Submarine Cable Systems Engineering Training

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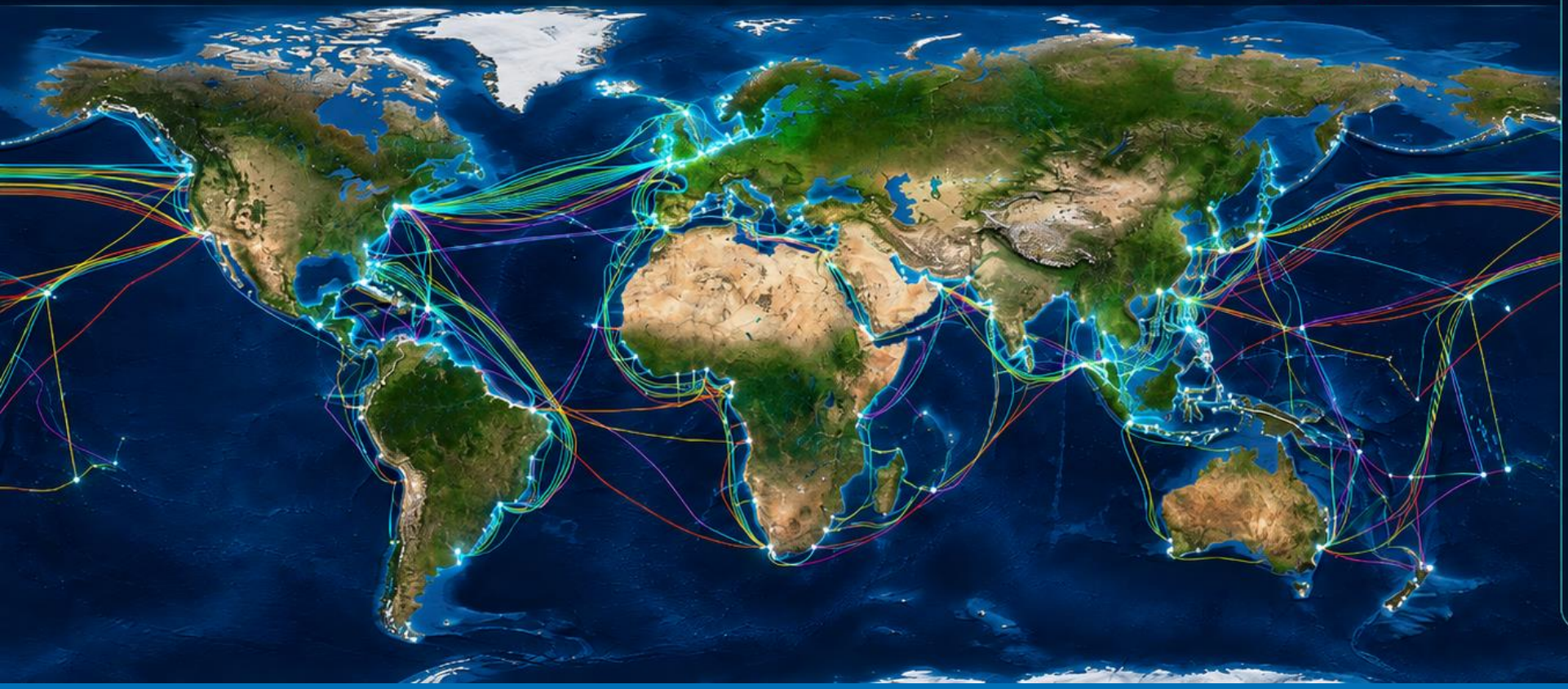
Global Submarine Cable Systems

GLOBAL SUBMARINE CABLE SYSTEMS

The Backbone of Global Connectivity

Submarine cable systems are the backbone of the global Internet and international telecommunications network, carrying approximately 99% of all international data traffic. They connect countries and continents using fiber-optic cables laid on the ocean floor, enabling high-speed, low-latency communications. As of 2026, there are approximately 570 active (in-service) submarine telecommunications cable systems operating worldwide. This number changes every year as new systems enter service and older systems are retired. The engineered design life of a submarine cable system is 25 years.



PRIMARY FUNCTIONS OF A SUBMARINE CABLE SYSTEM

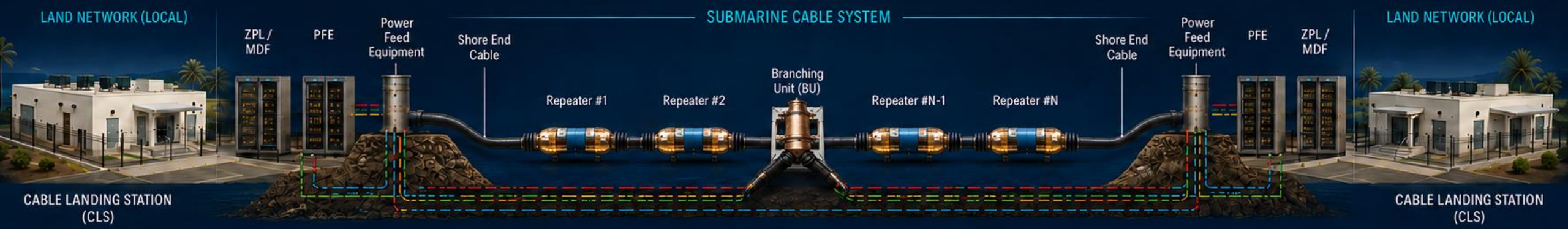
1. Internet Connectivity
2. Telecommunications
3. Data Center Interconnection
4. Financial Services
5. Government and Defense Communications
6. Scientific Research
7. Connecting Islands and Remote Regions

End-to-End Submarine Cable System Architecture

END-TO-END SUBMARINE CABLE SYSTEM ARCHITECTURE

RELIABLE · RESILIENT · CONNECTED · POWERED

Connecting the World. Powering the Cloud. Securing the Future.



TERRESTRIAL NETWORK
Customer & Digital Ecosystem (PoP / DC)

SUBMARINE INFRASTRUCTURE
DCI (Open Cable System)

TERRESTRIAL NETWORK
Customer & Digital Ecosystem (PoP / DC)

1. CABLE LANDING STATION (CLS)

- Secure facility housing network equipment
- Environmental control
- Power & security systems

2. ZPL / MAIN DISTRIBUTION FRAME (MDF)

- Cross-connect interface
- Customer connections
- Traffic management

3. POWER FEED EQUIPMENT (PFE)

- Converts AC to regulated DC
- Feeds power to SLTE
- Monitors system health

4. SHORE END CABLE

- Connects CLS to seabed
- Transition from terrestrial to submarine environment
- Buried for protection

5. REPEATERS (SLTE)

- Amplify optical signals
- Restore signal quality
- Spaced 50–100 km apart typically

6. BRANCHING UNIT (BU)

- Enables network branching
- Adds flexibility & resilience
- Supports future expansion

7. SUBMARINE CABLE

- Optical fibers for data
- Power conductors
- Protective layers
- Laid on the seabed

8. SYSTEM MONITORING & CONTROL

- 24/7 network monitoring
- Fault detection & alarm
- Performance management
- Rapid response coordination

BUILT FOR RELIABILITY
Engineered for 25+ years of operational life

ALWAYS ON
Continuous monitoring and rapid fault response

GLOBAL CONNECTIVITY
Enabling seamless communication across continents

SCALABLE & FUTURE-READY
Designed for capacity growth and emerging technologies

SUBMARINE CABLE SYSTEM DESIGN

A COMPREHENSIVE, END-TO-END DESIGN PROCESS FOR RELIABLE, SCALABLE AND FUTURE-READY NETWORKS

1 NETWORK ARCHITECTURE

- Define system objectives and capacity
- Identify landing points and interconnection hubs
- Develop network topology and diversity

2 NETWORK ROBUSTNESS & PROTECTION SCHEMES

- Path diversity and ring topologies
- Branching units and mesh capabilities
- Failure scenarios and restoration planning

3 TRANSMISSION DESIGN

- Optical system design (capacity, reach, margins)
- Repeater spacing and power budget
- WDM and spectral efficiency planning

4 FUTURE PROOFING

- Scalable capacity and upgrade path
- Technology roadmap alignment
- Design for next-generation systems

5 ROUTE & CABLE STUDY & ENGINEERING

- Bathymetry and seabed analysis
- Hazards assessment and route optimization
- Cable type selection and protection strategy
- Marine engineering design

6 PERMIT STUDY & ACQUISITION

- Environmental and regulatory requirements
- Stakeholder consultation
- Permit application, review and approvals

7 TERMINAL STATION ENGINEERING

- Landing and site selection
- Civil, structural and architectural design
- Power, HVAC and security design
- Integration with network operations

RELIABILITY BY DESIGN | OPTIMIZED PERFORMANCE | SCALABLE & FUTURE-READY | ENVIRONMENTALLY RESPONSIBLE | COLLABORATIVE & COMPLIANT

Desktop Study (DTS)

DESK TOP STUDY (DTS)

THE FOUNDATION FOR A SAFE, RELIABLE AND PERMIITTABLE CABLE SYSTEM

The DTS serves to identify system risk and acts as the foundation for all future engineering and implementation of the submarine cable system.

