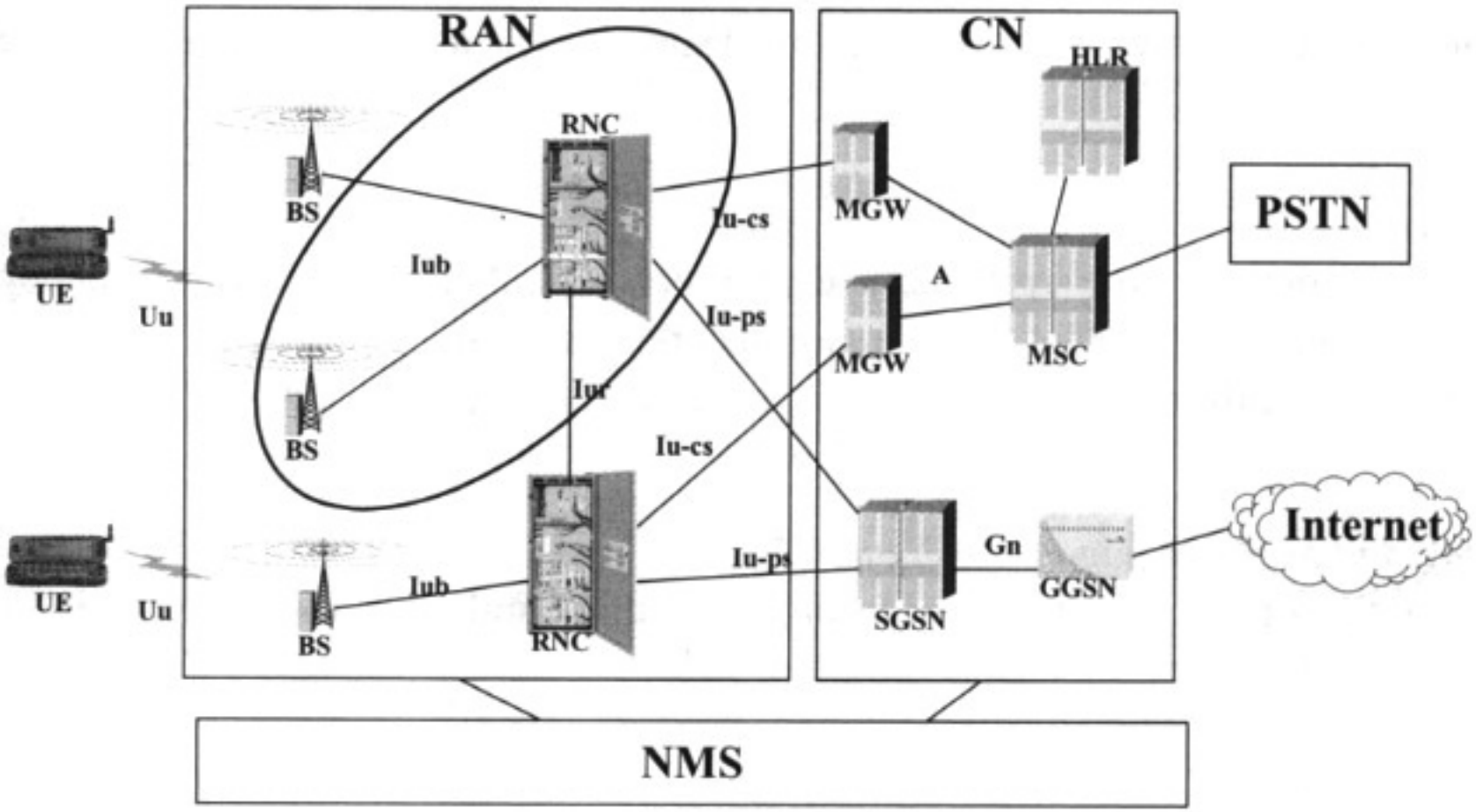
3G Transmission Network Planning and Optimization

The Scope of Transmission Network Planning

- Transmission network planning encompasses the interfaces between the BS and RNC, between the RNC and CN, and between RNC



Elements in 3G Transmission Networks

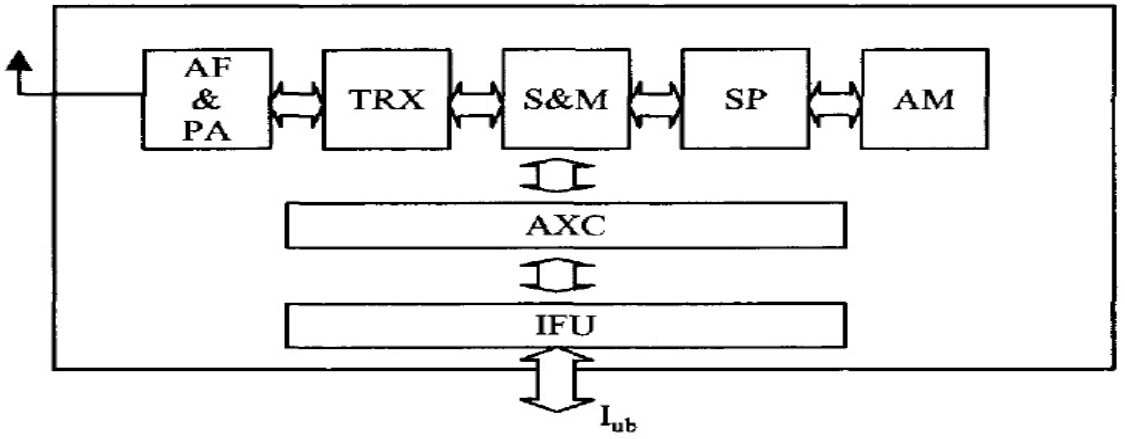
Base *Station (Node B):* Base stations play an important role in 3G transmission networks. This role is different from GSM transmission networks.

Antenna Filter and Power Amplifier (AF and PA)

- The filter isolates the transmitted and received signals. The amplifier amplifies the received signals.

Transceivers

- Transceivers contain one transmitter and two receivers. The major differences from a GSM TRX include accurate power control, a different frame structure, and altered channelization.



Summing and Multiplexing Units (S and M)

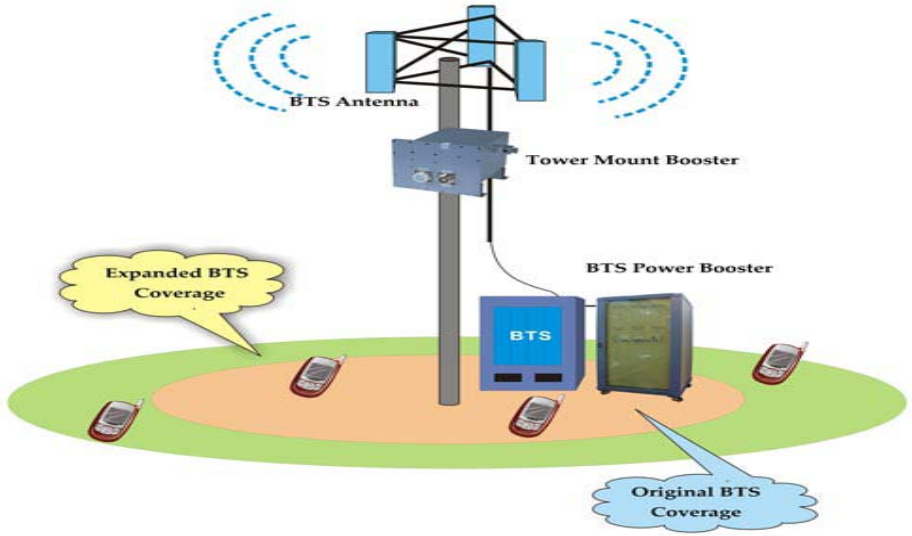
- These sum the signals from the various other summing and multiplexing units and/or from signal processing units.

ATM Cross-connect (AXC)

- This is responsible for cross-connection at the ATM (asynchronous transfer mode) level. It also acts as an interface between the AM and the interface units.

Interface Unit (IFU)

- This is the interface between the base station and Iub interface. It may vary depending on the type of transmission - E1/T1/JT1 or PDH/SDH, etc.

