Optical Network Development

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MMNOG

MYANMAR NETWORK OPERATORS GROUP

1. Optical Fiber Fundamentals
2. Passive Optical Network
3. Optical Distribution Network
4. Optimization of Aerial Fiber
5. Undersea Fiber Communication System

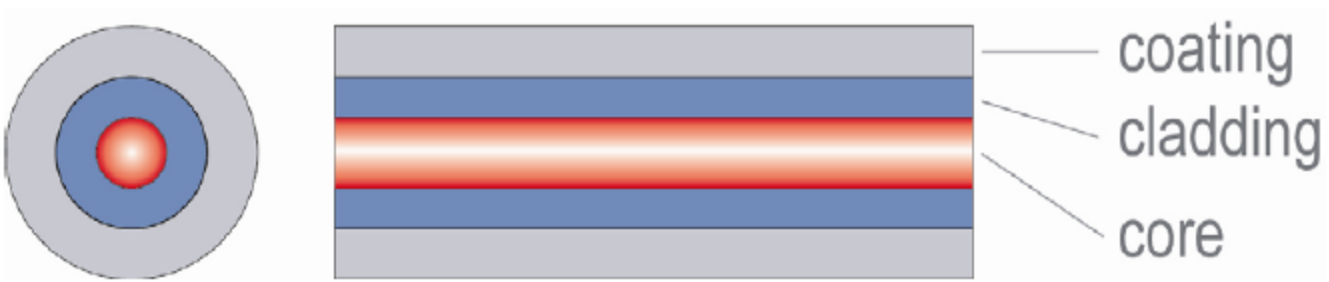
1. Optical Fiber Fundamentals

Optical Fiber Construction

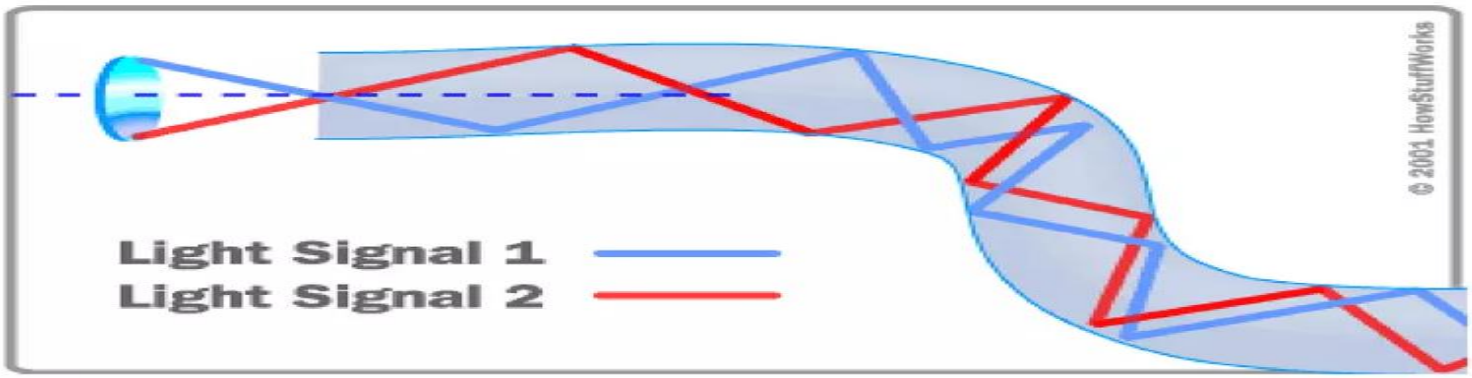
Core: This central section, made of silica or doped silica, is the light transmitting region of the fiber

Cladding: This is the first layer around the core. It is also made of silica, but not the same composition as the core. This creates an optical waveguide which confines the light in the core by total internal reflection at the core-cladding interface.

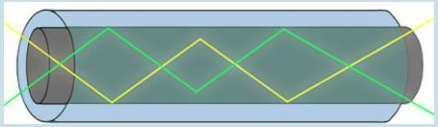
Coating: The coating consists of one or more layers of polymer that protect the silica structure against physical or environmental damage



The light is guided down the core of the fiber by the optical cladding which has lower refractive index that traps light in the core through "total internal reflection."

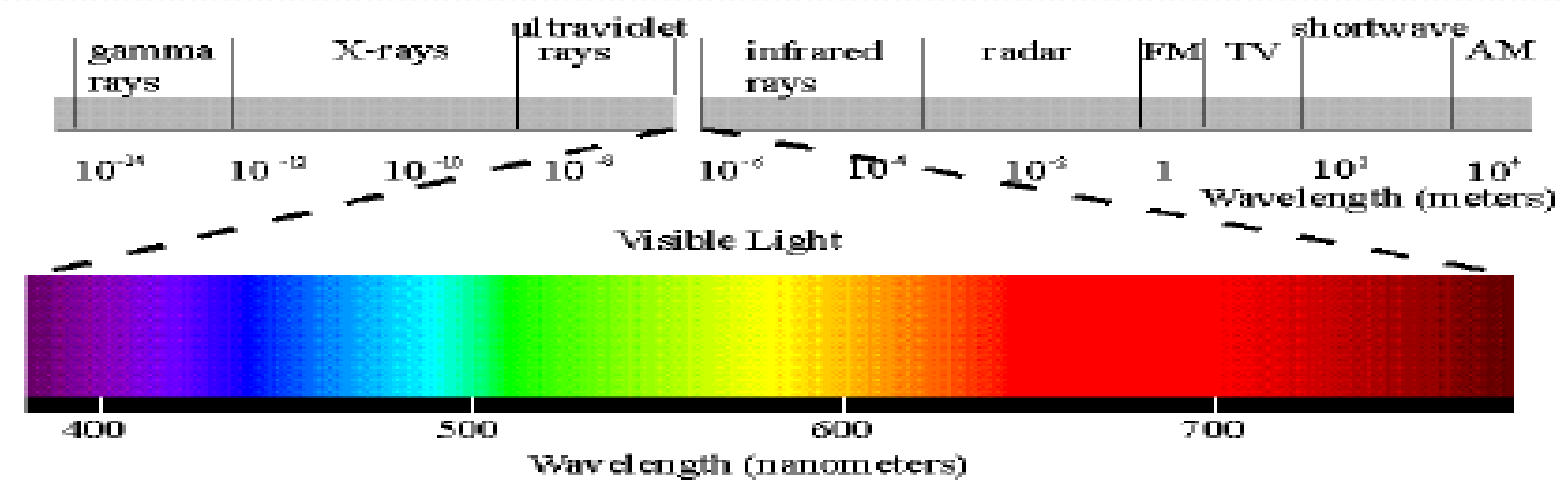


Optical Fiber Types

Single Mode Fiber		Multimode Fiber
		
9 µm	**Core Diameter**	50 to 62.5 µm
125 µm	**Cladding diameter**	125 µm
Laser	**Light Source**	LED
1310 nm, 1550 nm	**Common Wavelength**	850 nm
80Km without repeater	**Max Distance**	2Km for lower speed, 550 m for 10 Gbps
0.35dB/Km @ 1310 nm	**Attenuation**	3.5dB/Km @ 850 nm
Long-haul telecom, high-speed WAN link	**Application**	Data Center, LAN, short distance backbone link
G.652, G.654, G.657	**ITU-T Standard**	G.651

The world of wavelengths

These light sources produce light at certain wavelengths depending upon the materials from which they are made. Most fiber optic sources use wavelengths in the infrared band, specifically 850 nm, 1310nm and 1550nm.



Electromagnetic Spectrum

The world of wavelengths

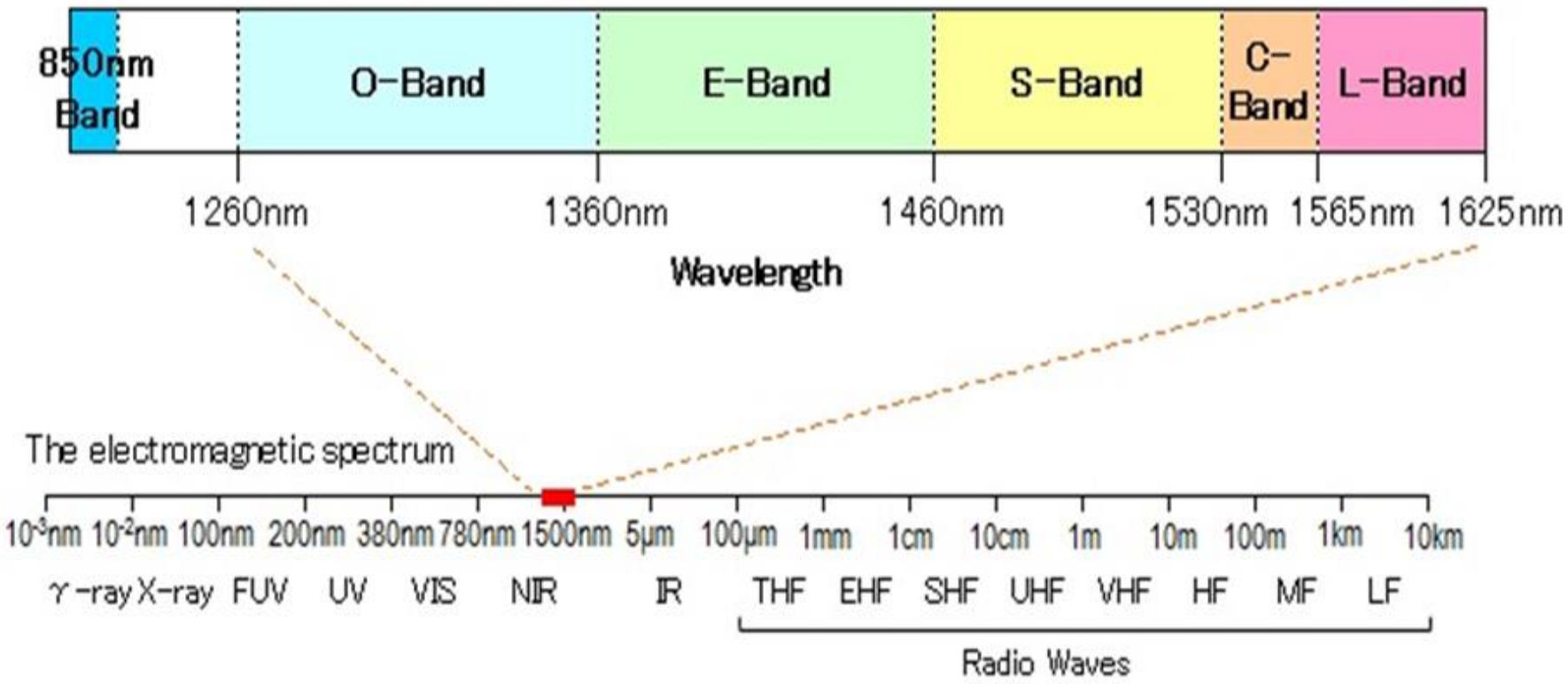
O (Original-Band: 1260 ~ 1360 nm)

E (Extended-Band: 1360 ~ 1460 nm)

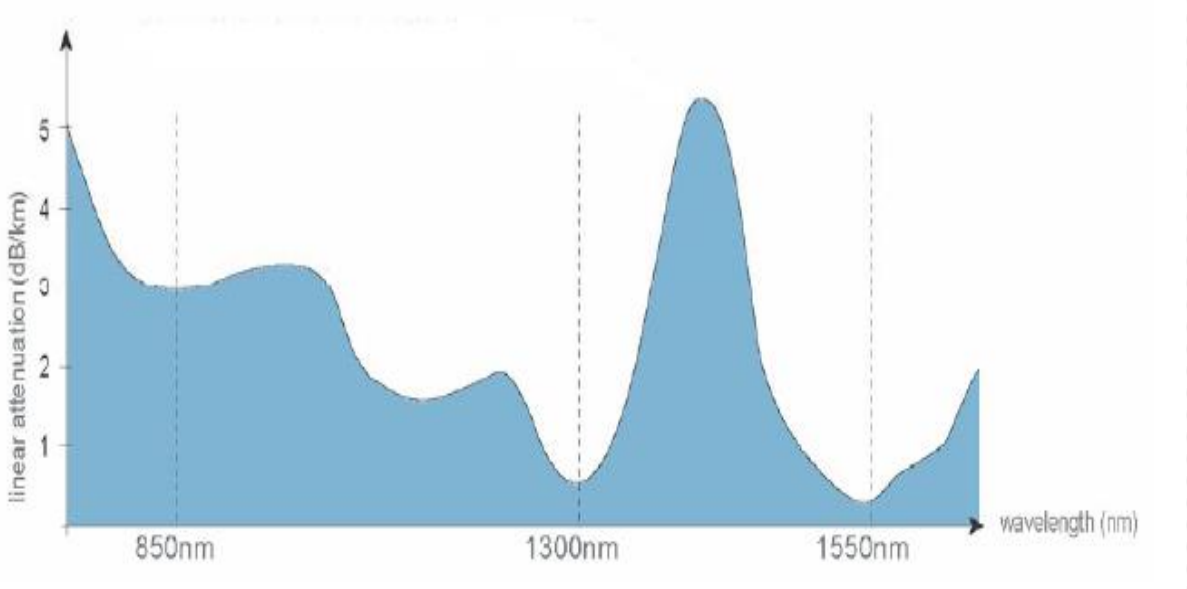
S (Short-Band: 1460 ~ 1530 nm)

C (Conventional-Band: 1530 ~ 1565 nm)

L (Long-Band: 1565 ~ 1625 nm)



Attenuation vs. Wavelength of Optical Fiber

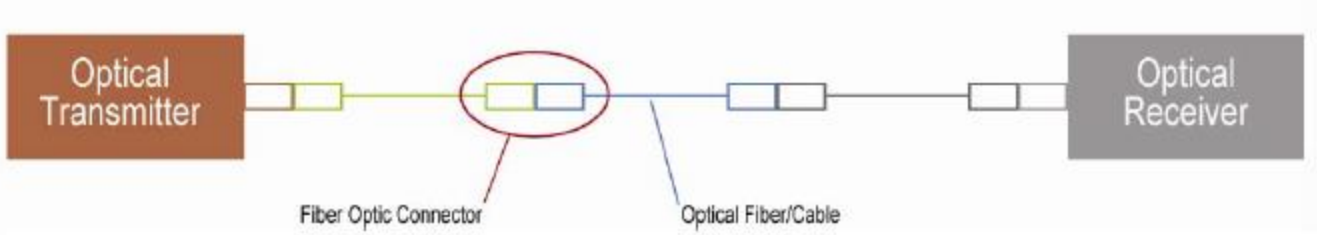


Wavelength	dB/Km
850nm	2.7
1310nm	0.35
1550nm	0.20

Fiber Optic Link Components

There are four main components in a fiber optic link:

- Optical Transmitter
- Optical Fiber Cable
- Connectors
- Optical Receiver



Optical Transmitter

Optical Transmitter uses LED/ LASER Diode as Light Source to convert the electrical signals into optical.

- Light Emitting Diode (LED) is used in multimode applications
- LASER Diode (Light Amplification by Simulated Emission of Radiation Diode) is used in single mode application

Optical Receiver

Optical Receiver uses a photodiode to convert the optical signals into electrical.

- Positive Intrinsic Negative (PIN) (Photo Diode)
- Avalanche Photodiode (APD) (Photo Diode)

Fiber Optic Connecting Method

Fiber Optic Link requires a method to connect the transmitter to the receiver.

Methods :

- 1. Fusion Splice
- 2. Mechanical Splice (Connectors)

Fusion Splice

This operation consists of directly linking two fibers by welding with an electric arc or fusion splicer.

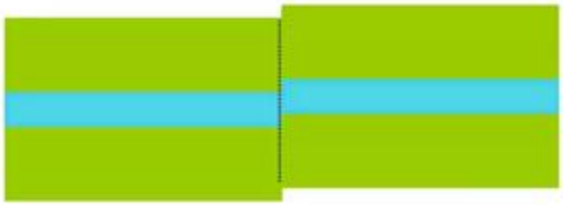
The advantages are fast and sample and very little insertion loss.

The disadvantages are relatively fragile and the initial cost is high.

Joining Fiber with Fusion Splicer

bad alignment

- cores are not centered
- big power loss



good alignment

- cores are centered
- small power loss

Mechanical Splice

A connector terminates the optical fiber inside a ceramic ferrule, using epoxy to hold the fiber.

The advantages are that the connectors are robust, can be chosen according to the applications (such as FC, SC, LC, etc.), can connect/disconnect hundreds of time without damaging the connectors.

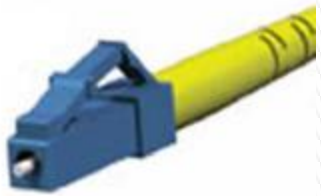
The disadvantages are that the insertion loss can be higher.

Commonly Used Connectors

- FC (Ferrule Connector): still used in measuring equipment

FC-Ferrule Connector

- LC (Lucent Connector): used on small form-factor pluggable transceivers

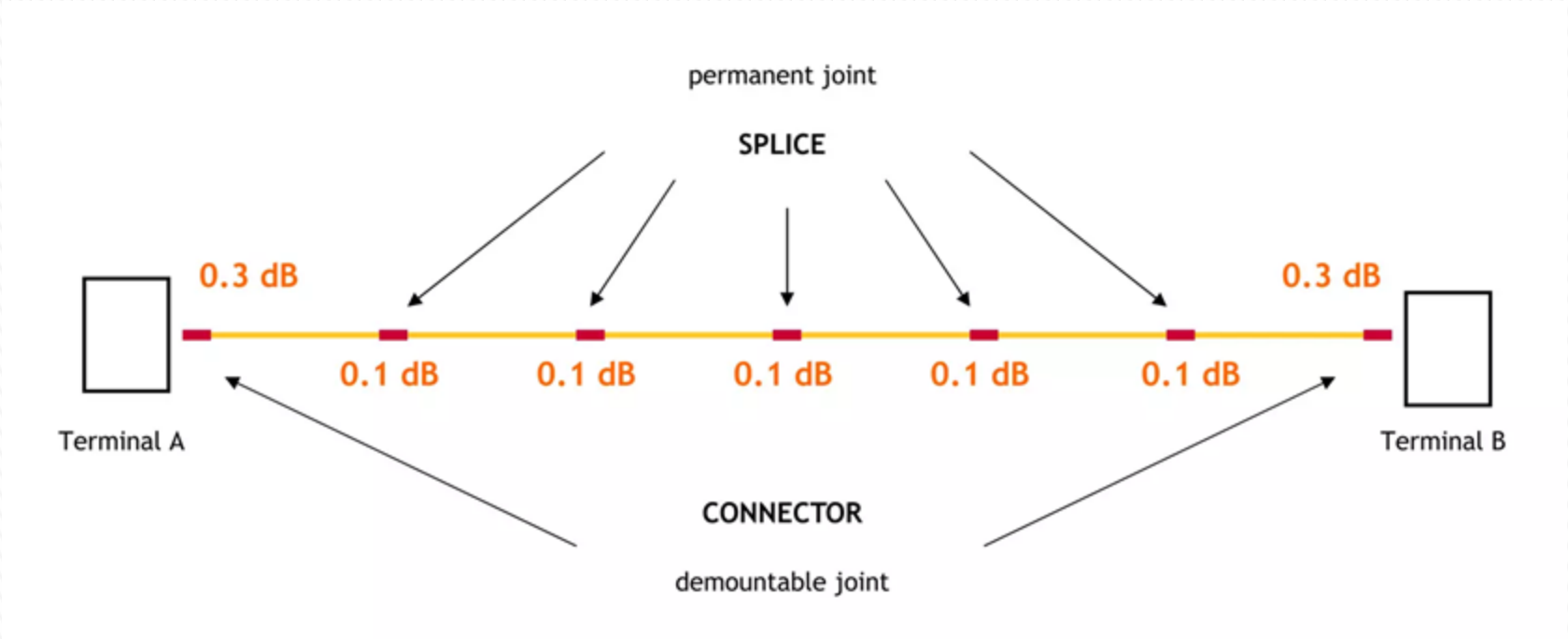


LC-Lucent Connector

- SC (Subscriber Connector): used in telecom and data connections

SC-Subscriber Connector

Fiber Connections and Losses



Structure of Optical Fiber

Fig-8,
Overhead

Under Ground

Optical Transmission Performance	Single Mode 1310/1550nm	Multimode 850 nm			
	9/125µm (OS2)	50/125µm (OM1)	50/125µm (OM2)	50/125µm (OM3)	50/125µm (OM4)
Max Attenuation (dB/Km)	0.35/ 0.20	3.0	2.7	2.7	2.7

Optical Distribution Box (ODB)

- 19″ Rack Mount
- Drawer Type Design
- Structure made from Electro Galvanize Steel for durability and lightweight

Joint Closure – Dome Type

- Support optical cable link, branch, distribution
- Made of high impact polycarbonate plastic
- Can be used in wall-mounting, aerial on pole and underground

Joint Closure – Horizontal Type

- Support optical cable link, branch, distribution
- Made of high impact polycarbonate plastic
- Can be used in wall-mounting, aerial on pole and underground

Fiber Testing with OTDR

- OTDR = Optical Time Domain Reflectometer
- To troubleshoot FTTH or P2P network link from one end
- To diagnose faults exceeding specification
- To verify loss of FTTH splitter
- To verify GPON / 10 GPON power level
- To pinpoint location of macro-bends or breaks

Fiber Testing with Power Meter

- To test link loss measurement
- To check SM and MM links specification
- To check continuity and fiber identification

CSM1 Power Meter

Advantages of Fiber

- High bandwidth
- Smaller-diameter, lighter-weight cables
- Lack of crosstalk between parallel fibers
- Immunity to electromagnetic interference (EMI)
- High-quality transmission
- Lower installation and operating costs by comparing with copper cable

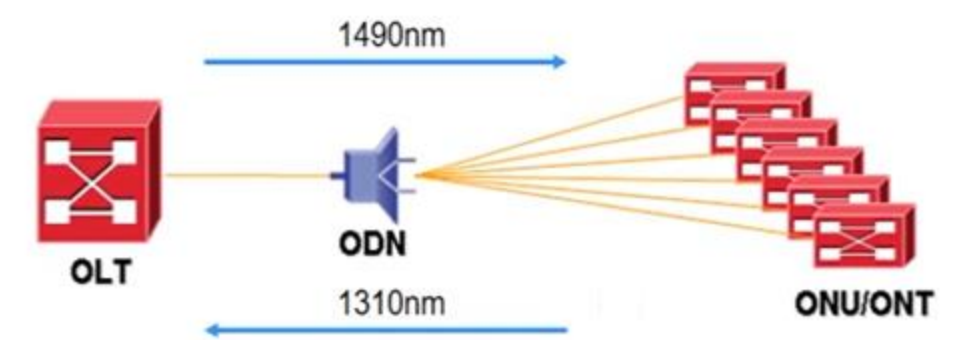
2. Passive Optical Networking

Terminology

PON = Passive Optical Network (published by ITU-T).

- Optical Line Terminal (OLT) – Devices that multiplex all optical signals from ONTs and converted into electrical signal.
- Optical Network Termination (ONT) – Devices that connect end-user of PON network and converted into optical signal.
- Optical Network Unit (ONU) – Devices that connect multiple end-users of PON network and converted into optical signal.
- Splitters – Devices that multiplex/demultiplex fiber optic signals to/from a single upstream fiber optic cable. (1:4, 1:8, 1:32, 1:64, and 1:128)
- Optical Distribution Network (ODN) – Compose of physical fiber and optical devices including splitters that distributed signals to users in telecommunication network.

