DWDM network design on BdREN Network System

(Transmission network)

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Declaration

I, strongly, declare that this project has been done by us and it has not been submitted elsewhere for any degree or diplomas.

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Approval

The project report entitled "Implementation of DWDM network on BdREN- UGC Educational Enhancement Project" submitted by **Md. Mehedi Hassan, ID No: 2013-3-98-003 & A. N. M. Shamsuddin, ID No: 2013-3-98-006**, to the Department of Electronics & Communications Engineering, East West University, has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of Master of Science in Telecommunications Engineering and approved as to its style and contents.

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Acknowledgement

Abstract

Dense Wavelength Division Multiplexing (DWDM) is regarded as one of the newest transmission technology in optical fiber communication system. It gives us new era of communication. It is an emerging technology which will minimize the cost and afford of working. However, there are some challenges to design the DWDM system. DWDM techniques increase the current capacity up-to device total capacity. Though it is a new technology it already gives a big impression in the industry. In this design we are try to ensure an optimum network which has ensure security with maximum transmission. Anyone can design DWDM network on TDM transmission system. So it has vast application on transmission system.

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CHAPTER: 1

INTRODUCTION

1.1 Introduction:

With today's seemingly limitless demand for transmission capacity, various service providers often cope with extreme fiber usage and exhaust across significant portions of their networks. Therefore, an enormous amount of bandwidth capacity is required to provide the services of customers. The expansion of existing links needs for simple, cost effective solutions that cause minimum disruption to working systems.

The telecommunications industry has so far met these needs by using dense wavelength division multiplexing (DWDM) systems. DWDM can optimize the use of current facilities with greater capacities of both new and existing fiber optic links to carry several channels simultaneously.

Network operators are also faced the challenge of integration of multiple technologies for the transmission in a physical layer infrastructure.

Voice transmission, e-mail, video and multimedia data are just some examples of service which can be simultaneously transmitted in DWDM systems. These data can't depends on transmission formats i.e. synchronous optical network (SONET), synchronous digital hierarchy(SDH), asynchronous transfer mode (ATM), Internet Protocol (IP), packet over SONET/SDH (PoS) or Gigabit Ethernet (GigE).

The planning, installation, and maintenance of DWDM networks closer attention are paid to a number of performance limiting parameters.

1.2 DWDM Technology Background:

Once the laying of new fiber is the only way to accommodate with fiber exhaust in telecommunication industry. In this process cost and labor intensive included. The main drawback of this process was inability to enable new services.

With the dramatic increase of voice services and newly included new services, especially the quick chance of IP technology, network capacity will inevitably faced with big challenge.

Traditional methods for transmission network capacity expansion adopt space division multiplexing (SDM) or time division Multiplexing (TDM).

1.2.1 Space Division Multiplexing (SDM)

Space division multiplexing expands the transmission capacity by adding fibers, and the transmission equipments are also linearly added.

Now a day, fiber manufacture technology is quite mature. Ribbon optical fiber cables with tens of cores are rather prevalent and advanced connection technique for optical fiber simplifies cable construction. However, the increment of fibers brings much inconvenience to the construction and circuit maintenance in the future. Additionally, if the existing optical fiber cable lines have no sufficient fibers and required to lay new fiber cables for capacity expansion, engineering cost will increase in duplicate. Moreover, this method doesn't sufficient utilize the transmission bandwidth o f the optical fiber. It's not possible to add new optical fibers to expand the capacity during the construction of communication networks. Actually, in the initial stage of the project, it is hard to predict the ever-growing service demands and to plan the number of fibers to lay. Hence, SDM method for capacity expansion is quite limited.

In early 1980s, time domain multiplexing (TDM) made it possible to increase the bit-rate. TDM is commonly used method for capacity expansion e.g. multiplexing of the primary group to the fourth group of the traditional PDH, and STM-1, STM-4, STM-16 and STM-64 of current SDH. TDM technology can enhance the capacity of optical transmission information in duplication and greatly reduce the circuit cost in equipment and line. It is especially suitable for networks requiring the protection strategy o f self-healing rings. Slicing the time into smaller intervals for increasing the capacity of a single fiber. In TDM systems, each communication fiber is able to transport an optical signal from a single leaser. Fig 1.1 shows typical TDM system of optical fiber communication system.

However, TDM method has two disadvantages. Firstly, it affects services. An overall upgrade to higher rate levels requires replacing the network interfaces and equipment completely. Thus the equipment in operation must be interrupted during upgrade process. Secondly, rate upgrade lacks of flexibility.

Currently, TDM is a commonly used capacity expansion method. It can implement capacity expansion via continuous system rate upgrade. When certain rate level is reached, other solutions must be found because of characteristic limitations of device, line, etc.
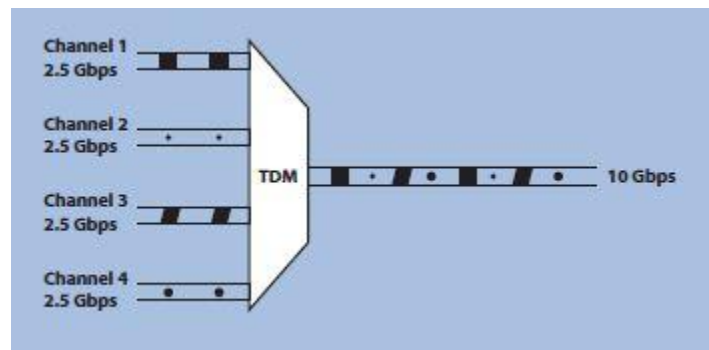
Fig 1.1: Time Division Multiplexing

1.2.2 DWDM theory:

Wavelength division multiplexing (WDM), the simultaneous transmission of multiple signals at different wavelengths over a single fiber proved to be a more reliable alternative. At the end of 1980s, the first WDM technology was deployed, multiplexed signals from the lasers of two very different wavelengths. The disadvantage of this technique was that the multiplexed signal had to be separated each time before being electrically regenerated.

In order to increase the number of service i.e. bandwidth, the channel spaces can be moved closer together (for example a space of just 0.8 nm between two channels), creating Dense wavelength Division Multiplexing or DWDM as it is commonly known this technology. DWDM technology utilizes the bandwidth and low attenuation characteristics of single mode optical fiber, adopts multiple wavelengths as carriers and allows them to transmit in the fiber simultaneously.

In analog carrier communication systems, the frequency division multiplexing (FDM) method is often adopted to make full use of the bandwidth resources of cables and enhance the transmission capacity of the system, i.e transmitting several channels of signals simultaneously in a single cable and at the receiver end, utilizing band-pas filter the signal on each channel according to the frequency differences among the carriers.

Similarly, in optical fiber communication systems, optical frequency division multiplexing method can also be used to enhance the transmission capacity of the systems. In fact, this multiplexing method is very effective in optical communication systems. Unlike the frequency division multiplexing in analog carrier communication systems, optical fiber communication systems utilize optical wavelengths as signal carriers, divide the low attenuation window of optical fibers into several channels according to the frequency (or wavelength) difference of each wavelength channel and implement multiplexing transmission of multi-channel optical signals in a single fiber. Fig 1.2 shows DWDM transmission technique.
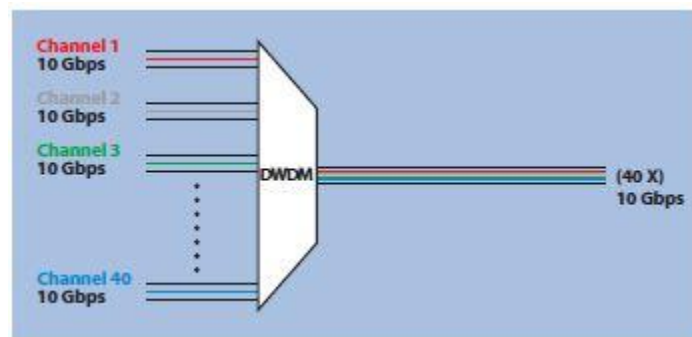
Fig 1.2: Dense Wavelength Division Multiplexing