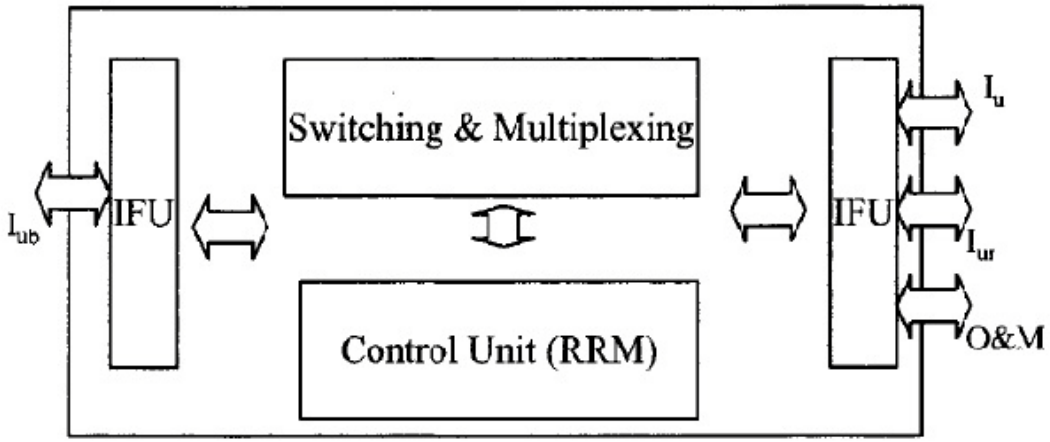


Elements in 3G Transmission Networks

Base *Station (Node B)*

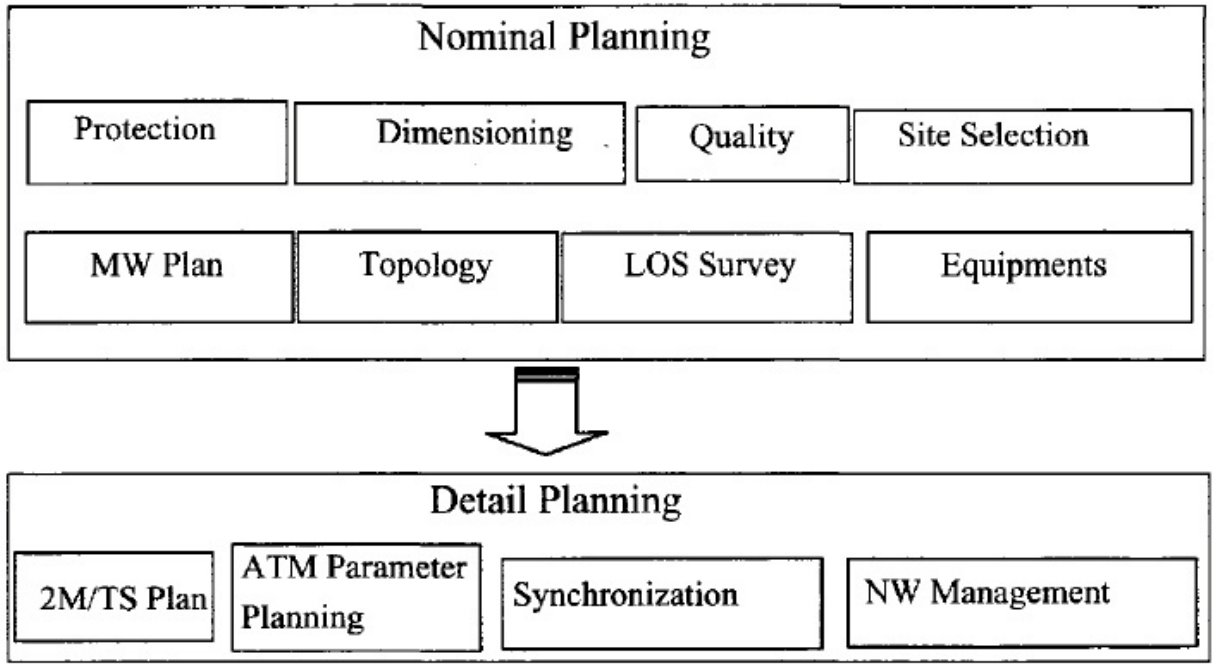
Radio Network Controller (RNC)

- *Interface Unit (IFU) :* There are mainly two kinds of interface unit, PDH and SDH. On either of the interfaces (Iub/Iur/IuX a PDH or SDH interface can be configured.
- *Switching and Multiplexing Unit:* Asynchronous transfer mode (ATM) forms the backbone of WCDMA networks.
- *Control Unit (RRM):* The control unit is responsible for RRM functions such as handovers, admission control, power control etc.



Block diagram of radio network controller (RNC)

TRANSMISSION NETWORK PLANNING PROCESS

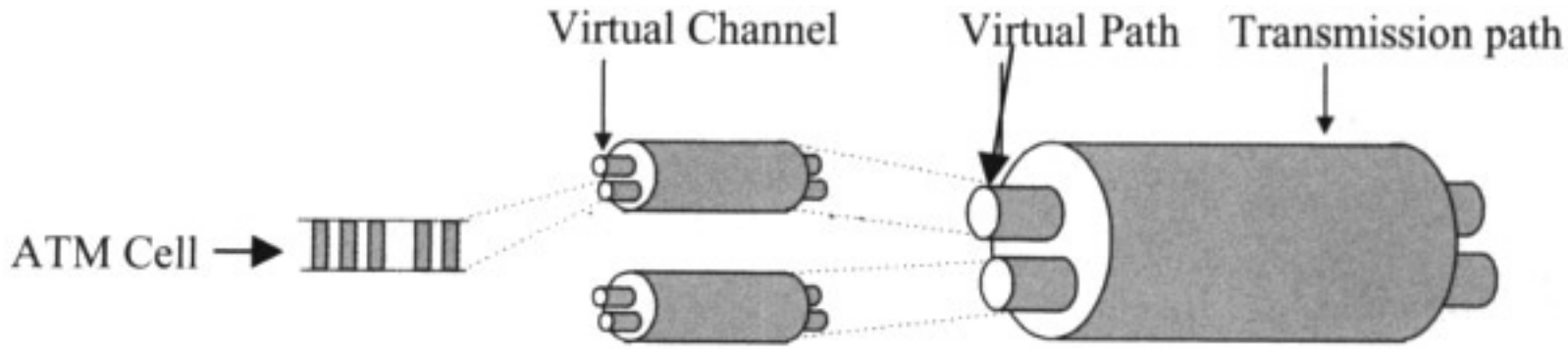


Transmission network planning process

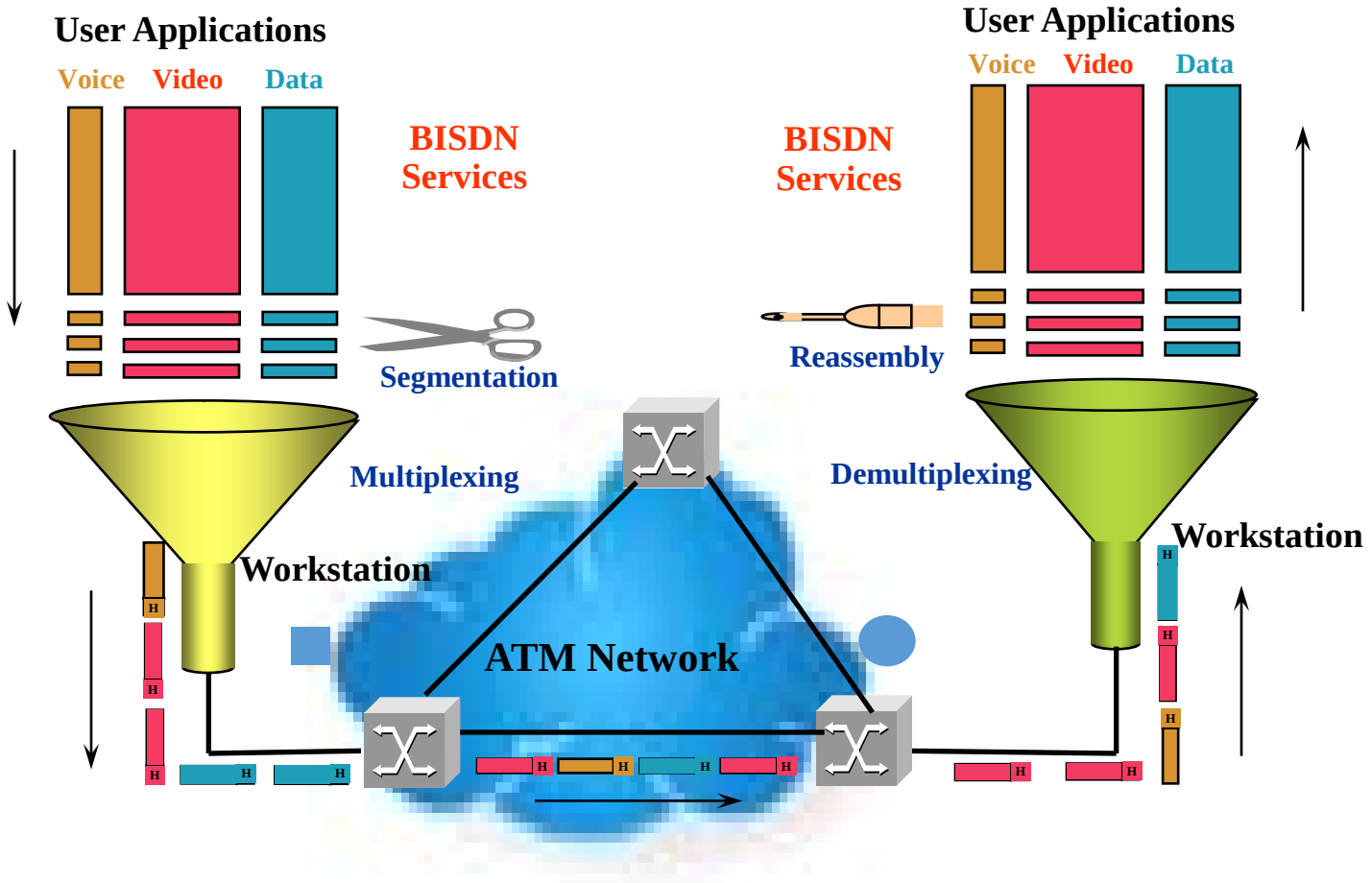
Nominal planning is fundamentally the same as for GSM transmission planning - protection, link budget calculations, topology, equipment dimensioning, etc. The main difference is in dimensioning of the transmission network.

ASYNCHRONOUS TRANSFER MODE (ATM)