KEY DTS & DESIGN CONSIDERATIONS

- Landing Points - CLS - terrestrial backhaul
- Beach and Inshore Approaches
- Maritime Boundaries
- Geopolitics - Contested Areas
- Cable Fault Data Base
- Deep Burial Required?
- Pre-Laid Shore Ends & Direct Landings
- Horizontal Directional Drilling necessary?
- Permitting & Fisherman Negotiations
- Natural and manmade obstacles
- Mineral/Oil & Gas exploration
- Cable selection
- Branching Unit deployments
- Other submarine cables
- Pipelines
- Unexploded Ordnance
- Cable / Pipeline Database
- Permitting and Other Seabed User Agreements
- Piracy, Icebergs, other risks

OPTIMIZED ROUTES
Minimizing risk and latency

RISK MITIGATION
Avoid hazards and conflicts

REGULATORY COMPLIANCE
Permits and agreements

DATA DRIVEN
Leverage industry databases

STAKEHOLDER ENGAGEMENT
Users, regulators, communities

FUTURE READY
Scalable and resilient design

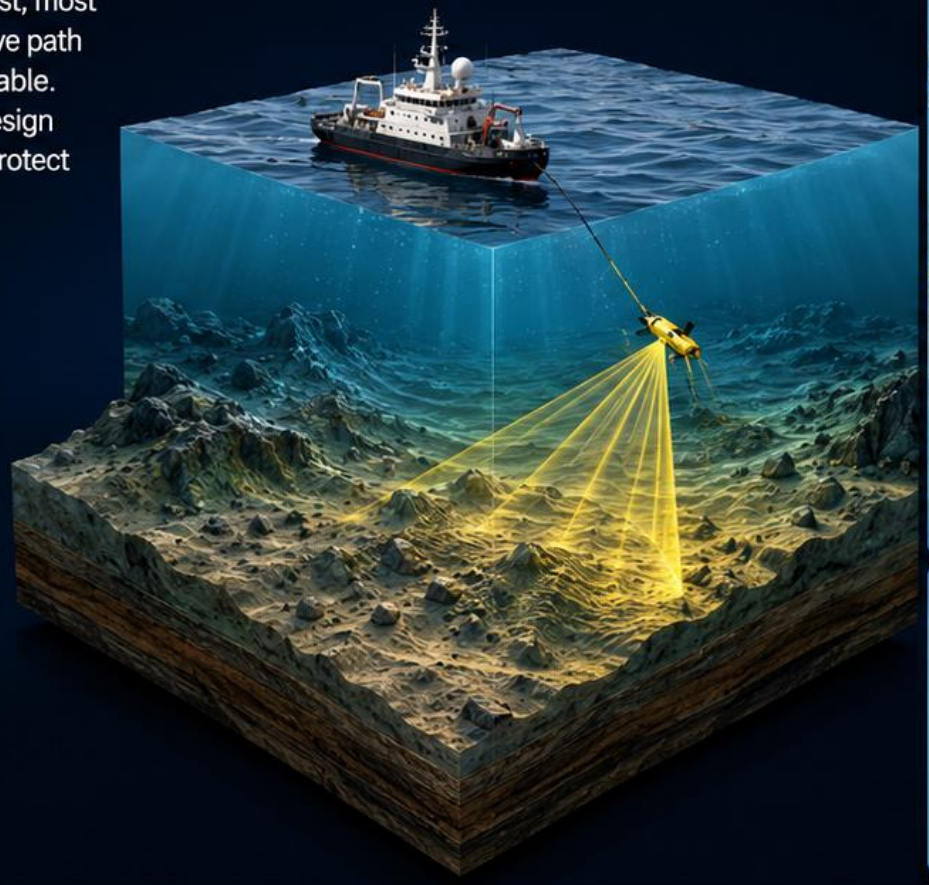
Marine Route Survey

MARINE ROUTE SURVEY

A marine route survey for a submarine cable system is conducted to determine the safest, most technically feasible, and most cost-effective path for installing and operating an undersea cable. The survey provides the data needed to design the route, minimize installation risks, and protect the cable throughout its operational life.

MAIN PURPOSES INCLUDE:

1. Seafloor Mapping
2. Seabed Characterization
3. Hazard Identification
4. Cable Burial Assessment
5. Route Optimization
6. Engineering Design Support
7. Environmental & Regulatory Compliance
8. Installation Planning
9. Risk Reduction



ANALYSIS OF RESULTS – FINAL ROUTE ENGINEERING

- Route Engineering
- Cable Armoring & Protection
- Burial Conditions
- Recommendation for Installation Procedures

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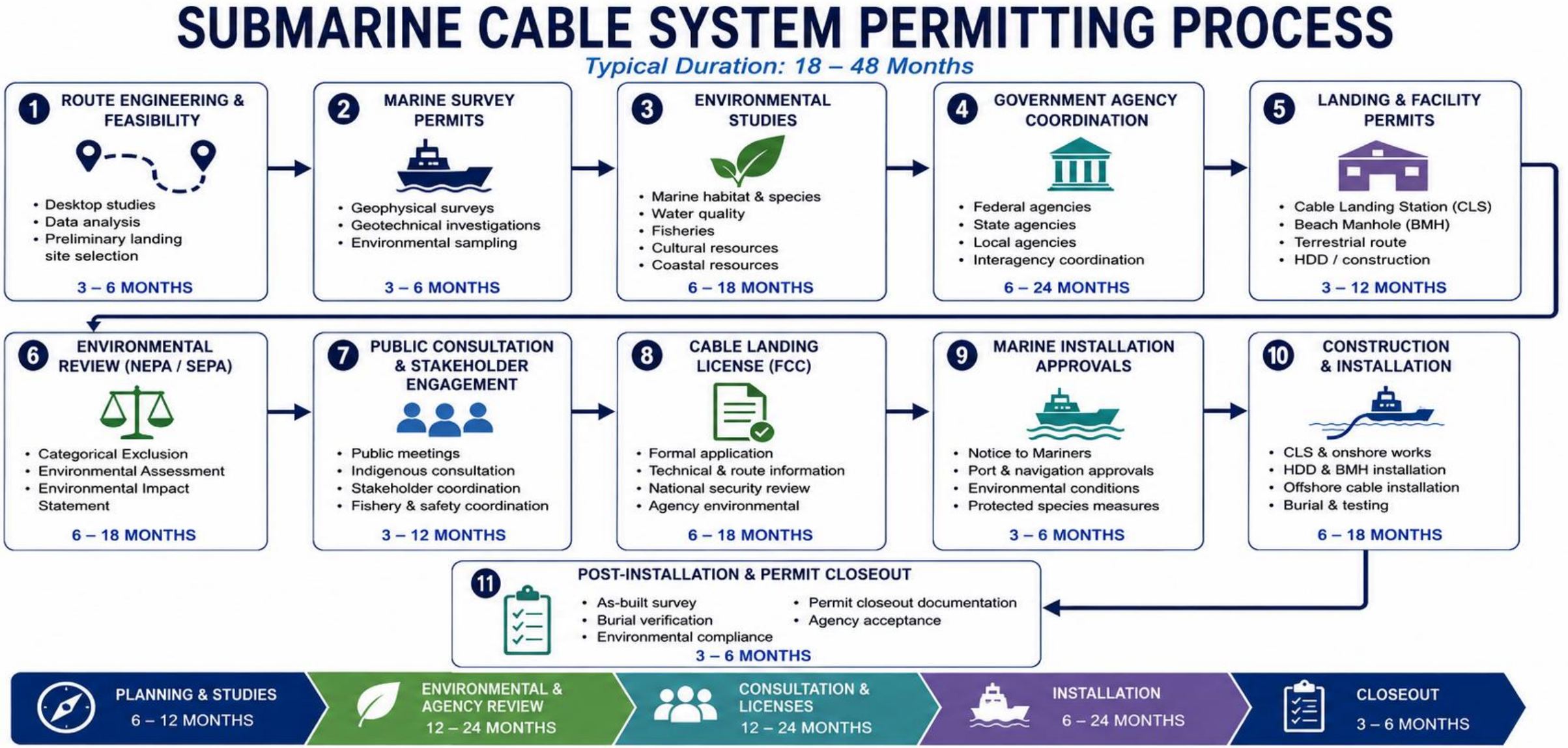
Permitting Process



Global Suppliers

GLOBAL SUBMARINE CABLE SYSTEM SUPPLIERS

TURNKEY • CABLE / WET PLANT • SLTE • PFE • INSTALLATION & REPAIR VESSELS • SYSTEM DEVELOPER & PROJECT MANAGEMENT

1 TURNKEY SUBMARINE CABLE SYSTEM SUPPLIERS

SUPPLIER	HEADQUARTERS
SubCom	USA
Alcatel Submarine Networks (ASN)	France
NEC	Japan
HMN Technologies	China
Xtera	UK / USA
Prysmian / NSW (Norddeutsche Seekabelwerke)	Italy / Germany
International Telecom (IT) Canada	Canada

Full end-to-end capability including system design, cable, repeaters, terminal equipment, PFE, SLTE, marine installation, commissioning and project management.

2 SUBMARINE FIBER-OPTIC CABLE / WET-PLANT SUPPLIERS

SUPPLIER	HEADQUARTERS
SubCom	USA
ASN	France
NEC	Japan
HMN Technologies	China
Prysmian / NSW (Norddeutsche Seekabelwerke)	Italy / Germany
Nexans	France
Hexatronic	Sweden
Hengtong	China
ZTT	China
LS Cable & System	South Korea

Manufacture of submarine fiber-optic cables (repeatered and unrepeatered) and associated wet-plant components.