The diagram of DWDM system structure and optical spectrum is shown in figure 1.3. At the transmit end, optical transmitters output optical signals of different wavelengths whose accuracy and stability meet certain requirements. These signals are multiplexed via an optical wavelength multiplexer and sent to an erbium-doped optical fiber power amplifier (it is mainly used to compensate the power loss and enhance the launched power of the optical signals).
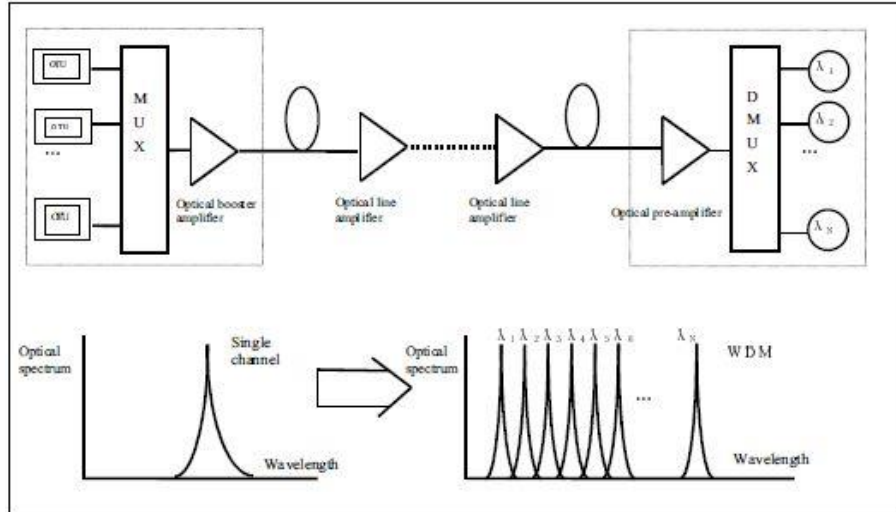
Fig 1.3: The diagram of DWDM system structure and spectrum

After amplification, this multi-channel optical signal is sent to the optical fiber for transmitting. In the midway optical line amplifiers can be installed or not according to practical conditions. At the receiver end, the signals are amplified by the optical pre-amplifier (it is mainly used to enhance receiving sensitivity and prolong transmission distance) and sent to the optical wavelength de-multiplexer which separates them into the original multi-channel optical signals.

1.3 DWDM Operation modes:

There three types o f operational modes of DWDM equipments.

      i. Two-fiber Bi-directional Transmission

      ii. Single fiber Bi-directional Transmission

      iii. Add and drop of optical signals

1.3.1 Two-fiber Bi-directional transmission

As show in fig 1.4, a single optical fiber implements only one directional transmission of optical signals. Hence the same wavelengths can be reused in two directions.
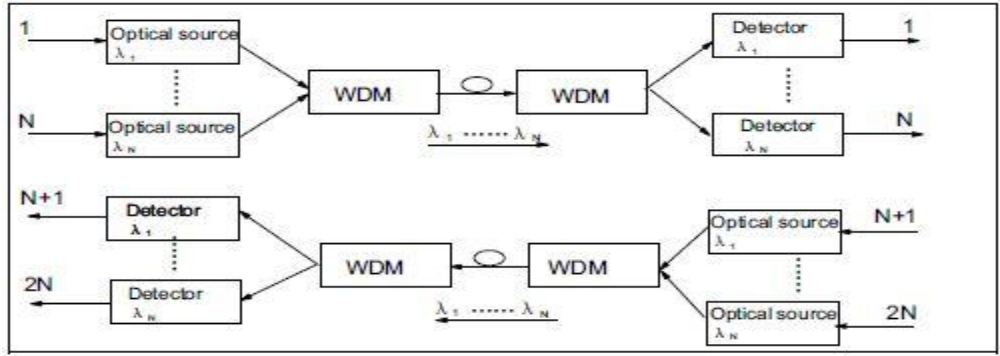
Fig 1.4: Two-fiber bi-directional transmission DWDM system

This kind of DWDM system can effectively exploit the huge bandwidth resources of optical fiber and expand the transmission capacity of a signal optical fiber in several or tens of times. In long-haul networks, capacity can be expanded by adding wavelengths gradually according to the demands of practical traffic, which is very flexible.

1.3.2 Single fiber Bi-directional Transmission

As shown in fig 1.5, a single fiber transmits optical signal of two directions simultaneously, and the signals in the two different directions should be assigned on different wavelengths.
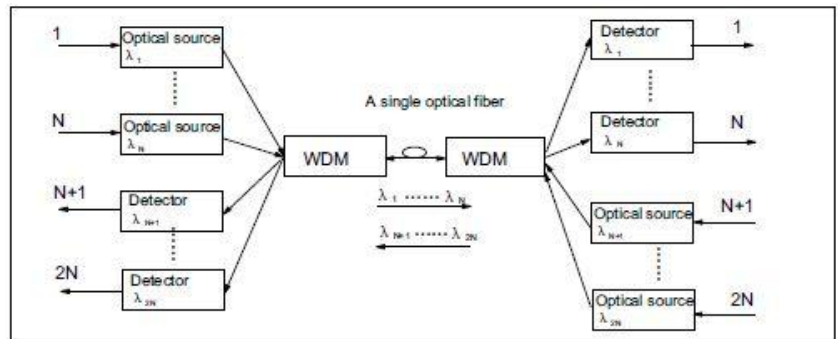
Fig 1.5: The DWDM system of single fiber bi-directional transmission

Single fiber bi-directional transmission allows a single fiber to carry full duplex channels and generally, saves one half of the fiber components of unidirectional transmission. Since signals transmitted in the two directions do not interact and create FWM (Four-wave Mixing) products, its total FWM products are much less than two-fiber unidirectional transmission. However, the disadvantages of this system is that it requires a special measure to deal with the light

reflection (including discrete reflection resulted by optical connectors and Rayleigh backward reflection of the fiber) to avoid multi-path interference. When the optical signal needs to be amplified to elongate prolong transmission distance, their noise factor is a little worse.

1.3.3 Add and Drop of Optical Signals

By utilizing optical add/drop multiplexer (OADM), optical signals of the wavelength can be added and dropped in the intermediate stations, i.e. implementing add/drop of optical paths. This method can be used to implement ring type networking of DWDM systems. At present, OADM can only be made as fixed wavelength add/drop device (as shown in fig 1.6) and thus the flexibility of this operating mode is limited.
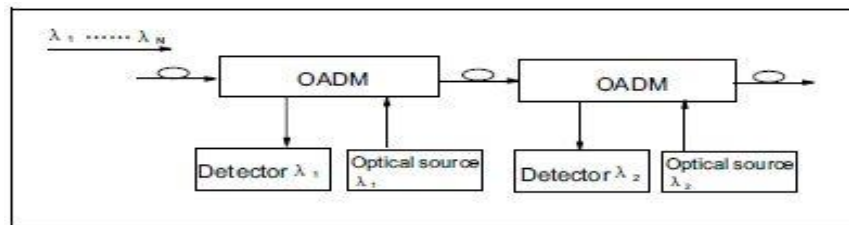
Fig 1.6: Optical add and drop transmission

CHAPTER: 2

SCOPE OF WORK AND CHALLENGES

2.1 Introduction

While debate continues as to whether WDM or TDM is best suited for the expansion of existing fiber networks, it has become clear that only solutions incorporating both technologies will give service providers the flexibility and capacity for future requirements. These requirements could for example enable them to:

- Maintain different dedicated wavelength for different customers
- Lease individual wavelengths as opposed to entire fibers
- Expand portions of their networks
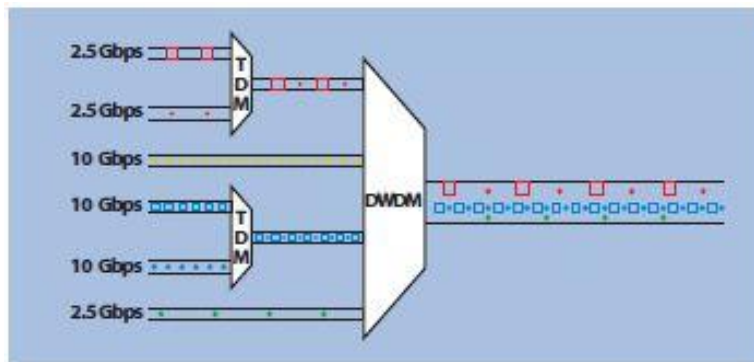
Fig 2.1: Increased capacity by combining TDM with DWDM

Demands for new data services, home office and internet applications all contribute to the pressure being placed on service providers worldwide. Although 10 Gbps seems to be a sufficiently high bit-rat for most networks today, this level of capacity may not be enough in the long term.
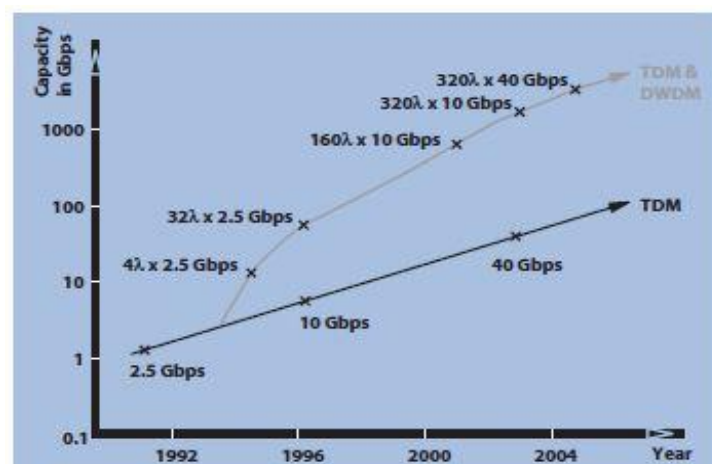
Fig 2.2: Capacity of TDM and TDM & DWDM systems