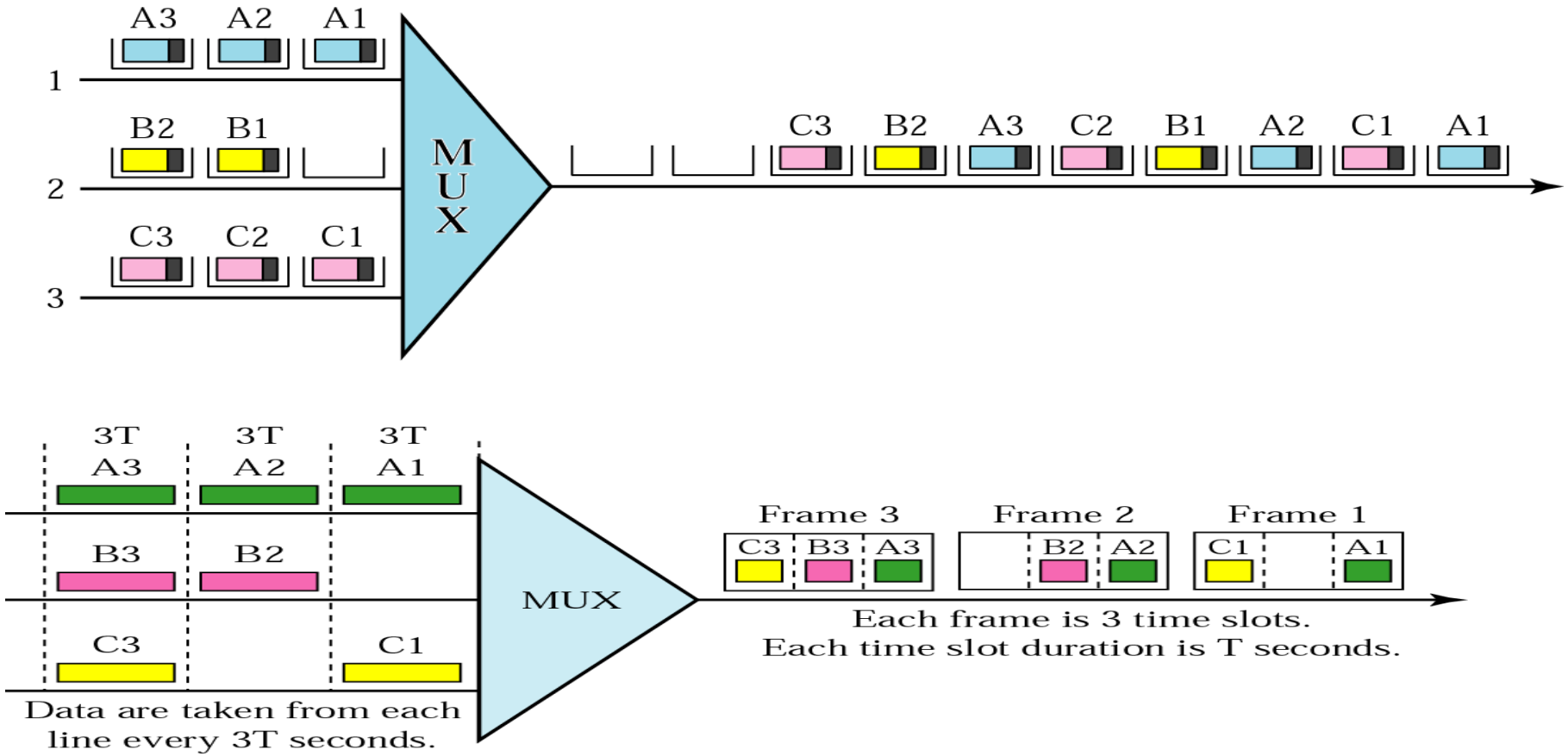
- A high-performance, cell-oriented switching and multiplexing technology that utilizes fixed-length packets to carry different types of traffic
- A cell-switched network (architecture). Fixed-size cell (53-Bytes) One ATM cell is 53 bytes in length and is divided into two parts: header and payload. The header is 5 bytes long and the payload 48 bytes.
- Uses Asynchronous time-division multiplexing (Asynchronous TDM)
- ATM is independent of the transmission medium. ATM cells can be sent on a wire or fiber, and can also be packaged inside the payload of other carrier system.



Because of the variable nature of B-ISDN(Broadband Integrated Services Digital Network), ATM was selected as a switching and multiplexing technique as it is capable of giving the desired quality of service for different applications.



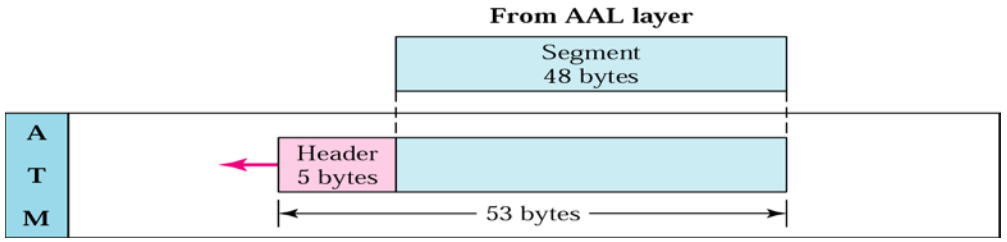
ATM multiplexing

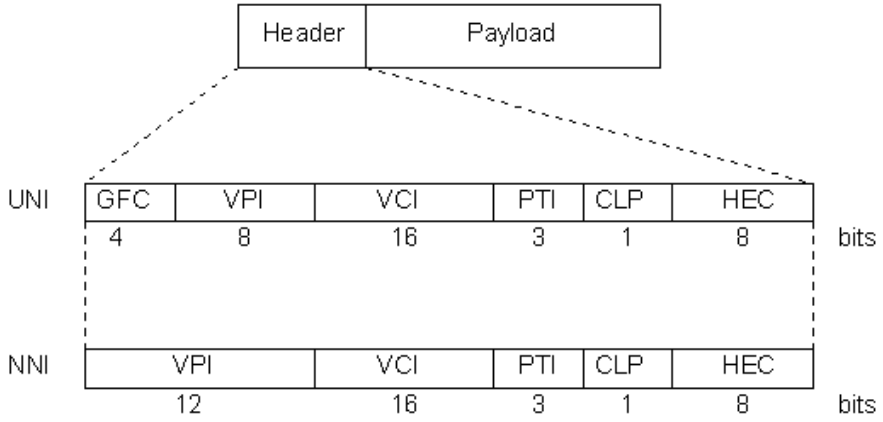


a) Asynchronous TDM : ATM multiplexers fill a slot with a cell from any input channel that has a cell.

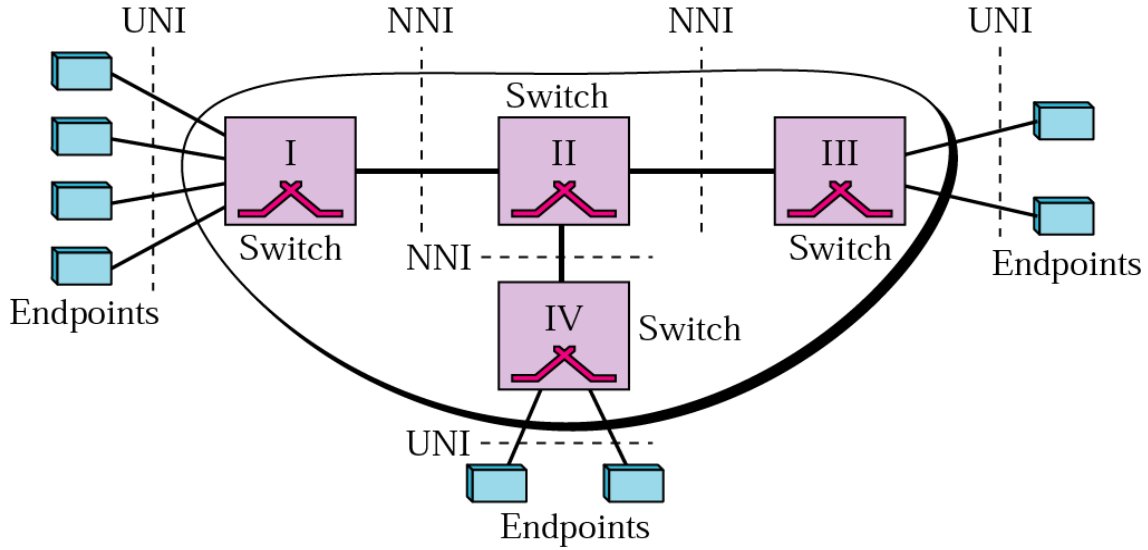
b) TDM

Architecture of ATM Network





- User-to-network interface (**UNI**): interface between endpoint (user access devices) and network switches.
- Network-to-network interface (**NNIs**): interface between switches insides the network.



Header Error Control (HEC) HEC is for error detection and 1-bit error correction of the 5-byte header. It is 8 bits in length .

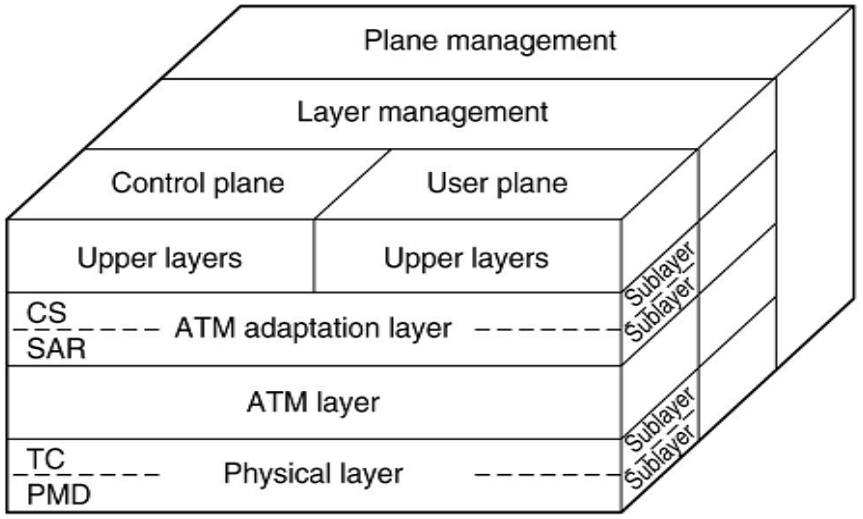
Identifiers for Virtual Path (VPI) and Virtual Channel (VCI) ATM cell is multiplexed in virtual channels and virtual paths. A virtual path is a number of virtual channels sharing one single link, which bundles different VCs into one VP. For the cell to be able to identify its virtual channel and virtual path, identifiers are needed. Cell routing is based on the values of VPI and VCI. The VPI has 8 bits for UNI and 12 bits for NNI.

Payload Type (PT) The payload type basically indicates the type of information a cell is carrying (user information or management information).

Cell Loss Priority (CLP) CLP is a 1-bit information field that gives the priority for cell loss, basically used for traffic management.

Generic Flow Control (GFC) This is a feature of a UNI cell header which basically helps the user to control the traffic flow for obtaining a desired quality of service. It is a 4-bit space in the UNI cell.

ATM Protocol Layers



Control : responsible for generating and managing signaling request (connection management).
User : deals with data transport, flow control, error correction, and other user functions.
Layer Management : manages layer-specific functions (detection of failures and protocol problems)
Plane Management: manages and coordinates functions related to the complete system.

Physical Layer

- Generally it is said that the physical layer is the physical (transmission) medium. However, that is only a part of the physical layer. In the ATM protocol structure, the physical layer consists of two sub-layers: physical medium (PM) and transmission convergence (TC).
- PM is the lowest sub-layer and its functions are dependent on the physical medium. The main functions usually include bit alignment, line coding and electrical/optical conversion.
- TC lies above the PM and its main functions include maintaining the cell rate of the ATM cells. It does this by adding/extracting cells to adapt the rate of ATM cells. Other functions of TC include cell delineation, frame generation and frame recovery.