3 SLTE – SUBMARINE LINE TERMINAL EQUIPMENT SUPPLIERS

SUPPLIER	HEADQUARTERS
Ciena	USA
Nokia (including former Infinera portfolio)	Finland
Xtera	UK / USA
NEC	Japan
SubCom	USA
ASN	France
HMN Technologies	China
Cisco	USA
Huawei	China

Optical transmission systems and SLTE for open and integrated submarine cable networks. Nokia includes the former Infinera portfolio (ICE coherent technology).

4 PFE – POWER FEED EQUIPMENT SUPPLIERS

SUPPLIER	HEADQUARTERS
SubCom	USA
ASN	France
NEC	Japan
HMN Technologies	China
Xtera	UK / USA
Spellman High Voltage Electronics	USA

High-voltage Power Feed Equipment (PFE) suppliers for repeatered submarine cable systems.

5 INSTALLATION, MAINTENANCE & CABLE-REPAIR VESSEL OPERATORS

OPERATOR	HEADQUARTERS	INSTALLATION	REPAIR / MAINTENANCE
SubCom	USA	✓	✓
ASN	France	✓	✓
Orange Marine	France	✓	✓
Global Marine	UK	✓	✓
OMS Group	Malaysia	✓	✓
KDDI Cable Ship & Subsea Engineering	Japan	✓	✓
NTT World Engineering Marine (NTT-WE/M)	Japan	✓	✓
International Telecom (IT) Canada	Canada	✓	✓
SBSS	China	✓	✓
E-Marine	UAE	✓	✓
Seaway7	Norway	✓	–
Jan De Nul	Belgium	✓	–
Van Oord	Netherlands	✓	–
Boskalis	Netherlands	✓	–

Marine installation, route survey, burial, maintenance and emergency cable repair services.

CONSOLIDATED SUPPLIER CAPABILITY MATRIX

COMPANY	TURNKEY SYSTEMS	CABLE / WET PLANT	SLTE	PFE	MARINE INSTALLATION	REPAIR / MAINTENANCE	NOTES
SubCom	✓	✓	✓	✓	✓	✓	(1)
ASN (Alcatel Submarine Networks)	✓	✓	✓	✓	✓	✓	
NEC	✓	✓	✓	✓	✓	✓	(1)
HMN Technologies	✓	✓	✓	✓	✓	✓	
Xtera	✓	✓	✓	✓	✓	✓	(2)
Prysmian / NSW (Norddeutsche Seekabelwerke)	✓	✓	–	–	Project dependent	Project dependent	(3)
Nexans	–	✓	–	–	–	–	(4)
Ciena	–	–	✓	–	–	–	–
Nokia (incl. former Infinera portfolio)	–	–	✓	–	–	–	–
Cisco	–	–	✓	–	–	–	–
Spellman High Voltage Electronics	–	–	–	✓	–	–	–
MARINE OPERATORS (see list above)	–	–	–	–	✓	✓	Marine Specialists

NOTES & KEY POINTS

(1) NEC historically uses chartered/partner marine resources rather than a vertically integrated fleet model. Japan is supporting expansion of NEC's dedicated marine capability.

(2) Xtera provides technology and system integration; uses manufacturing and installation partners within its turnkey model.

(3) Prysmian/NSW solutions are particularly applicable to point-to-point / unrepeatered and specialized telecom systems.

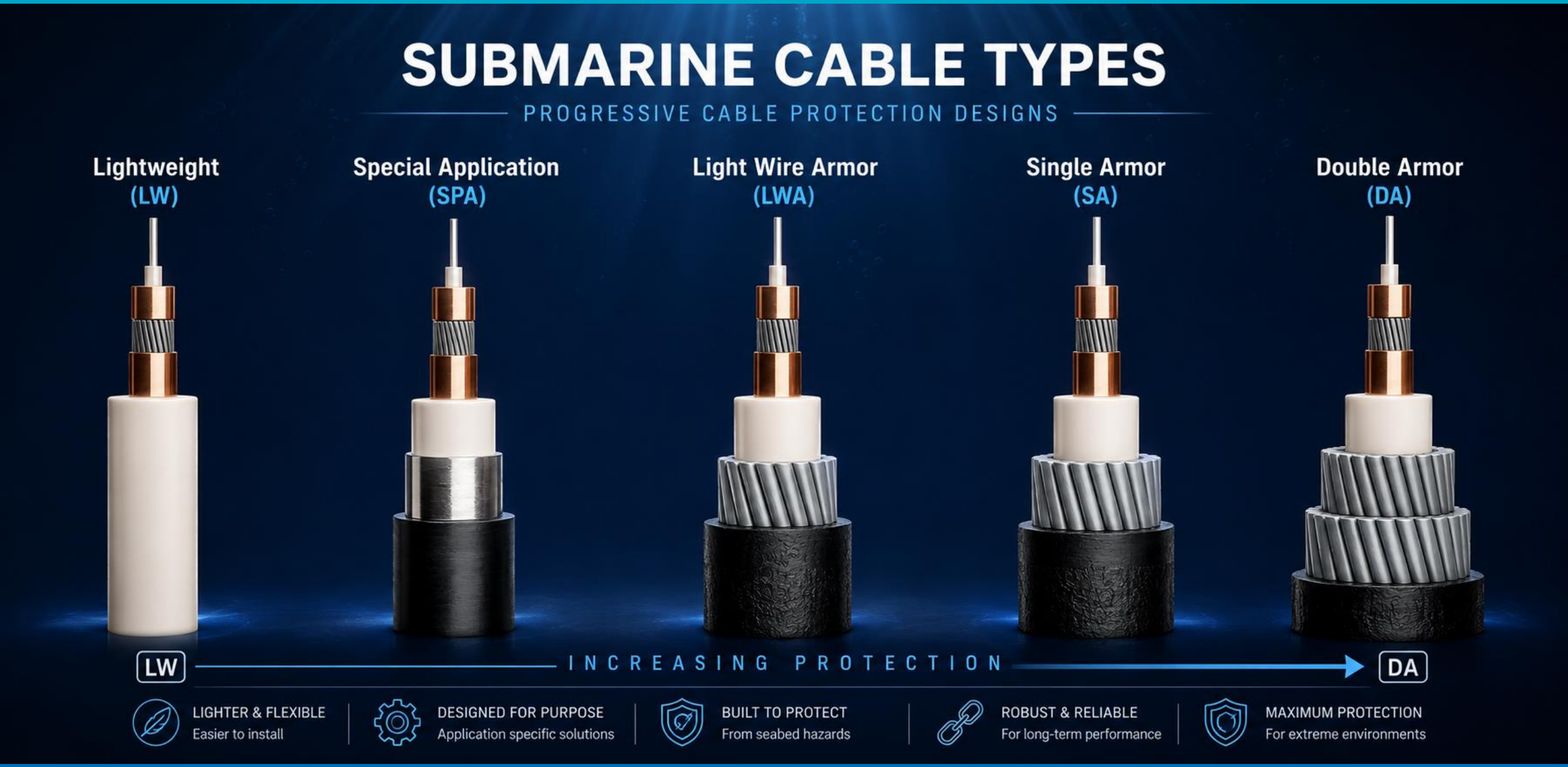
(4) Nexans' subsea business is substantially oriented toward submarine power/energy cables; not a primary long-haul repeatered telecom OEM.

SYSTEM DEVELOPER & PROJECT MANAGEMENT COMPANY

Ocean Networks, Inc. (ONI) is a global System Developer and Project Management company specializing in submarine cable system projects.

Suppliers and capabilities are subject to change. This slide reflects information available as of May 2025.

Submarine Cable Types

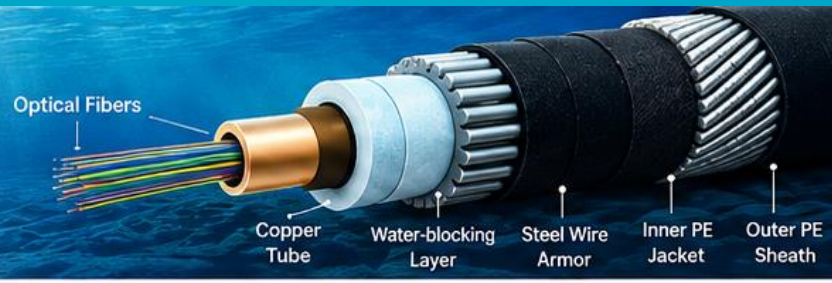


Submarine Cable Optical Fiber Types

OPTICAL FIBER TYPES

TYPICALLY USED IN SUBMARINE CABLE SYSTEMS

Submarine cables systems use single-mode optical fibers that deliver very low loss and high bandwidth over thousands of kilometers.



Modern submarine cable optical fibers incorporate multiple layers of protection to ensure reliable performance in harsh marine environments.

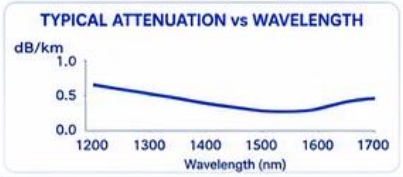
G.652.D
STANDARD SINGLE-MODE FIBER

The workhorse fiber for submarine systems

Designed for minimal attenuation in the C and L bands. Optimized for long-distance communication in submarine cable systems.