2.2 Components of a DWDM system

A DWDM system can be described as parallel set of optical channels, where each channels using a slightly different wavelength, but all sharing a single transmission medium or fiber. Figure 2.3 shows a multichannel DWDM transmission system when various 10 Gbps signals are fed to optical transmission modules. An optical DWDM multiplexer bunches these optical signals together on one fiber and forwards them as a multiplexed signal to an optical fiber amplifier (OFA).
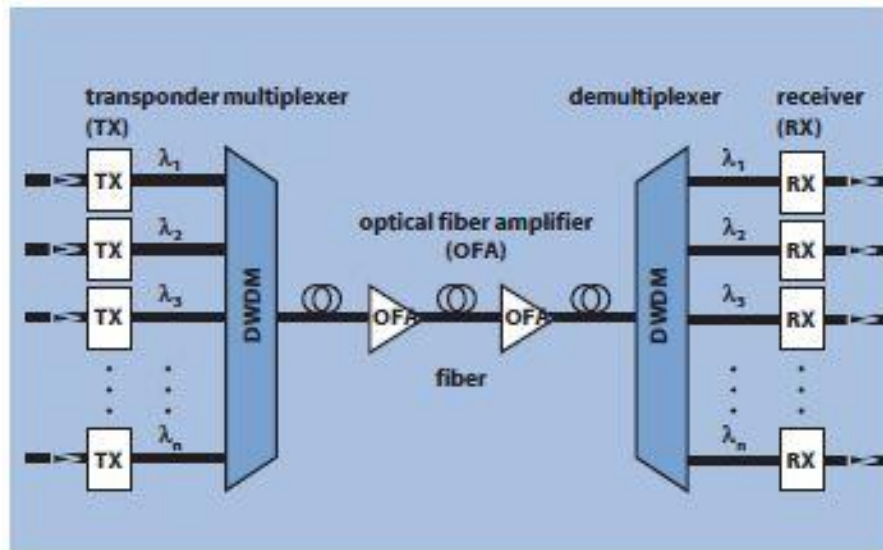
Fig 2.3: Multichannel DWDM transmission system.

2.2.1 Transponder:

Transponders receive optical signals and send them out carrying digital information at predefined wavelengths in accordance with ITU-T guidelines.

In networks with dense channel spacing, transponder temperature must be stabilized. This can be enabled with the use of thermo-electric coolers.

2.2.2 Multiplexer (MUX)

MUX are deployed in DWDM systems to combine the signals at different wavelengths onto a single fiber through which they then travel simultaneously. Each wavelength carriers its own information and represents a channel.

An ideal MUX requires uniformly high transmission across the pass-band with a very high drop at the edge.

2.2.3 Fiber

Fiber is one of the most critical components of DWDM systems as it provides the physical transportation medium. Optical fiber consists of both core and cladding. The core is the inner light-guiding section and is surrounded by the cladding. As the refractive index of the core is higher than that of the cladding, light entering it at angle called numerical aperture.

Light propagates down the fiber core in a stable path known as a mode. In multimode fibers, multiple paths arise making them unsuitable for use in long haul DWDM transmission.

The core of single mode fiber is so narrow that it can only support one mode, making it the only suitable choice for use in DWDM telecommunication networks.

2.2.4 Amplifier

Amplifier boost signals traveling down a fiber so they can cover longer spans. In the early stages of fiber optic telecommunications, lasers emitted relatively low power which led to the rapid use of Amplifier.

Amplifier receives the signal and converts it to electrical signal then reshaped, retimed and amplified the signal again.
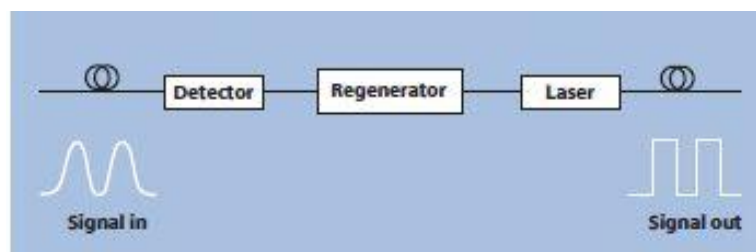
Fig 2.4: Principle of an electrical regenerator

In DWDM systems, the multiplexed signal has to be demultiplexed before each channel is regenerated, emitted by a laser and then multiplexed again. This is a process which is both complex and expensive.

2.3 Target Area of work:

Our main target to draw a optimum connection diagram for transmission system of several University of the Bangladesh. For this reason first we need to the targeted sites. Below table shows the University name where we will build a network connection. This transmission system is build for Ethernet network.

Table 2.1: University list where need to build a transmission pop.

Batch	Site	Zone	Site detail Name
NOC	UGC		University Grand Commission
1	BUET	DAC	Bangladesh University of Engineering Technology
2	BUT	DAC	Bangladesh University of Textiles
3	JU	DAC	Jahangirnagar University
4	BUP	DAC	Bangladesh University of Professionals
5	CU	CTG	Chittagong University
6	CUET	CTG	Chittagong University of Engineering Technology
7	CVASU	CTG	Chittagong Veterinary and Animal Sciences University
8	NSTU	CTG	Noakhali Science and Technology University
9	COU	CTG	Comilla University
10	SAU	SYL	Sher-e-Bangla Agriculture University
11	SUST	SYL	Shahjalal University of Science & Technology
12	NU	DAC	National University
13	BSMRAU	DAC	Bangabandhu Sheikh Mujibur Rahman Agricultural University
14	DUET	DAC	Dhaka University of Engineering & Technology
15	KU	KHL	Khulna University
16	KUET	KHL	Khulna University of Engineering Technology
17	BSMRSTU	KHL	Bangabandhu Sheikh Mujibur Rahman Science and Technology University
18	BU	KHL	University of Barisal
19	PSTU	KHL	Patuakhali Science and Technology University
20	DU-1	DAC	Dhaka University
21	DU-2	DAC	Dhaka University
22	JNU	DAC	Jagannath University
23	RU	RAJ	Rajshahi University
24	RUET	RAJ	Rajshahi University of Engineering Technology
25	HSTU	RAJ	Hajee Mohammad Danesh Science & Technology

26	BRUR	RAJ	Begum Rokeya University
27	IU	KHL	Islamic University
28	JSTU	KHL	Jessore Science and Technology University
29	JKKNIU	MYN	Jatiya Kabi Kazi Nazrul Islam University
30	BAU	MYN	Bangladesh Agricultural University
31	MBSTU	MYN	Mawlana Bhashani Science and Technology University
32	PUST	RAJ	Pabna University of Science and Technology

2.4 Current scenario:

Currently BdREN connected six universities, University Grants Commission of Bangladesh (UGC) and Ministry of Education whose are currently connected with 45Mbps of TIEN3 network and 60Mbps bandwidth of BTCL network.

The connected institutions are:

- University Grants Commission of Bangladesh (UGC)

- Dhaka University

- Bangladesh University of Engineering Technology (BUET)

- Bangabandhu Sheikh Mujib Medical University (BSMMU)

- Jahangirnagar University (JU)

- Sher-e-Bangla Agricultural University (SAU)

- North South University (NSU)

- Ministry of Education (MoE)

Connectivity Diagram:
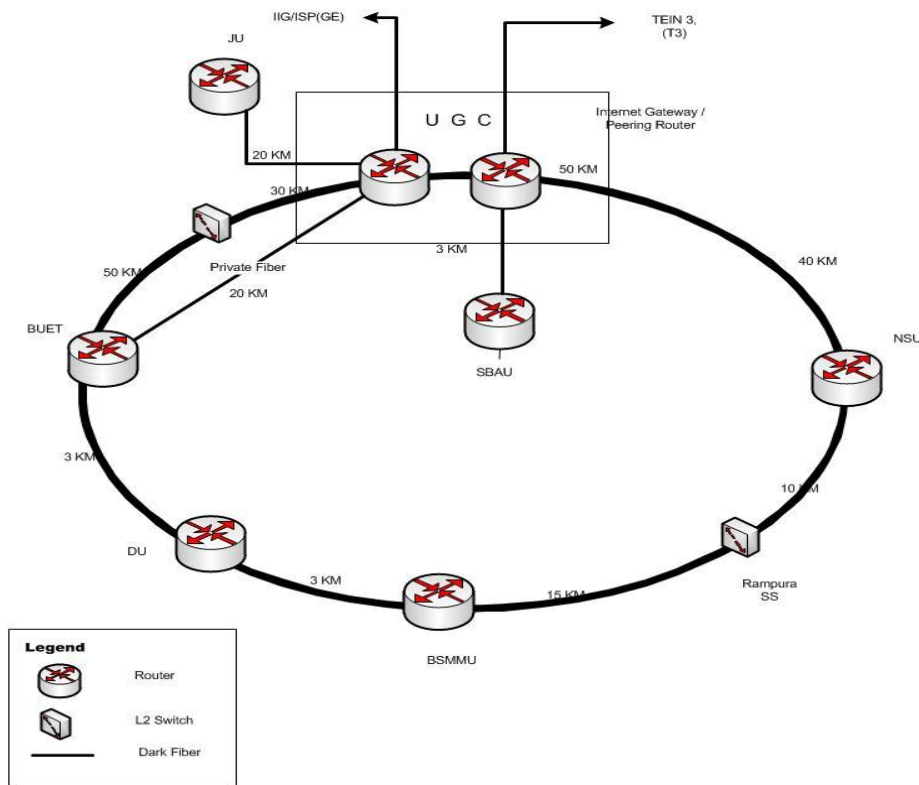
Fig 2.5: Current network diagram