ATM Layer

- This is the layer in which virtual paths and virtual channels are established. It is responsible for providing the connection-oriented service (i.e. it establishes connections before transmission).
- It is responsible for generic flow control (only for the UNI) and generation (and extractions) of cell headers.
- Another important function includes cell VPI/VCI translations at the switching/cross-connect nodes. It is in this layer that cells from individual VPs and VCs are multiplexed into one resulting composite cell stream.

ATM defines four versions of the AAL:

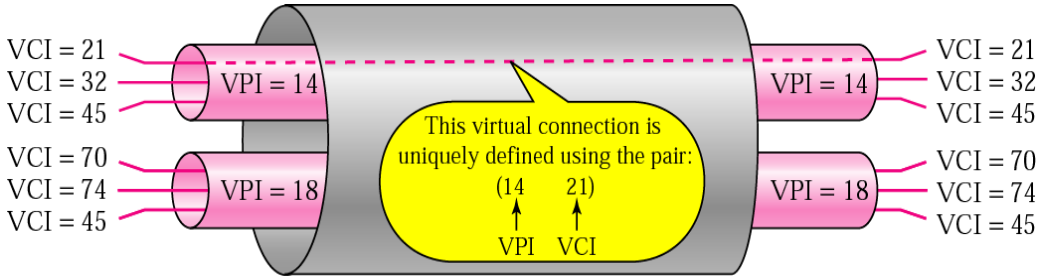
AAL1: Support Constant-bit-rate data (CBR) from upper layer; video and voice.

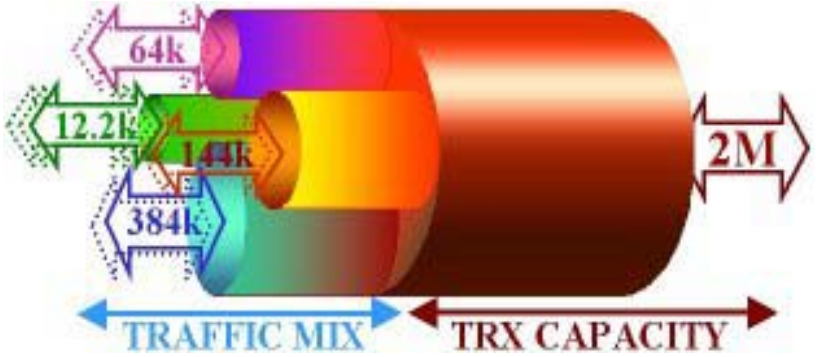
AAL2: Used for low-bit-rate and short-frame traffic such as audio (compressed or uncompressed), video, or fax. AAL2 allows the multiplexing of short frames into one cell.

AAL3/4: support connection-oriented and connectionless data services

AAL5: Assumes that all cells belonging to a single message travel sequentially and that control functions are included in the layers of the sending application.

Multiplexing and Switching in the ATM





ATM Services

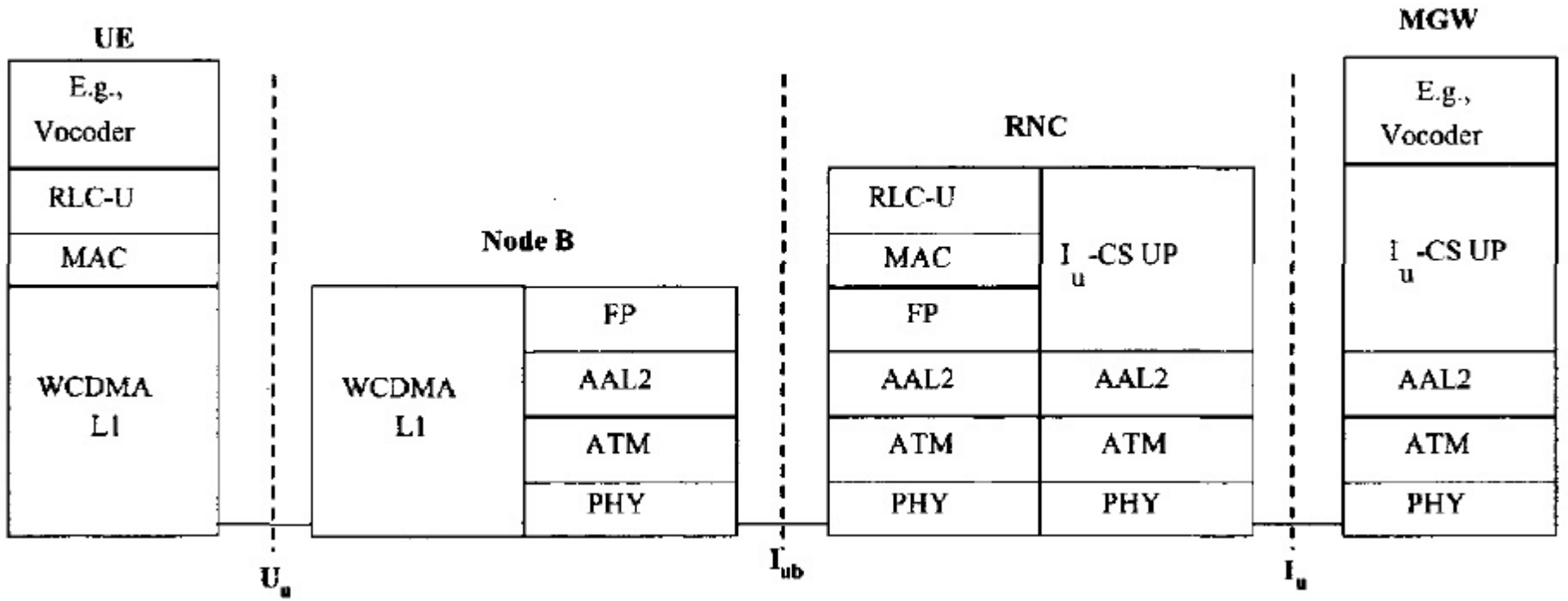
- Constant bit rate (CBR): It required a static bandwidth that is available for the connection's lifetime. Traffic is fixed and synchronous. A typical example is real-time voice or video services.
- Real-time variable bit rate (RT-VBR): This is for services requiring a variable bit rate at the time of use. A typical example is compressed video.
- Non-real-time variable bit rate (NRT-VBR): Another form to VBR, this is for applications that are not delay-critical. A typical example is e-mail.
- Available bit rate (ABR): Bursty traffic with a known bandwidth requirement falls under this category. Basically the traffic will follow whatever bandwidth the network can give to this. A typical example is Web browsing.
- Unspecified bit rate (UBR): Applications not having strict requirements for delay and delay variations fall under this category. It is also known as 'best-effort traffic', and there is no QoS guaranteed for this service class. Typical examples are e-mail and FTP.

DIMENSIONING

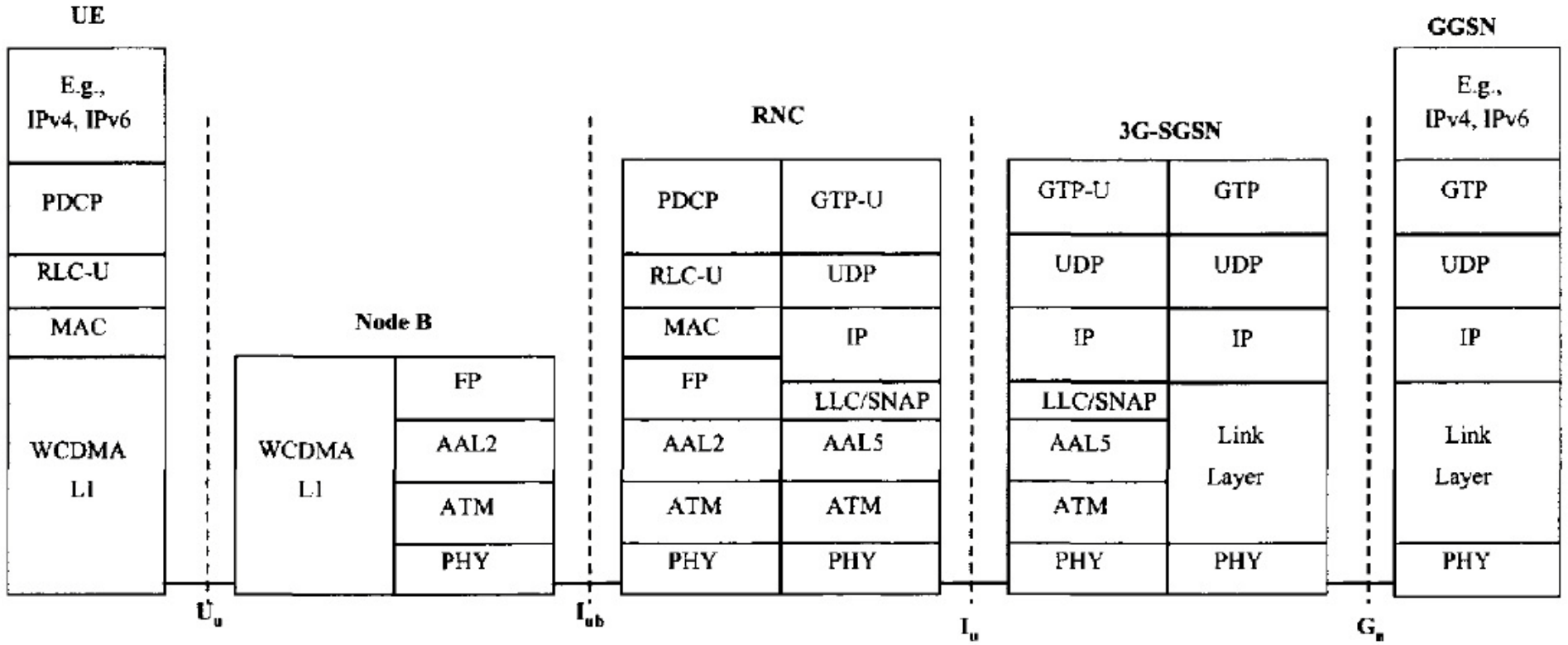
- For the dimensioning of interfaces, some knowledge of protocol stacks for CS data and PS data is required.

Protocol Stacks

CS:



PS:



PDCP is Packet Data Convergence Protocol. It is one of the layers of the Radio Traffic Stack in UMTS and performs IP header compression and decompression

FP: Frame protocol is a user plane protocol for dedicated transport channels.