Wavelength Division Multiplexing (WDM) is a technology that multiplexes a two optical carriers signals onto a single fiber core that uses different wavelengths.



GPON adopts WDM to transmit data of different upstream/downstream wavelengths over the same ODN. Wavelength 1310 nm is in the upstream direction and 1490 nm is in the downstream direction.

Additional a Wavelength for Video

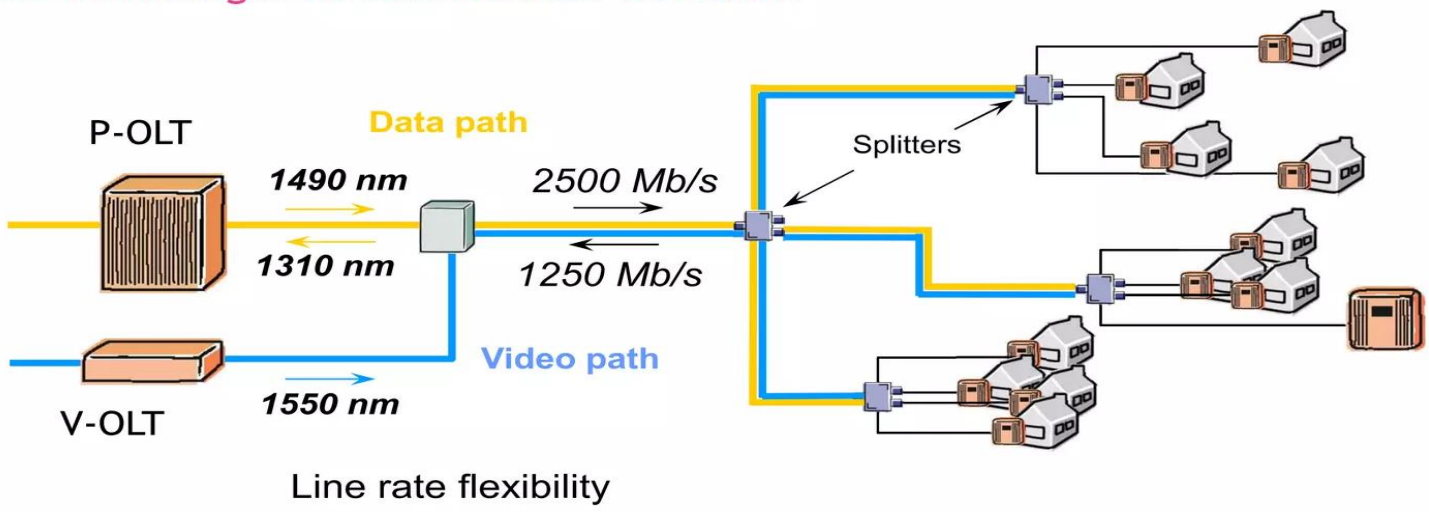
PON lambdas

Voice and data over a single fiber

- two wavelengths in opposite directions (Upstream and Downstream)

Video

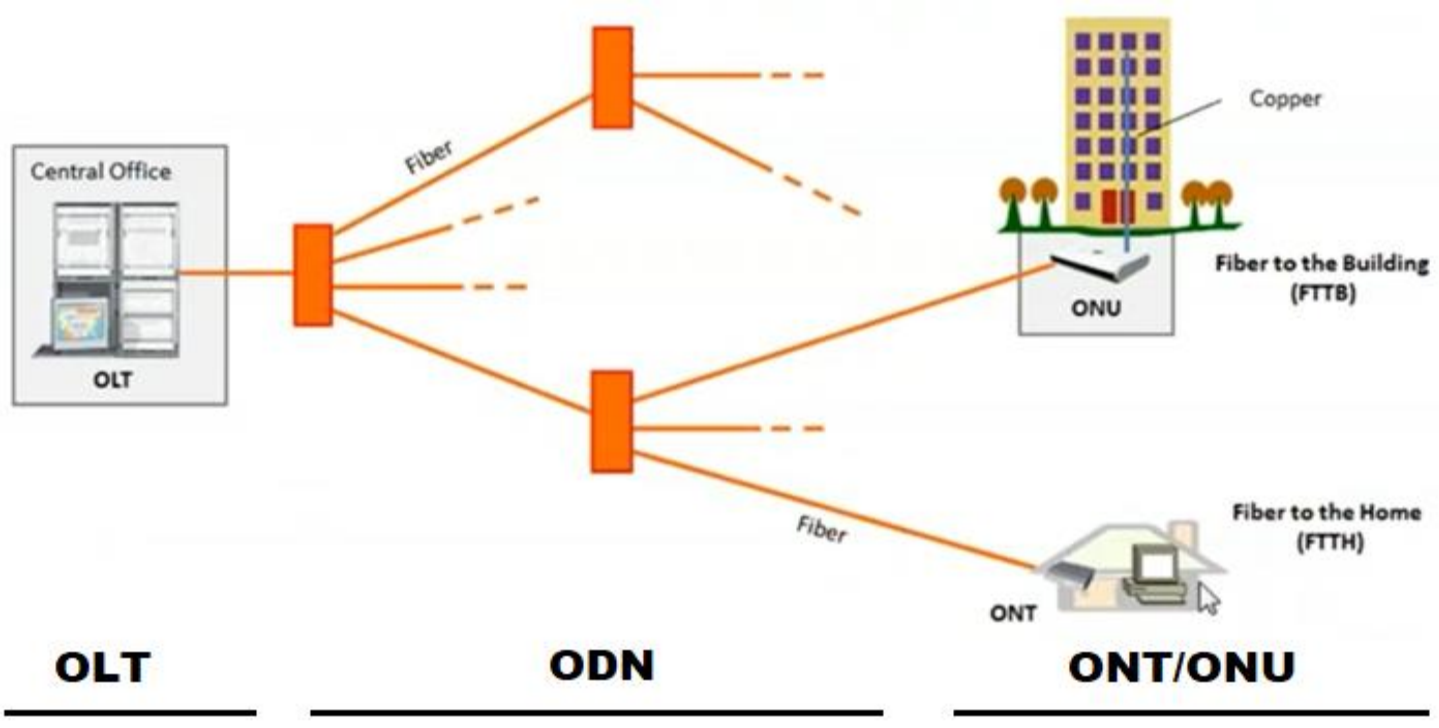
- one wavelength in downstream direction



Line rate flexibility

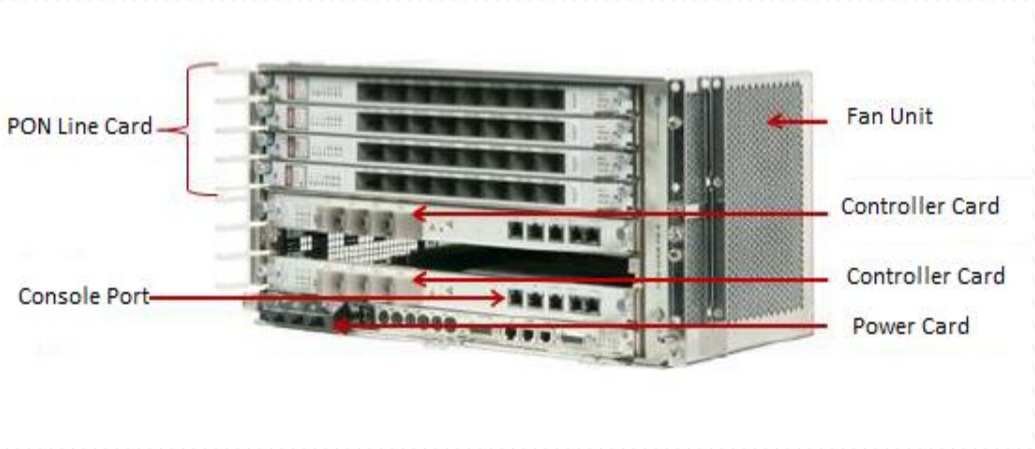
PON Limitations

- Maximum fiber distance between OLT and ONU/ONT is 20 Km
- Split ratio: Restricted by path loss, PON with passive splitters ([16, 32, 64, or 128 way)
- Rate : 1.25 Gbps Up , 2.5 Gbps down (for GPON)



Optical Line Terminal (OLT) Architecture

- 6.4 Tbps backplane capacity
- 2.5 Tbps switching matrix
- 100 Gbps uplink capacity
- All services on a single platform
- 2 controller cards (Redundancy)
- 4 PON Line Cards

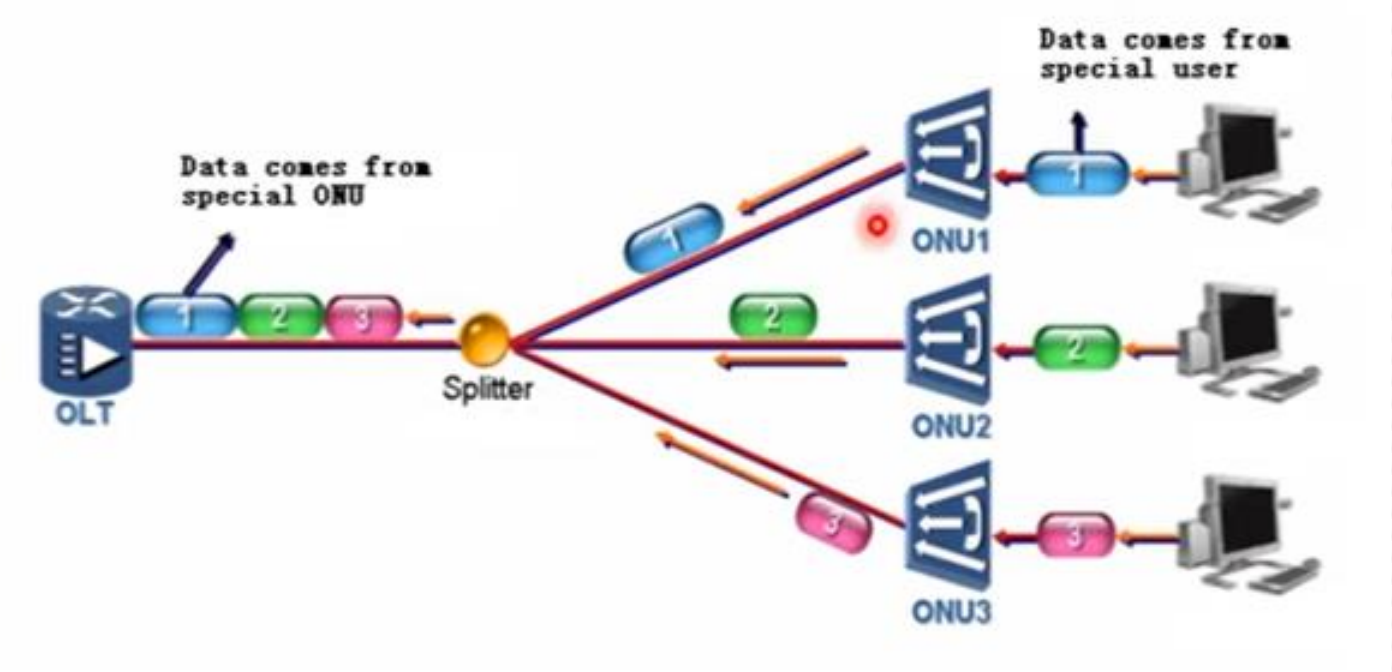


Optical Network Terminal, ONT

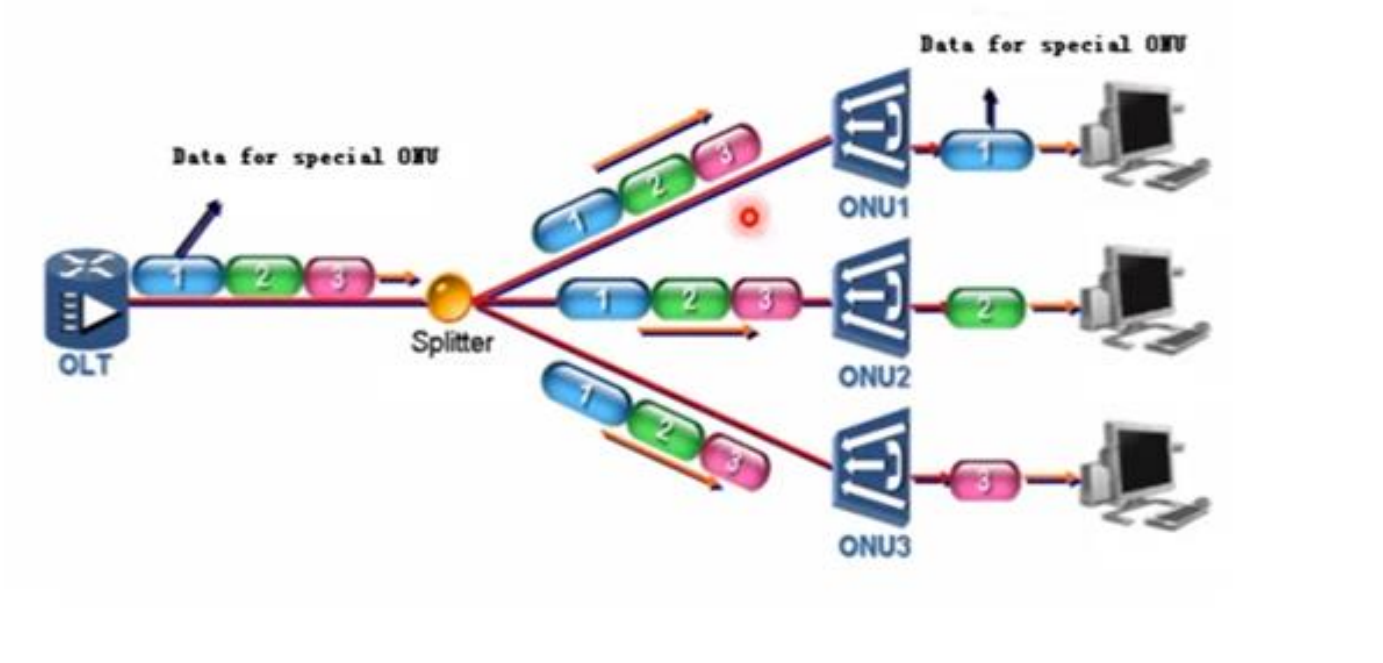
- 4 x RJ-45 10/100/1000 Ethernet port
- 2 x POTS port (Optional)
- Support Bridge mode
- Support Routed mode (NAT, Firewall, port forwarding, DMZ and DNS)
- Voice interworking (POTS vs VoIP)
- Support RSSI

RSSI = Received Signal Strength Indication

GPON Upstream Data (TDMA Mode)

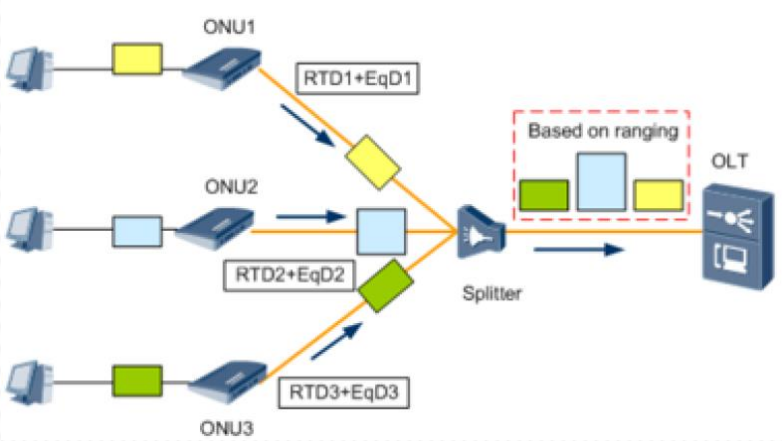


GPON Downstream Data (Broadcast Mode)



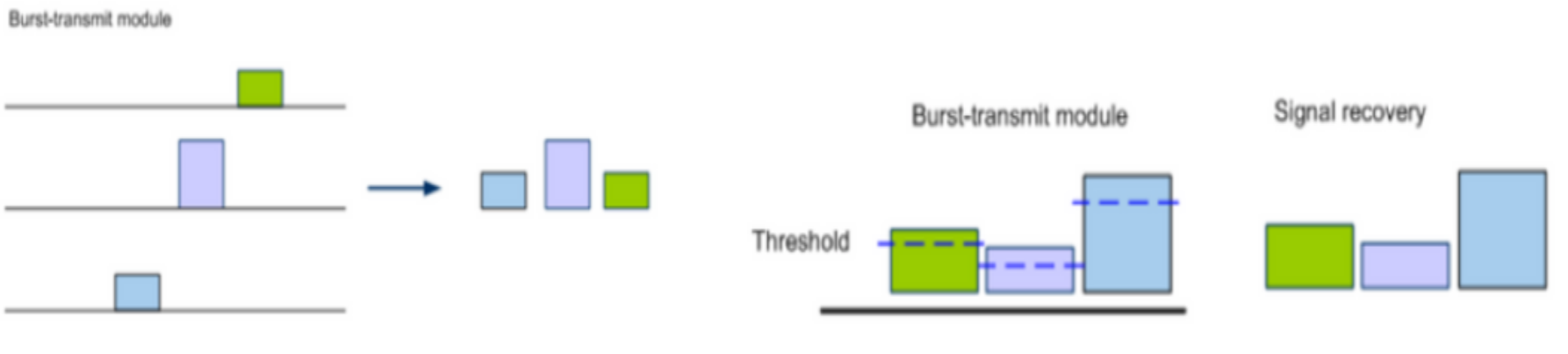
Ranging (same Time)

In order to prevent data collisions, OLT range with individual ONU to get the round trip delay (RTD) (To measure) and add with Equalization Delay (EqD) (To calculate) for its time slot to be uniformed all time slot.



Time slot = RTD + EqD

Burst Technology (same Amplitude)



- ONU transmits Burst
- OLT receive Bust
- OLT disable weak optical signal (if under threshold)
- OLT adjust dynamically uniform optical signal level (if above threshold)

Dynamic Bandwidth Allocation (DBA)

- OLT monitors for congestion, bandwidth usage, and configuration

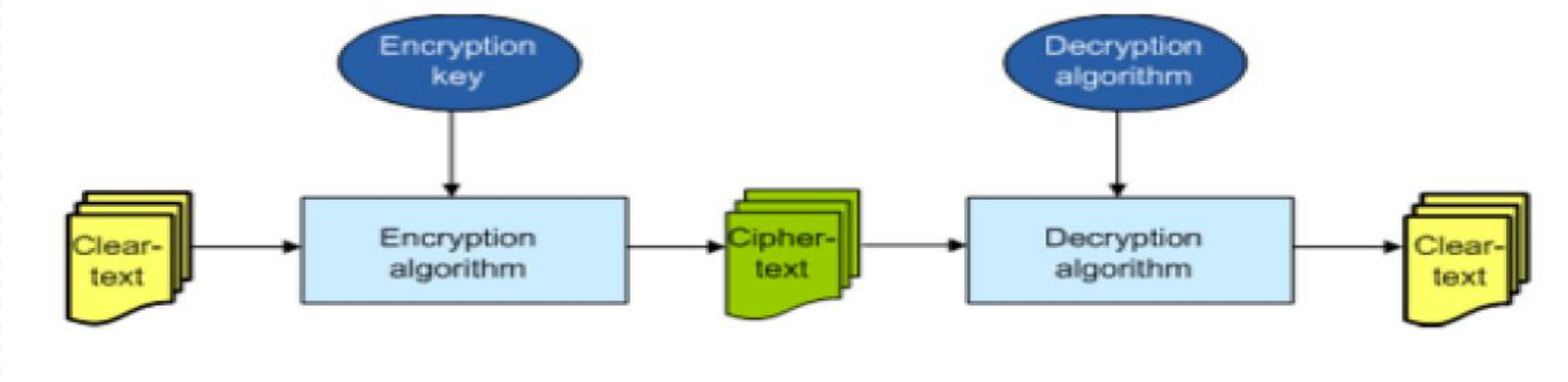
- OLT send Bandwidth Map to ONU
- ONU allocate respective Bandwidth to OLT

Forward Error Correction (FEC)

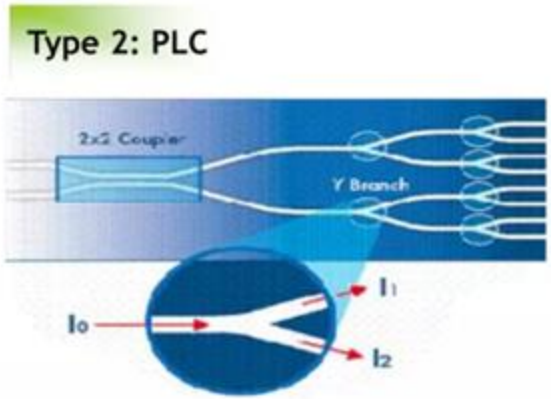
- Transmission can make the bit errors which can degrade quality.
- FEC enables the Receive end to check and correct the bit errors.
- Don’t need data retransmission.
- Supports FEC in the downstream direction only.
- Improved transmission quality.

Line Encryption

- OLT broadcasts to all ONUs.
- Individual ONU should correct data (to prevent data from unauthorized ONU)
- GPON utilizes the AES128 algorithm to encrypt data packets.