2.5 Proposed Network:

BdREN currently connects six universities and research institutions throughout Bangladesh, via a nationwide IP backbone at 45Mbps capacity. With more bandwidth intensive applications and greater user demand, it is envisaged that BdREN will evolve from the current 45Mbps backbone to a larger scale network in the following phase. BdREN backbone is versatile to support all types of traffic. Our researchers are running and operating various applications such as video conferencing, digital video transport system (DVTS), data computing, and visualization/image modeling and e-learning. Therefore, it is important for BdREN to continue to deliver the quality performance required by the research communities. Members are connected to BdREN via their respective access link, which can either be a fiber link or microwave link. The access connection varies according to the user's requirements. BdREN connectivity is centralized at BdREN Network Operation Centre (NOC) located in Dhaka.
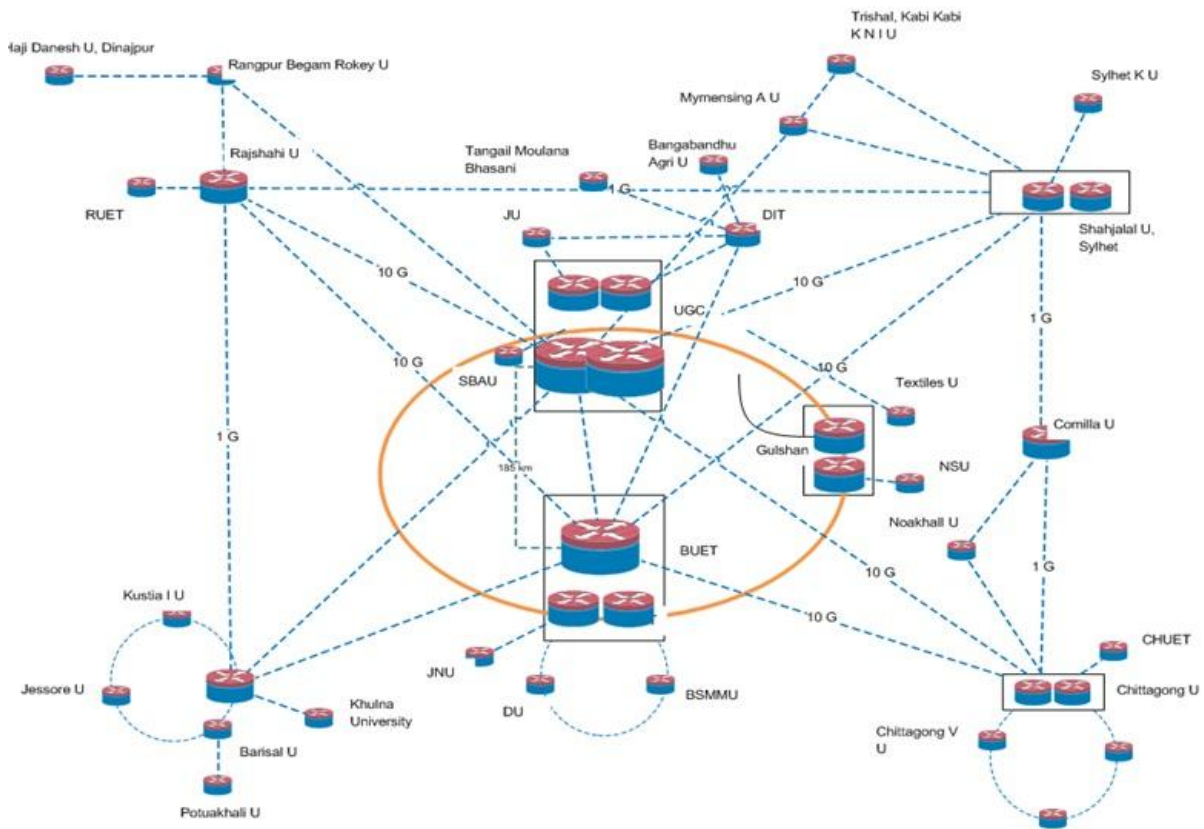
Fig 2.6: Proposed design Diagram

2.6 Challenges:

For achieving connectivity over the country is a big challenge. We have only three options in our hand. First we can make a fiber laying connectivity all over the country, which is very expensive. Secondly we can have connectivity from BTCL whose has not covered all the sites. Also reliability is low. Thirdly, we can lease a pair of core from OPGW networks of PGCB who has covered most of sites.

So we finally decided that PGCB's OPGW fiber back is used for our transmission system.

CHAPTER: 3

TRANSMISSION NETWORK DESIGN

3.1. Design Direction

This document will describe technical design details for Transmission network of BdREN Network System which we have from bdren.net website. The network will establish through PGCB optical fiber connection network. UGC / BdREN have acquired one pair of Dark Optical fiber of PGCB from PGCB's OPGW network on Transmission line through Indefeasible Right of Use (IRU) for 20 years. The backbone network of BdREN is designed based on this OPGW network. Fig 2.1 shows OPGW of PGCB.
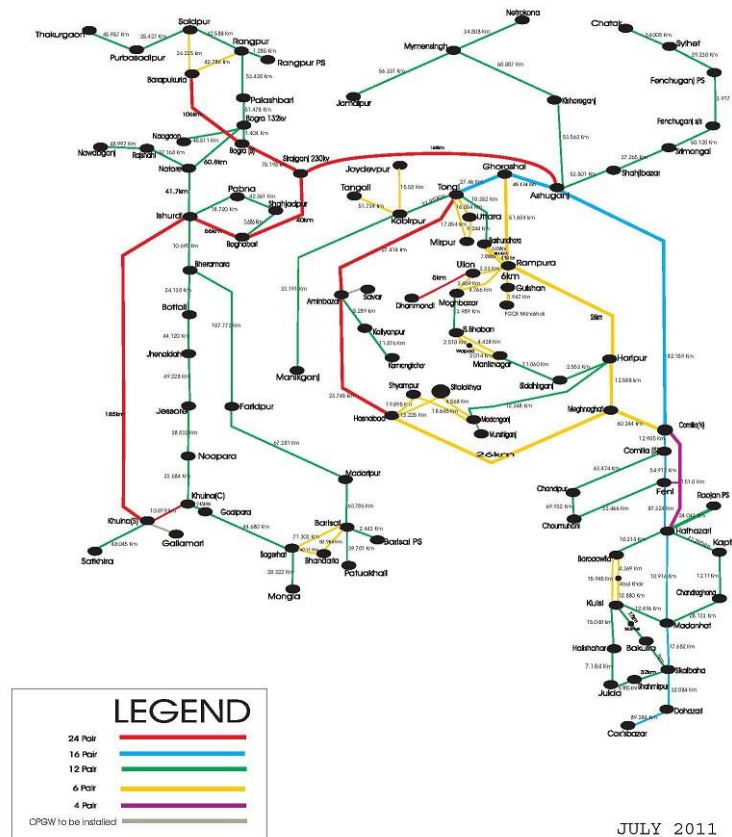
Fig 3.1: OPGW diagram of PGCB

3.2. Purpose of Design

Transmission network will be used to build an IP / MPLS data network for connecting some of the Universities of the country that could not reached long distance with dark fiber cable.

3.3. Scope of Transmission Network

The scope of transmission network system is as follows:

- Install DWDM equipment in University/ BdREN room or PGCB site.
- Provide reliable connectivity among the router to router via 1GE and 10GE user interface of DWDM network
- Provide Transmission NMS System for DWDM network management.

3.4 Benefit of Using Transmission System

To expand network, traditional way is laying new fiber or increase the bit rate of existing systems. However laying new fiber is costly proposition. When we are using wavelength division multiplexing (WDM) technology, several wavelengths or light colors, can simultaneously in one optic cable. Bandwidth aside, DWDM's most compelling technical advantages can be summarized as follows:

- Transparency: Because DWDM is physical layer architecture, it can transparently support both TDM and data formats such as ATM, Gigabit Ethernet, ESCON, and Fiber Channel with open interfaces over a common physical layer. BdREN Transmission network is focused on Gigabit Ethernet.