KEY FEATURES

- Low attenuation (≤ 0.20 dB/km @ 1550 nm)
- Full C + L band performance
- Proven reliability and vast technology
- Standard fiber in most new submarine cable systems



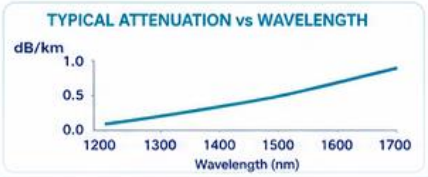
G.655
NON-ZERO DISPERSION SHIFTED FIBER (NZDSF)

Extended reach with high capacity transmission

Optimized dispersion characteristics with non-zero slope, extending the usable C + L band. Ideal for high-bitrate long-haul and DWDM.

KEY FEATURES

- Zero dispersion wavelength shifted to ~1550 nm
- Low non-zero slope dispersion in L band
- Supports higher bit rates and longer unrepeated spans
- Ideal for high-capacity DWDM systems



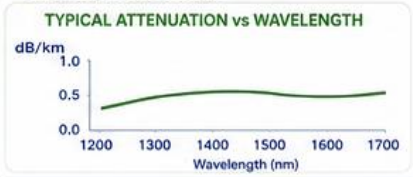
G.656
WIDEBAND NON-ZERO DISPERSION SHIFTED FIBER

Wideband performance for future systems

Combines low loss with wideband dispersion optimization across the entire transmission window.

KEY FEATURES

- Wide zero-dispersion plateau
- Low attenuation across extended wavelength range
- Excellent non-linear margin and spectral efficiency
- Supports future high-capacity and long-haul systems



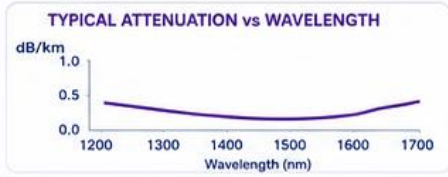
ITU-T G.654.E
LOW-LOSS FIBER (LARGE EFFECTIVE AREA)

Maximizes reliability for modern submarine cable systems

Lowest attenuation single-mode fiber with large effective area. Ideal for maximum span and capacity for submarine cable systems.

KEY FEATURES

- Ultra-low attenuation (≤ 0.17 dB/km @ 1550 nm)
- Large effective area for reduced nonlinearity
- Enhanced performance for long spans and high bit rates
- Optimized for high-capacity DWDM submarine systems



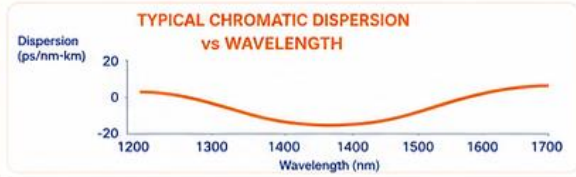
DSF
DISPERSION-SHIFTED FIBER (EARLY TECHNOLOGY)

Designed for reduced chromatic dispersion in C-band

Legacy fiber type. Dispersion shifted to minimize chromatic dispersion in the operating wavelength, typically in the C band. Largely superseded by NZDSF, G.655 and G.654.E in modern submarine systems.

KEY FEATURES

- Low chromatic dispersion at operating wavelength
- High bandwidth and long reach
- Supports high bit rate transmission
- Legacy technology – limited use in new submarine cable systems



WHY IT MATTERS

Selecting the right optical fiber type is critical to achieving the required capacity, reach, and reliability in modern submarine cable systems.

- ENHANCED CAPACITY
- LONGER REACH
- OPTIMIZED PERFORMANCE
- HIGH RELIABILITY
- FUTURE SCALABILITY

Optical Repeater (Amplifier)

OPTICAL REPEATER

THE HEART OF LONG-HAUL SUBMARINE CABLE SYSTEMS

Optical repeaters are placed at regular intervals along a submarine cable route to amplify and recondition the optical signal, enabling high-capacity data transmission over thousands of kilometers.

- AMP-FREE SYGNAL STRENGTH
- EXTENDS SYSTEM REACH
- RUGGED & RELIABLE LASER SEA DESIGN
- ENHANCES HIGH SYSTEM CAPACITY

PRESSURE HOUSING
Titanium or stainless steel housing provides extreme strength and long-term sea pressure protection.

ELECTRONICS MODULE
Monitors performance and controls, and ensures stable powering and safety functions.

POWER FEED THROUGH
Enables power via high-voltage feed of hundreds to operate the repeater electronics.

OPTICAL AMPLIFIER
Erbium Doped Fiber Amplifier (EDFA) boosts the optical signal with low noise and high efficiency.

OPTICAL PATH
The optical signal is received, amplified, and re-transmitted with minimal distortion.

THERMAL MANAGEMENT
Internal design ensures efficient heat dissipation for stable long-term operation.

REPEATER SIGNAL FLOW

Incoming Optical Signal → **OPTICAL RECEIVER** → **SIGNAL PROCESSING** → **OPTICAL AMPLIFIER** → **OPTICAL TRANSMITTER** → Outgoing Optical Signal

- OPTICAL RECEIVER: Detects and converts the incoming optical signal to electrical.
- SIGNAL PROCESSING: Conditions and regenerates the electrical signal.
- OPTICAL AMPLIFIER: Amplifies the optical signal to compensate for transmission loss.
- OPTICAL TRANSMITTER: Converts electrical signal back to optical and transmits onward.

POWER FEED FROM BOTH CABLE ENDS

KEY FEATURES

- Erbium Doped Fiber Amplifier (EDFA)
- Low noise figure for maximum reach
- Built-in re-liable electronic design and pressure and corrosion compensation
- Remote monitoring and control
- Hermetically sealed for 25+ years of operation

KEY BENEFITS

- Extends ultra-long distance submarine cable systems
- Maximizes high-speed capacity and data throughput
- Supports fully repeatered transoceanic installations
- Maintains transmission once with proven long-term reliability

Optical repeaters are critical to the performance and reliability of modern submarine cable systems, making global connectivity possible across continents and oceans.

Optical Branching Unit (BU)

BRANCHING UNIT (BU)

ENABLING CONNECTIVITY. EXTENDING REACH.

A Branching Unit (BU) is a subsea device used in submarine cable systems to split optical fibers from a main trunk cable and direct a portion of the fibers to a branch cable that connects to an additional Cable Landing Station (CLS).

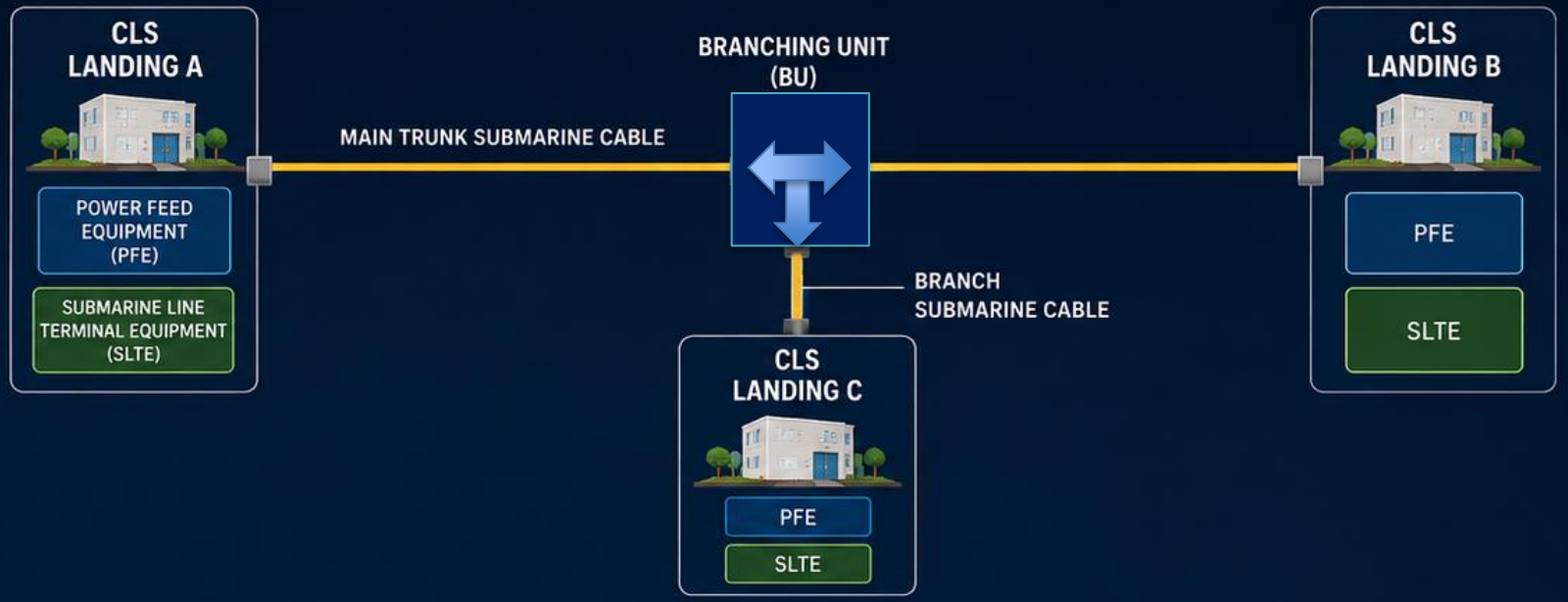
Reliable Subsea Performance

Extends Network Reach Without New Trunk Cable

Cost-Effective Scalability

Enables Connectivity Across Multiple Landing Points

TYPICAL SUBMARINE CABLE SYSTEM WITH BRANCHING UNIT



DESCRIPTION

- A BU is installed on the seabed and integrated into the main trunk cable.
- It contains passive optical components that split a portion of the fibers.
- The branched fibers are routed into a branch cable that connects to another CLS.
- BUs are fully sealed, pressure-resistant units designed for long-term subsea reliability.