Splitter



PLC – Planar Lightwave Circuit

- Built into glass waveguides
- Solid state
- No mechanical parts
- Compact
-Splits: 1x4, 1x8, 1x16, 1x32
-Splits: 2x4, 2x8, etc

Splitter - Example

CONNECTORISED

- Flexible
- Patch cords included
- Easy to replace

Available with factory terminated pigtails

Power Budgeting - Losses

Potential Losses:

- 1. splitters loss
- 2. Fiber loss (< 0.35 dB per km)
- 3. Splice Loss (< 0.2 dB)
- 4. Connector loss (< 0.6 dB)
- 5. Fiber bending loss

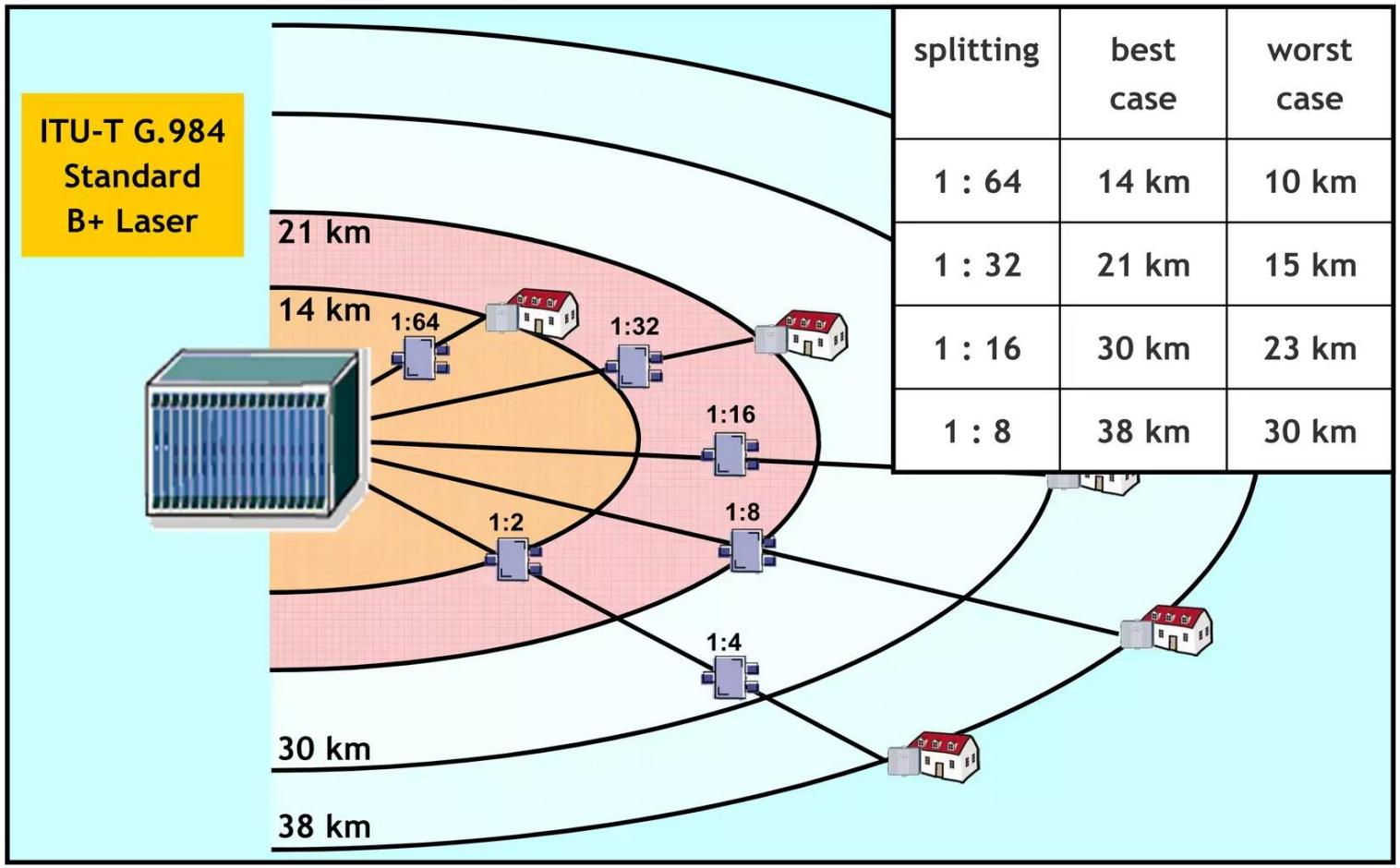
Optical Splitters	Loss [dB]
Splitter 1 x 64	20.1
Splitter 1 x 32	17.4
Splitter 1 x 16	13.8
Splitter 1 x 8	10.5
Splitter 1 x 4	7.0

Power Budgeting – Allowable Optical Path Loss

	Class-A	Class-B	Class-B+	Class-C
Minimum Loss	5 dB	10 dB	13 dB	15 dB
Maximum Loss	20 dB	25 dB	28 dB	30 dB

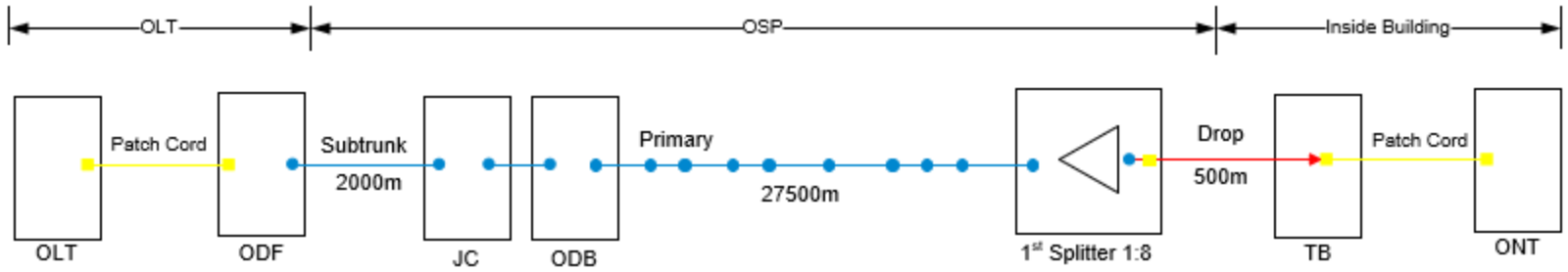
OLT Port SFP Connector

Maximum range per splitter - configuration



splitting	best case	worst case
1 : 64	14 km	10 km
1 : 32	21 km	15 km
1 : 16	30 km	23 km
1 : 8	38 km	30 km

Link Budget Calculation based on 1:8 Splitter (Class B+)

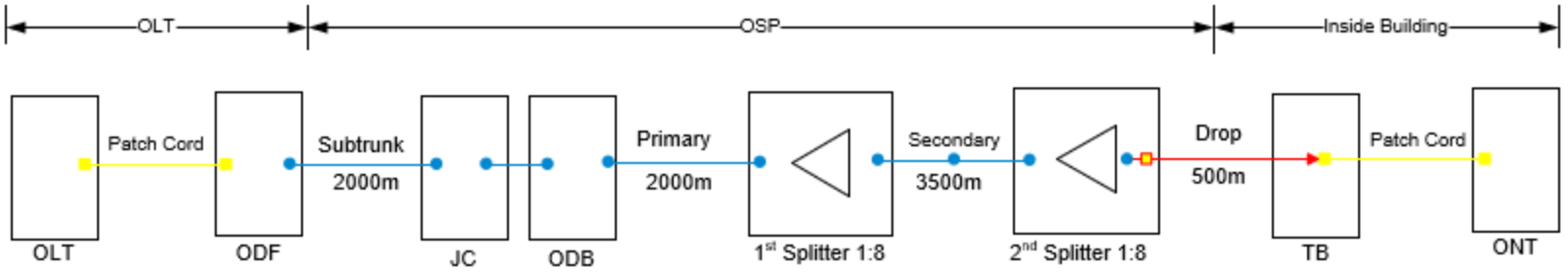


Total Loss = Splitter Attenuation + Adapter Attenuation x Qty of Adapter + Splice Attenuation x Qty of Splice + Fiber Attenuation x Cable Length

=	10.5	+	(0.3 x 3)	+	(0.1 x 14)	+	(0.35 x 30)
=	10.5	+	0.9	+	1.4	+	10.5
=	23.3 dB	<	28 dB (Pass)				

Adapter Splicing Assemble Connector

Link Budget Calculation based on 1:8 x 2 Splitters (Class B+)



Total Loss = Splitter Attenuation + Adapter Attenuation x Qty of Adapter + Splice Attenuation x Qty of Splice + Fiber Attenuation x Cable Length

= (10.5 + 10.5) + (0.3 x 3) + (0.1 x 9) + (0.35 x 8)

= 21 + 0.9 + 0.9 + 2.8

= 25.6 dB < 28 dB (Pass)

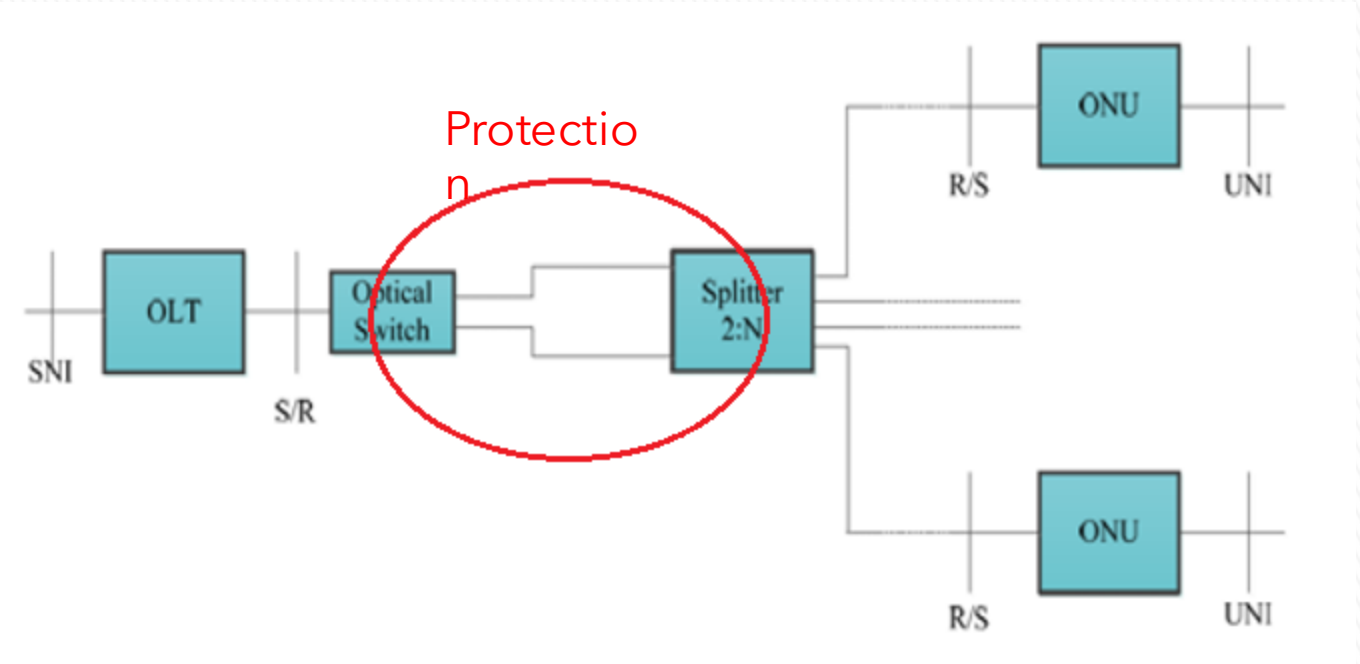
Adapter Splicing Assemble Connector

Network Protection

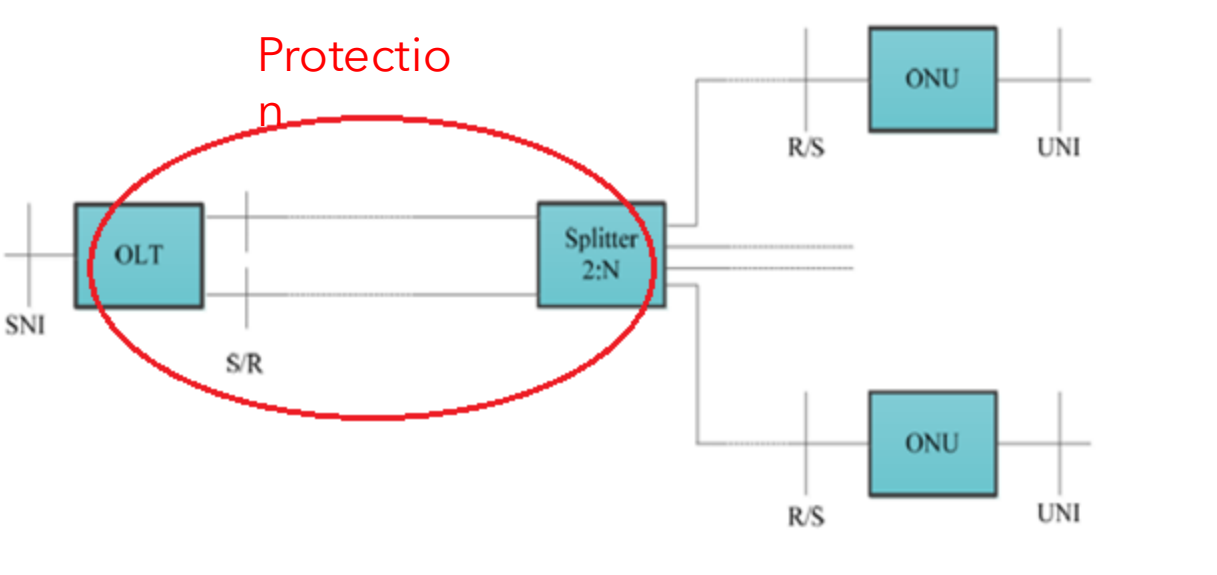
ITU-T G.984.1 specifies 3 types of redundancy between OLT and ONT.

	OLT Port	ODN	ONU
Type-A	No	Yes	No
Type-B	Yes	Yes	No
Type-C	Yes	Yes	Yes

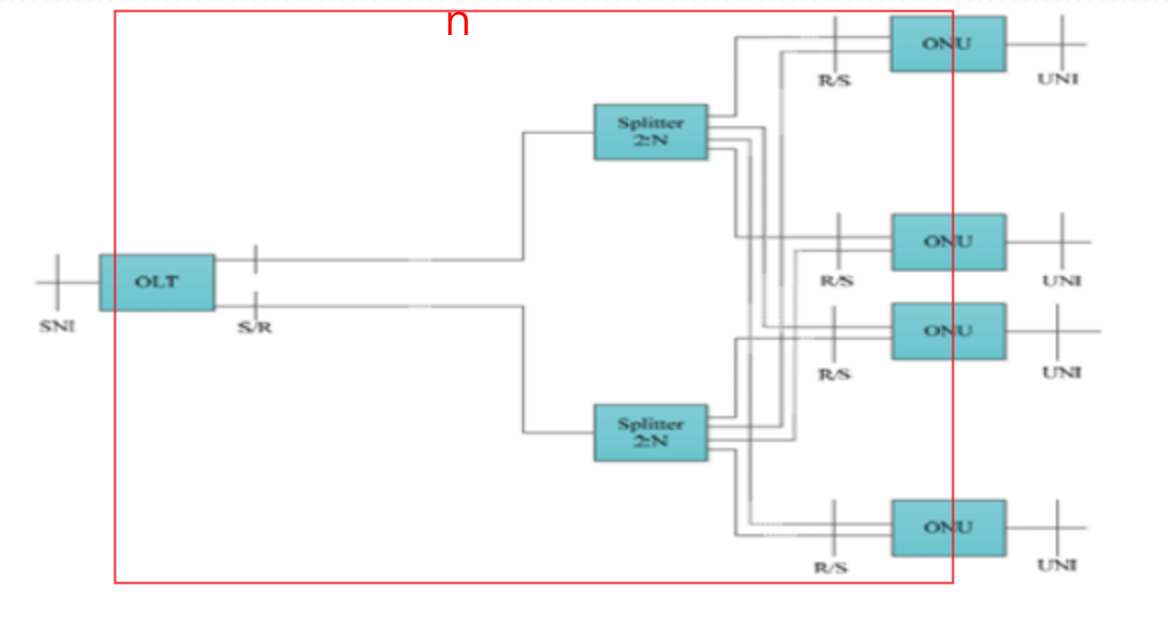
Network Protection Modes; Type A

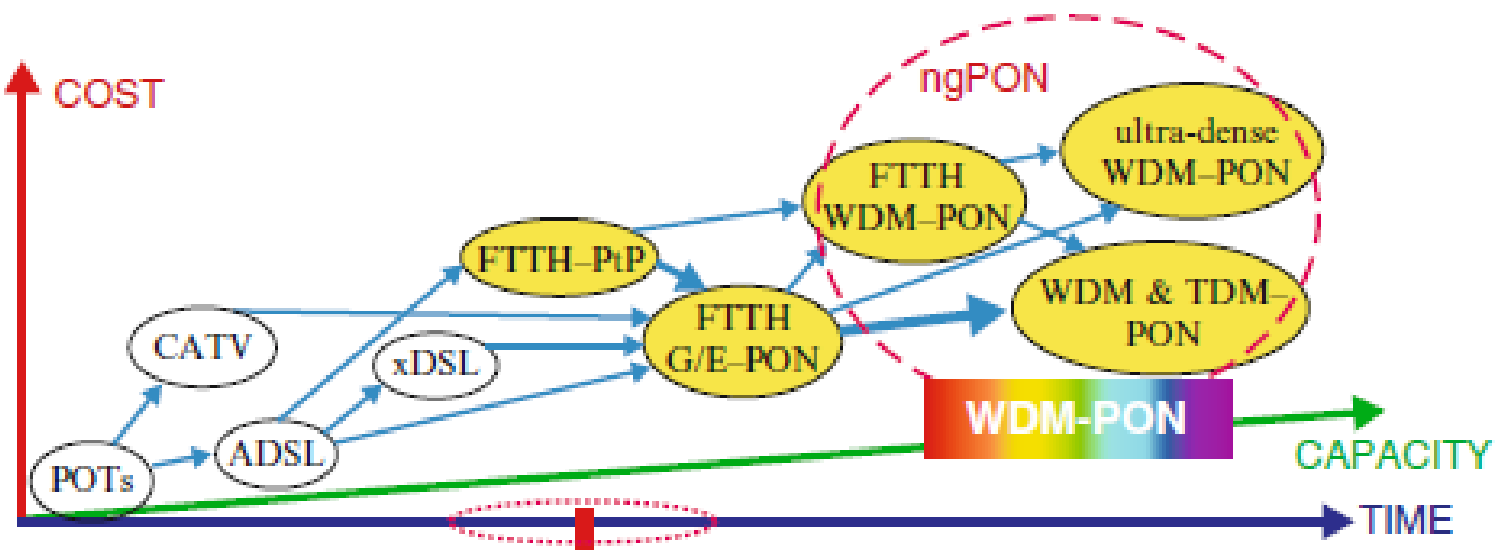


Network Protection Modes; Type B



Network Protection Modes; Type C





Evolution of access technologies

NG-PON Features

- High splitting ration (> 64)
- High speed (> 1 Gbps)
- Bidirectional transmission, symmetrical data rate, single fiber access
- Long reach (> 20 Km)
- Passive

PON benefits

- Purely passive fiber plant
  - Low maintenance costs and high reliability
- Share feeder fiber over multiple users
  - Less fibers needed; less ports needed at CO
- Fiber is virtually not limiting the bandwidth
  - Much higher bandwidth x distance than copper networks
- Fiber's bandwidth can be further exploited by WDM or equipment upgrade
  - Installed fiber infrastructure is future-proof
- PON offers bundled services over a single fiber
  - Triple play – vice/ data / video

3. Optical Distribution Network

FTTH Description and Overview

1. FTTH Introduction
2. Planning the Network
3. Building the Network

FTTH INTRODUCTION

What is FTTH Networks (Broadband Network)

- FTTH Network = End-users are connected to a Central Point using only optical fiber cabling.
- Central Office (CO) = Center Point = Point of Presence (PoP) – transmission equipment to deliver applications and services
- End users = located in residences. “Fourth Utility” (Electric, Water, Gas, Fiber)

What do FTTH Access Networks connects?

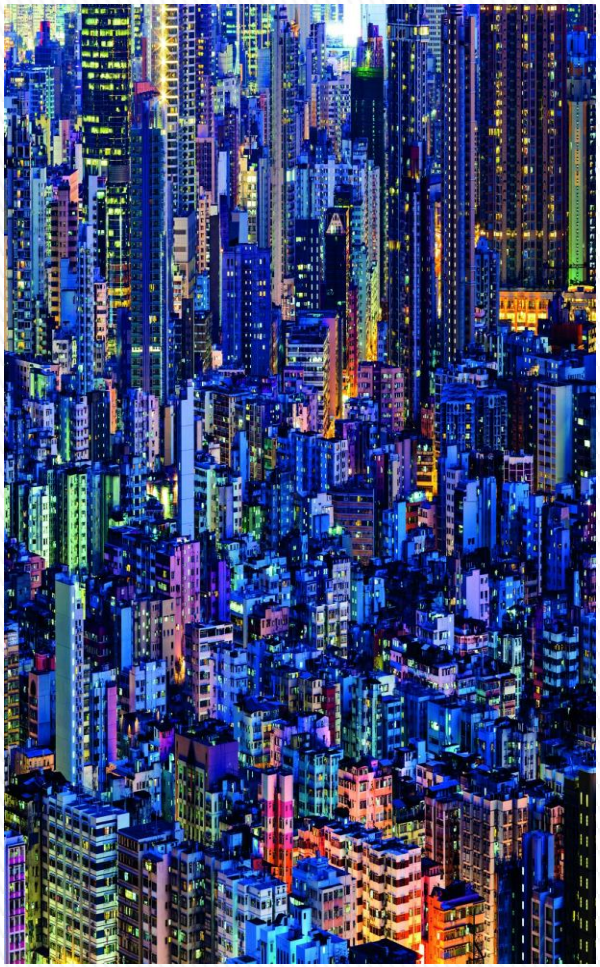
- Fixed Wireless Network (Wi-Fi, WiMAX).
- Mobile Base Stations (3G, 4G, 5G).
- SDU (Single Dwelling Units), MDU (Multi-Dwelling Units).
- Campus Network (schools, hospital and businesses).
- Security and monitoring (CCTV, alarms, control devices…).

What are the key attributes of a FTTH Network?

- High-bandwidth Services (100Mbps, …. 1Gbps)
- Direct Fiber Connection
- Future Service demands (IoT, AI … etc.)
- Future Network Upgrade and Expansion
- Minimum Disruption during Network Deployment

Influences on FTTH deployment

- Site Type – (Dense-urban, Urban, or Ruban).
- Network Size (256…4096 subscribers).
- CAPEX (USD 120 per Subscriber).
- OPEX (USD 1 per Month).
- Restrictions (Local, Authority).