- Scalability: DWDM can leverage the abundance of dark fiber in country wide area and to quickly meet demand for capacity on point-to-point links and on spans of existing network rings. BdREN Transmission network can support 40 Channels scalability.

- Dynamic provisioning : Fast, simple, and dynamic provisioning of network connections give providers the ability to provide high-bandwidth services in days rather than months.

3.5. Design Concept

3.5.1 Architecture Design Scope

System architecture for BdREN transmission network can be summarized as follows:

- Traffic Architecture
    - 1G traffic: Mainly sent collected universities data traffic from Edge POP to Distribution POP.
    - 10G traffic: Mainly Sent collected universities data traffic from Distribution POP to DC, DR.

- NMS Architecture
    - Information collected through the channel between OSC equipment
    - Collect equipment information through the OSC channel between equipment and equipment .
    - Connect GNE node to NMS Sever
    - Manage a DWDM Network via connect NMS sever to network.

3.5.2. Architecture Design Principle

- Reliability
    - Design network with redundant control cards and power supplies to minimize shortage of service against hardware failures.
    - Design network with detour path from Distribution POP to DC and DR.
    - To ensure the reliable transmission network than dark fiber by using a DWDM FEC (Forward Error Correction)
- Availability
    - To cover the dense traffic requirement with low cost, Design a multiple transponder effect by using a single transponder.

- Scalability

  - Minimize the use of the frequency by using the same frequency in different regions,

  - Enable the future network channels add by using the unused frequency.

3.6. Architecture Design

Table 3.1: Architecture design description.

List	Description	Remarks
Reliability	- Design network with two TNC-E control cards and two power supplies for each shelf - Redundancy 10G Route - Rajshahi - UGC(DC) via Kabirpur - Rajshahi - BUET(DR) via Ashuganj - KUET - UGC(DC) via Kabirpur - KUET - BUET(DR) via Ashuganj - Sylhtet - UGC(DC) via Kabirpur - Sylhtet - BUET(DR) via Rampura - Chitagong - UGC(DC) via Kabirpur - Sylhtet - BUET(DR) via Nokhali and Rampura - UGC - BUET via Short path (10Km) - UGC - BUET via long path (85Km) - NSU - UGC via Kabirpur - NSU - BUET via Rampura - Redundancy 1G Route - Rajshahi - Dinajpur via Short Path - Rajshahi - Dinajpur via Long Path - KUET - Barisal via Short Path - KUET - Barisal via Long Path - KUET - Gopalganj via Short Path - KUET - Gopalganj via Long Path	
Availability	- Designed with 'ONS 15454 Any-Rate Muxponder' to cover maximum 2 different directions with 1 transponder. - Designed with '10x10G Multi rate Client Line Card' to cover maximum 5 different directions with 1 transponder.	
Scalability	-BdREN transmission network designed 18 10GbE channels and 24 1GbE channels using 11 frequencies. -BdREN transmission network can be expanded with remaining 29 frequencies.	

3.7. Detailed Design for Transmission Network

3.7.1. Overall Diagram
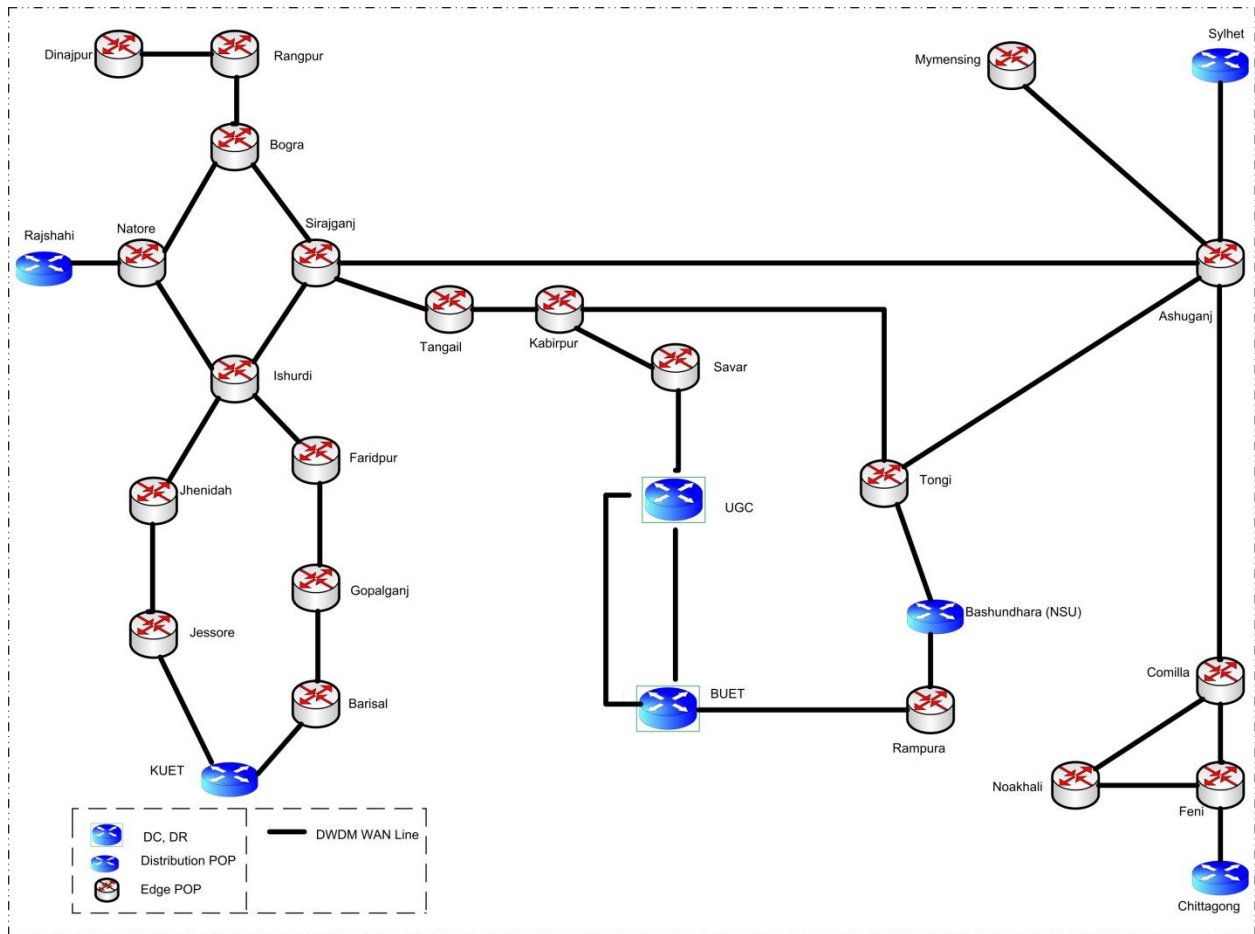
Fig 3.2: Overall diagram

3.7.2. Spanloss Calculation

- Calculation assuming

  - Assumed that the attenuation shall be 0.25dB per kilometer at 1550 nm

  - Assumed that average splice loss at each location will not exceed 0.30dB unidirectional or 0.15dB bidirectional

  - Assumed that dB Loss/KM is 0.217(Bogra to Sirajgonj) as per RFP document.

  - Assumed that dB Loss/KM is 0.378(Ishurdi to Baghabari), 0.224 (Baghabari to Sirajgonj) as per RFP documents.

- Assumed that dB Loss/KM is 0.646(Tongi to Bashundhara) as per RFP documents.

- Assumed that dB Loss/KM is 0.231(Ashuganj to Comilla) as per RFP RFP documents.

- Assumed that dB Loss/KM is 0.308(Ishurdi to Khulna) as per RFP documents.

Please refer to the appendix3.2 for span-loss calculation value.