GTP/ GTP-U: GPRS Tunneling Protocol –User plane

Radio Link Control (RLC) : The Radio Link Control protocol connects the MAC layer with the RRC layer on the control plane and the PDCP layer on the data plane. It offers transparent, unacknowledged and acknowledged data transfer.

Overheads

When the traffic/signal moves from one layer to another, some overhead bits are added.

- Voice activity factor (VAF) overhead: Once a mobile is connected to the network, the subscriber will either speak or listen (active or silent mode). The type of voice connection can be defined in terms of AMR (adaptive multi-rate) codec modes. There are eight AMR codec rates, from AMR-0 to AMR-7, with the rates ranging from 12.2 kbps to 4.75 kbps respectively. Usually dimensioning for voice is done for AMR-0, or 12.2 kbps codec rate.
- Soft handover (SHO) overhead : ensure continuous connectivity for the subscriber.
- Protocol overhead: As the signal moves from one layer to another, some bits are added at each of these layers. This includes the RLC, FP and AAL2, etc., layers.
- Signaling overhead: For each call, signaling is required. This signaling also needs capacity to associate itself with the data (CS/PS) when a call is being made from one subscriber to another.

RNC Dimensioning

- Interface traffic
- The number of TRXs
- The number of BTS.

MICROWAVE LINK PLANNING

Error Rate and ATM Performance

- BER threshold of 10^{-6} is considered during link planning.
- ATM performance is measured by using parameters such as 'cell loss ratio' (CLR). To keep this value to a minimum, availability targets are usually kept larger than 99.99%.

Topology

- Longer chains/loops are not preferred in these networks.
- Star is preferred to reduces the delay.

Example of Transmission Network Dimensioning

- *There are 10 000 subscribers each in the dense urban, urban, sub-urban and rural types of area.*
- *Each region has 50 base stations and each site has a configuration of 1 + 1 + 1.*
- *SHO = 40%.*
- *VAF = 67%.*
- *Total CS voice = 20 mErl per subscriber.*
- *Total CS data (64 kbps) = 1.50 mErl per subscriber.*
- *Total PS data (64 kbps) = 0.012 kbps per subscriber.*
- *Total PS data (128 kbps) = 0.272 kbps per subscriber.*
- *Total PS data (384 kbps) = 0.06 kbps per subscriber.*

Total I_{ub} traffic = CS (voice + data) traffic + PS traffic + signalling + overheads + O&M.

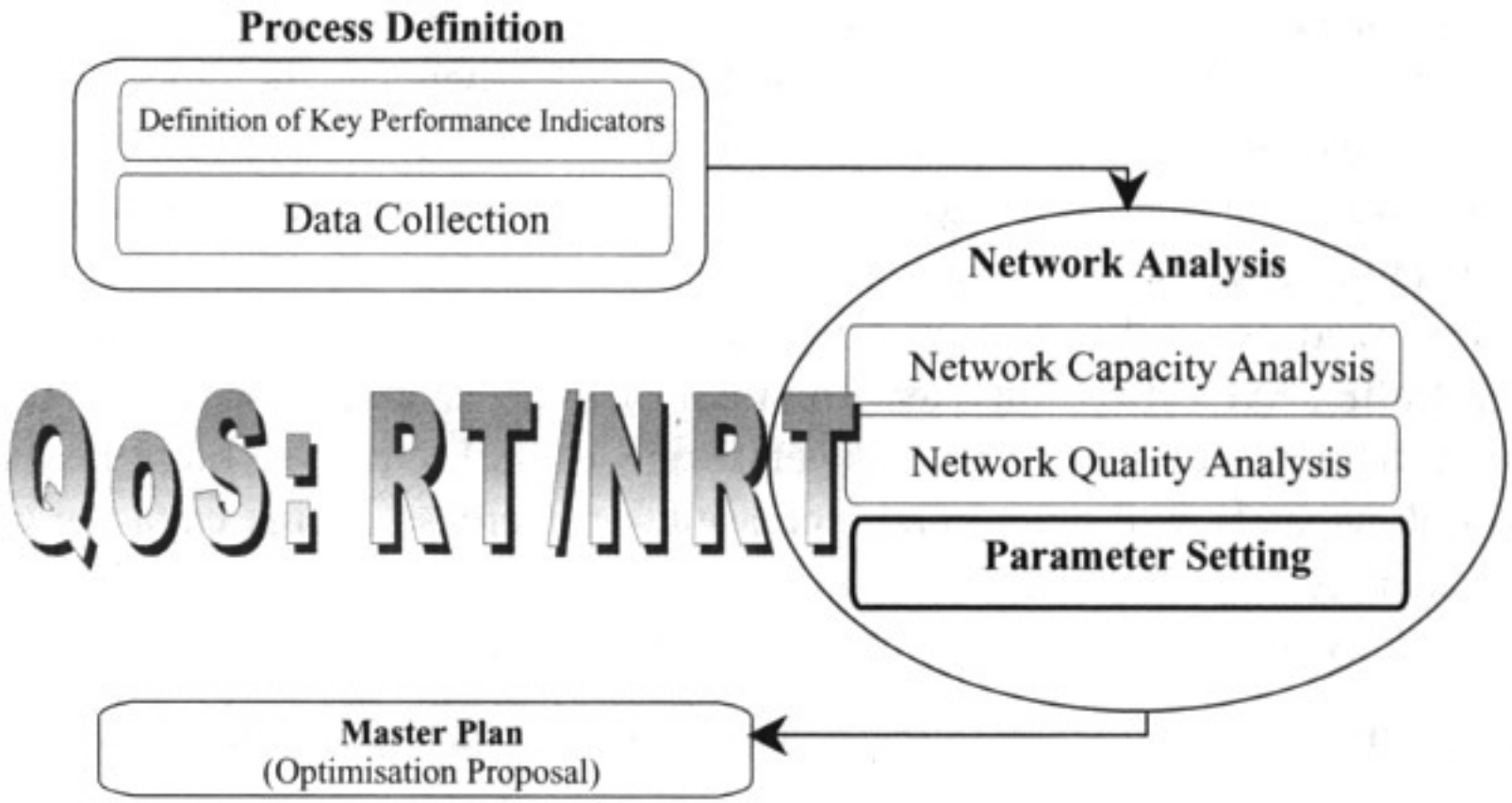
Assuming that the ATM overheads are 30%, signalling overheads in both the RAN and CN are 10% each, and the packet data overhead (GTP, IP, etc.) is 20%

Area	subs	BS Type	TRX	Total Sites (BS)	Total TRX	CS Voice (kbps)	CS Da ta (kbps)	PS Da ta (kbps)	Total traffic/site (kbps)	Total Iub per si te (kbps)	Total traffic to RNC (Mbps)
Phase 1											
D Urban	10000	1+1+1	3	50	150	178.3	349.4	0.0	527.70	1.2	58.0
Urban	10000	1+1+1	3	50	150	178.3	349.4	474.0	1001.70	1.2	58.0
Suburban	10000	1+1+1	3	50	150	178.3	349.4	474.0	1001.70	1.2	58.0
Rural	10000	1+1+1	3	50	150	178.3	349.4	474.0	1001.70	1.2	58.0
				200	600						

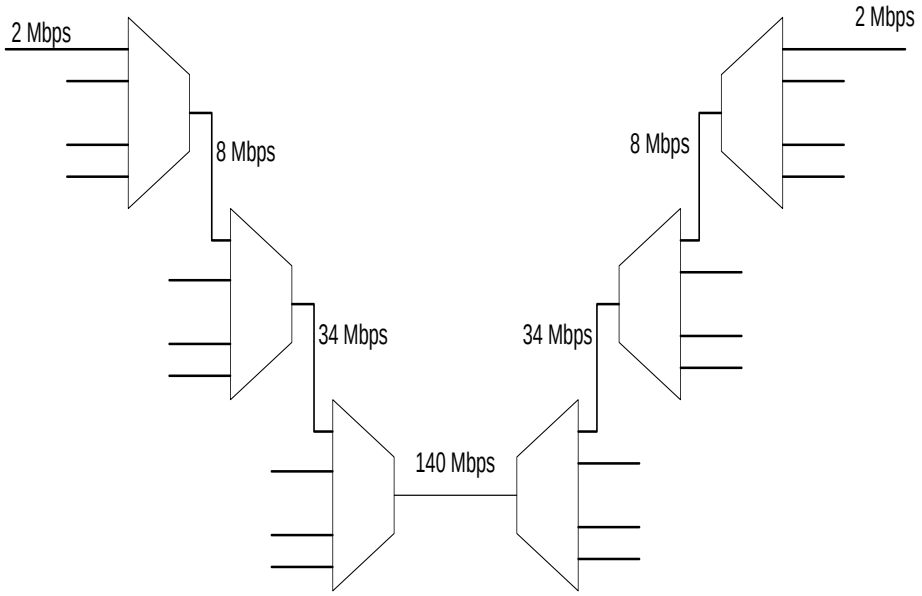
					Iu to MSC	Iu to SGSN	Iur
Area	No of Subs	BS Type	#Sites (BS)	CS Mbps	CSMbps RNC ->MSC	PSMbps RNC -> SGSN	Mbps RNC- RNC
Phase 1							
D Urban	10000	1+1+1	50	4.94	5.44	12.89	0.27
Urban	10000	1+1+1	50	4.94	5.44	12.89	0.27
Suburban	10000	1+1+1	50	4.94	5.44	12.89	0.27
Rural	10000	1+1+1	50	4.94	5.44	12.89	0.27
	40000		200		21.74	51.57	1.10