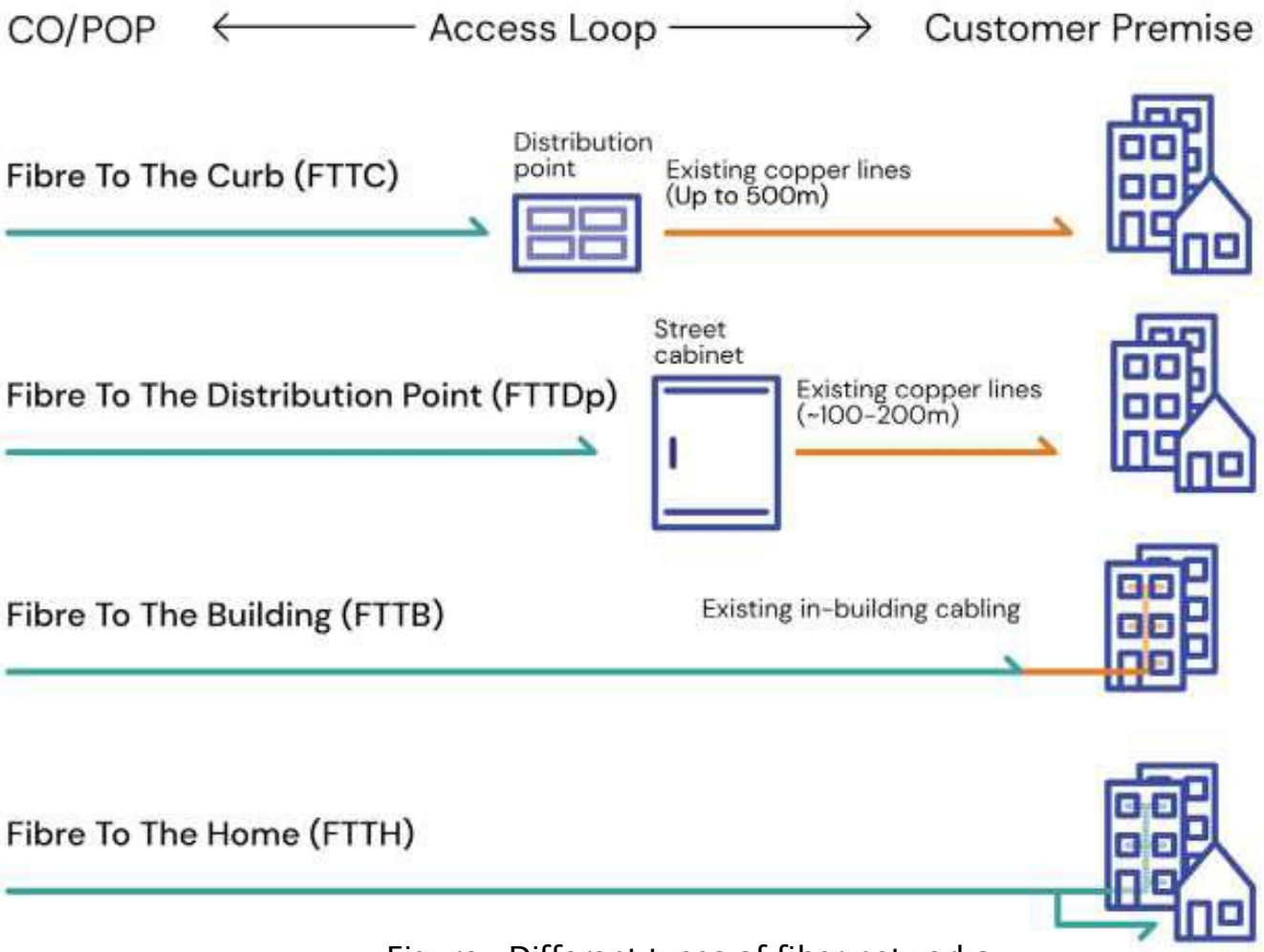


Figure . Different types of fiber networks

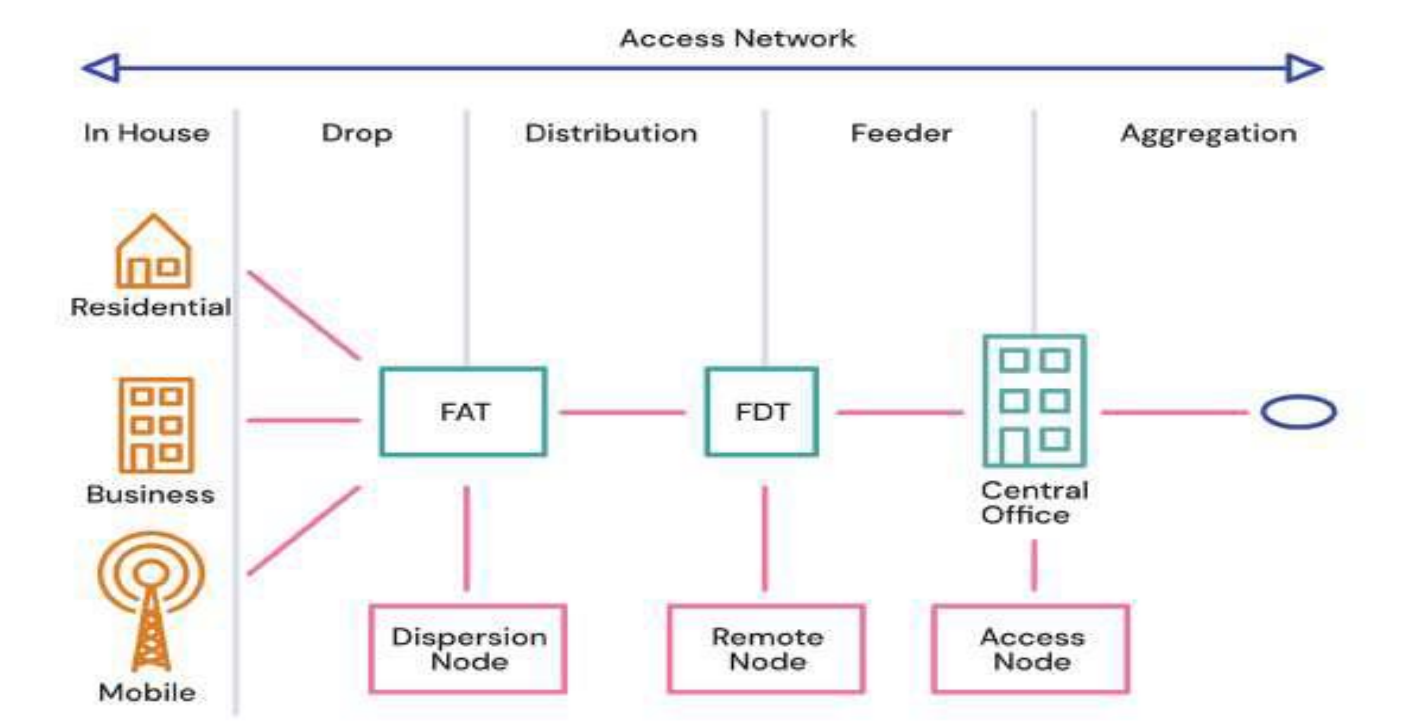
PLANNING THE NETWORK

Network Environments

- Ruban and Urban – favorable space.
- Dense-urban - limited space.
- Brownfield deployment - Favorable with existing infra
- Greenfield development – build the entire network
- A fiber network is a long-term investment (25 years or more).
- The active equipment is several upgrade (5 Years each).
- Non-telecom operators (Utilities, Municipalities, and Real estate)
- FTTH plus SDU, MDU
- FTTH plus 4G, 5G

Key Architecture Decisions

The access network is essentially the connection of end users to an aggregation node. It connects active equipment, such as OLT, to the end customer via different passive elements.



Feeder Cable	Distribution Cable	Drop Cable
Underground Installation	Overhead Installation	Overhead Installation
Between OLT to 1st Splitter	Between 1st Splitter and FAT	Between FAT and ONT
The higher the count (48 to 288 fibers), the broader the FTTH footprint	12 to 24 Cores	1 to 4 Cores

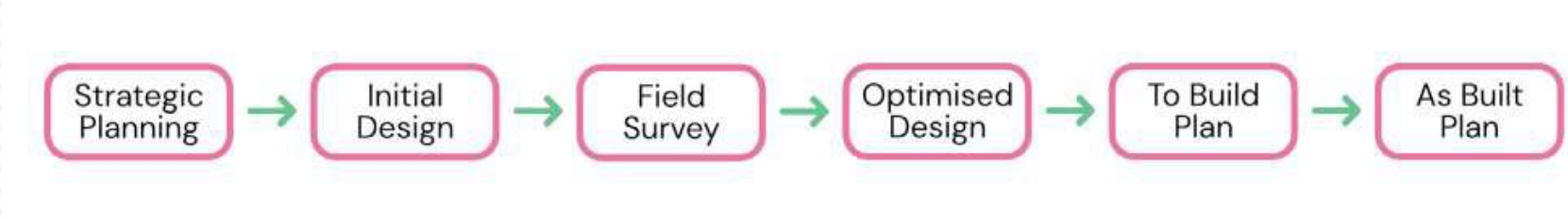
BUILD THE NETWORK

1. Network Design
2. Installation Techniques
3. FTTH Test Guidelines

Detail Network Design - Survey

Type of survey :

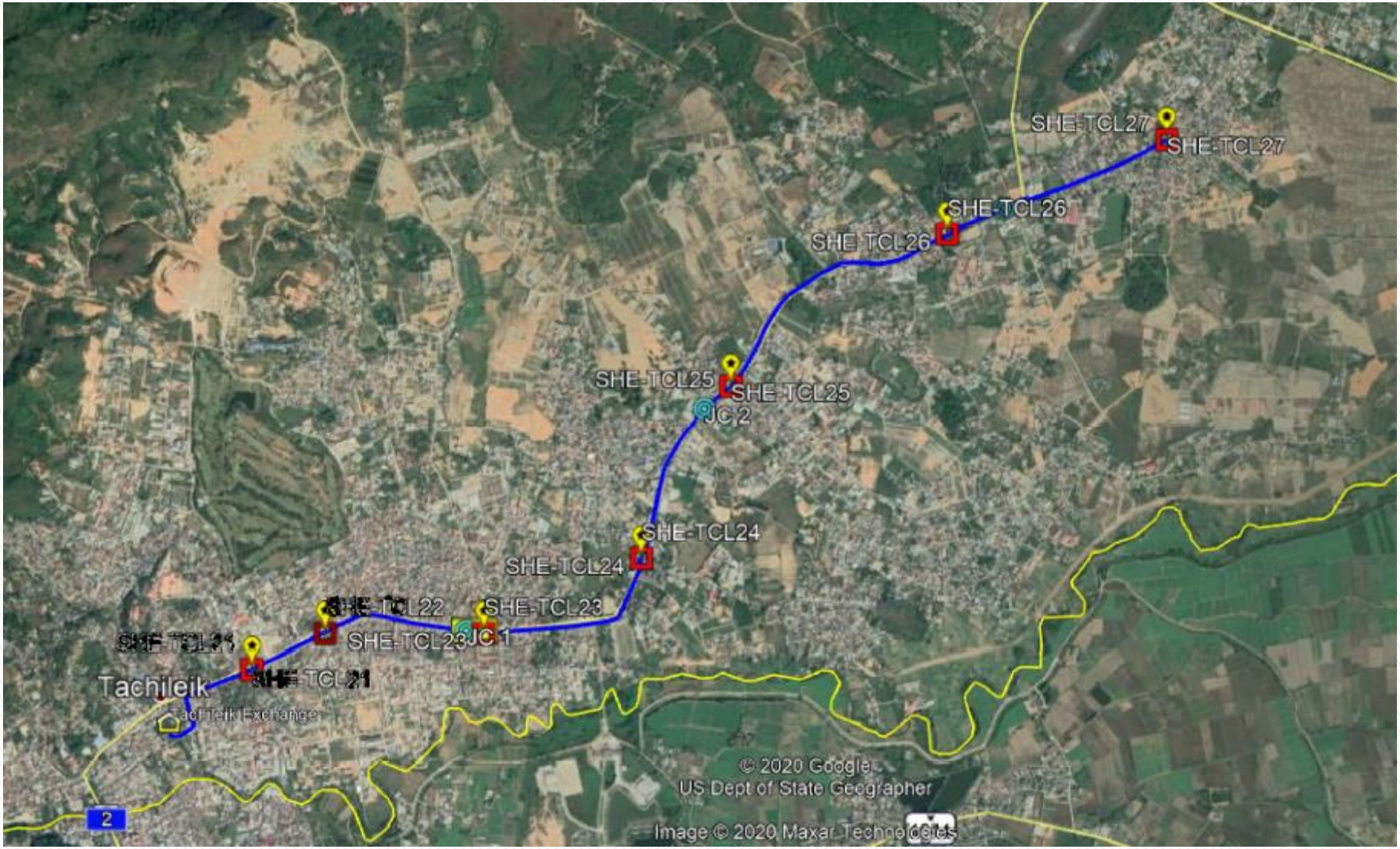
1. Desktop survey (with Google Map – Road, Tree)
2. Field survey (after that LLD)



Detail Network Design (High Level Design)

1. HLD based on Google Earth
2. Field Survey (Cable Route, ODF Location, Pole Location, Stay Wire Requirement)
3. TSSR (Photos, Coordinate, Existing Pole Status, Road Crossing, Electric Pole, Bridge Crossing, Pole ID)
4. Survey BoQ

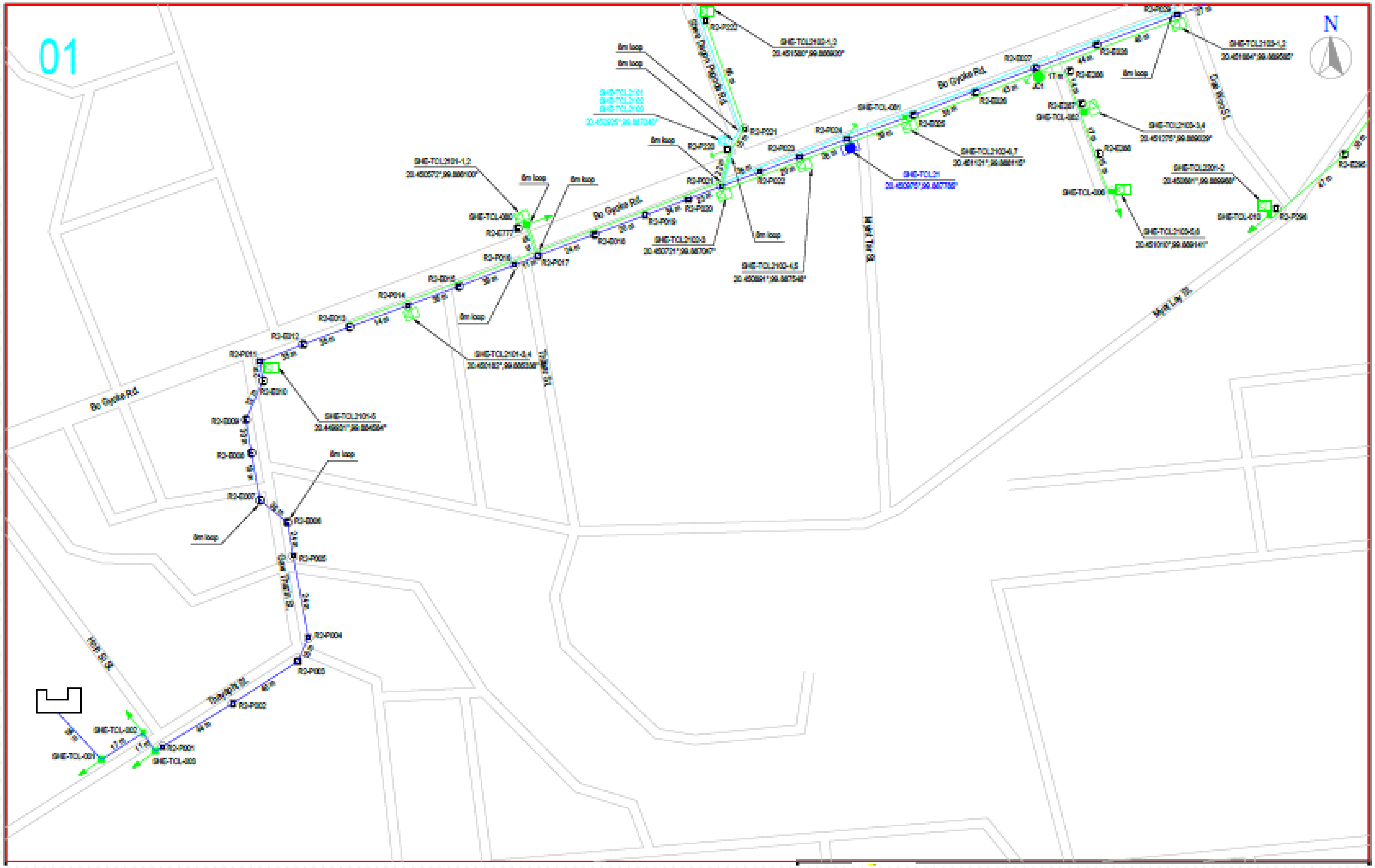
Detail Network Design (High Level Design)



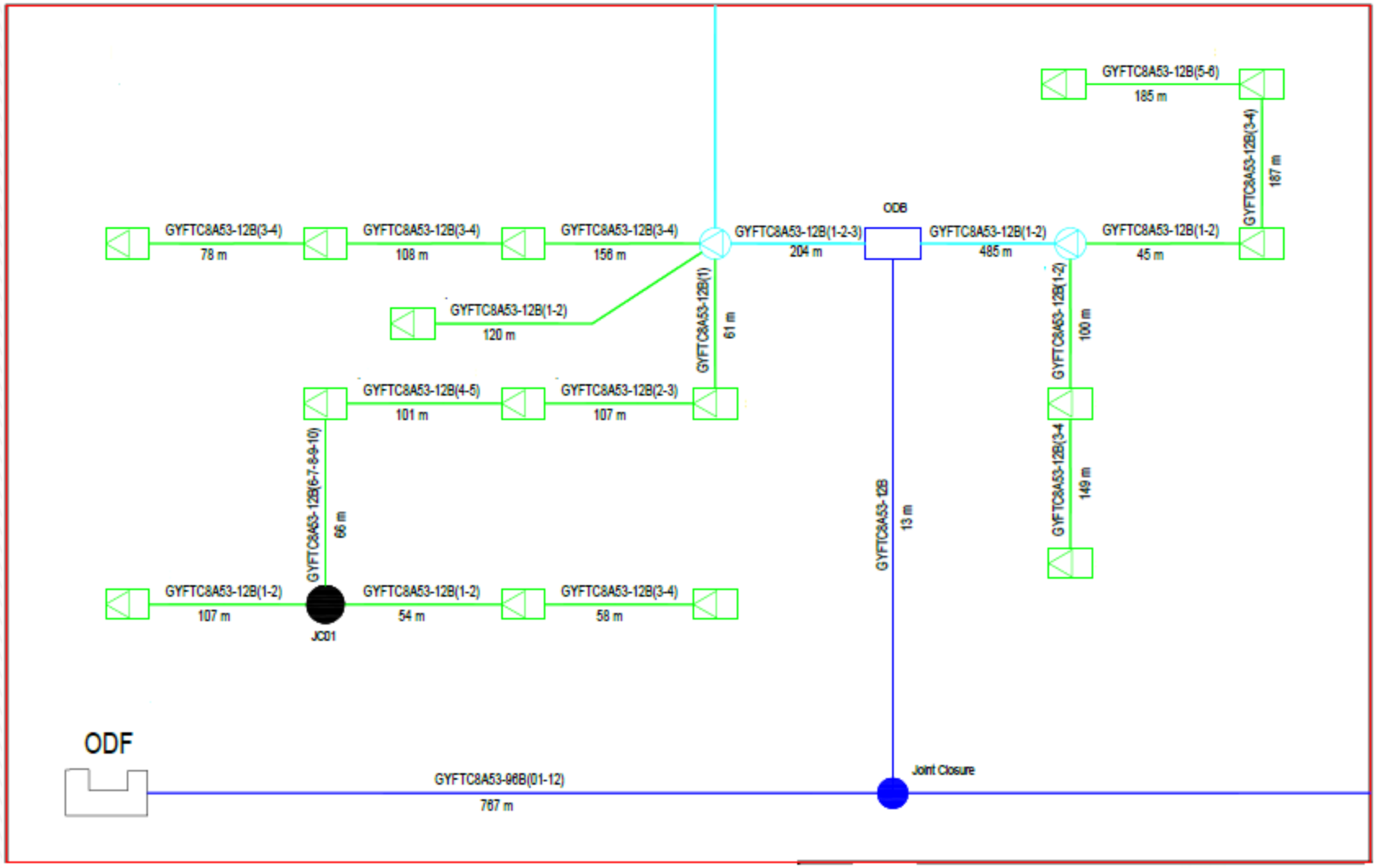
Detail Network Design - Low Level Design

1. LLD (Existing Pole Location, Cable Route, Detail Aerial Installation Method, Pole distance, Grounding, Stay Wire Requirement, New Pole Requirement, Equipment on Pole and Labelling)
2. Auto CAD Drawing
3. Network Topology
4. Core Assignment Plan
5. BOQ calculation based on LLD (in the drawing)

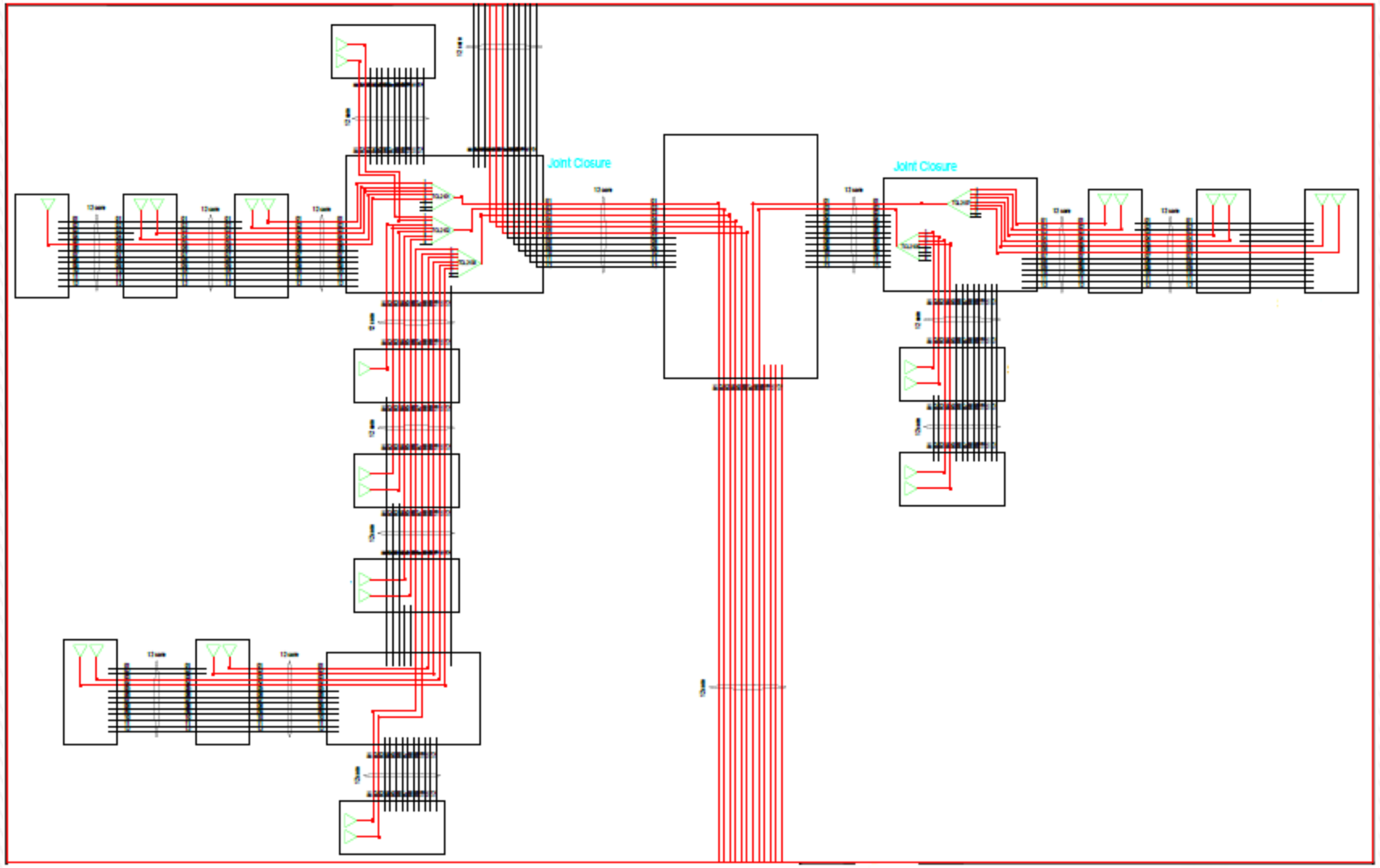
Sample Route Map (Low Level Design)



Sample Topology (Low Level Design)



Sample Core Plan (Low Level Design)



Sample BOQ (Low Level Design)

Item	Description	Unit	Qty
1	Reserved cable rack	kit	396
2	U shaped Galvanized hoop R75mm*12mm	pcs	396
4	Pole provision(aerial, 7m concrete pole)	Pcs	86
5	Pole provision(aerial, 8m concrete pole)	Pcs	10
6	Stay wire provision(7 / 2.2 single strand stay wire)	Pcs	64
7	Stay wire warning pipe	pcs	64
8	Warning marker pipe(2m in length)	pcs	88
9	Power line cross protection device (50m one coil)	m	80
10	Φ16mm,L=2000mm copper bonded steel rod	PCS	37
11	general copper earthing clamp	KIT	37
12	H07V-K&RV Yellow-green 1×35mm2 Wire	m	222
13	U-pvc pipe Φ20mm	m	148
14	Stainless Steel Clamp for fixing 8-figure Fiber Cable	pcs	687
15	Stainless Steel Tape	m	1260
16	Stainless Steel Tape Locking Seal	pcs	2100
17	U-shaped steel card Φ8 mm	pcs	1716
18	Hoop of stay wire	pcs	286
19	Stay wire backing ring (3#)	pcs	572
20	Cable marker	pcs	328
22	Equipment Label	pcs	166
23	spiral marker	m	267

Installation Techniques

1. Fiber Deployment
2. Underground Installation
3. Aerial Installation
4. Micro Duct Installation

Pre-Installation Cable Checking

1. Check the cable spec including cable type, no. of fiber, cable length
2. Inspect the cable reel for sign of excessive damage.
3. Do not accept the delivery of an optical fiber cable if the reel is visibly damaged.
4. Reel on site, must be on chocked to prevent them from moving and rolling
5. All optical fiber cables must be tested while on the reel, prior to deployment.
6. OTDR testing shall be done on fibers in one direction at 1550 nm
7. OTDR trace must be stored and electronic copy must be submitted to authorized person

Pre-Installation Cable Checking (Cont.)