PURPOSE

Extend Network Reach
Enables connection to additional landing points without installing a separate trunk cable.

Cost Efficiency
Reduces overall system cost by sharing the main trunk infrastructure.

Network Resilience
Provides alternate landing options and enhances network redundancy.

KEY BENEFITS

- ✓ Extends connectivity to new regions and markets
- ✓ Supports future scalability and additional branch connections
- ✓ Minimizes environmental impact by reducing seabed cable routes
- ✓ Built to withstand harsh deep-sea environments
- ✓ Proven long-term operational reliability

Branching Units are a proven technology that enables flexible, scalable, and cost-effective expansion of global submarine cable networks.

Cable Landing Station (CLS)

CABLE LANDING STATION (CLS)

THE SHORE END POINT OF A SUBMARINE CABLE SYSTEM

The Cable Landing Station is the critical link between the submarine cable and terrestrial networks. It houses the equipment that powers, protects, and terminates the submarine cable and provides a secure interface to connect to the global communications infrastructure.

KEY FUNCTIONS

- Cable termination and signal interface
- Power feeding and protection
- Environmental monitoring and control
- Secure facility with 24/7 operations
- Connection to terrestrial fiber networks

SUBMARINE TERMINAL EQUIPMENT (SLTE)

POWER FEED EQUIPMENT (PFE)

TERRESTRIAL NETWORK INTERFACE

NETWORK OPERATIONS CENTER (NOC)

SUBMARINE LINE TERMINAL EQUIPMENT (SLTE)

The Intelligent Gateway Between Undersea Cable and Terrestrial Networks

OVERVIEW

SLTE is the core optical transmission platform located in the Cable Landing Station (CLS). It terminates the submarine cable and interfaces with terrestrial networks, delivering high-capacity, low-latency connectivity with monitoring, management, and protection capabilities.

KEY FUNCTIONS

OPTICAL TERMINATION
Terminates optical fibers from the submarine cable and conditions signals for terrestrial transmission.

SIGNAL REGENERATION
Amplifies, reshapes, and retimes optical signals as needed.

WAVELENGTH MANAGEMENT
Generates/manages multiple optical wavelengths (DWDM).

PROTECTION & RESILIENCY
Supports switching, redundancy, and restoration.

MONITORING & CONTROL
Monitors optical power, BER, OSNR, latency, alarms, and system status.

TYPICAL COMPONENTS

- Optical Line System (Transponders)
- Optical Amplifiers
- Wavelength Multiplexers (WDM)
- Optical Cross Connects (OXC)
- Timing & Synchronization
- Control & Management System
- Power Distribution Units (DC/AC)
- Environmental Monitoring

High Capacity. High Reliability. Built for the World's Most Important Connections.

POWER FEED EQUIPMENT (PFE)

Delivering Reliable DC Power to the Undersea Cable System

OVERVIEW

Power Feed Equipment (PFE) supplies high-voltage direct current (HVDC) power from the Cable Landing Station to the submarine cable system to operate in-line optical amplifiers (repeaters) and other undersea powered elements.

- High Voltage DC Output
- Reliable & Redundant Design
- Continuous Monitoring & Remote Control
- 24/7 Carrier-Grade Operation

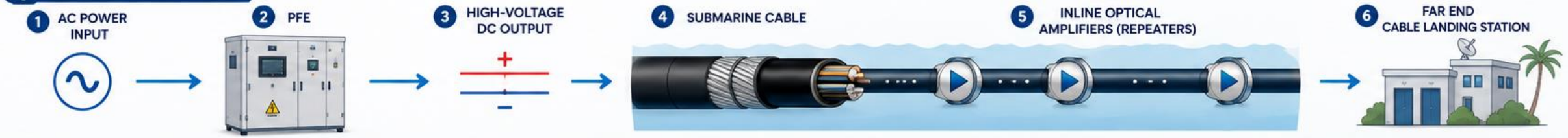
PURPOSE

The PFE provides stable, precisely controlled DC power to the submarine cable conductors. This power is essential for operating in-line optical amplifiers (repeaters) and other submerged powered components over long distances.

KEY FUNCTIONS

- Converts incoming AC utility power into regulated high-voltage DC power.
- Injects DC power into the submarine cable conductor pair.
- Maintains stable voltage and current levels for continuous operation.
- Continuously monitors voltage, current, insulation resistance, and faults.
- Provides protection against overcurrent, faults, and abnormal conditions.
- Supports alarms, diagnostics, and remote monitoring through the network management system.

HOW POWER FEED WORKS

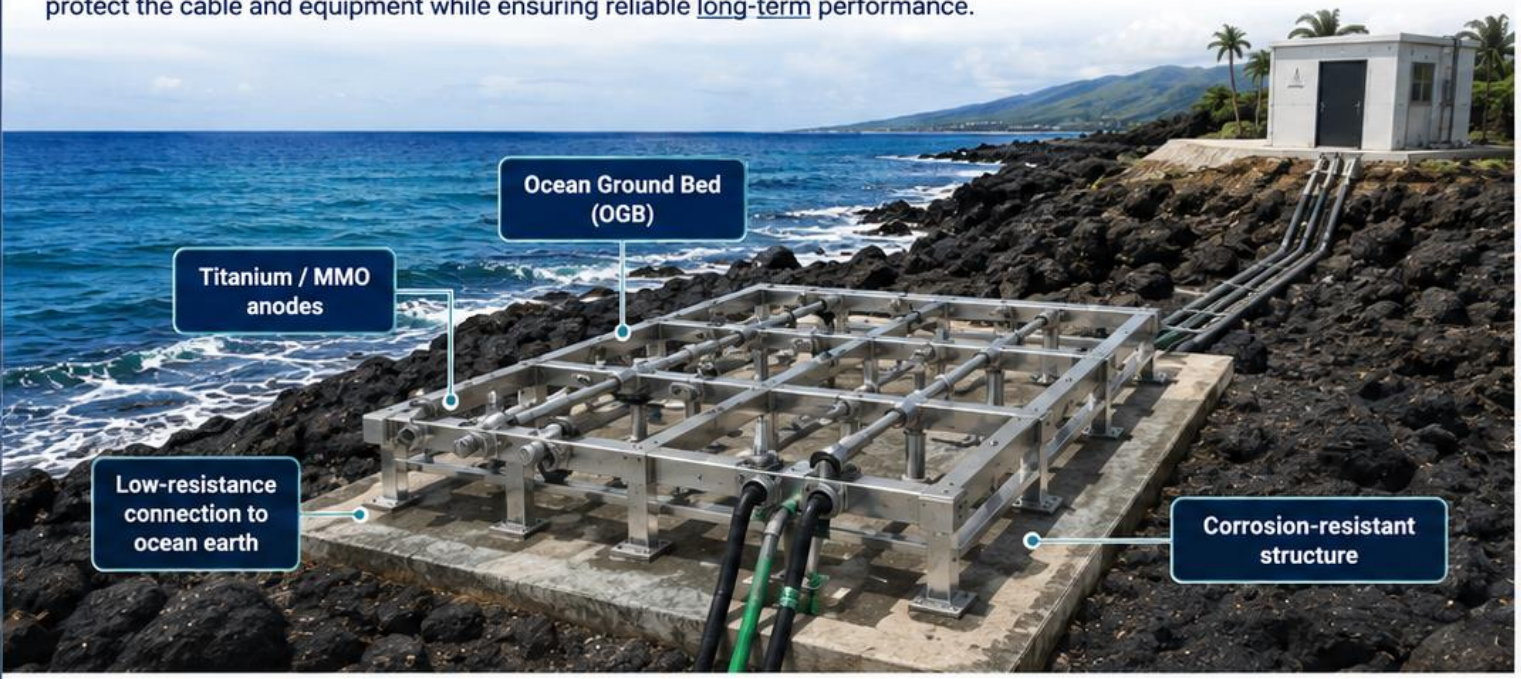


Reliable Power. Continuous Operation. Essential for Long-Haul Submarine Networks.

OCEAN GROUND BED (OGB)

Electrical Reference and Protection System for Submarine Cables

The OGB provides a low-resistance electrical reference to earth for the submarine cable system, helping protect the cable and equipment while ensuring reliable long-term performance.



PRIMARY FUNCTIONS

1. Provide a low-resistance electrical path to seawater for HVDC return current.
2. Complete the power circuit for submerged repeaters and powered branching units.
3. Maintain a stable electrical reference for the Power Feed Equipment (PFE).
4. Safely dissipate electrical current while minimizing voltage gradients and environmental impact.
5. Protect personnel and equipment from hazardous touch and step voltages.
6. Improve long-term system reliability and resist marine corrosion.