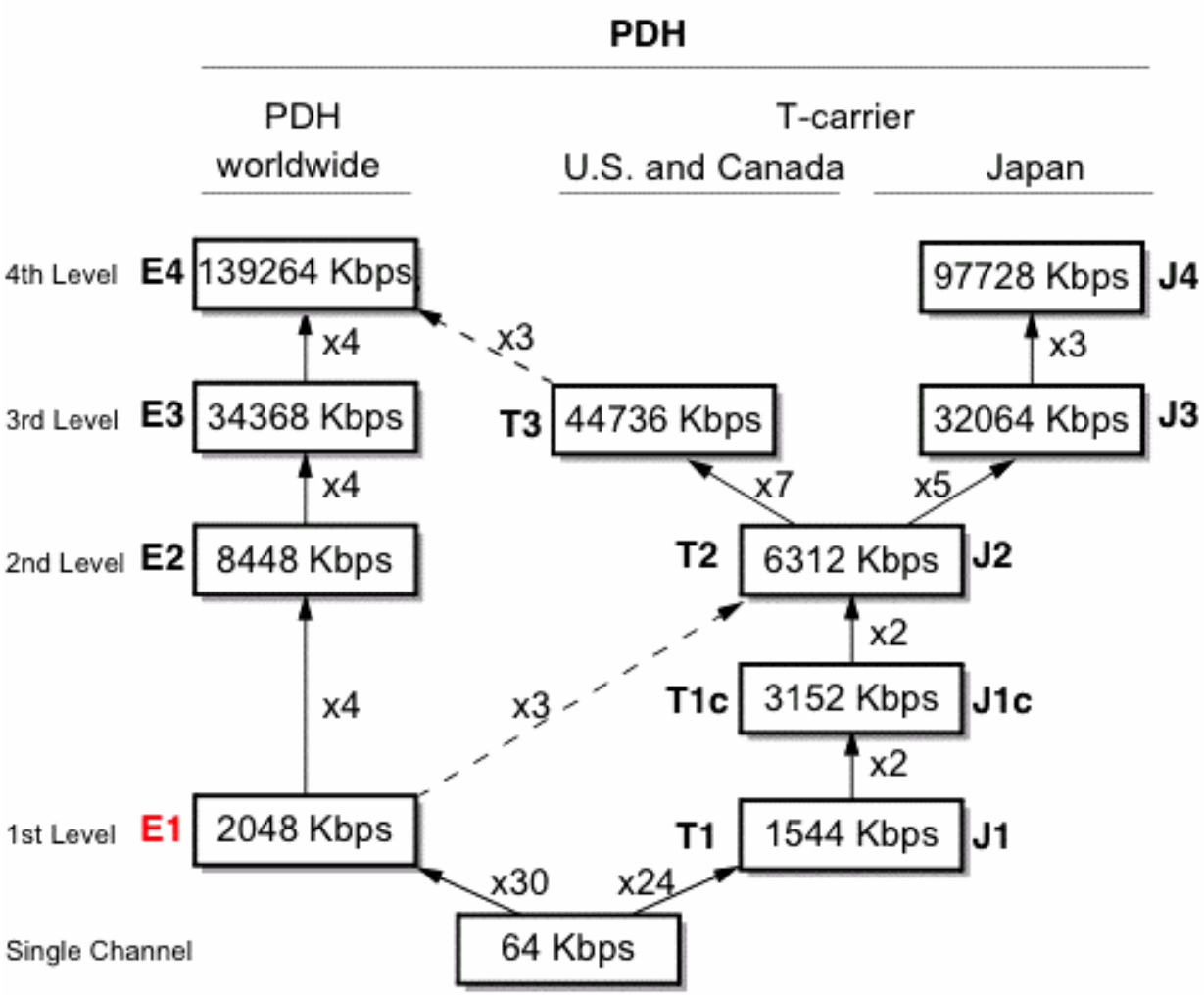
Detailed Planning : Skipped

TRANSMISSION NETWORK OPTIMISATION



PDH/ E1: The PDH high capacity transmission networks are based on a hierarchy of digital multiplexed signals: E.1 to E.4 (E1, 2E1, 4E1, 8E1)

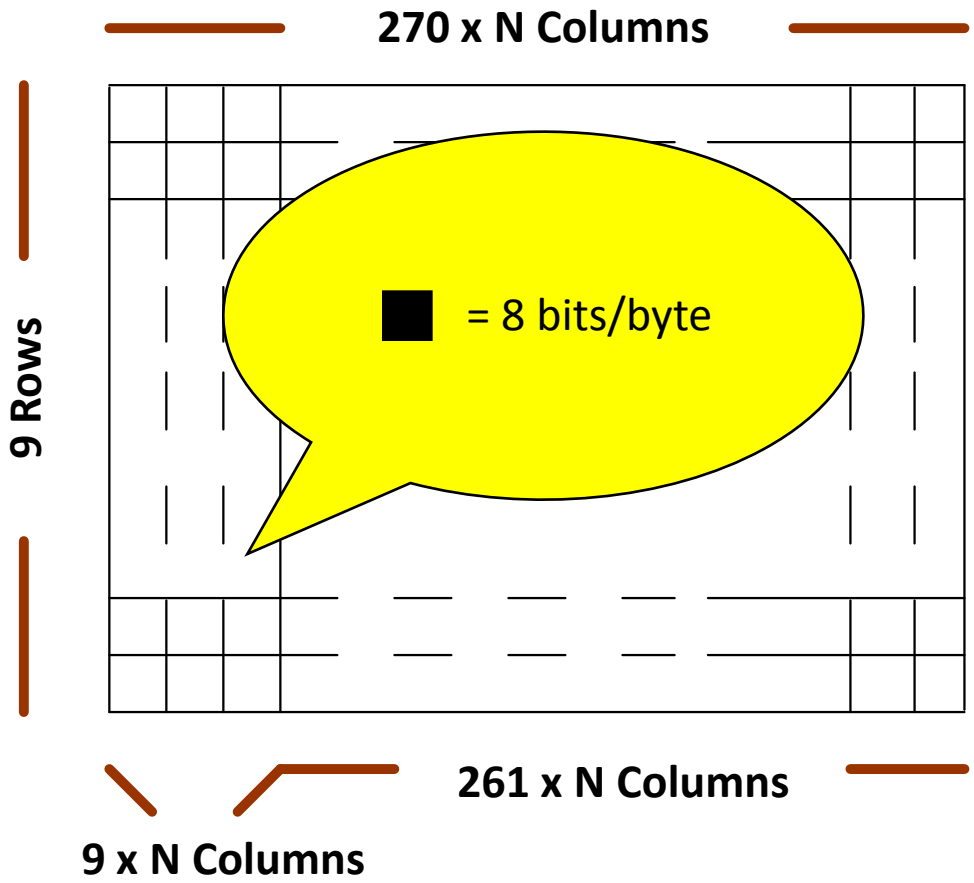




The SDH signal is transported as a synchronous structure which comprises a set of 8-bit bytes organized into a two dimensional frame.

SDH FRAME STRUCTURE

STM-N FRAME STRUCTURE



SDH FRAME STRUCTURE

ITU-T defines the frequency to be 8000 frames per second for all levels in STM hierarchy

STM-1 Rate :

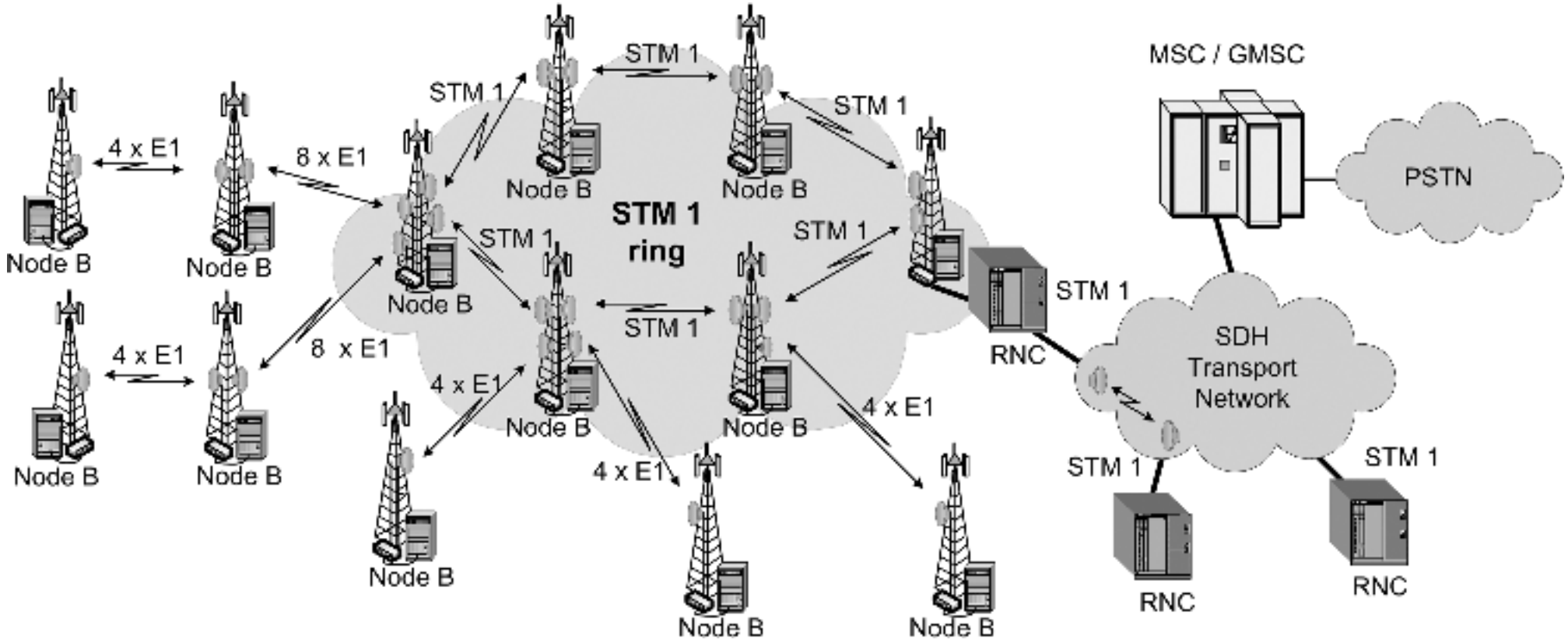
9 rows x 270 columns x 8 bits/byte x 8000 frames per second

= 155.52 Mb/s

STM-4 Rate :