1. Bend Radius: The cable should not be pulled over a bend radius smaller than 20 times the cable diameter
2. Pulling Tension: the maximum allowable pulling tension for a particular cable can be found on the cable spec sheet.
3. To eliminate possible cable contact with the ground, play the cable off from the top of the drum.
4. Aerial pulley should be used on the poles for smooth cable pulling.
5. The pulling team must pull the cable.
6. The drum team must feed the cable off the drum at the same speed at which the cable is being pulled.
7. There must be no strain on the cable between the drum and the first pulley.

Aerial Fiber Cabling Process Steps

1. Pole Construction
    1. Stay Wire
2. Fiber Laying
    1. Fixing Fiber on the Pole
    2. Cable Tensioning
    3. Reserve Cable Rack Installation
    4. Cable Marking
    5. Warning Pipe
    6. Fiber Optic Cable Labeling
    7. Grounding
3. ODF Installation
4. Joint Closure Installation
5. FAT Installation
6. Drop Cable Installation

Fiber Deployment

Large drums handling.

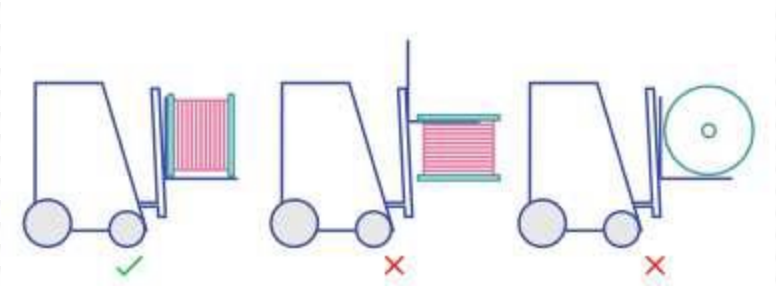


Figure - Safely moving drums with a forklift

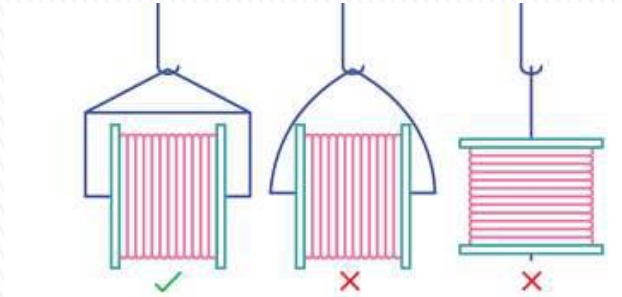


Figure – Safely moving drums with an electric hoist

Never drop or roll from a higher step

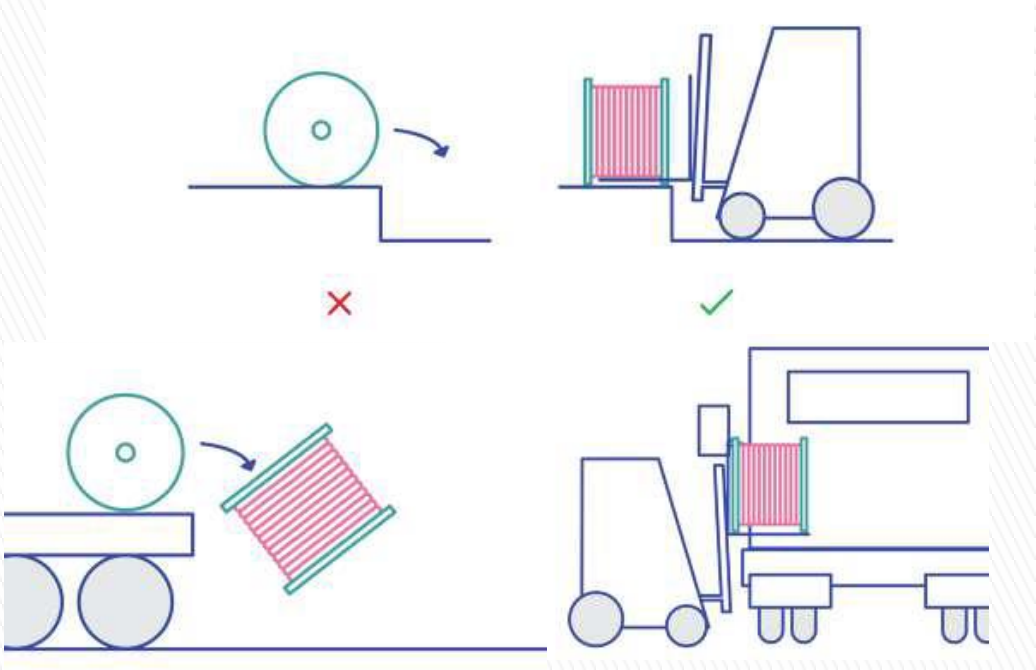


Figure – Never roll the drum from a high step or the back of truck

Drum Rolling Direction

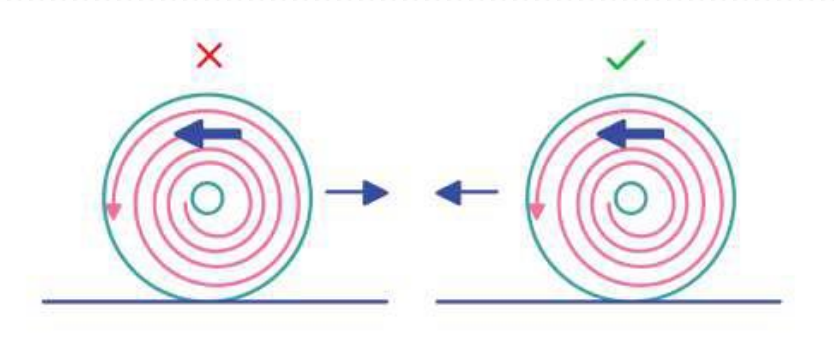


Figure – Drum rolling direction

Drum Vertical Positioning

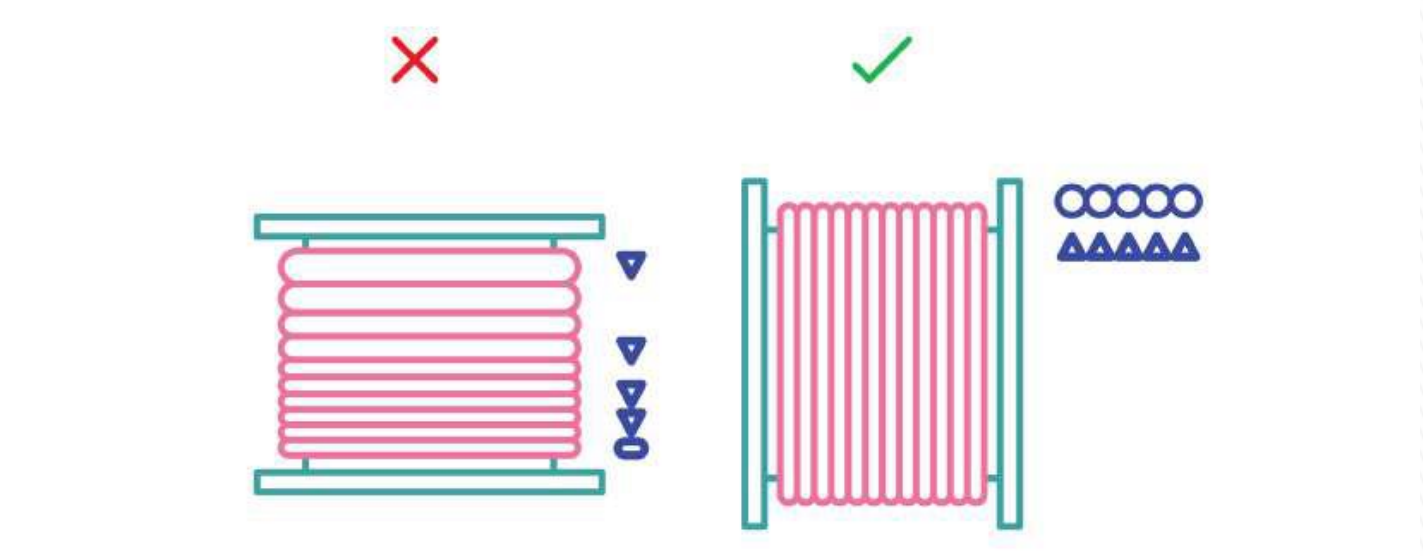


Figure – Vertical positioning

Avoid resting the drum on the cable

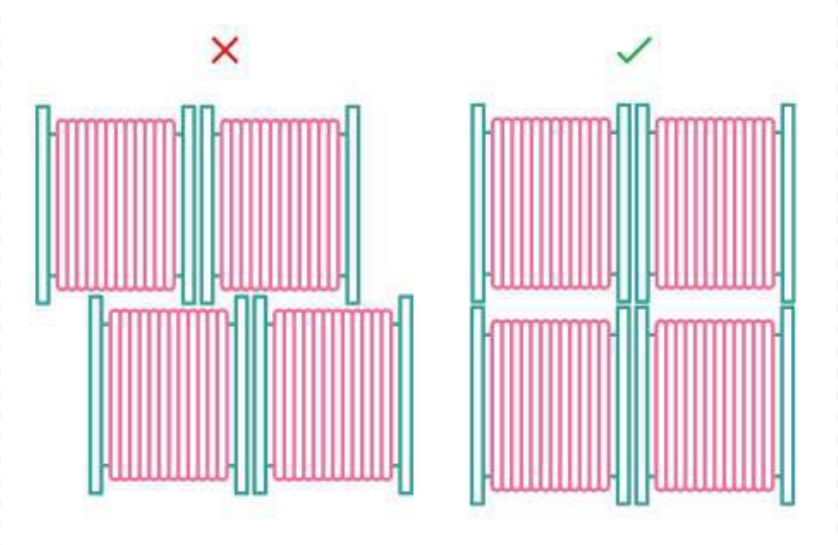
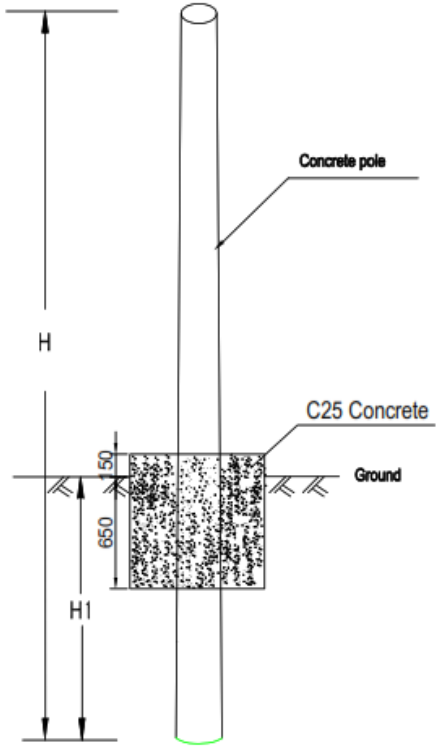


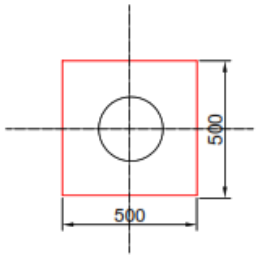
Figure – Avoid resting the drum on the cable

Tools

Shovels 	Sledgehammers 	Earth Auger 	Measurement Tape 
Water Level 	Plumb-Bob 	Theodolite 	Steel Wire Cutter 
Wrench Set 	Diagonal Plier 	Ladder Fixing Strap Stabilizer 	Ladder 

Pole Excavation



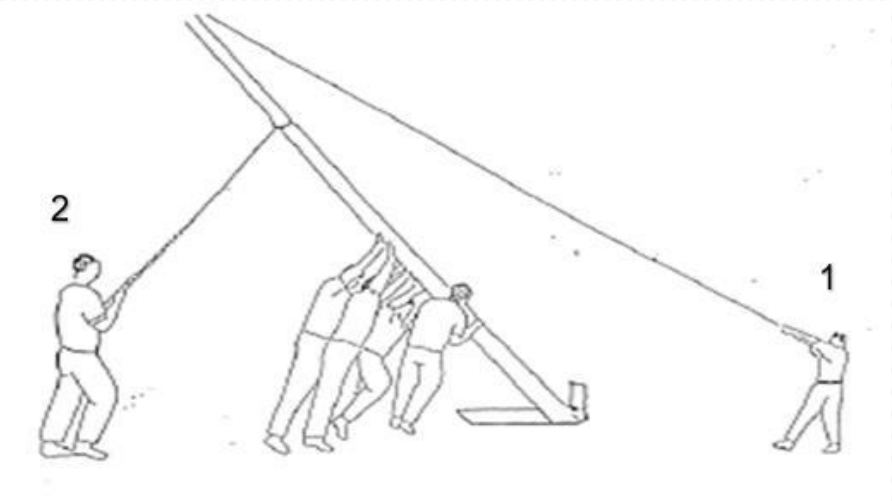


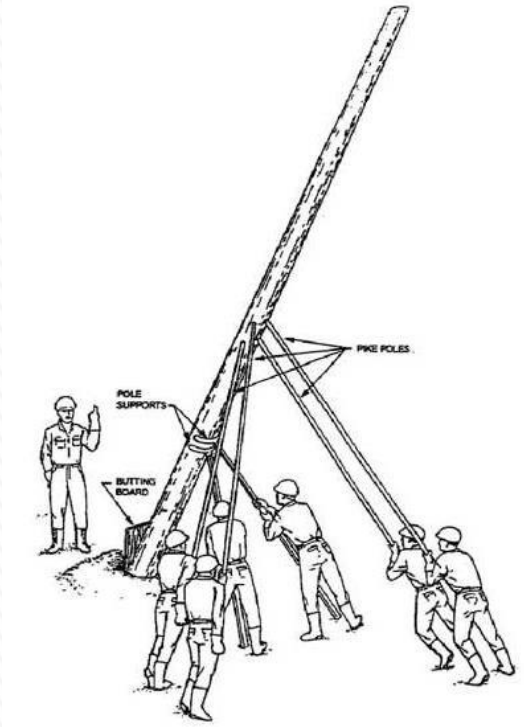
Scetion 1-1

Buried Depth of Concrete pole(Unite:m)

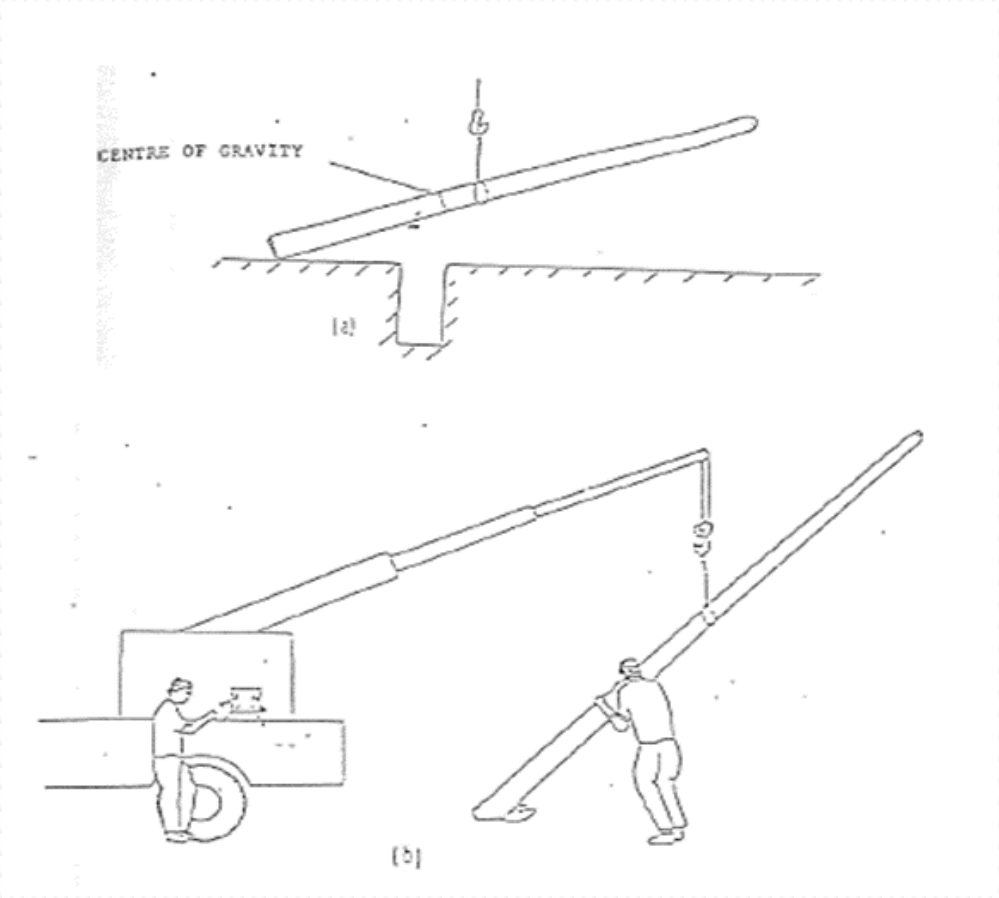
Soil / H1 / H	Normal soil	Hard soil	Gravel soil
7m	1.4	1.2	1.0
8m	1.5	1.4	1.2

