessary layers of equipment, which also lowers operational costs and simplifies the network architecture.

Carriers can create revenue today by providing protocol-transparent, high-speed LAN and SAN services to large organizations, as well as a mixture of lower-speed services (Token Ring, FDDI, Ethernet[7]) to smaller organizations. In implementing an optical network, they are ensuring that they can play in the competitive field of the future.

Physical topology of the proposed backbon: We design DWDM based optical Ethernet backbone, which is illustrated in Fig. 3. At present status of Dhaka city misses DWDM based optical infrastructure. DWDM based optical infrastructure is a future demanded technology. For this reason, we are highly induced to design these types of network. It is a point-to-point optical Ethernet network than optical ring network. Optical ring network has some drawbacks. If one station occurs some problem

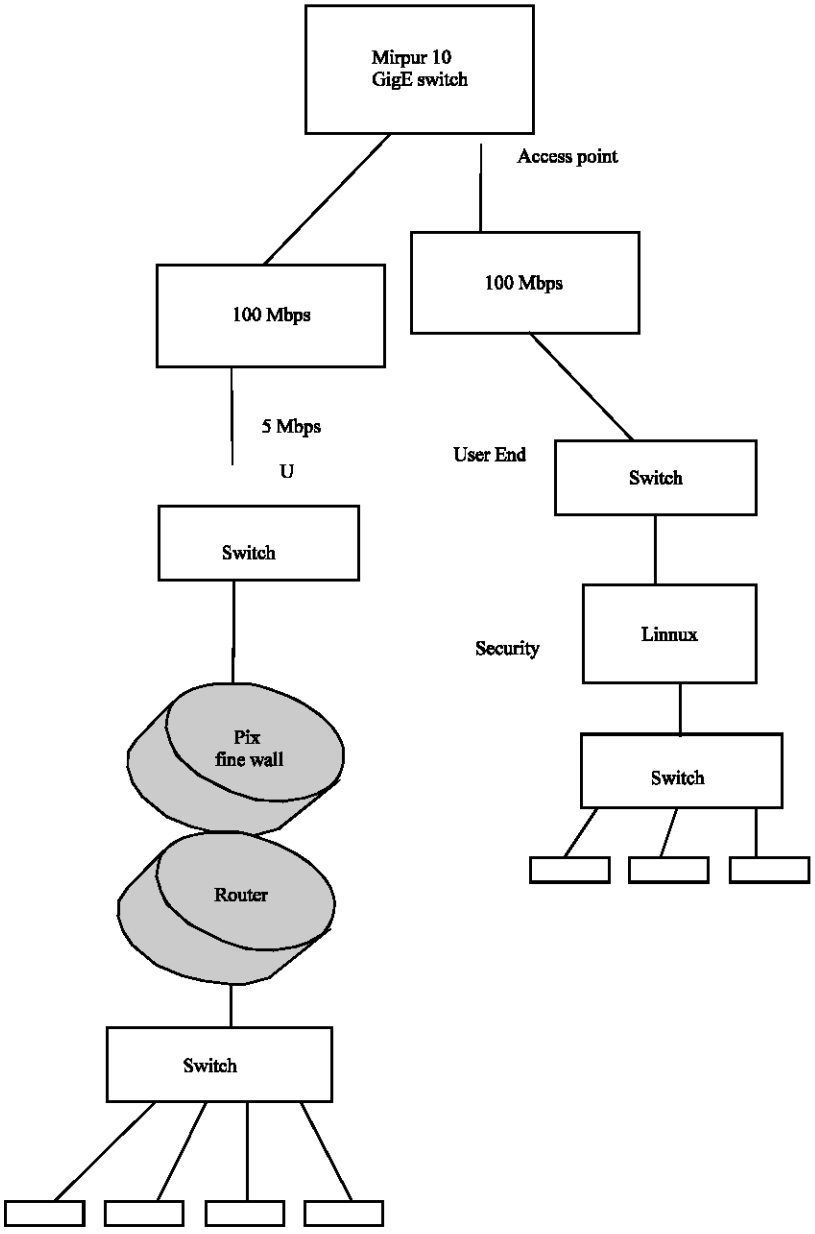

Fig. 4: The LAN connection with security for an access point

then other few stations may not works properly until that station is recovered. This type of problem cannot occur in point-to-point network. Because if one station occurs some problem, it affects only that station. Other station may not affect by it. Ethernet is the most widely used familiar technology than others. Ethernet is the cheapest technology than others like SONET/SDH or ATM. The entire In this proposed design Dhaka city is divided in two zones. One is Banani zone and the other is Motijheel zone. Banani zone includes Banani, Gulshan, Uttara, Moakhali, Mirpur, Farmgate, Kawran Bazar, Dhanmondi and Mohammadpur. Motijheel zone includes Motijheel, Gullistan, Sayadabad, Malibagh, Palton, Khilgaon and Rampura. Each zone contains one DWDM device. DWDM has a lot of advantages. It is very essential for future proof optical infrastructure. The two zones are also called centralized operation center. Every hub point is mainly considered from centralized center.

Hub point: Hub point is a point from which some access points are selected. Each hub point is a 10 Giga Ethernet Switch. It is a Layer 3 Switch. In selection with hub point, we consider road distance and best route is selected for hub point. Consider Mirpur10 and Pallabi. Mirpur10 is our

hub point and Pallabi is access point. If we consider hub point is Pallabi then it will carry more cost. Because the main backbone cable will go pallabi at first then it will come back Mirpur10. It's need twice cabling cost. Hub point can also be a access point.

Access point: Access point is a point from which each user connection is established. Each access point is divided from hub point. Access point is a Fast Ethernet or Gigabit Ethernet optical switch.

Consider any access point named Mirpur10. The LAN connection with security is shown in Fig. 4:

Comparison between existing network and our network: The existing MetroNet's network is Optical ring network. Ring network[8] has some disadvantages. If one node or access point fails then some other stations may fail or not works completely until problem node is recovered. Our network is point-to-point. So, if any access point occurs some problem then it affects only that access point. Other access point will remain free from that problem and they can work completely. It is a great advantage of point-to-point network. MetroNet network's[9] completely misses the DWDM based optical infrastructure. On the other hand, our network is completely DWDM based optical Ethernet network. Ethernet is the cheapest technology in the world. Besides DWDM device can multiplex many optical channel to single fiber. So we believe our network is robust, cheapest and future oriented backbone.

CONCLUSION

The optical fiber backbone topology has been developed to span the entire city. Some of the fiber links already exist, although not at the proposed capacity. Also the DWDM base is missing in the current infrastructure. In our thesis the implementation of a DWDM infrastructure has been analyzed in details and the possibility of capacity extension and technology coexistence has been discussed. We believe we have proposed robust, flexible and future-proof network architecture and it is vital for a sustainable growth in the ICT sector in Bangladesh.

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