9 rows x (270 x 4) columns x 8 bits/byte x 8000 frames per second

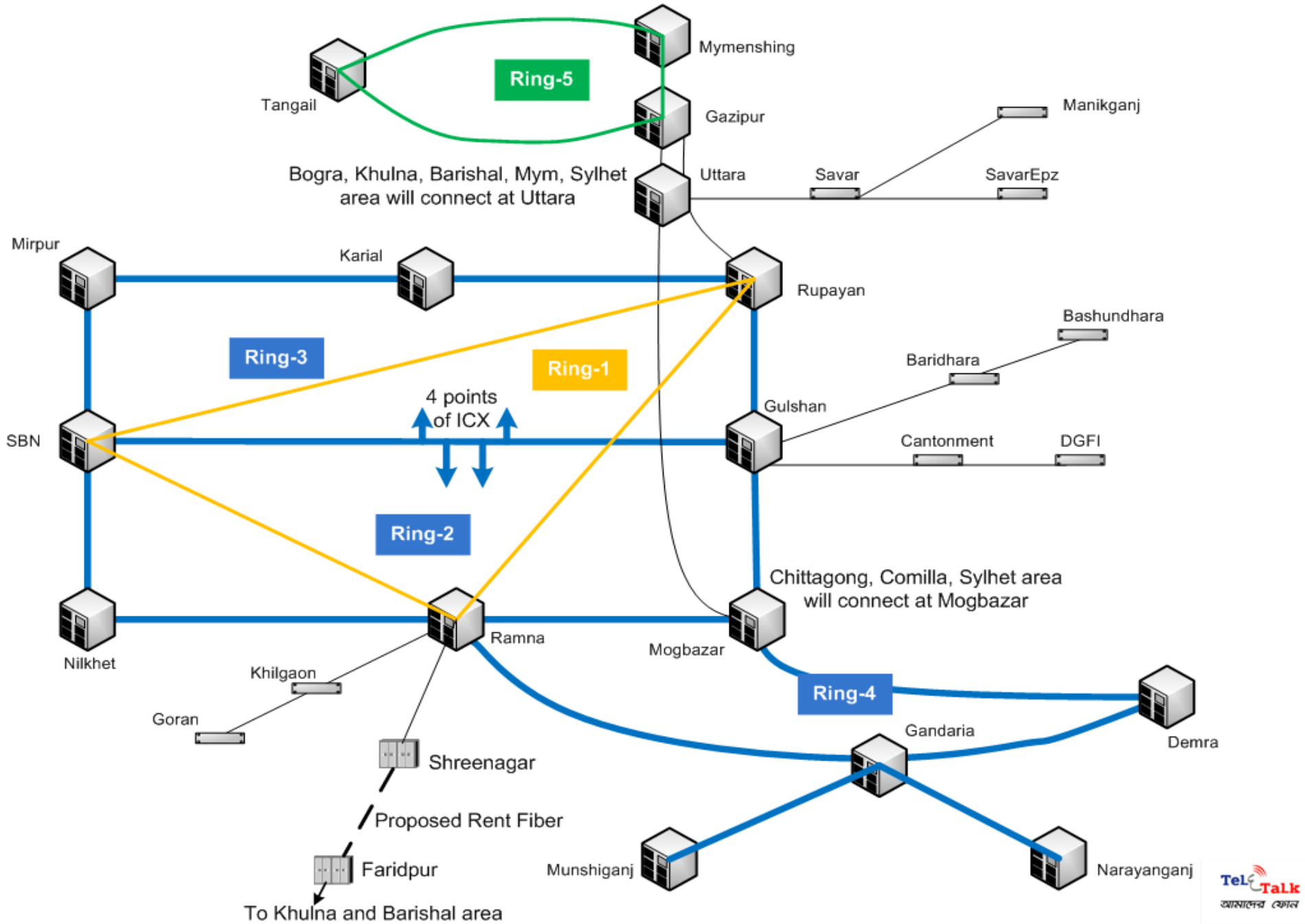
= 622 Mb/s



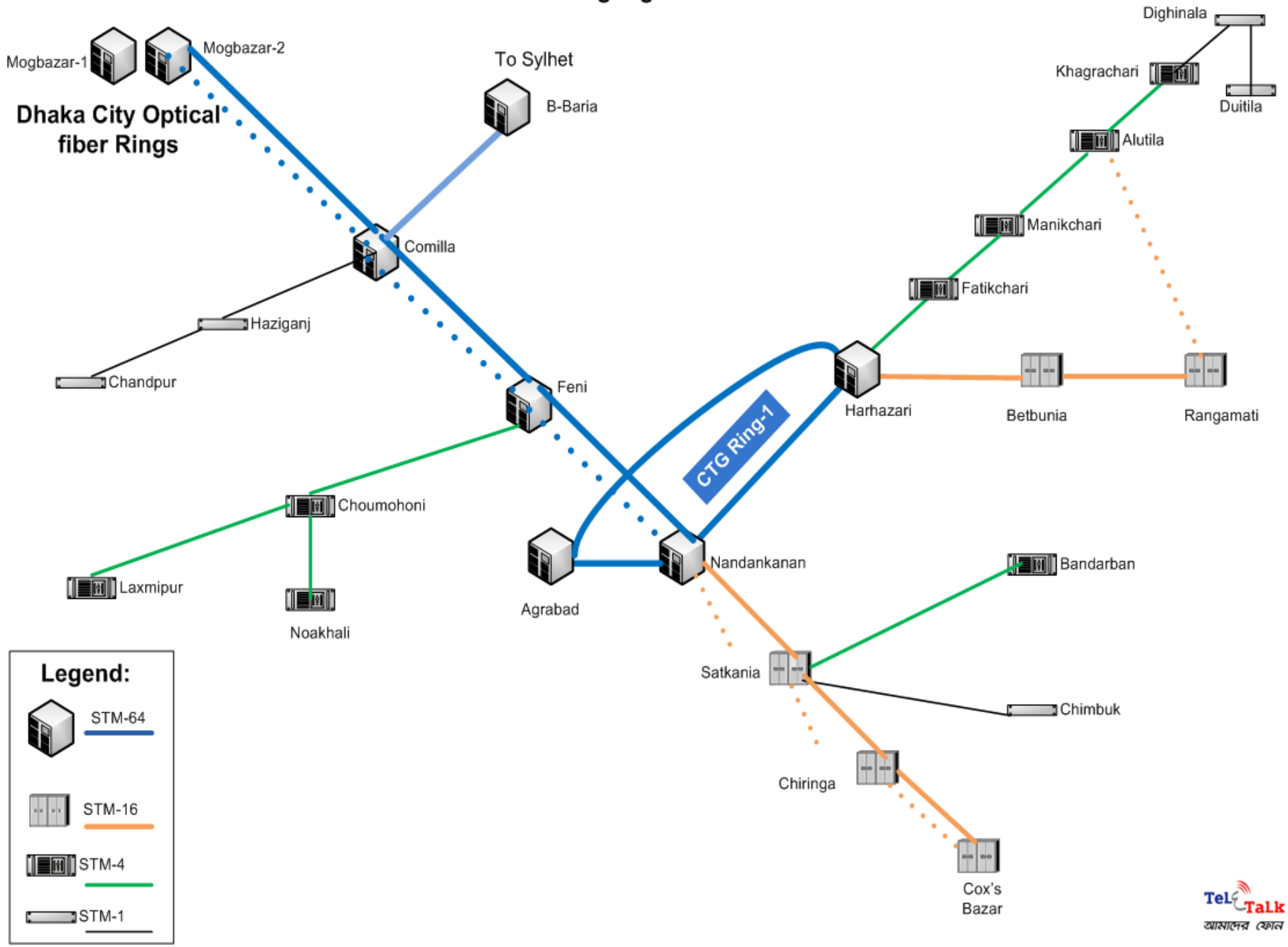
E1 is the European term for the transmission (digital). The data rate of E1 is about 2 mega bits per second. It has 32 channels at the speed of 64 Kbps.

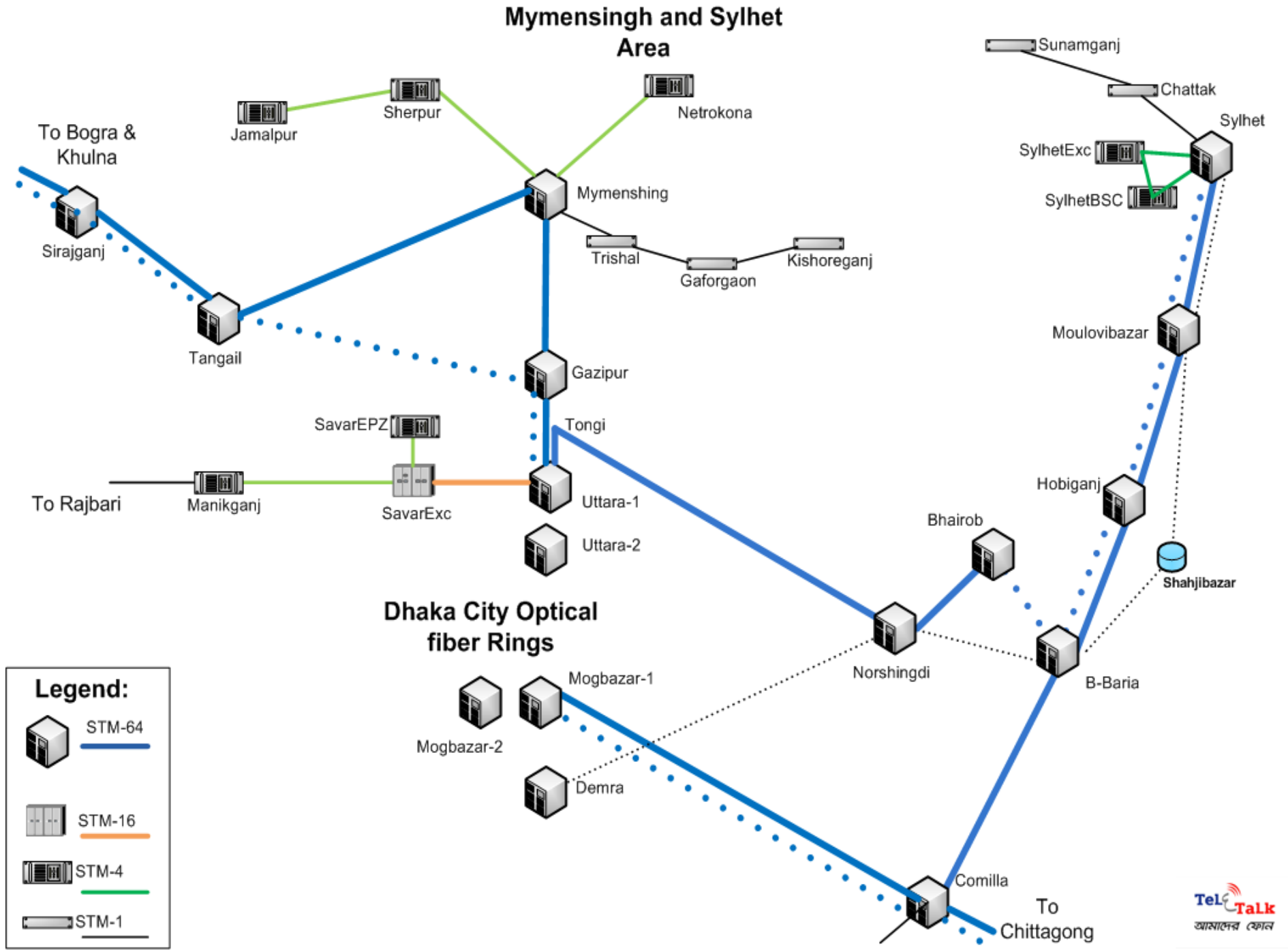
STM-1 refers to a transmission format used in fiber optic networks. STM-1 is an abbreviation for Synchronous Transport Module level-1. STM1=155.52Mbps