Manual Pole Erection

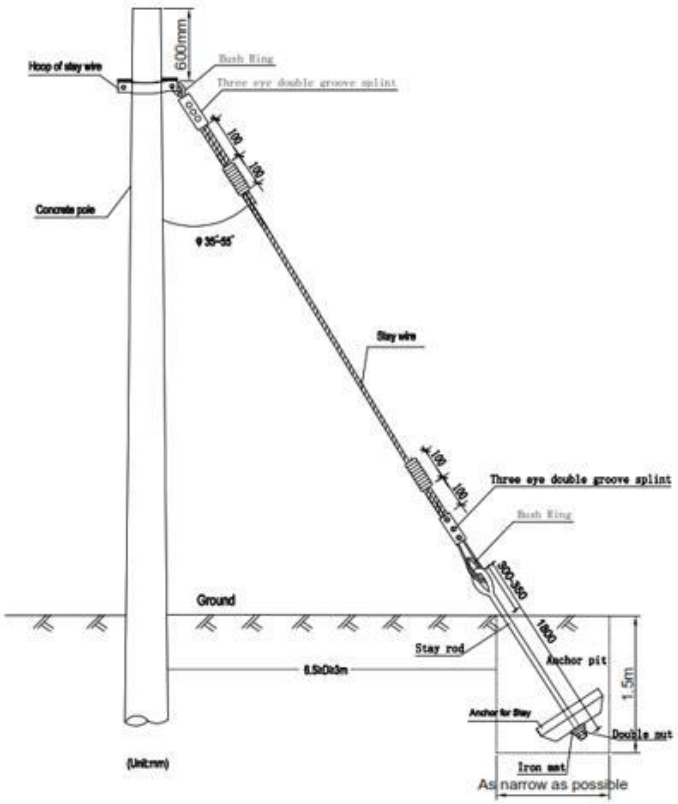




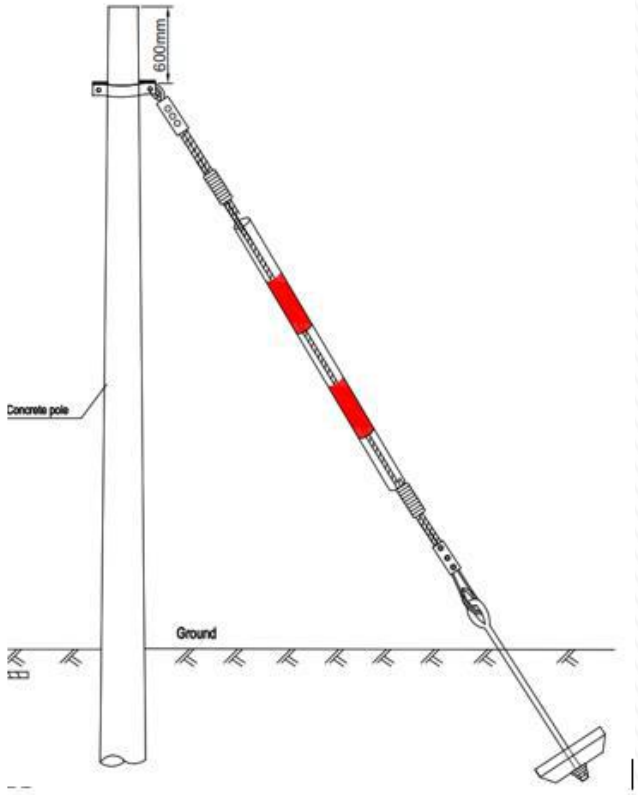
Pole Erection by Machine



Stay Wire Installation



Stay wire installation details



Stay Wire Warning Pipe

Aerial Installation

The Pull-back method of cable deployment

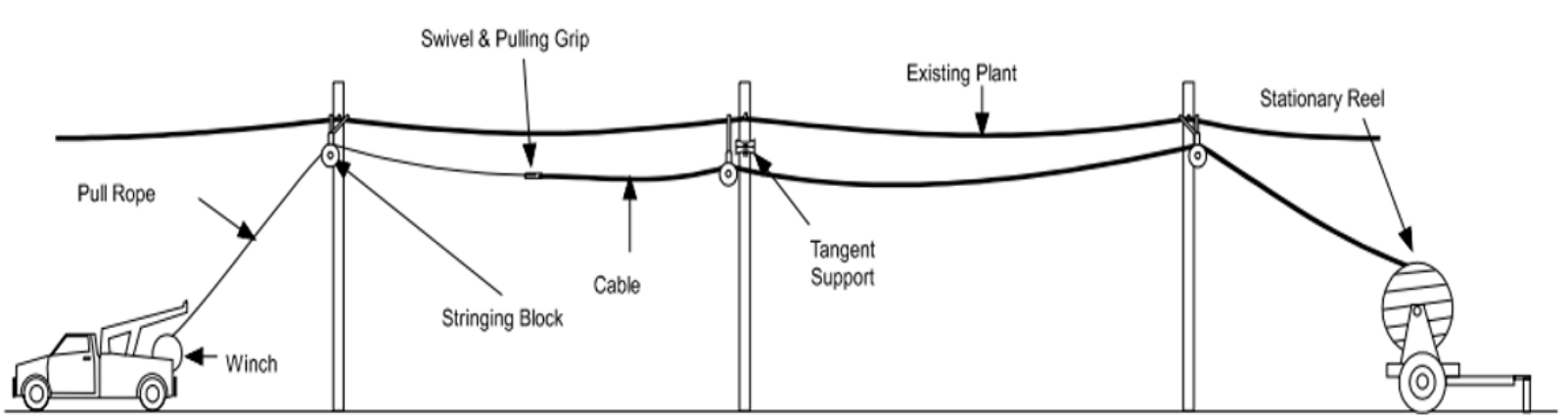


Figure – The pull-back method of cable deployment

Sample Pole Erection Photos

Fiber Cable Laying Sample Photo

To eliminate possible cable contact with the ground

Take care maximum Pulling Tension

Direct Buried Cable Installation Method

Trenching

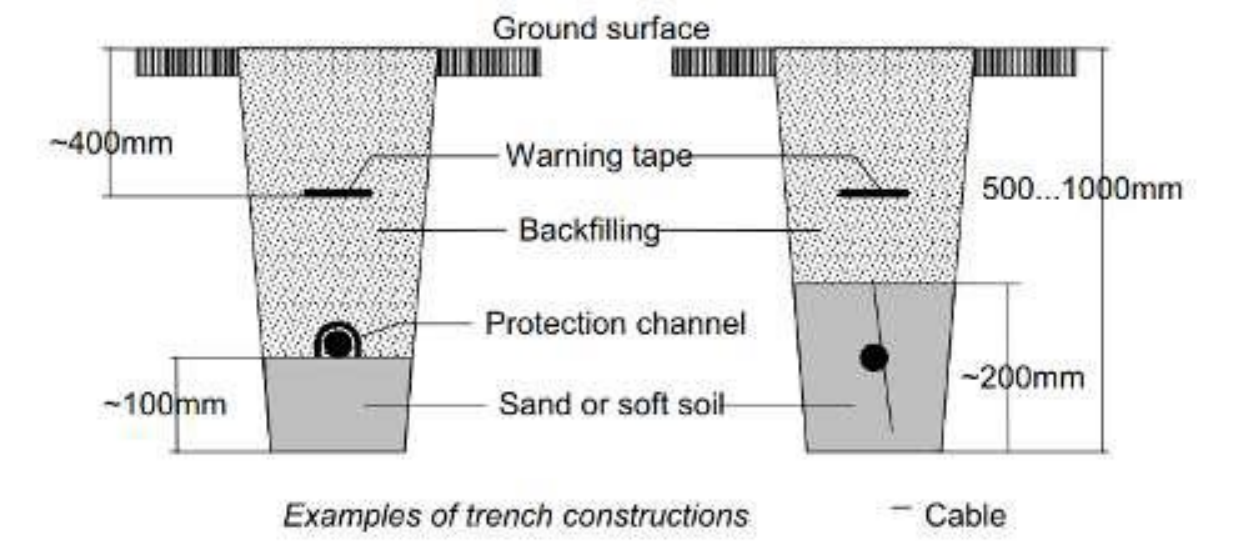


Figure – Direct Buried method

Underground Cable Installation in Ducts

Cable Pulling

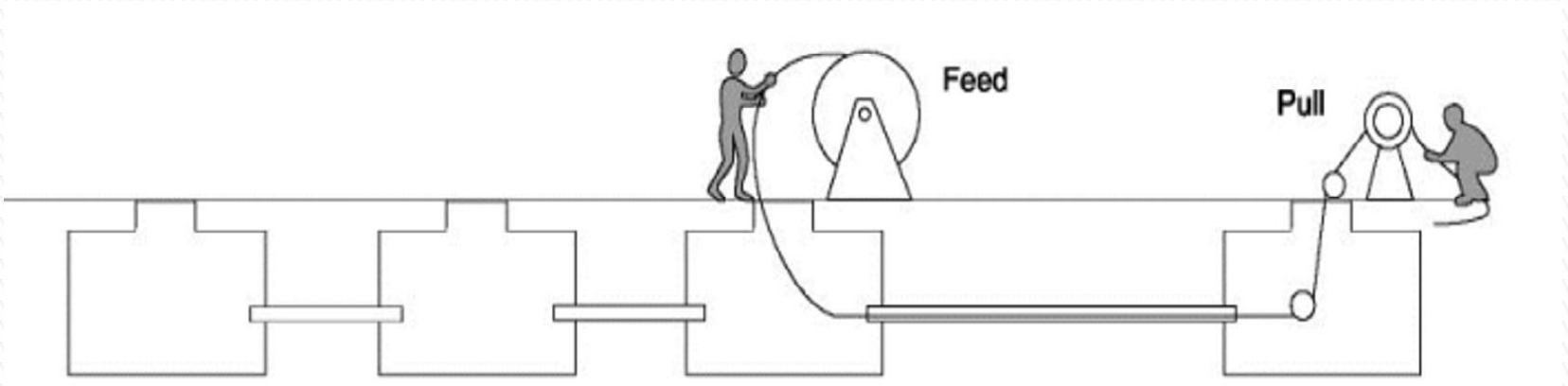


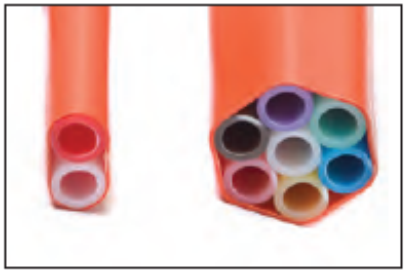
Figure – Underground Cabling Installation by pulling method

Micro Duct System

Micro Duct System Tube Bundle

Direct Bury metal free (DBmf) - Thickwall

DBmf Heavy-Wall Microduct Bundles



All these bundles have simplicity and strength. They have exceptional toughness and crush resistance and can be directly buried without the need for additional protective closures at branch-off points, or inline connections. The individual microducts are so strong that the outer sheath does not need to be protective in design, but simply holds the bundle together. The individual tubes can be joined by Protected and Directly Buried rated connectors (page 66-68). This solution is easy to use, quick to install and will reduce the Total Cost of Ownership long term.
The 1, 2 and 3 way bundles are also suitable for slot cut installations.

Example configuration

Micro-trenching

Figure – Micro trenching deployment technique

Duct and Microduct Installation

Figure – Protected microduct laid in open trenches

Air Blowing

Figure – Air blowing of microducts

Optical cable handling during installation

Figure – Splice closure and slack storage

Figure – Optical fiber splicing

Optical cable handling during installation

Commissioning

- Record all steps and test results.
- An initial visual inspection - damaged during transport and manipulation.
- Test with OTDR
- Test with OPM

Optical cable handling during installation

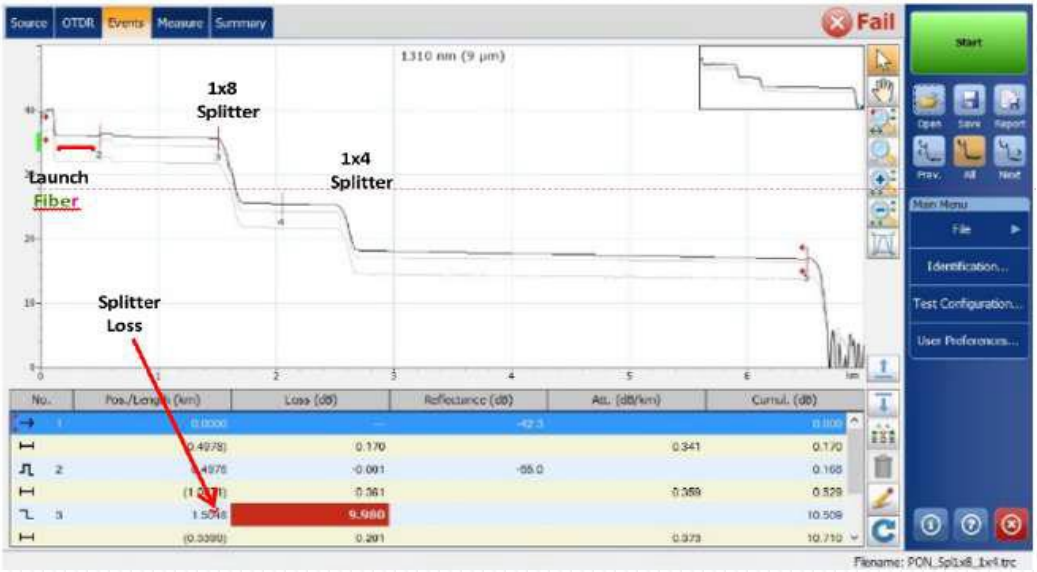


Figure – Sample OTDR Trace

Figure – OPM Measurement

FTTH Test Guidelines

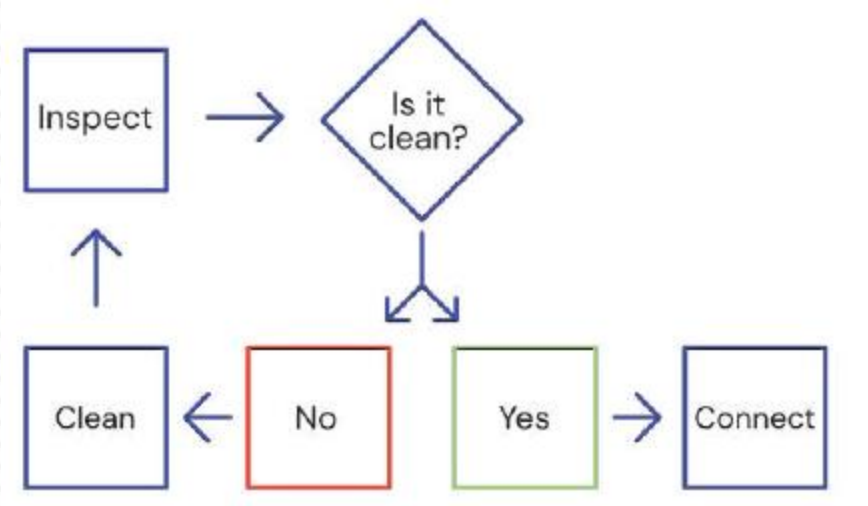


Figure – Connector mating decision tree.

FTTH Test Guidelines

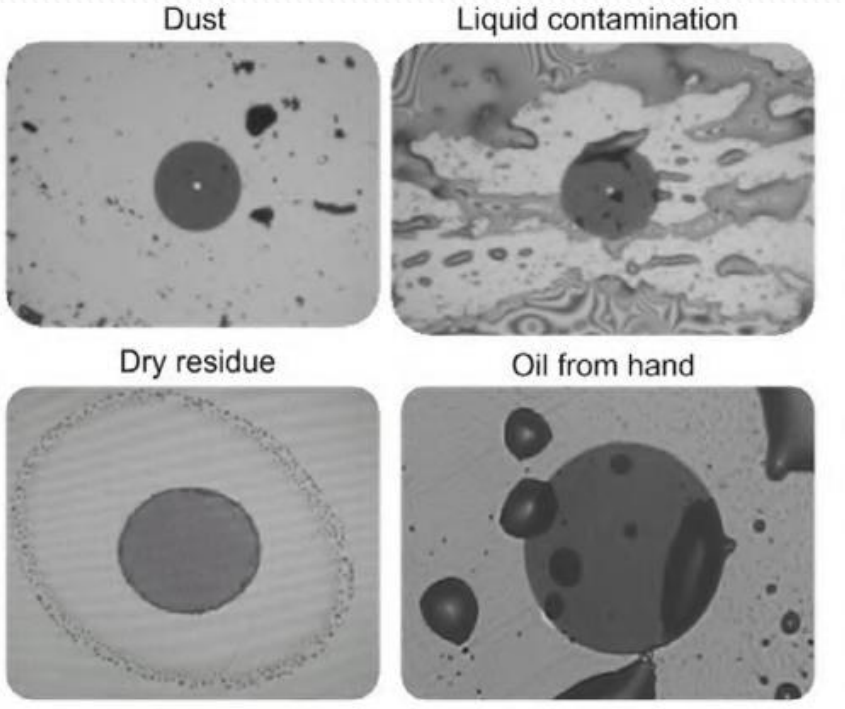


Figure – Appearance of various contaminants on a connector end face.

Sample Power Meter Test Results

4. Aerial Fiber Optimization

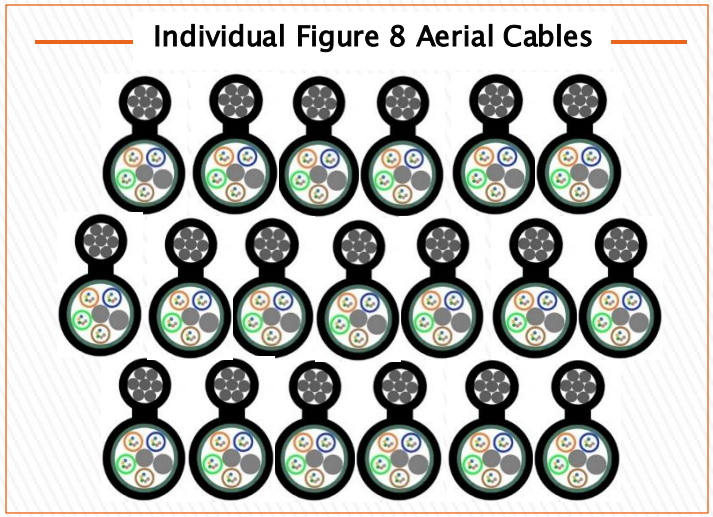
RESOLVE AERIAL FIBRE OPTIC CABLE & Right of Way (RoW) Issues In Mandalay

Credit : OpenAI

Problem of Uncontrolled Aerial Fibre

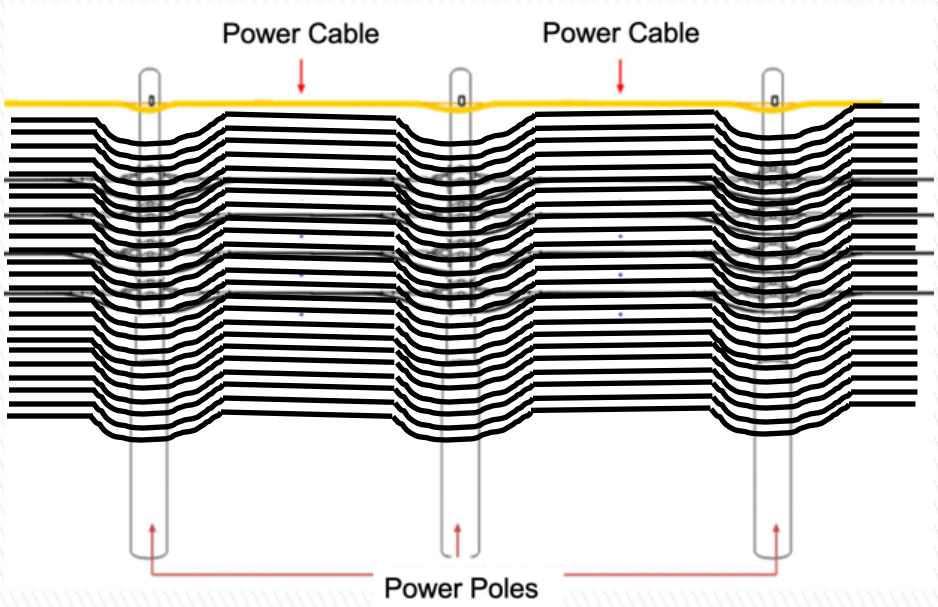
(1)Lack of Standards,
(2) Professional Discipline and Cable Management

without Standards
'very messy' installations.



Solution
- Need Cable Management
for Multiple RoW Concession Holders

Multiple Figure-8 Aerial Fibre Cables Pole Mounted

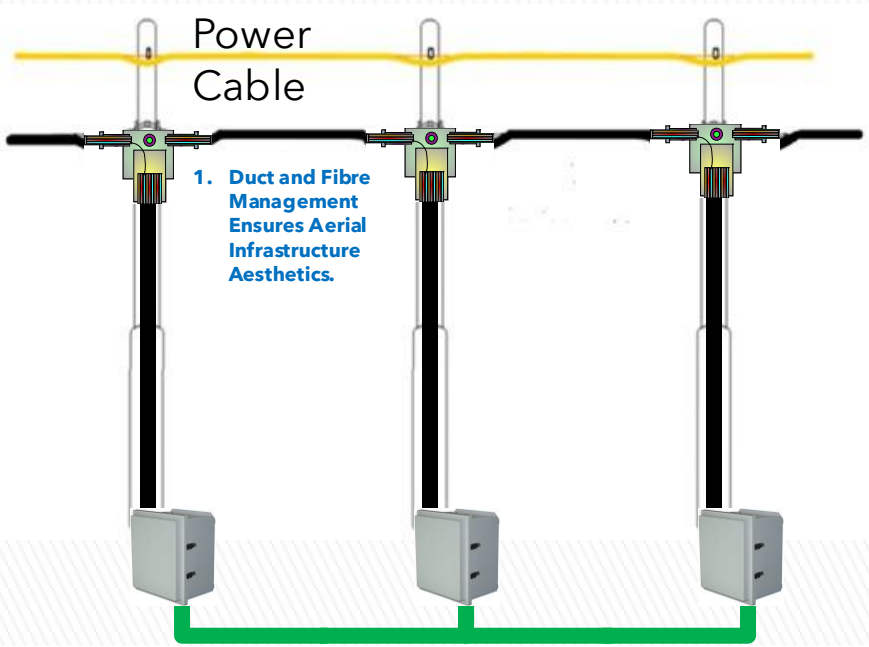


misconception : N x Aerial ROW holders = N x Aerial Cables !

Main Issues

- **Cable Management Issue.**
- Untidy Cables,
- Increasing Cable
- Poles stressed & misaligned .
- Safety issues
- Manpower intensive
- Expensive due to overbuild

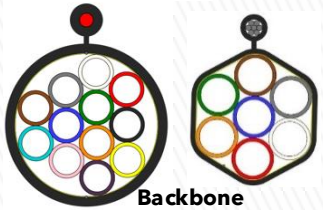
MicroDuct & MicroFibre Solution



2. Correct Termination Cabinets (or Manhole) Positioning aids future Migration to UG Duct.

MicroDuct

Last Mile Aerial Duct



Backbone Aerial Duct

Underground (UG) Duct

Aerial ADSS Duct Blown Microfibre Innovation

ADSS= All Dielectric Self Supporting

National Development Objectives

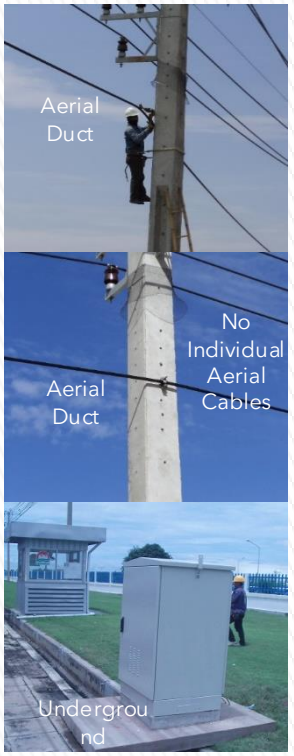
- Multiple ROW - fast Broadband Services Deployments
- Fair Market Collaboration
- Future Proof Network.
- Aerial Fibre deployment 'Discipline' without the mess seen
- Reuses existing Aerial Fibre for Rural Broadband

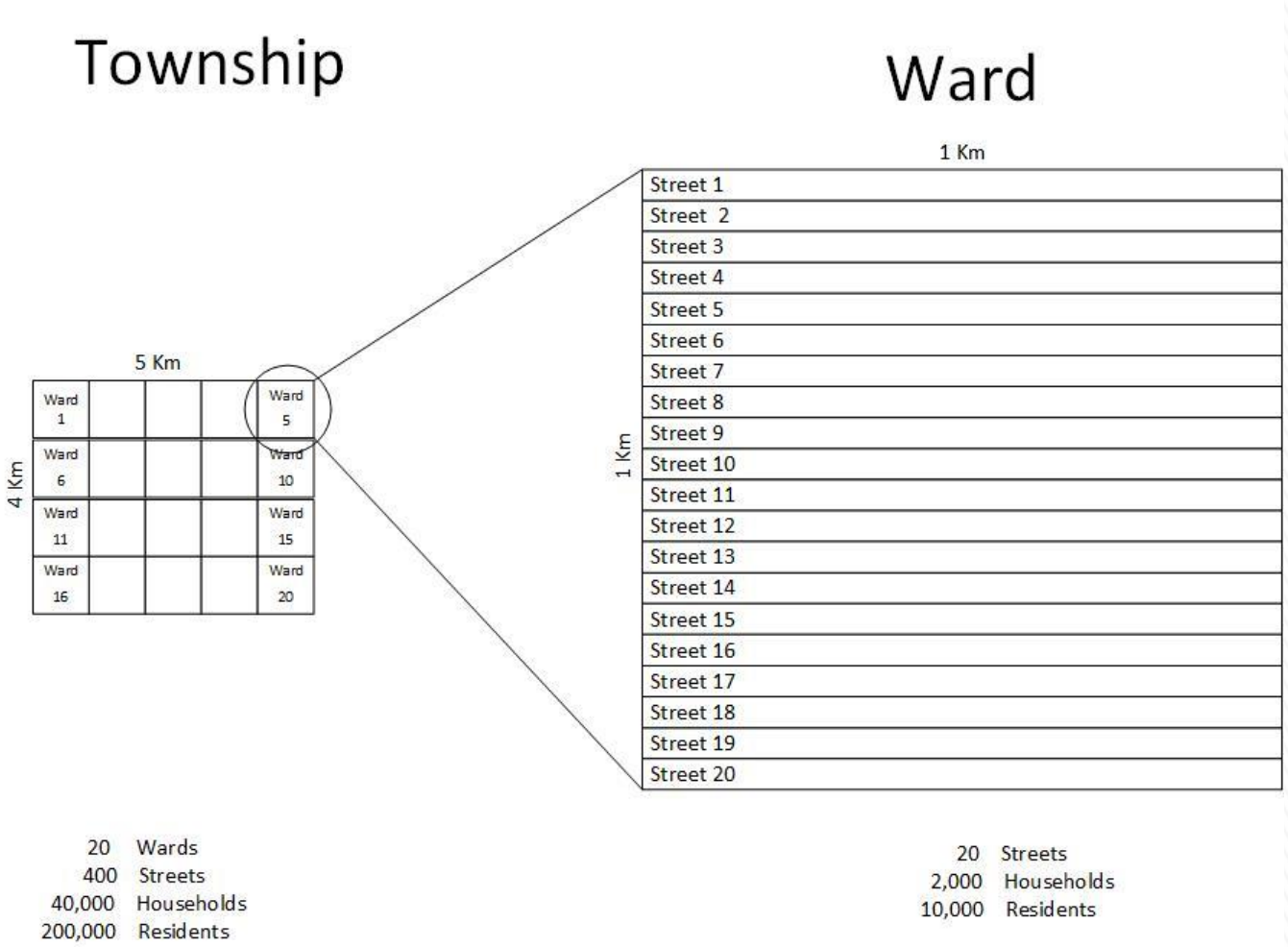
Faster, Cheaper, Lighter, Smaller

- One time Cost for aerial duct
- Future Low cost cables added by blowing
- Cost saving and time.
- Good cable management,
- Less Wind Loading
- Easy Branch out
- Easy expansion
- Old Telecom Poles –reuse in Rural,
- Better visual impact on the city.