TYPICAL CONFIGURATION

- Titanium anode grid
- Corrosion-resistant hardware
- Parallel low-resistance paths
- Direct bond to cable metallic sheath

KEY BENEFITS

- System Reliability
- Personnel & Equipment Protection
- Low Electrical Resistance
- Long Service Life in Marine Environment

HOW THE OGB WORKS

SUBMARINE CABLE SYSTEM: FRONT HAUL & BACK HAUL

Connecting the Submarine Cable to the World

SUBMARINE CABLE SYSTEM

The submarine cable connects to shore at the Beach Manhole (BMH)

FRONT HAUL

Terrestrial cable segment between the Beach Manhole (BMH) and Cable Landing Station (CLS)

BACK HAUL

Terrestrial network connecting the CLS to carrier networks and end destinations

SUBMARINE CABLE SYSTEM

- Marine Installation
- Submarine Cable
- Repeaters
- Branching Units

FRONT HAUL

- Terrestrial Fiber Cable
- Conduit / Direct Burial
- HDD Crossings
- Secure & Protected Path

BACK HAUL

- Terrestrial Fiber Network
- High-Capacity DWDM
- Redundant Routes
- Connects to Global Networks

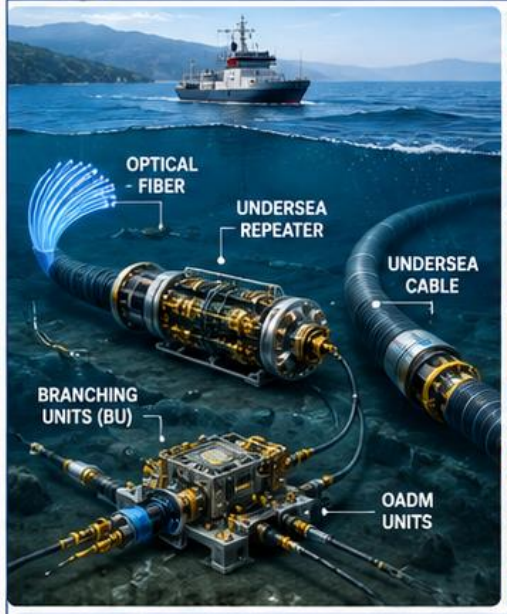
ONE SEAMLESS CONNECTION | From the ocean floor to the world — delivering high-capacity, reliable, and low-latency connectivity.

MANUFACTURING THE WET PLANT & DRY PLANT

Submarine Cable System

Key Manufacturing Components and Factory Integration

WET PLANT MANUFACTURING




PRECISION ELECTRONICS ASSEMBLY


REPEATER INTERNAL ASSEMBLY


WET PLANT FACTORY & ASSEMBLY

- Optical Fiber (P-Type Fiber)
- Undersea Repeaters
- Undersea Cable
- Branching Units (BU)
- Optical Add Drop Multiplexing (OADM) Units
- System Assembly & FAT
- Land Cable
- Jointing and Kit Manufacturing

Wet plant manufacturing delivers the submerged transmission path and powered subsea elements.

DRY PLANT MANUFACTURING


TERMINAL STATION EQUIPMENT (TSE)


SLTE TRANSPONDERS & COU SHELF


DRY PLANT INTEGRATION & TEST

- Terminal Station Equipment (TSE)
- Power Feed Equipment (PFE)
- Open Cable Interface (OCI)
- Command Response Equipment (CRE)
- Line Monitoring Equipment (LME)
- Common Optical Units (COU)
- Submarine Line Terminating Equipment (SLTE Transponders)

Dry plant manufacturing provides shore-based power, control, monitoring, and optical terminal functions.

WET PLANT
Submerged Transmission Path & Powered Elements

FACTORY INTEGRATION & FAT
End-to-End System Assembly, Testing & Validation

DRY PLANT
Shore-Based Power, Control, Monitoring & Optical Terminal

FACTORY ACCEPTANCE TESTING (FAT)

Submarine Cable System

Verifying Performance, Compliance, and Readiness Before Shipment

Quality Assurance | Risk Reduction | Pre-Shipment Verification

OVERVIEW

Factory Acceptance Testing (FAT) is a comprehensive series of inspections, measurements, and functional tests performed at the manufacturer's facility before equipment is shipped for installation. FAT verifies that submarine cable system components meet technical specifications, contractual requirements, and performance criteria before deployment.

WHY FAT MATTERS

FAT reduces installation risk by identifying and correcting defects before shipment, when repairs are less costly and less disruptive than after deployment.

TYPICAL FAT ACTIVITIES

1. Visual and Mechanical Inspection
2. Optical Testing
3. Electrical Testing
4. Repeater Testing
5. Branching Unit (BU) Testing
6. Wet Plant Assembly Testing
7. Pressure Testing
8. System Integration Testing
9. Documentation Review

Inspect → Test → Validate → Document → Approve for Shipment

Ensuring Reliability Before Deployment

Direct Shore Landing

HORIZONTAL DIRECTIONAL DRILLING (HDD)

SHORE-TO-OCEAN INSTALLATION FOR SUBMARINE CABLE SYSTEMS

HDD provides a safe, reliable, and environmentally responsible method to install submarine cables beneath shorelines and sensitive coastal areas.

KEY BENEFITS

- Minimizes environmental impact and protects sensitive habitats
- Avoids roads, structures, and other obstacles
- Provides a safe and secure installation method
- Cost-effective and efficient compared to open trenching
- Ensures long-term cable protection and reliability

TYPICAL APPLICATIONS

- Beach and shoreline crossings
- Roads, railways, and utilities
- Lakes, rivers, and wetlands
- Environmental and protected areas

THE HDD PROCESS

1 PILOT HOLE
A small diameter pilot hole is drilled along the designed path.

2 PRE-REAM
The pilot hole is enlarged to the required diameter.

3 PULL BACK
The reamer is pulled back to widen the bore and prepare for installation.

4 INSTALL DUCT
HDPE duct is attached and pulled back through the bore.

5 PULL CABLE
The submarine cable is pulled through the duct to the exit point in the ocean.

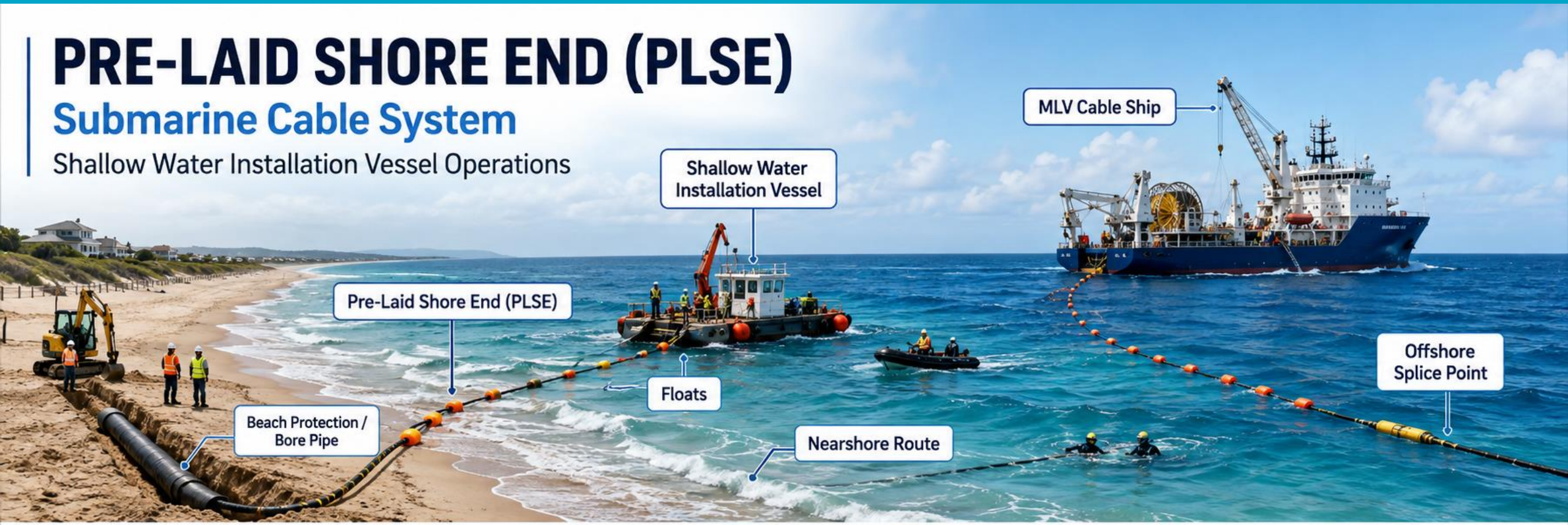
6 COMPLETE
The cable is secured and ready for connection to the submarine system.

HDD ENABLES RELIABLE CONNECTIONS WHILE PRESERVING OUR ENVIRONMENT AND INFRASTRUCTURE.

PRE-LAID SHORE END (PLSE)

Submarine Cable System

Shallow Water Installation Vessel Operations



1 Shallow Water Installation

Used where seabed contours prevent the MLV from approaching close enough for a direct shore landing.

2 Pre-Installed Shore End

The cable is installed from the beach to a water depth where the offshore MLV can later recover it.

3 Recover & Splice

The MLV recovers the PLSE cable offshore and splices it to the main submarine cable.

4 Regional Vessel Support

Pre-laid shore-end vessels are often locally or regionally sourced for nearshore operations.

BEACH MANHOLE (BMH)

Submarine Cable System

Protected Transition Between Land Cable and Submarine Cable

TYPICAL PRECAST BMH STRUCTURE

A Beach Manhole (BMH) is the transition point between the terrestrial cable network and the submarine cable. It provides a protected underground structure where the cable can be installed, jointed, tested, and maintained before entering the ocean.