3.7.3. Degree Design

Transmission network has 28 nodes, each node has number of degrees 1 ~ 5 according to its connecting line and each of nodes has unique degree serial. For example Dinajpur has one direction for Rampur, that is, Dianjpur to Rangpur degree will be 'A' and degree number will be one (1).
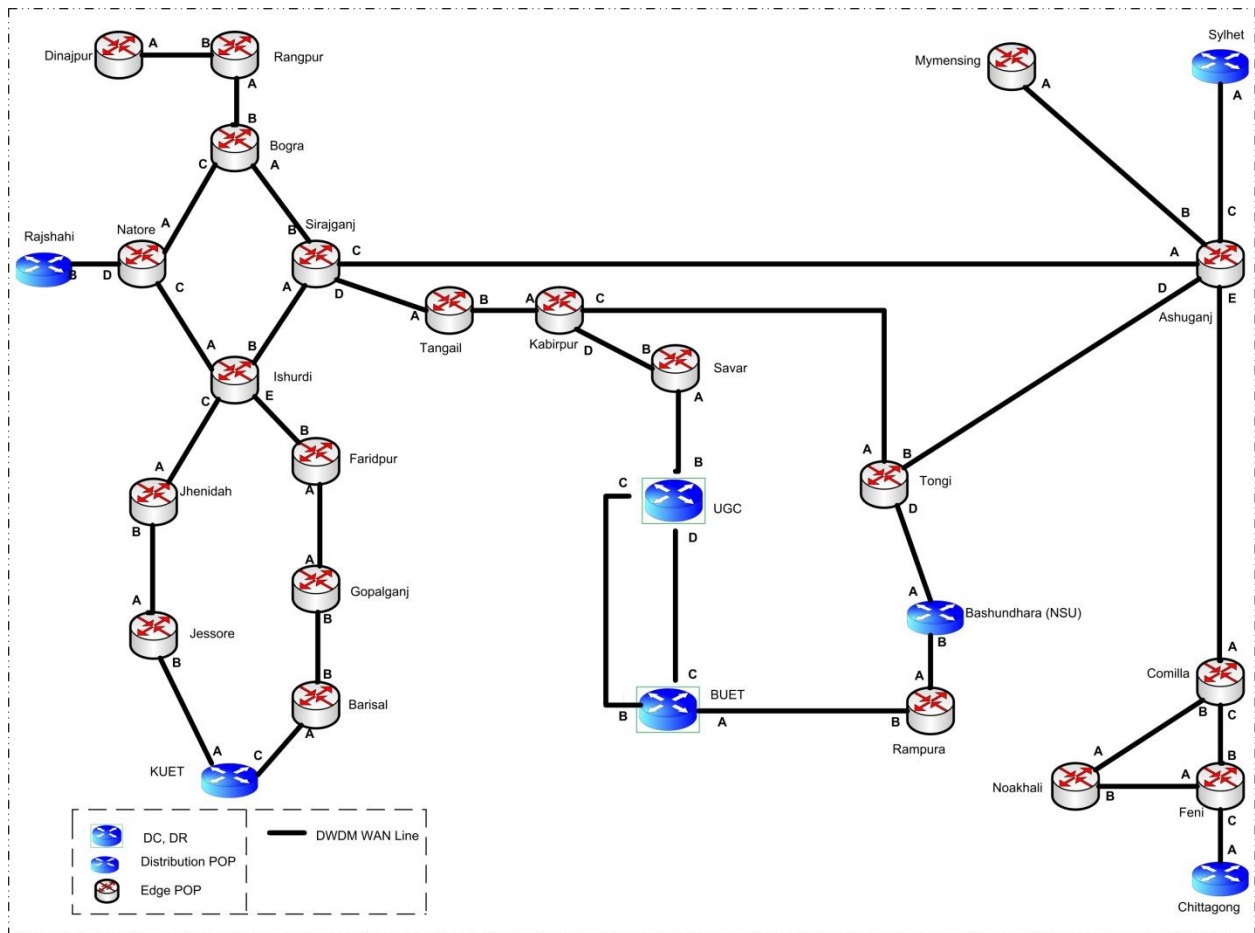
Fig 3.3: Degree diagram

Table 3.2: Number of degrees for each node.

No	Node Name	Degree	Remark
1	Ashuganj	5	
2	Barisal	2	
3	Bogra	3	
4	BUET	3	
5	Chittagong	1	
6	Comilla	3	
7	Dinajpur	1	
8	Faridpur	2	
9	Feni	3	
10	Goalgunj	2	
11	Ishurdi	4	
12	Jenidah	2	
13	Jessore	2	
14	Kabirpur	3	
5	Chittagon	1	
6	Comilla	3	
7	Dinajpur	1	
8	Faridpur	2	
9	Feni	3	
10	Goalgunj	2	
11	Ishurdi	4	
12	Jenidah	2	
13	Jessore	2	
14	Kabirpur	3	
15	KUET	2	
16	Mymensing	1	
17	Natore	3	
18	Nokhali	2	

3.8. Logical diagram
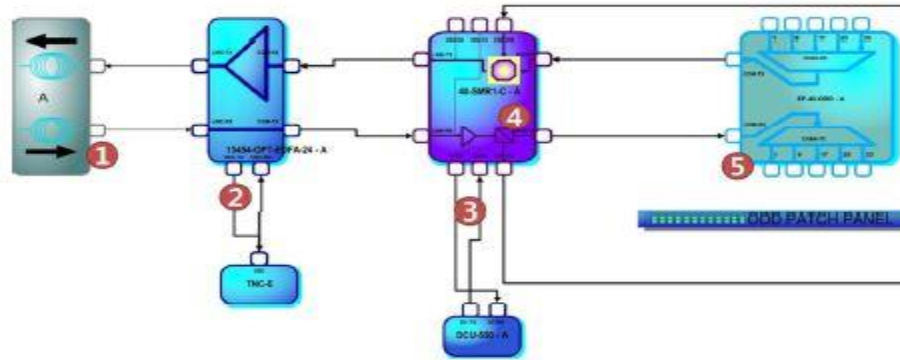
Fig 3.4: Traffic flow in Node.

Above figure is sample logical diagram. The input DWDM signal comes through the line interface (1). Optical supervisory channel (OSC) Signal is separated and mixed through a control card (2). Dispersed signal through the pre amplifier is compensated by DCU (Dispersion compensation unit) (3). Amplified signal is split into pass-through traffic and local drop traffic (4). The local drop traffic is connected to the mux and transponder card.

3.9. Channel Matrix

Table 3.3 Channels ID and path.

No	To	From	Path
10G-1	UGC	BUET	Direct
10G-2	UGC	BUET	Direct
10G-3	UGC	BUET	Direct
10G-4	UGC	BUET	Direct
10G-17	BUET	Chittagong	via Feni-Noakhali-Comilla-Ashuganj-Tongi-NSU-Rampura
10G-9	UGC	Chittagong	via Feni-Comilla-Ashuganj-Tongi-Kabirpur-Savar
10G-12	UGC	Kabirpur	via Savar
10G-15	BUET	KUET	via Barisal-Gopalganj-Faridpur-Ishurdi-Shirajganj-Ashuganj-Tongi-NSU-Rampura
10G-7	UGC	KUET	via Barisal-Gopalganj-Faridpur-Ishurdi-Shirajganj-Ashuganj-Tongi-NSU-Rampura
10G-13	BUET	NSU	via Rampura
10G-14	BUET	NSU	via Rampura
10G-5	UGC	NSU	via Savar-Kabipur-Tongi
10G-6	UGC	NSU	via Savar-Kabipur-Tongi
10G-16	BUET	Rajshahi	via Natore-Ishurdi-Shirajganj-Ashuganj-Tongi-NSU-Rampura
10G-8	UGC	Rajshahi	via Natore-Bogra-Shirajganj-Tangail-Kabirpur-Savar via Ashuganj-Tongi-NSU-Rampura
10G-18	BUET	Sylhet	via Ashuganj-Tongi-Kabirpur-Savar
10G-10	UGC	Sylhet	via NSU-Rampura
10G-11	BUET	Savar	Direct
1G-1	UGC	Savar	Direct
1G-2	UGC	Rangpur	via Bogra-sirajganj-Tangail-Kabirpur-Savar
1G-3	UGC	Mymensing	via Ashuganj-Tongi-Kabirpur-Savar
1G-4	NSU	Rampura	Direct
1G-5	BUET	Tongi	Via NSU-Rampura
1G-6	KUET	Jessore	Direct
1G-7	KUET	Jenidah	Via Jessore
1G-8	KUET	Barisal	Direct

Below figure is showing traffic route diagram for 1G Ethernet and 10G Ethernet.