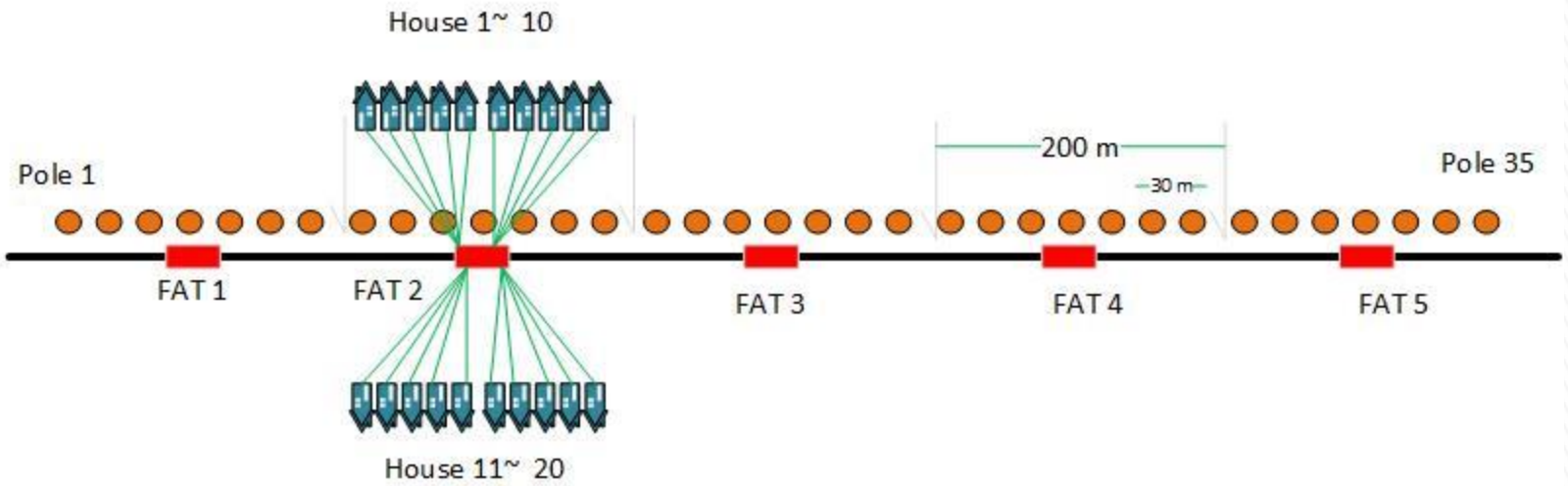
Shared Infrastructure & ROW Concept

1. **Share Investments.**
2. **Build, Operate, Transfer** (BOT) Model with Authorities.
3. 7-way sub-duct of an Aerial
4. Single **30 Year ROW**.
5. Authorities Benefits
    1. a Sub-Duct and Fibre Cable - Free of Charge.
    2. a monthly ROW Fee per km per Sub-Duct



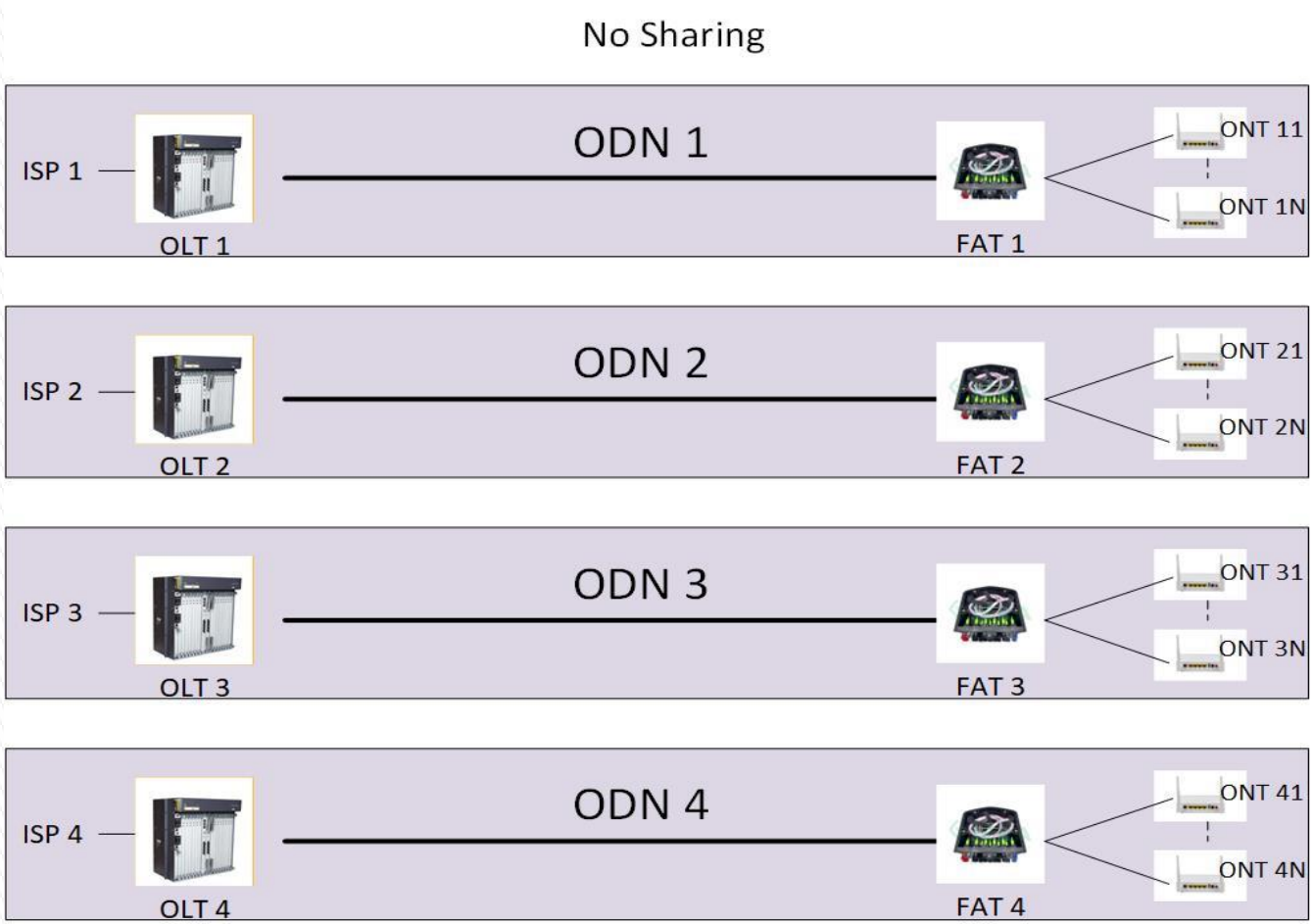

Township
Ward
5 Km
4 Km
Ward 1
Ward 5
Ward 6
Ward 10
Ward 11
Ward 15
Ward 16
Ward 20
1 Km
1 Km
Street 1
Street 2
Street 3
Street 4
Street 5
Street 6
Street 7
Street 8
Street 9
Street 10
Street 11
Street 12
Street 13
Street 14
Street 15
Street 16
Street 17
Street 18
Street 19
Street 20
20 Wards
400 Streets
40,000 Households
200,000 Residents
20 Streets
2,000 Households
10,000 Residents

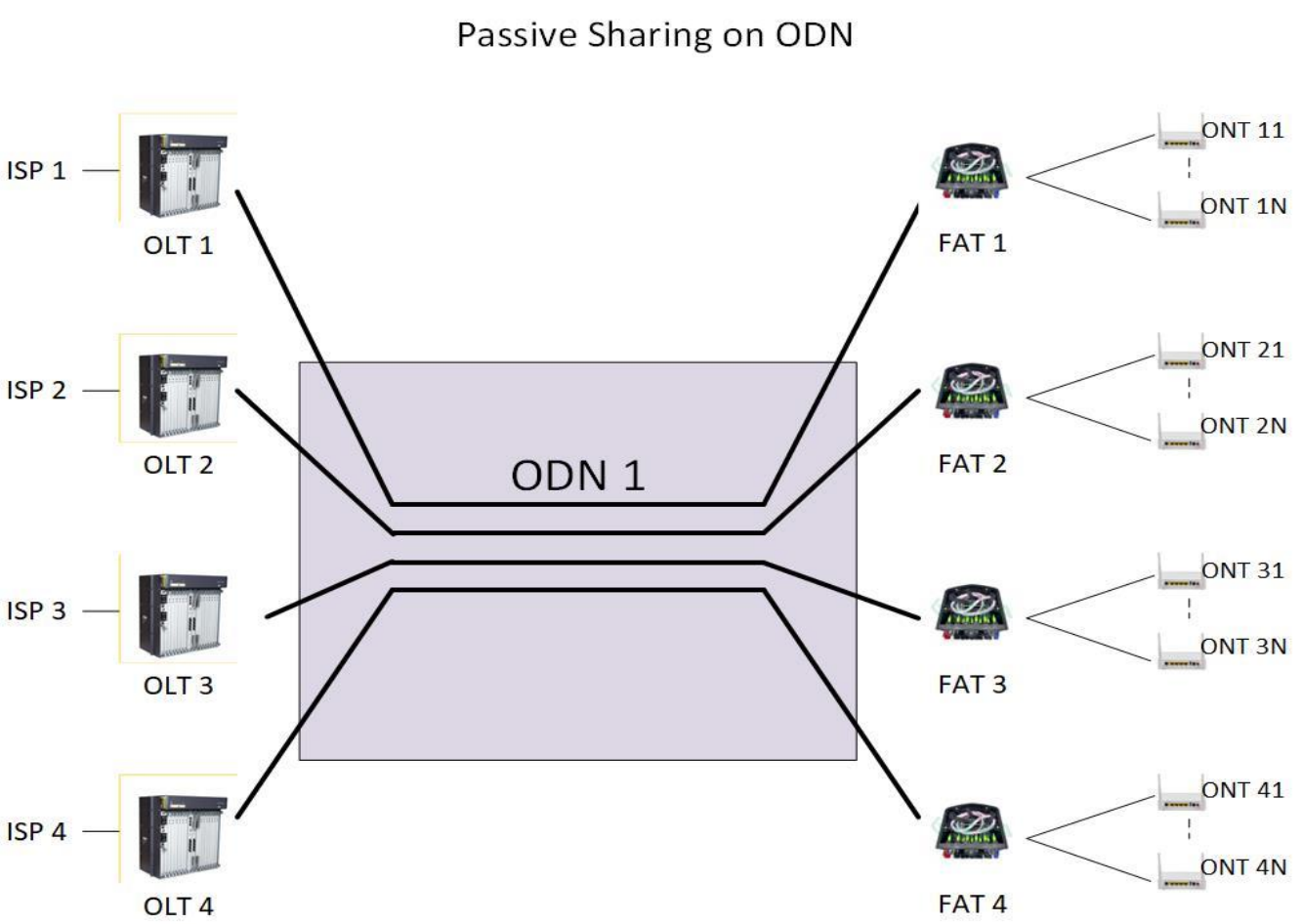
Street

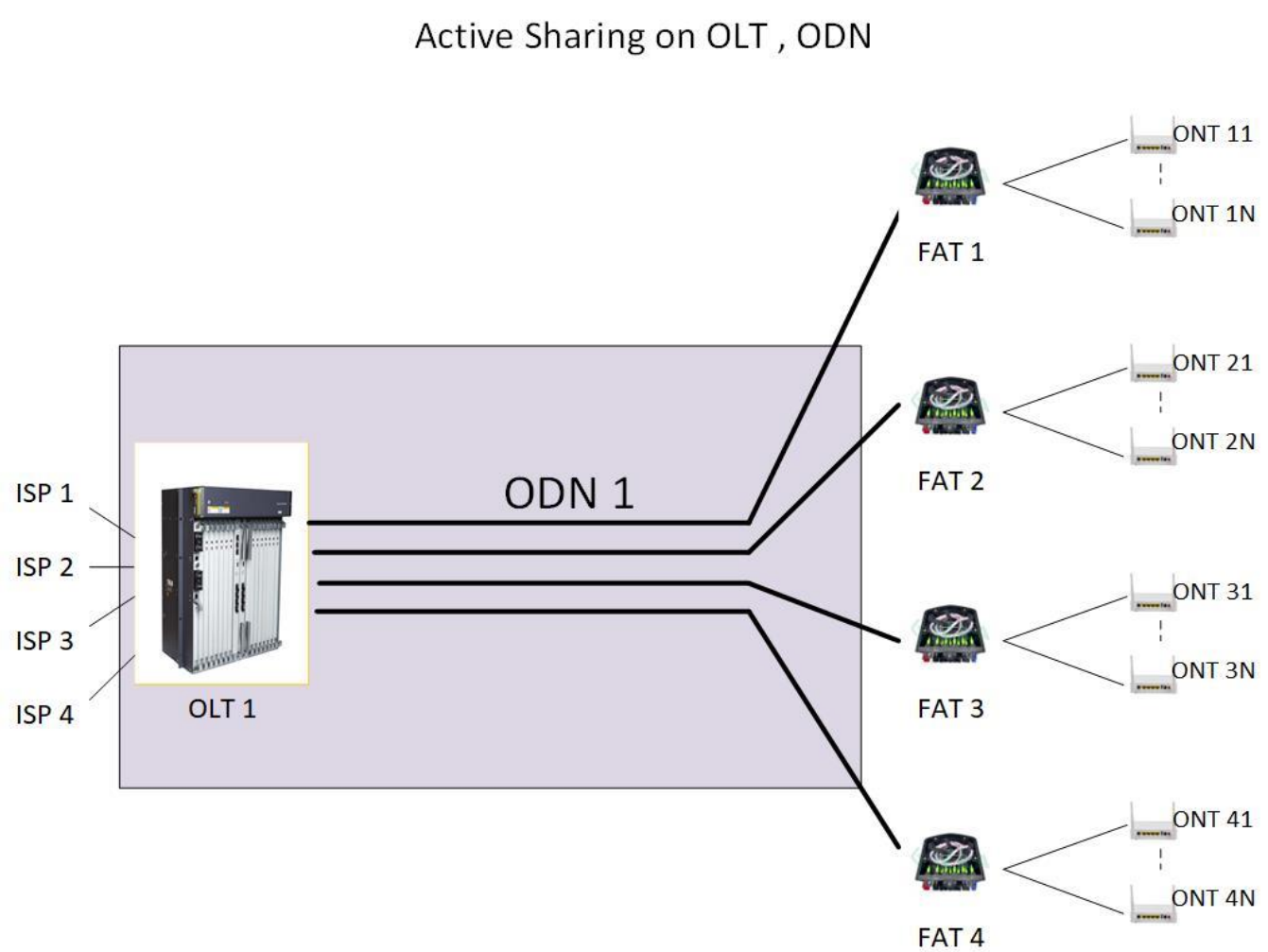


100 Households
500 Residents
5 FATs (1:N splitters)
35 Poles

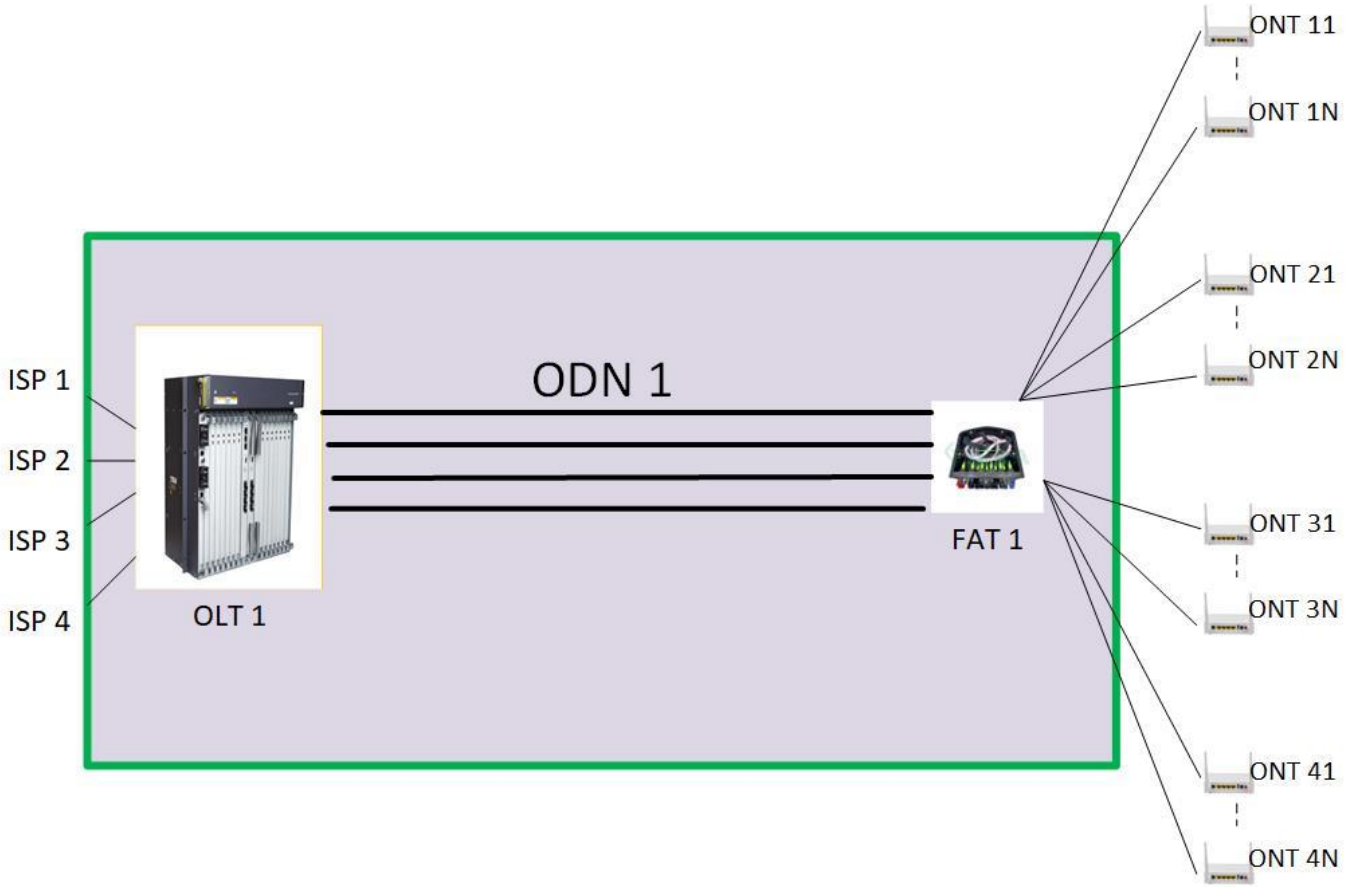
1000 m


No Sharing
ISP 1
OLT 1
ODN 1
FAT 1
ONT 11
ONT 1N
ISP 2
OLT 2
ODN 2
FAT 2
ONT 21
ONT 2N
ISP 3
OLT 3
ODN 3
FAT 3
ONT 31
ONT 3N
ISP 4
OLT 4
ODN 4
FAT 4
ONT 41
ONT 4N


Passive Sharing on ODN
ISP 1
ISP 2
ISP 3
ISP 4
OLT 1
OLT 2
OLT 3
OLT 4
ODN 1
FAT 1
FAT 2
FAT 3
FAT 4
ONT 11
ONT 1N
ONT 21
ONT 2N
ONT 31
ONT 3N
ONT 41
ONT 4N


Active Sharing on OLT , ODN
ISP 1
ISP 2
ISP 3
ISP 4
OLT 1
ODN 1
FAT 1
FAT 2
FAT 3
FAT 4
ONT 11
ONT 1N
ONT 21
ONT 2N
ONT 31
ONT 3N
ONT 41
ONT 4N

Active Sharing on OLT , ODN , FAT

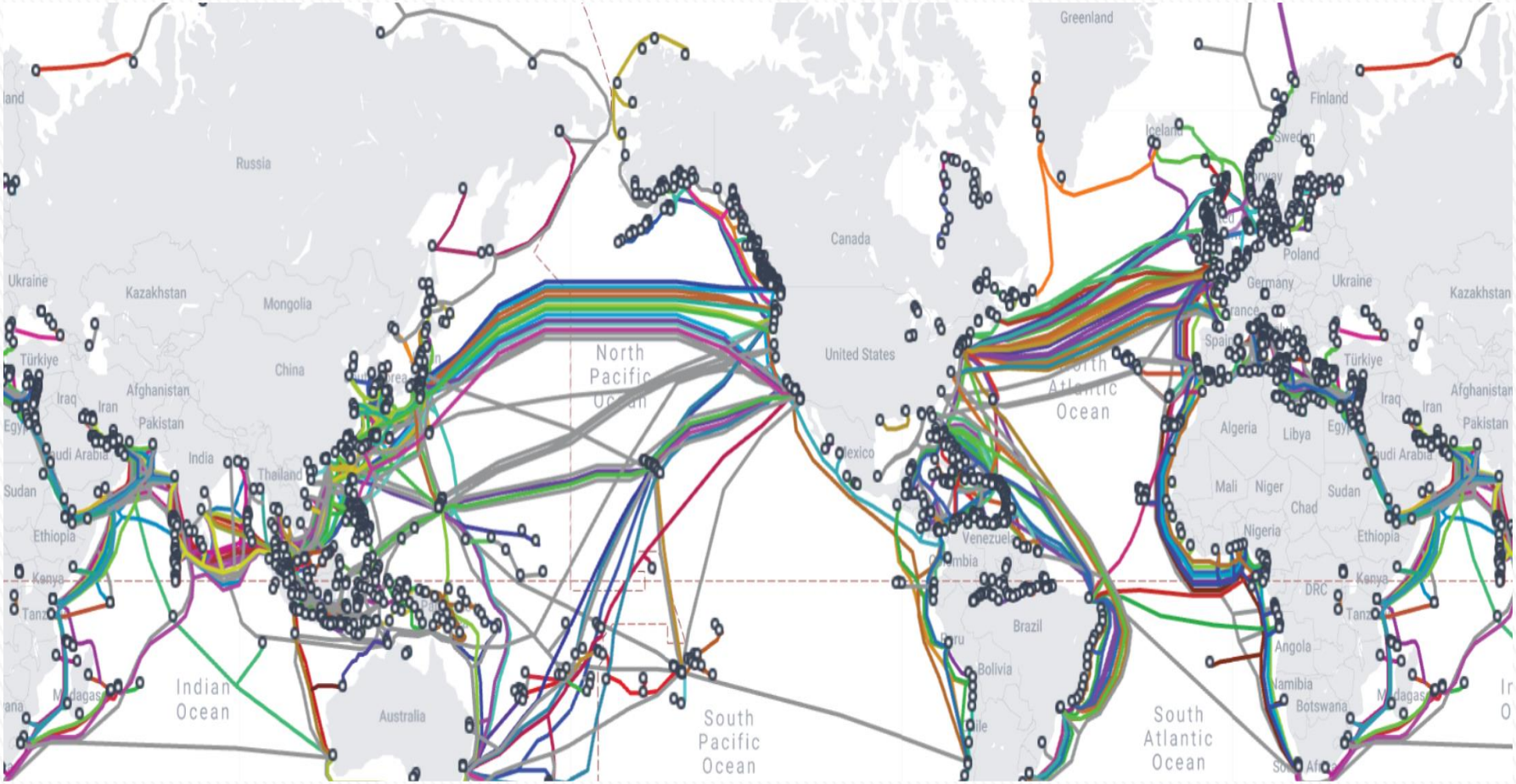


5. Undersea Fiber Communication System

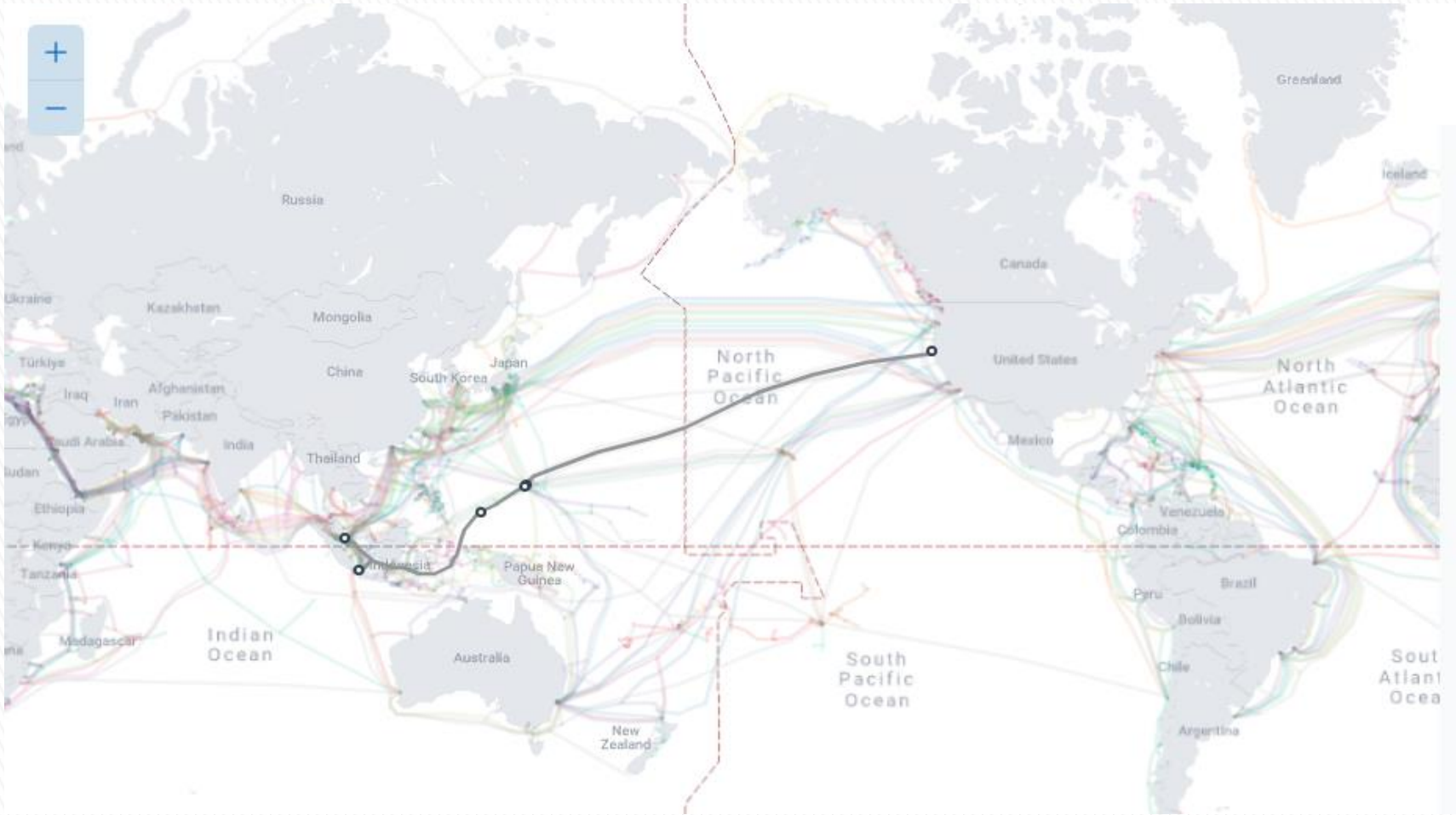
Presentation of Submarine Fiber Communication