Proposed optical fiber Rings inside Dhaka City



Chittagong Area




Mymensingh and Sylhet Area
Sunamganj
Chattak
Sylhet
SylhetExc
SylhetBSC
Jamalpur
Sherpur
Netrokona
To Bogra & Khulna
Mymenshing
Sirajganj
Trishal
Gaforgaon
Kishoreganj
Tangail
Moulovibazar
Gazipur
SavarEPZ
Tongi
Hobiganj
To Rajbari
Manikganj
SavarExc
Uttara-1
Uttara-2
Bhairob
Shahjibazar
Dhaka City Optical fiber Rings
Norshingdi
B-Baria
Mogbazar-1
Mogbazar-2
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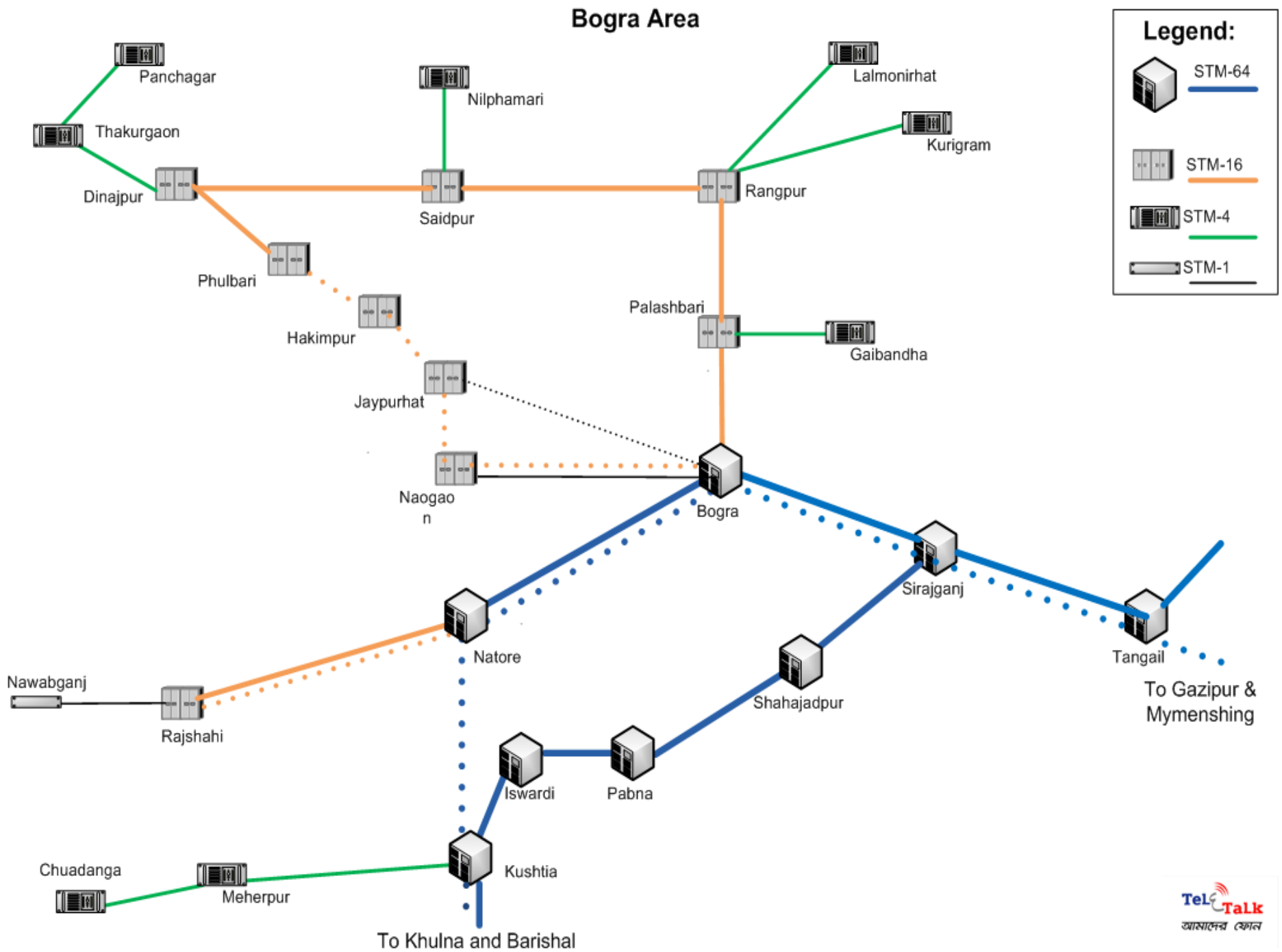
Bogra Area
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STM-16
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Panchagar
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Kurigram
Rangpur
Phulbari
Hakimpur
Jaypurhat
Naogaon
Palashbari
Gaibandha
Bogra
Sirajganj
Tangail
To Gazipur & Mymenshing
Natore
Nawabganj
Rajshahi
Shahajadpur
Iswardi
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Chuadanga
Meherpur
Kushtia
To Khulna and Barishal
TeleTalk
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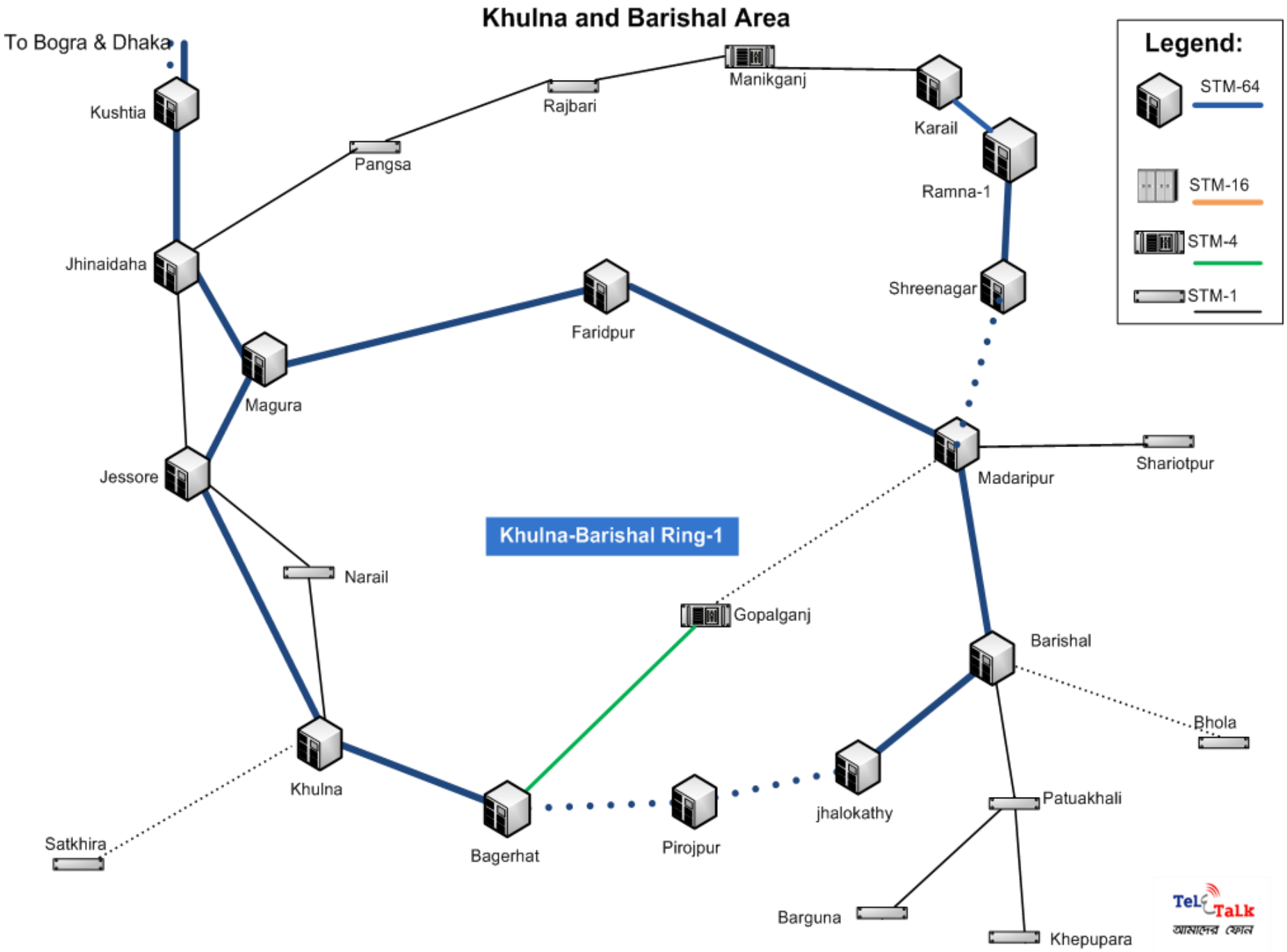
Khulna and Barishal Area
Legend:
STM-64
STM-16
STM-4
STM-1
To Bogra & Dhaka
Kushtia
Rajbari
Manikganj
Karail
Pangsa
Ramna-1
Jhinaidaha
Shreenagar
Faridpur
Magura
Madaripur
Shariotpur
Jessore
Khulna-Barishal Ring-1
Narail
Gopalganj
Barishal
Bhola
Khulna
Satkhira
Bagerhat
Pirojpur
jhalokathy
Patuakhali
Barguna
Khepupara
TeleTalk
আমাদের ফোন