Traffic from distribution node to UGC (DC) and BUET (DR) has different route for redundancy, for example 10G Ethernet for Rajshahi to UGC route is go through Tangail node, Rajshahi to BUET route is go through Ashuganj. Please refer to the appendix3.4 for each channels route.
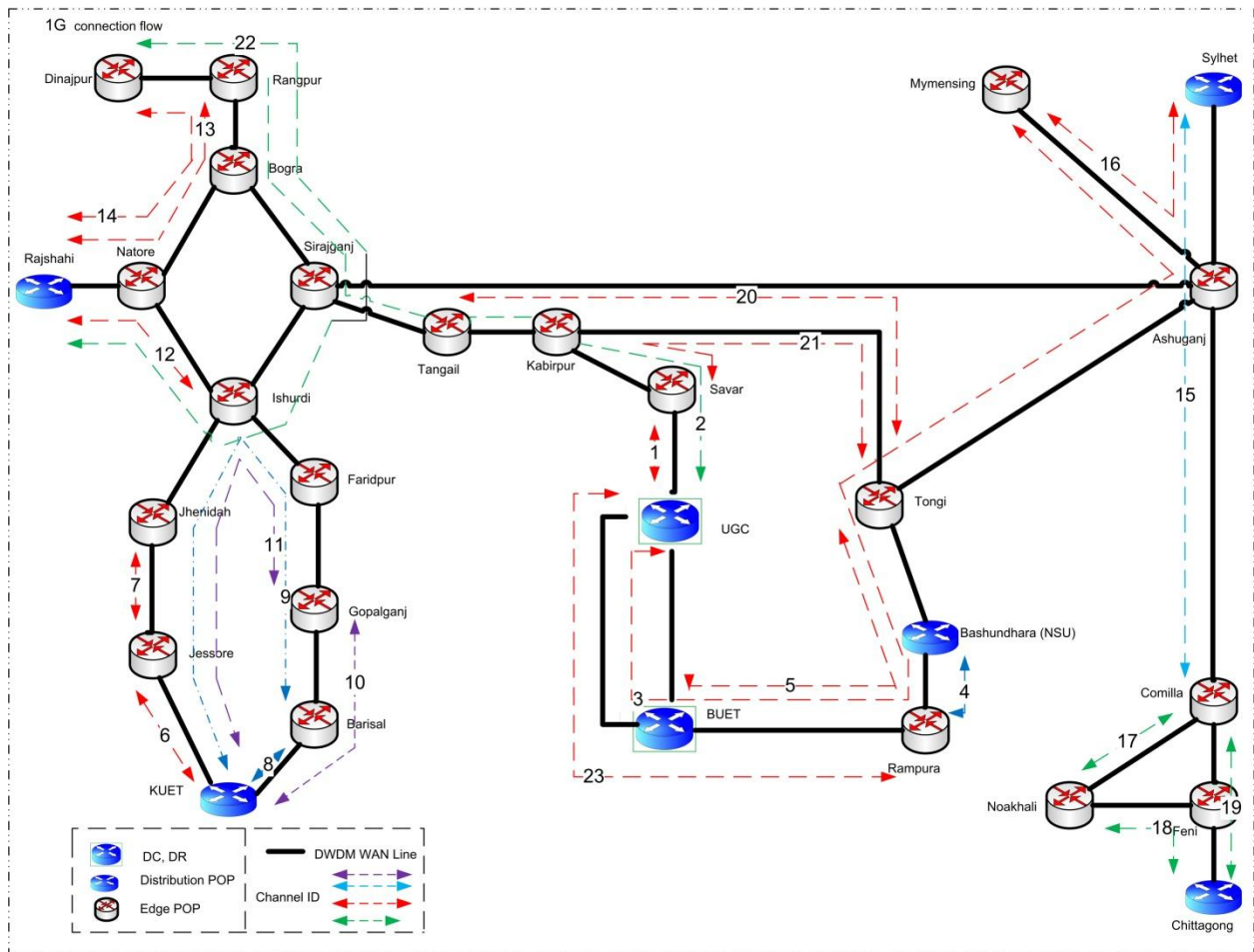
- 1G Ethernet

Fig 3.5: 1G Ethernet Connection

Table 3.4 1G Ethernet Channel Wavelength and Transponder Equipment

ID	Name	Wavelength	From	To	Equipment	Remarks
1G-1	Savar – UGC	0-39 (1,560.61)	Savar.A	UGC.B	15454-AR-MXP	
1G-2	Rangpur-UGC	0-34 (1,556.55)	Rangpur.A	UGC.B	15454-AR-MXP	
1G-3	UGC-Mymensing	0-38 (1,559.79)	UGC.B	Mymensing.A	15454-AR-MXP	
1G-4	NSU-Rampur	0-32 (1,554.94)	NSU.B	Rampura.A	15454-AR-MXP	
1G-5	Tongi-BUET	O-39 (1,560.61)	Tongi.D	BUET.A	15454-AR-MXP	
1G-6	Jessore-Khulna	O-36 (1,558.17)	Jessore.B	Khulna.A	15454-AR-MXP	
1G-7	Jenidah-Khulna	O-37 (1,558.98)	Jenidah.B	Khulna.A	15454-AR-MXP	
1G-8	Barisal-Khulna	O-39 (1,560.61)	Barisal.A	Khulna.C	15454-AR-MXP	
1G-9	Barisal-Khulna	O-39 (1,560.61)	Barisal.B	Khulna.A	15454-AR-MXP	
1G-10	Gopalgunj-Khulna	O-39 (1,559.79)	Gopalganj.B	Khulna.C	15454-AR-MXP	
1G-11	Gopalganj-Khulna	O-38 (1,559.79)	Gopalganj.A	Khulna.A	15454-AR-MXP	
1G-12	Ishurdi-Rajshahi	O-34 (1,556.55)	Ishurdi.A	Rajshahi.B	15454-AR-MXP	
1G-13	Rangpur-Rajshahi	O-39 (1,560.61)	Rangpur.A	Rajshahi.B	15454-AR-MXP	
1G-14	Rajshahi-Dinajpur	O-38 (1,559.79)	Rajshahi.B	Dinajpur.A	15454-AR-MXP	
1G-15	Sylhet-Comilla	O-39 (1,560.61)	Sylhet.A	Comilla.A	15454-AR-MXP	
1G-16	Sylhet-Mymensing	O-37 (1,558.98)	Sylhet.A	Mymensing.A	15454-AR-MXP	
1G-17	Nokhali-Comilla	O-39 (1,560.61)	Nokhali.A	Comilla.B	15454-AR-MXP	
1G-18	Nokhali-Chittagon	O-38 (1,559.79)	Nokhali.B	Chittagon.A	15454-AR-MXP	
1G-19	Chittagon-Comilla	O-39 (1,560.61)	Chittagon.A	Comilla.C	15454-AR-MXP	
1G-20	Tongi-Tangail	O-39 (1,560.61)	Tongi.A	Tangail.B	15454-AR-MXP	
1G-21	Savar-Tongi	O-36 (1,558.17)	Savar.B	Tongi.A	15454-AR-MXP	

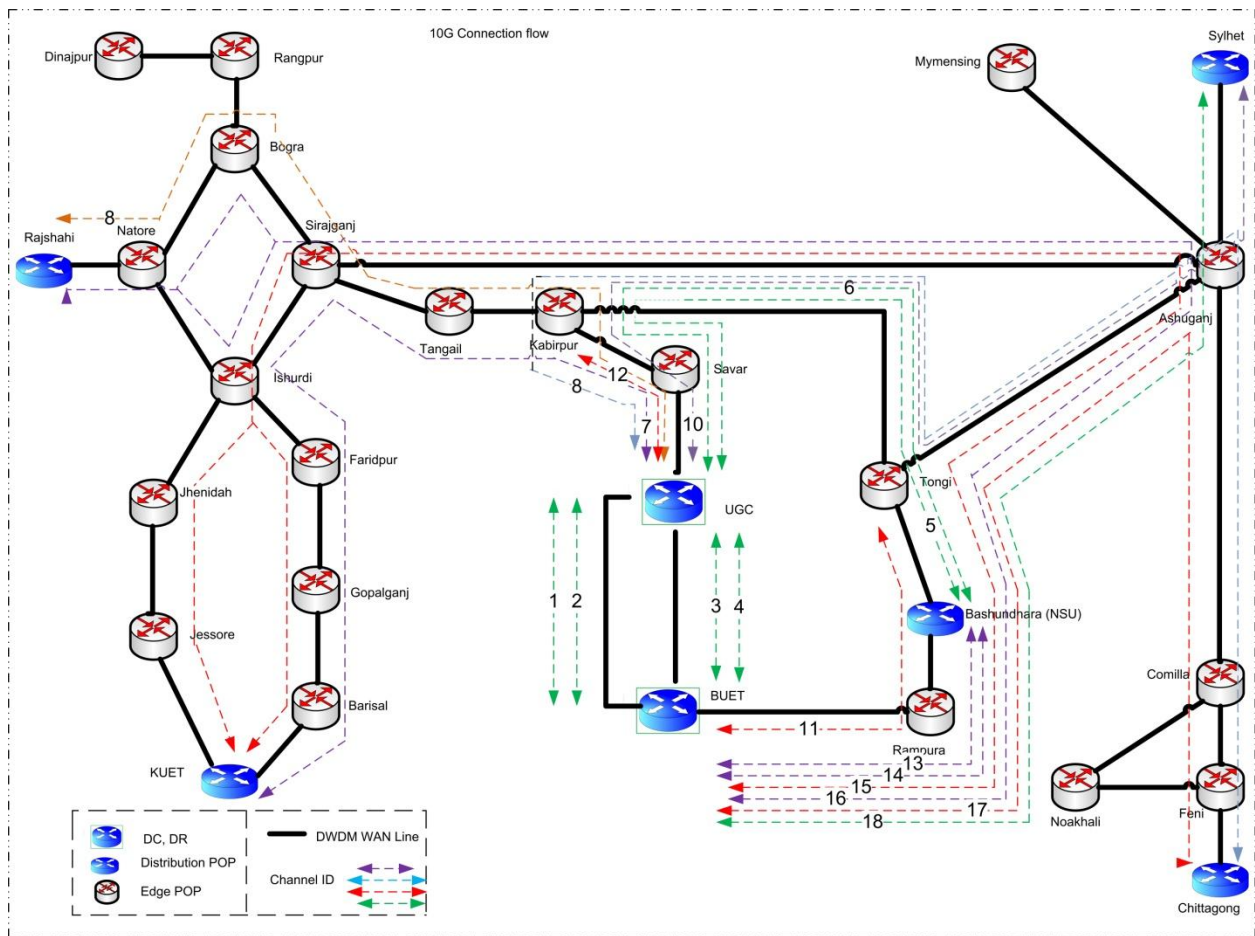| 1G-22	Rajshahi-Dinajpur_1	O-37 (1,558.98)	Rajshahi.B	Dinajpur.A	15454-AR-MXP	
1G-23	UGC-Rampura	O-32 (1,554.94)	UGC.C	Rampura.B	15454-AR-MXP	