KEY FUNCTIONS

- Transition point between land cable and submarine cable
- Protected chamber for cable installation, splicing, and storage
- Supports testing, maintenance, and future access
- Protects the shoreline cable connection from environmental exposure

TYPICAL FEATURES

- Reinforced concrete structure
- Access cover / hatch
- Cable entry and exit ducts
- Space for cable management and jointing

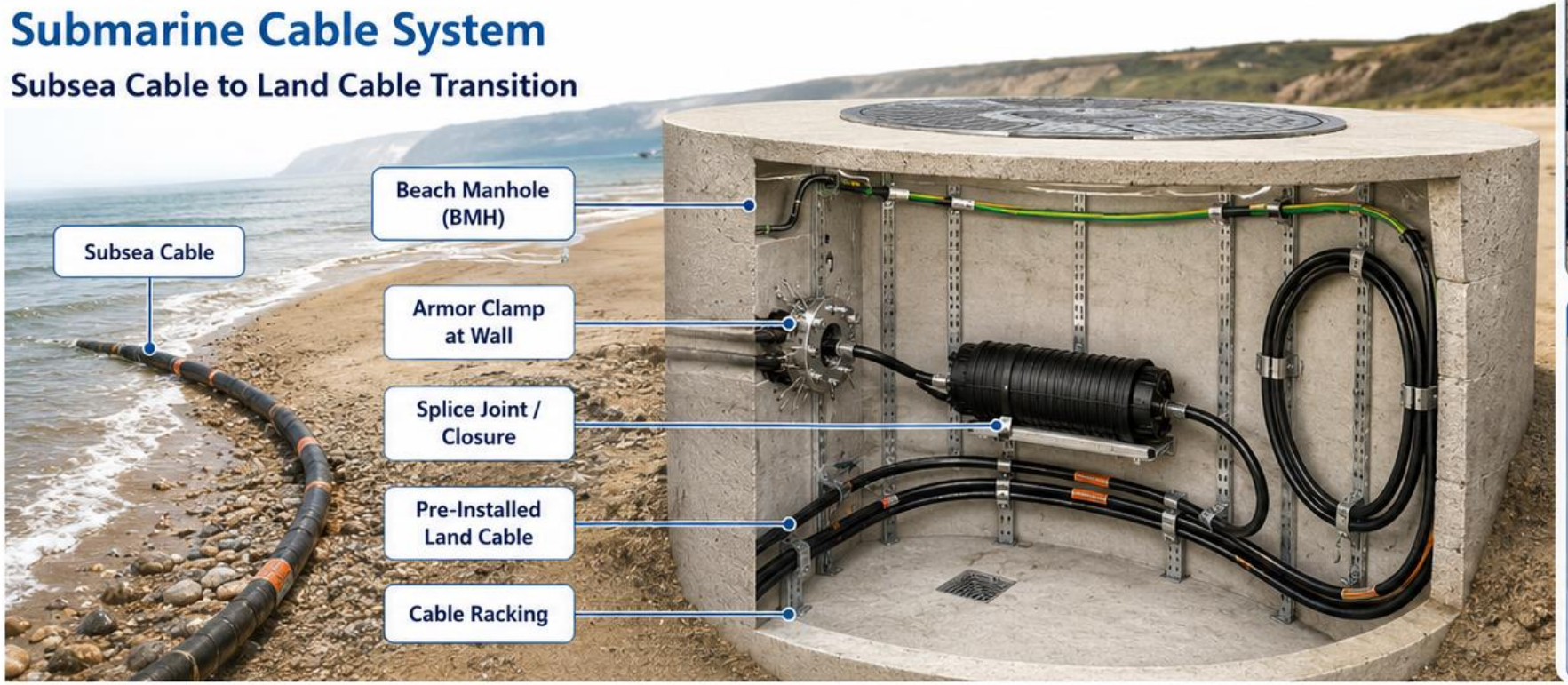
CLS — Cable Landing Station → **FRONT HAUL CABLE** — Buried terrestrial cable route → **BMH** — Beach Manhole (transition point) → **SUBMARINE CABLE** — Protected subsea cable route → **OCEAN** — Open ocean network

Beach Manhole (BMH) Splice

BEACH MANHOLE SPLICE

Submarine Cable System

Subsea Cable to Land Cable Transition



ARMOR CLAMP AT WALL

Secures cable and provides a reliable wall seal.

SPLICE JOINT / CLOSURE

Protects the splice from moisture and environmental conditions.

1 Cable Entry

Subsea cable is installed into the pre-installed beach manhole (BMH).

2 Secure at Wall

The cable is secured via armor clamp at the wall of the BMH.

3 Splice to Land Cable

The subsea cable is spliced to the pre-installed land cable stored within the BMH.

4 Protected Transition

The splice is organized, protected, and ready for reliable connection to the terrestrial network.

KEY FEATURES

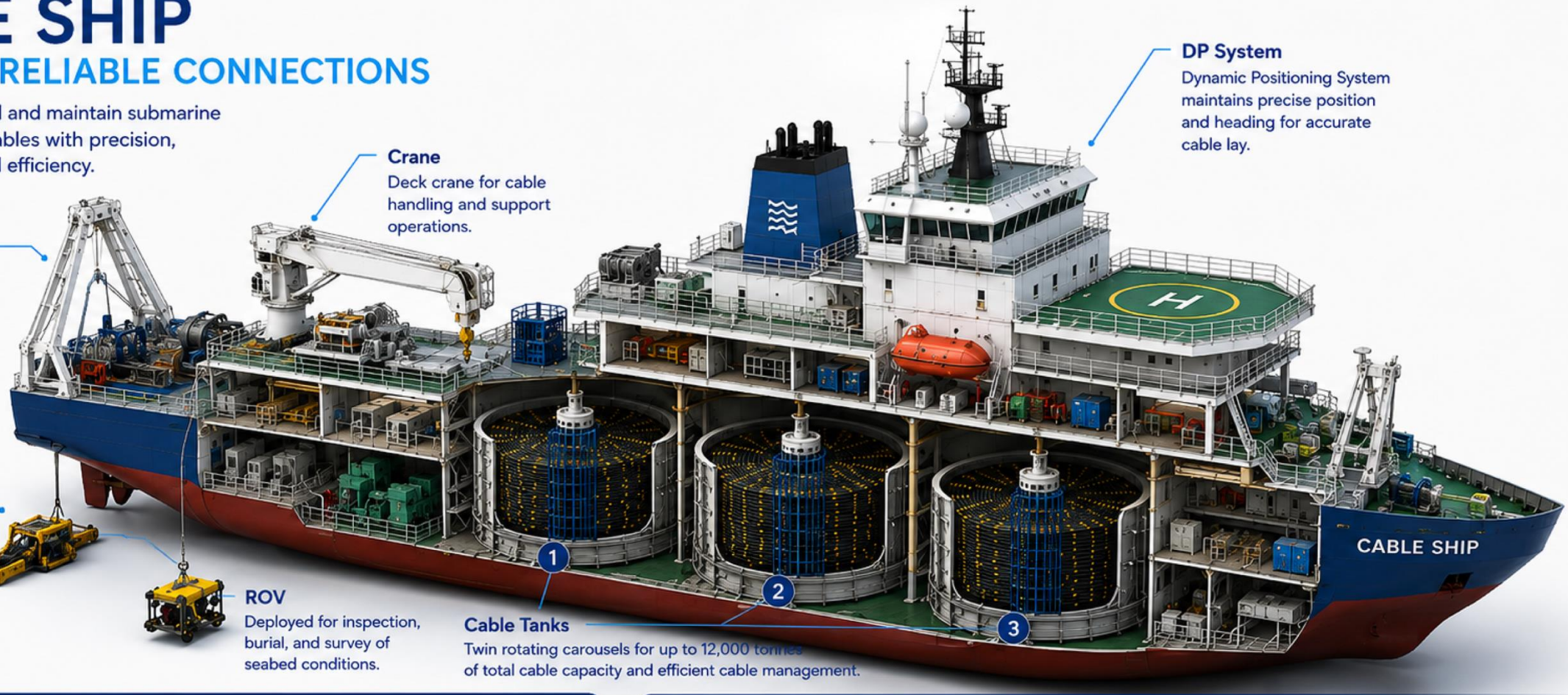
- Protected cable transition
- Secure wall penetration
- Organized cable storage
- Reliable subsea-to-land connection

Submarine Cable Installation & Repair Ship

CABLE SHIP

BUILT FOR RELIABLE CONNECTIONS

Purpose-built to install and maintain submarine telecommunication cables with precision, safety, and operational efficiency.



CABLE SHIP CAPABILITIES

- Up to 12,000+ ton total cable capacity
- Advanced cable handling for efficient and safe operations
- Built for safety, reliability and operational excellence
- Precision positioning for accurate cable lay

KEY SPECIFICATIONS (TYPICAL)

Length Overall	149.0 m	Service Speed	Up to 15 knots
Beam	27.0 m	DP System	DP Class 2 / DP Class 3
Cable Capacity	Up to 12,000 t w/w	Complement	~90 – 120 personnel

Dynamic Positioning (DP)

DYNAMIC POSITIONING (DP) FOR A CABLE SHIP

Precise Position. Accurate Installation. Safe Operations.

Dynamic Positioning (DP) automatically maneuvers the cable ship's position and heading using onboard sensors and thrusters—eliminating the need for anchors.