1. Submarine cable are transporting a very high capacity per fiber pair at a 200 Gbps channel
2. Submarine cable are providing high reliability ensure by 25 years of design life
3. Low traffic latency (Time needed for transmission over submarine cable between USA and Aisa is only 30 millisecond)
4. Low Cost when it is compared to Satellite system

Submarine Cable Map



Sample Submarine Cable Route



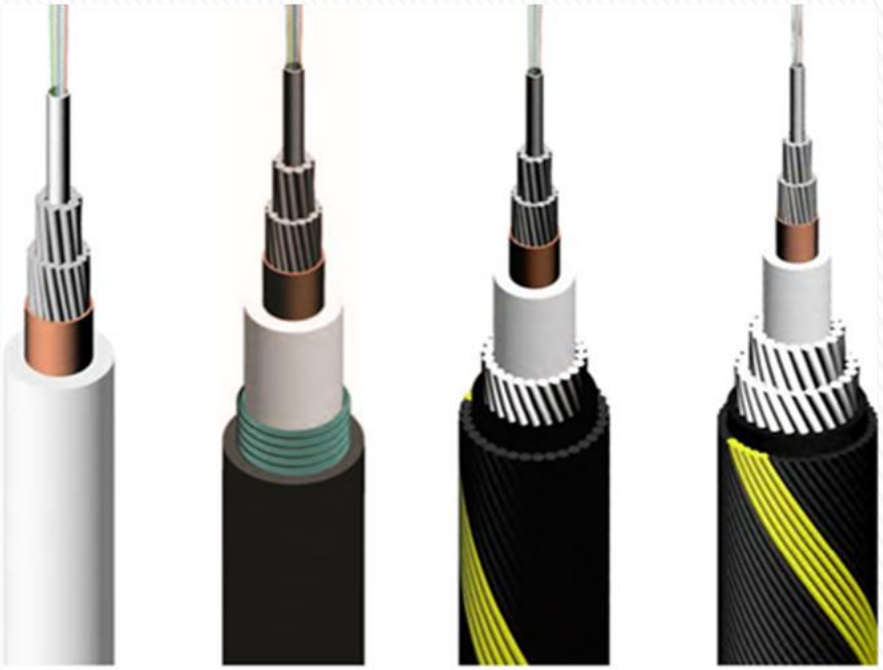
Echo submarine cable information

- Cable Name = Echo
- RFS = 2025 Q4
- Cable Length = 17,184 Km
- Cost = 1.7 Billion USD
- Owner = Google, Meta
- Landing Point = (Changi North, Singapore, Eureka, CA, US)

Configuration of Submarine Fiber Communication

1. The cable
2. The repeater
3. The brunching units (BU)
4. PFE (Power feeding equipment)
5. SLTE (Submarine Line Termination Equipment)
6. Network Management System

Submarine Fiber Cable



LW LWP SA DA

Submarine Fiber Cable

Light Weight (LW) cable adopts inner vault steel wires design with polyethylene (PE) extrusion outside. The LW cable can be deployed to 8,000m water depth.

Light Weight Protected (LWP) incorporates an additional outer polyethylene sheath on the LW cable. The LWP cable is suitable for deployment in the environment that marine animal bites and down to 7,000m water depth.

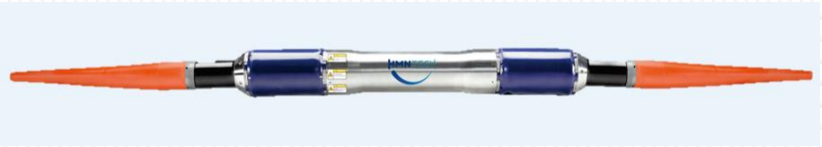
Single Armor (SA) equips a single layer of high strength galvanized armor wires at the external of the LW cable. The SA cable can be deployed & recovered at buried areas and risky regions with bottom trawling fishing etc. down to 2,000m water depth.

Double Armor (DA) adds two layers of high strength galvanized armor wires at the external of the LW cable. The DA cable is suitable for shallow water within 600m water depth where anchors can reach and abrasion might be a risk.

High Fiber Count
4 to 32 fiber pairs repeater to meet the transmission requirement.

Ultra-long Distance
High output optical power and low noise figure enable up to 160km span in a repeatered system, and support up to 16,000km in transoceanic system.

High Reliability
Utilize pressure-resistant and anti-corrosion titanium alloy housing, high-sealing structural design and high reliability redundancy design to ensure stable operation at 8,000m water depth for 25 years.



The Repeater

High Fiber Count
Up to 32 fiber pairs for different network applications, meet the needs of Large-capacity transmission.

Flexible Configuration
Support traffic allocation at different levels (Fiber/Spectrum) to enhance networking flexibility.

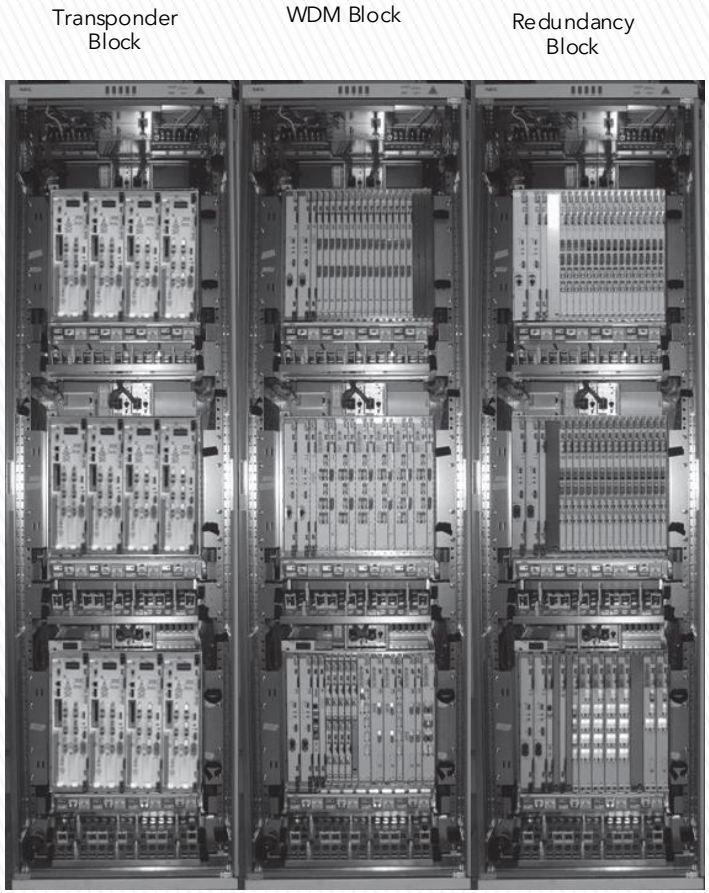
High Reliability
Utilize pressure-resistant and anti-corrosion titanium alloy housing and high-sealing structural design, and high-reliability redundancy backup design to ensure stable operation at 8,000m water depth for 25 years.

The Branching Unit

- High precision constant current supply
  (2 A max)
- Maximum output Voltage (10 kV ~ 18 kV)
- Output Power (27 kW)
- Multiple interlock to ensure personal safety
- Emergency Power Off Button
- Redundancy
- Used in repeatered submarine cable system

PFE
(Power feeding equipment)

- Technologies for Ultra-large/ Ultra Long
- DWDM Technology
- Optical Signal Modulation (QPSK)
- Error Correction (FEC)
- Wavelength Dispersion compensation
- ROADM for Branching Unit
- N:1 Redundancy (Switching from working unit to protection unit)

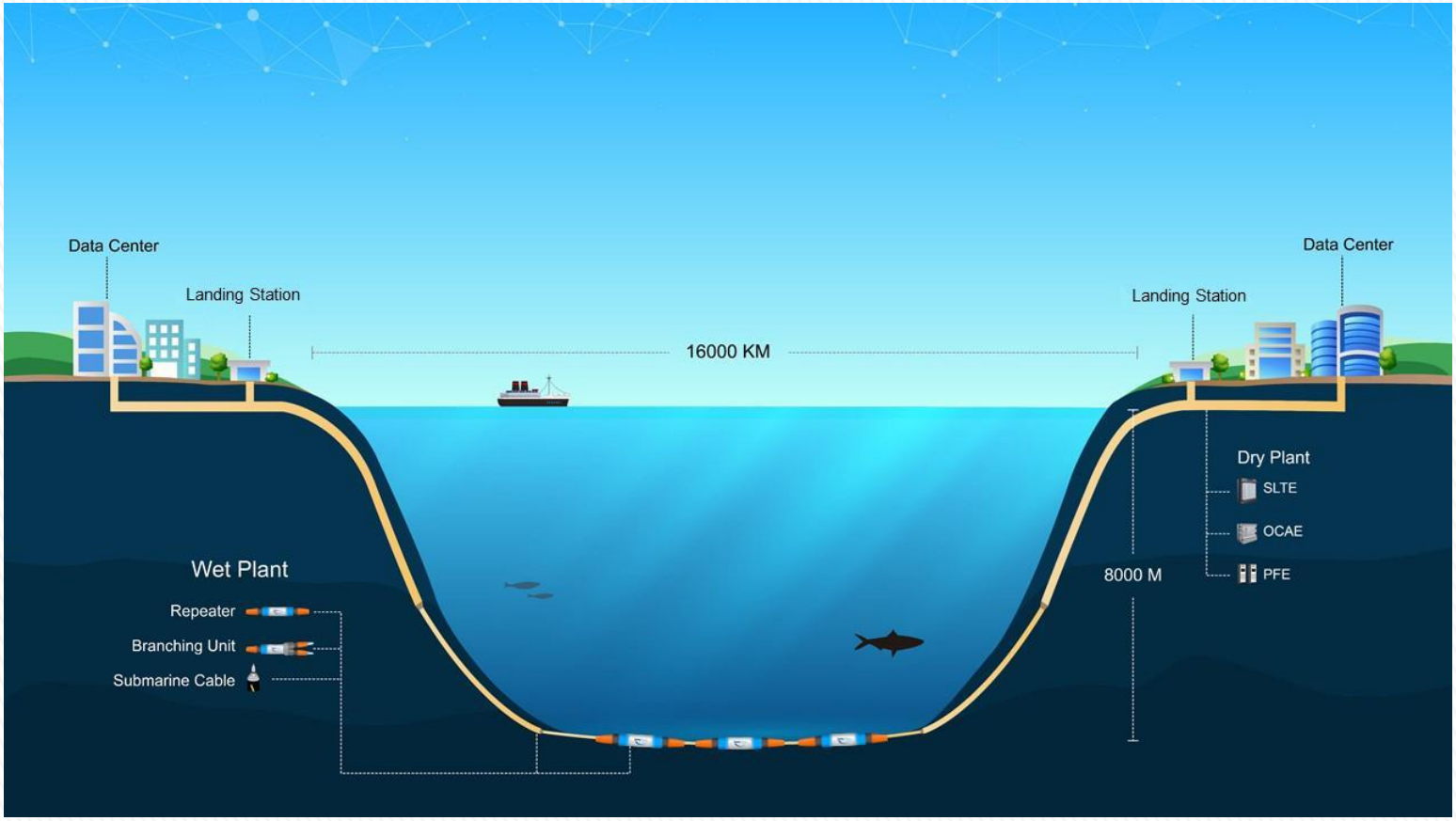


SLTE (Submarine Line Terminal Equipment)

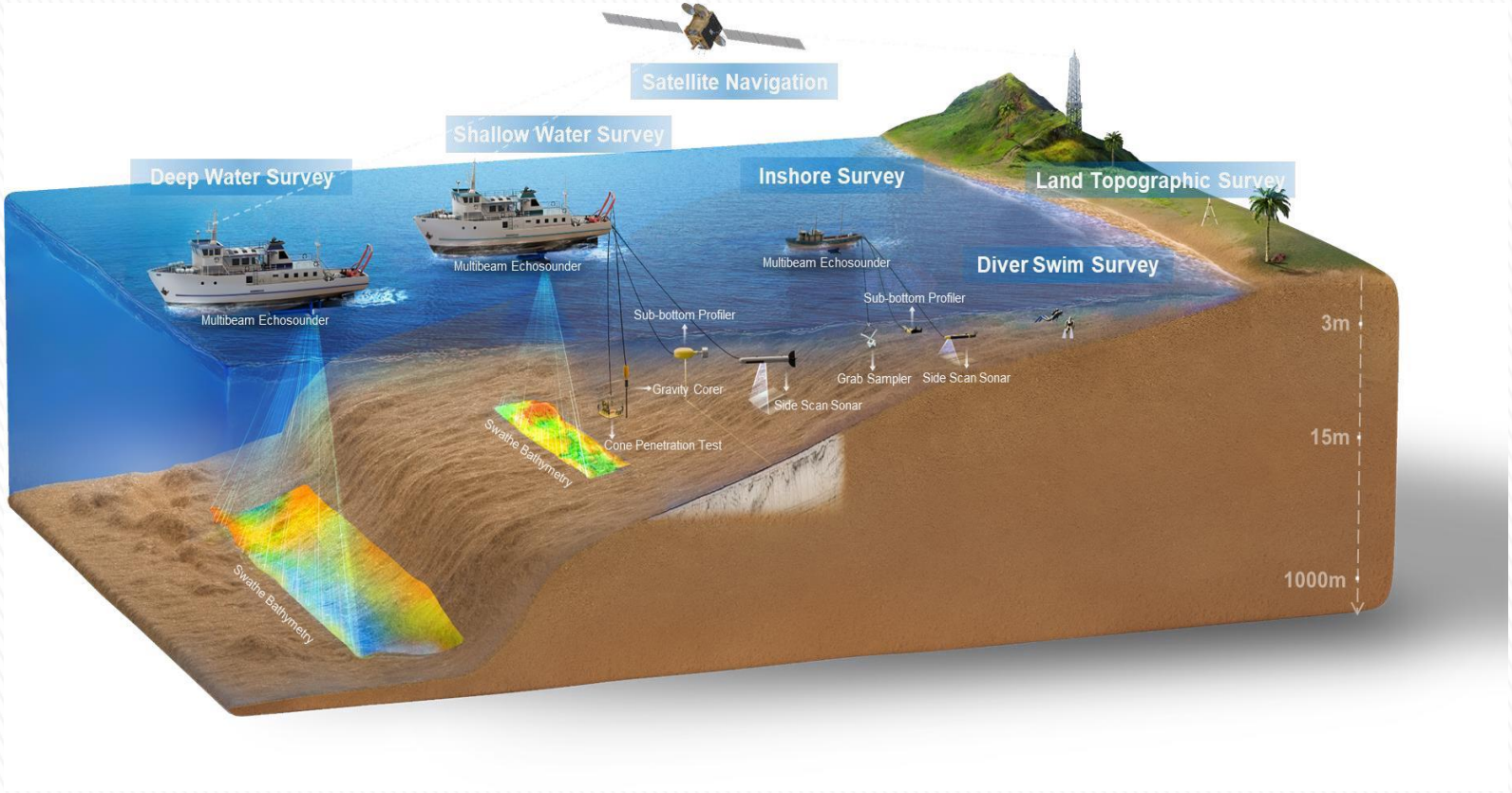
- Supervisory System
- Overall system monitoring
- Repeater Performance Monitoring

Network Management System

Dry Pant and Wet Plant Components



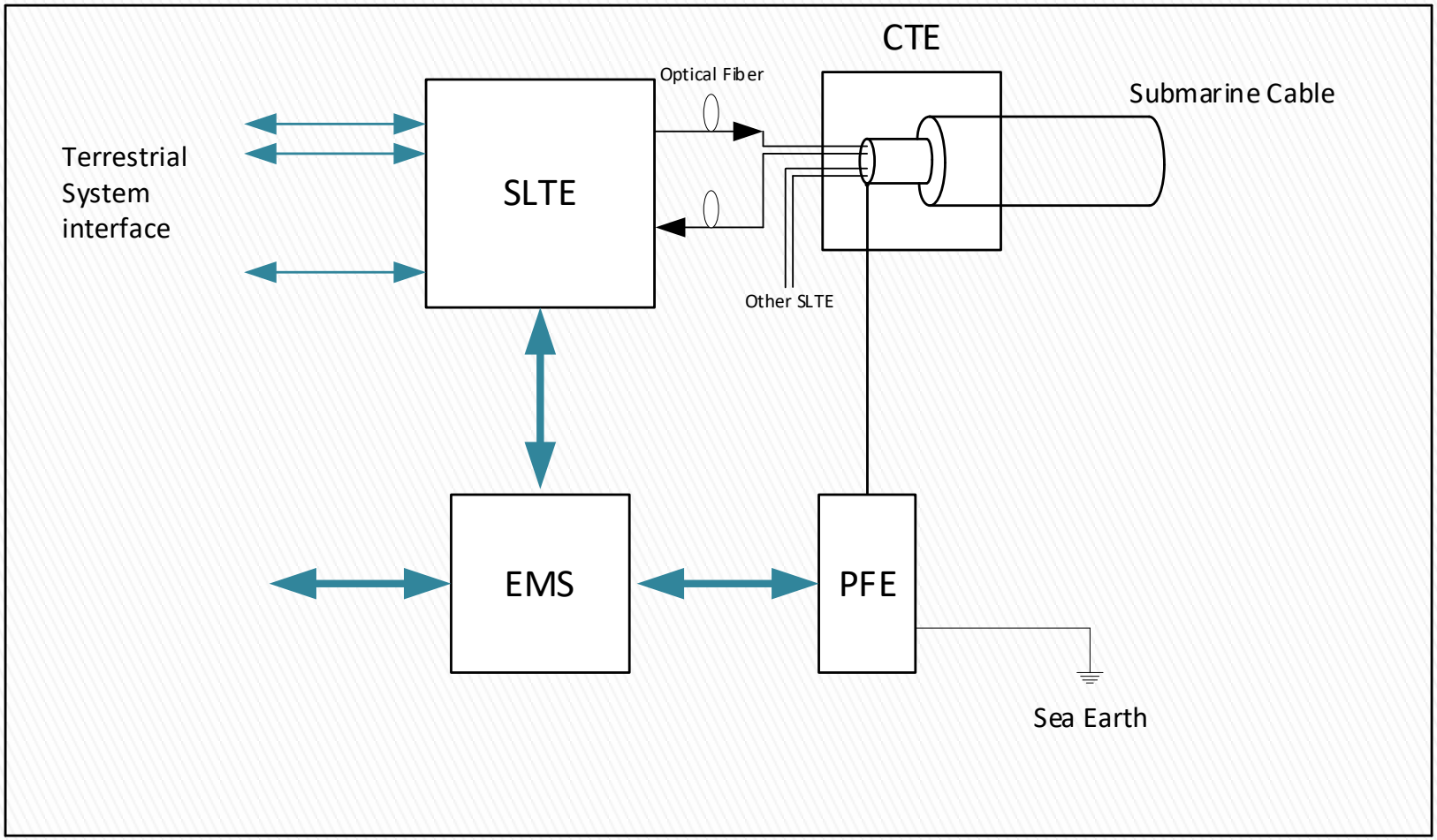
Basic Submarine Survey Technics



Basic Submarine Survey Technics

- **Bathymetry:** multibeam echosounders (20% overlap).
- **Side-Scan Sonar:** detect reefs, rocks, wrecks, cables, pipelines (100% coverage).
- **Seismic Profiling:** identify seabed sediment/bedrock.
- **Seabed Sampling:** gravity cores & grab sampling (~10 km intervals).
- **Cable Crossings:** magnetometer survey at crossing points.
- **Burial Assessment (BAS):** Cone Penetration Tests (CPTs) every ~4 km (20m–1000m depth).
- **Navigation/Positioning:** RTK GPS, GcGPS, DGPS, USBL as needed.

Basic Submarine Terminal Configuration



Future Evolution of Submarine Network

- The search for even higher capacity is a permanent driver
- 99% of Network Data is sent over subsea network
- There is no Plan B in submarine network so far
- Transmission technology will be 200G, 400G and 500G
- Multicore Fiber (current single mode fiber limitation is 100 Tbps)
- Special Division Multiplexing
- Dual Cable Design

Dual Cable System


APNIC
FOUNDATION


MMIX
Myanmar Internet Exchange


isif asia

THANK YOU!