- 10G Ethernet

Fig 3.6: 10G Ethernet connection Diagram

Table 3.5: 10G Ethernet Channel Wavelength and Transponder Equipment

ID	Name	Wavelength	From	To	Equipment	Remarks
10G-1	UGC-BUET	O-39 (1,560.61)	UGC.C	BUET.B	15454-M-10X10G-LC	Long Path
10G-2	UGC-BUET	O-38 (1,559.79)	UGC.C	BUET.B	15454-M-10X10G-LC	Long Path
10G-3	UGC-BUET	O-39 (1,560.61)	UGC.D	BUET.C	15454-M-10X10G-LC	Long Path
10G-4	UGC-BUET	O-38 (1,559.79)	UGC.D	BUET.C	15454-M-10X10G-LC	Long Path
10G-5	UGC-NSU	O-33 (1,555.75)	UGC.B	NSU.A	15454-M-10X10G-LC	
10G-6	UGC-NSU	O-32 (1,554.94)	UGC.B	NSU.A	15454-M-10X10G-LC	
10G-7	UGC-Khulna	O-28 (1,551.72)	UGC.A	Khulna.A	15454-M-10X10G-LC	
10G-8	UGC-Rajshahi	O-27 (1,550.92)	UGC.B	Rajshahi.B	15454-M-10X10G-LC	
10G-9	UGC-Chittagon	O-31 (1,554.13)	UGC.B	Chittagon.A	15454-M-10X10G-LC	
10G-10	UGC-Sylhet	O-29 (1,552.52)	UGC.B	Sylhet.A	15454-M-10X10G-LC	
10G-11	Tongi-BUET	O-31 (1,554.13)	Tongi.D	BUET.A	15454-M-10X10G-LC	
10G-12	Kabirpur-UGC	O-37 (1,558.98)	Kabirpur.D	UGC.B	15454-M-10X10G-LC	
10G-13	BUET-NSU	O-38 (1,559.79)	BUET.A	NSU.B	15454-M-10X10G-LC	
10G-14	BUET-NSU	O-33 (1,555.75)	BUET.A	NSU.B	15454-M-10X10G-LC	
10G-15	BUET-Khulna	O-34 (1,556.55)	BUET.A	Ashuganj.D	15454-M-10X10G-LC	Including 3R
10G-15	BUET-Khulna	O-34 (1,556.55)	Ashuganj.A	Faridpur.B	15454-M-10X10G-LC	Including 3R
10G-15	BUET-Khulna	O-34 (1,556.55)	Faridpur.A	Khulna.C	15454-M-10X10G-LC	Including 3R
10G-16	BUET-Rajshahi	O-36 (1,558.17)	BUET.A	Rajshahi.B	15454-M-10X10G-LC	
10G-17	BUET-Chittagong	O-37 (1,558.98)	BUET.A	Chittagong.A	15454-M-10X10G-LC	
10G-18	BUET-Sylhet	O-28 (1,551.72)	BUET.A	Sylhet.A	15454-M-10X10G-LC	

3.10 Power Consumption calculation:

Below power is assumed at rating power of equipment.

Table 3.6: Power consumption for each node

No	Node Name	Max Power Consumption(W)	Typical power Consumption(W)	Remark
1	Ashuganj	2620.7	1841.32	
2	Barisal	769.6	504.95	
3	Bogra	661.5	426.75	
4	BUET	1656.5	1210.575	
5	Chittagon	890.35	652.38	
6	Comilla	935.2	604.425	
7	Dinajpur	631.6	447.45	
8	Faridpur	828.25	561.07	
9	Feni	661.5	426.75	
10	Goalgunj	1357.5	937.45	
11	Ishurdi	1779.8	1278.754	
12	Jenidah	727.05	503.8	
13	Jessore	758.1	527.95	
14	Kabirpur	1259.75	873.165	
15	Khulna	1895.95	1395.365	
16	Mymensing	716.7	504.95	
17	Natore	661.5	426.75	
18	Nokhali	861.6	585.45	
19	NSU	936.35	673.885	
20	Rajshahi	975.45	712.41	
21	Rampura	1166.6	793.7	
22	Rangpur	843.2	584.53	
23	Savar	727.05	503.8	
24	Shirajganj	2366.55	1687.45	
25	Sylhet	970.85	665.03	
26	Tangail	758.1	526.225	
27	Tongi	1009.95	687.34	
28	UGC	3086.45	2165.525	

3.11 NMS

The DWDM devices deliver the management information of the nodes through the OSC (Optical Supervisory Channel). The OSC transmits control, configuration, and request messages from the NMS to nodes and delivers alarms, events, and response messages from nodes back to the NMS. Also, it allows remote management of several nodes from one single point. OSC and service signals are independent of each other. The OSC is not amplified. When the OSC signals are transmitted to another node, the OSC signals undergo E/O conversion at the OSC module and then are multiplexed by being combined with service signals amplified by the amplifier of the origin. When the signals arrive at the next node, the OSC are demultiplexed from service signals before entering to the amplifier of the destination and then undergo O/E conversion at the OSC module. As both modules and signals of OSC are separated from modules and signals of service, the failure of an OSC module is non-traffic affecting.
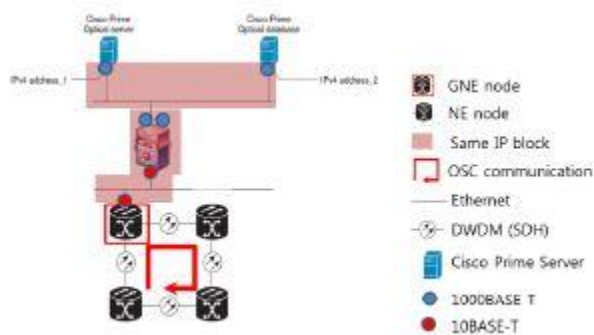

Figure 3.7 NMS diagram.

Basically BdREN transmission network system is using OSC channels for network management. All OSC management data will be collected to GNE (Gateway Network Element) node. The GNE acts as a proxy for the attached Network Elements. GNE node is connected to NMS servers via Backbone switch. GNE and NE(Network Element) has a unique IP address. GNE and NMS server is using same IP block so that GNE IP address is using for communication with NMS server. Also NEs (Network element) are using IP, but NE is using separated IP block for device identification. BdREN transmission network has one GNE node in UGC node.

CHAPTER: 5

Conclusion and Future work

4.1 Conclusion

In summary, this thesis focused on the design of DWDM transmission network. The objective of the design is to achieve optimum solution for implementation.

At end we can understand;

- How DWDM works

- Challenges of the practical network design

- How DWDM can implement in a existing TDM / WDM a network.

So in one word, DWDM has great feature of extensibility integration without interference of current network.

4.2 Future work

DWDM infrastructures provide solid foundations for future telecommunication networks as well as smooth network evolution for different services. It has a great feature of future expandability. So we can expand our network by add new area without adding new optical fiber from central side.

For ensuring QoS, management of the network and protection of the network, integration of NMS is very important.

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Appendix

1. DWDM – Dense Wavelength Division Multiplexing

2. TDM – Time Division Multiplexing.

3. SONET – Synchronous Optical network

4. SDH – Synchronous Digital Hierarchy

5. ATM – Asynchronous Transfer Mode

6. IP – Internet Protocol

7. PoS – Packet over SONET/SDH.

8. SDM – Space Division Multiplexing

9. WDM - Wavelength Division Multiplexing

10. FWM – Four Wave Mixing

11. NOC – Network Operation Centre

12. DVTS – Digital Video Transport System.

13. QoS – Quality of Service.

14. OSC – Optical Supervisory Channel.