DP MODE
Maintaining Position & Heading with Active Thruster Control

TARGET POSITION
LAT: 36° 45.123' N
LON: 137° 34.123' W

WIND

WAVES

CURRENT

AZIMUTH THRUSTER

AZIMUTH THRUSTER

TUNNEL THRUSTER

MAIN PROPULSION

SUBMARINE CABLE

DP CONTROL SYSTEM
The DP computer continuously process data from multiple sensors to detect environmental forces and vessel movement.

- **DGPS / GNSS** — Position reference
- **Gyrocompass** — Heading reference
- **MRU** — Motion reference
- **Wind Sensors** — Wind speed & direction
- **Laser / HiPAP** — Altitude positioning
- **EM Log / DVL** — Water velocity

DP COMPUTER

THRUSTER & PROPULSION CONTROL

THRUSTER SYSTEM
Thrusters adjust thrust to counteract environmental forces and keep the vessel on position.

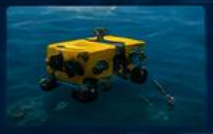
AZIMUTH THRUSTER | TUNNEL THRUSTER | MAIN PROPULSION

DP ENABLES PRECISE CABLE OPERATIONS

CABLE LAYING
Maintains absolute station and speed while laying cable on the seabed.

CABLE REPAIR
Holds station over fault location for safe recovery and repair.

CABLE DEPLOYMENT
Keeps vessel steady near cable shore ends for landing and Trenching.



ROV OPERATIONS
Provides a stable platform for ROV inspections, works and surveys.

SURF PLOW OPERATIONS
Maintains alignment and speed for consistent cable burial.

SURVEY AND AUVIUSV LAUNCHING
Enables precise positioning and safe launch/recovery of subsea vehicles.

DP CLASS

DP 1	Basic systems with no redundancy. Must avoid fault conditions.
DP 2	Redundant systems to handle a single fault / System set.
DP 3	Fully redundant systems with uninterrupted operations capability under any single component fault.

BENEFITS OF DYNAMIC POSITIONING

NO ANCHORS
Eliminates risk of anchor drag on cables and sensitive habitats.

HIGH ACCURACY
Maintains position within 1–2 meters for precise operations.

IMPROVED SAFETY
Reduces risk to crew, equipment and the marine environment.

OPERATIONAL EFFICIENCY
Less downtime and delays in weather and environmental events.

CABLE PROTECTION
Ensures proper cable tension and burial—minimizes risk of cable damage.

CABLE SHIP LOADING

Submarine Cable System

Loading Operations from the Cable Manufacturing Facility to Installation or Transport Vessels

TYPICAL LOADING OPERATIONS

- Direct MLV Load
- Pre-Laid Shore End (PLSE) Vessel Loads
- Cable Freighter with Fabricated Cable Tanks
- Containerized Loading Operations

1 Vessel Cable Tank / Carousel Loading

2 Deck Loading / Cable Transfer Operation

3 Cable Tank Interior – Cable Coiled

OVERVIEW

Main lay vessels (MLV) or transport/freighter vessels are directly loaded from the cable manufacturing facility. This integrated approach enables efficient and safe transfer of submarine cable for installation campaigns, PLSE operations, transport, or specialized freight operations.

KEY CONSIDERATIONS

- Cable handling and bend-radius control
- Tank capacity and loading sequence
- Vessel stability and deck readiness
- Protection of cable integrity during transfer

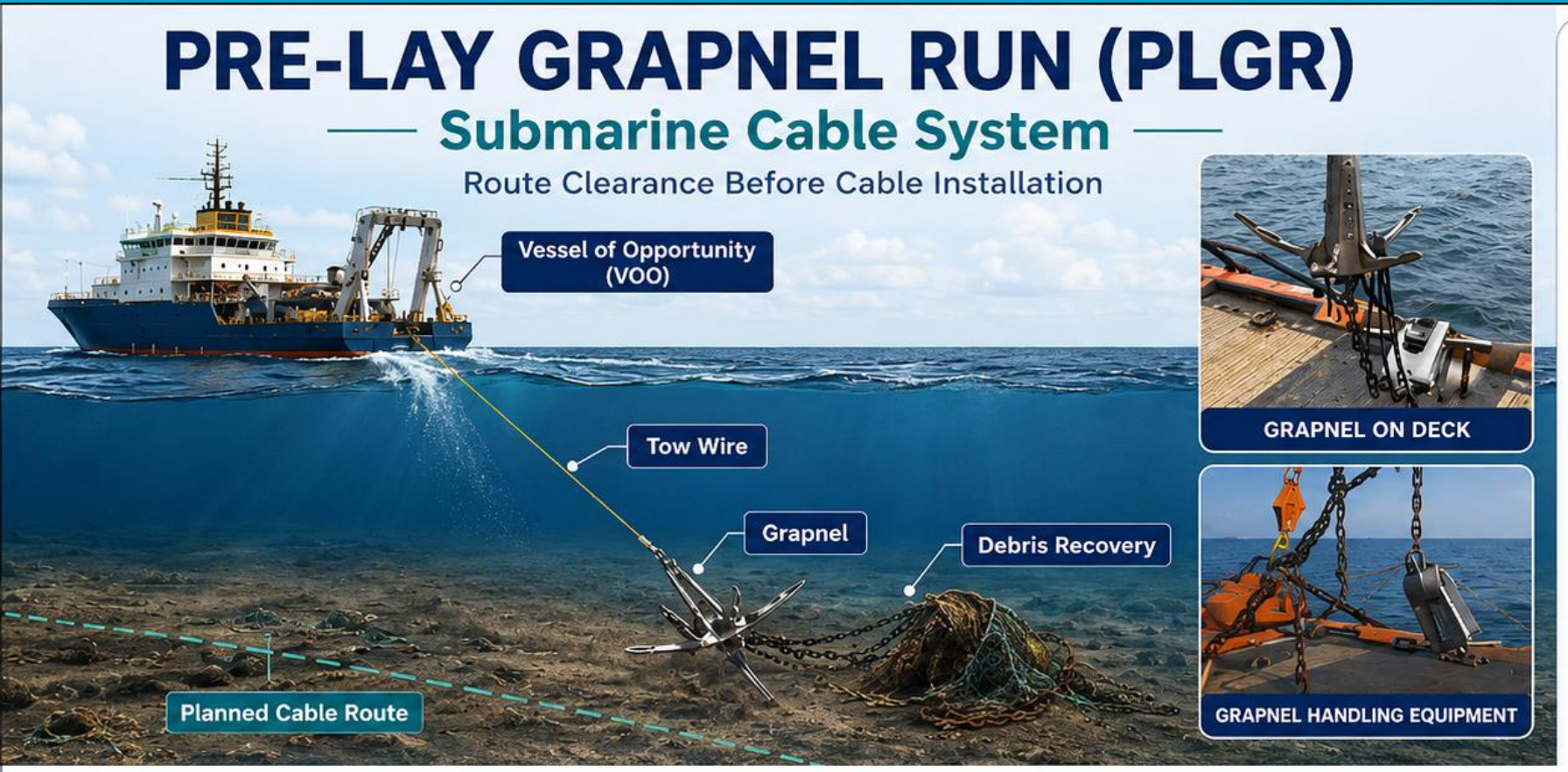
1. Manufacturing Facility
2. Cable Transfer
3. Shipboard Tank Loading
4. Securing & Inspection
5. Ready for Deployment / Transport

Pre-Lay Grapnel Run (PLGR)

PRE-LAY GRAPNEL RUN (PLGR)

Submarine Cable System

Route Clearance Before Cable Installation



GRAPNEL ON DECK

GRAPNEL HANDLING EQUIPMENT

OVERVIEW

A Pre-Lay Grapnel Run (PLGR) is a marine operation performed before submarine cable installation to clear the planned cable route of abandoned fishing gear, wire, ropes, chains, old cables, and other debris that could damage the new cable during installation or throughout its service life.

KEY FUNCTIONS

- Clears debris and obstructions from the planned cable route
- Reduces installation risk and cable damage
- Removes abandoned fishing gear, ropes, chains, and old cables
- Supports safer cable lay operations
- Protects long-term cable integrity & reliability

TYPICAL PLGR WORKFLOW

1. Route Preparation
2. Select Grapnel for Seabed Conditions
3. Tow Grapnel Along Planned Route
4. Recover and Inspect Debris
5. Confirm Route is Clear for Cable Installation

KEY CONSIDERATIONS

- Grapnel Selection
- Seabed Conditions
- Tow Speed & Tension
- Recovered Debris Handling
- Route Verification

PLGR HELPS ENSURE A SAFE, CLEAR, AND RELIABLE ROUTE FOR SUBMARINE CABLE INSTALLATION.

Submarine Cable Protection

SUBMARINE CABLE PROTECTION TYPES

Protecting submarine cables from environmental hazards, fishing activity, and anchors ensures long-term reliability and system integrity.

NATURAL BURIAL

Cable is installed below the seabed through natural processes such as sediment movement and burial.

PLOW BURIAL

A burial plow cuts a trench and simultaneously lays the cable to the target burial depth.

JETTING

High-pressure water jets fluidize the seabed, allowing the cable to be buried without mechanical cutting.

ROCK PLACEMENT

Rocks are placed over the cable using an ROV or fall pipe to provide protection in high-risk areas.

ARTICULATED PIPE

Articulated pipe is placed over the cable to protect against external aggression and heavy anchors.

CABLE MATTRESS

Concrete or polymer mats are installed over the cable to provide weight and protection.

TRENCHING (MECHANICAL CUTTER)

A mechanical cutter creates a precise trench for cable installation in hard or compact seabed.

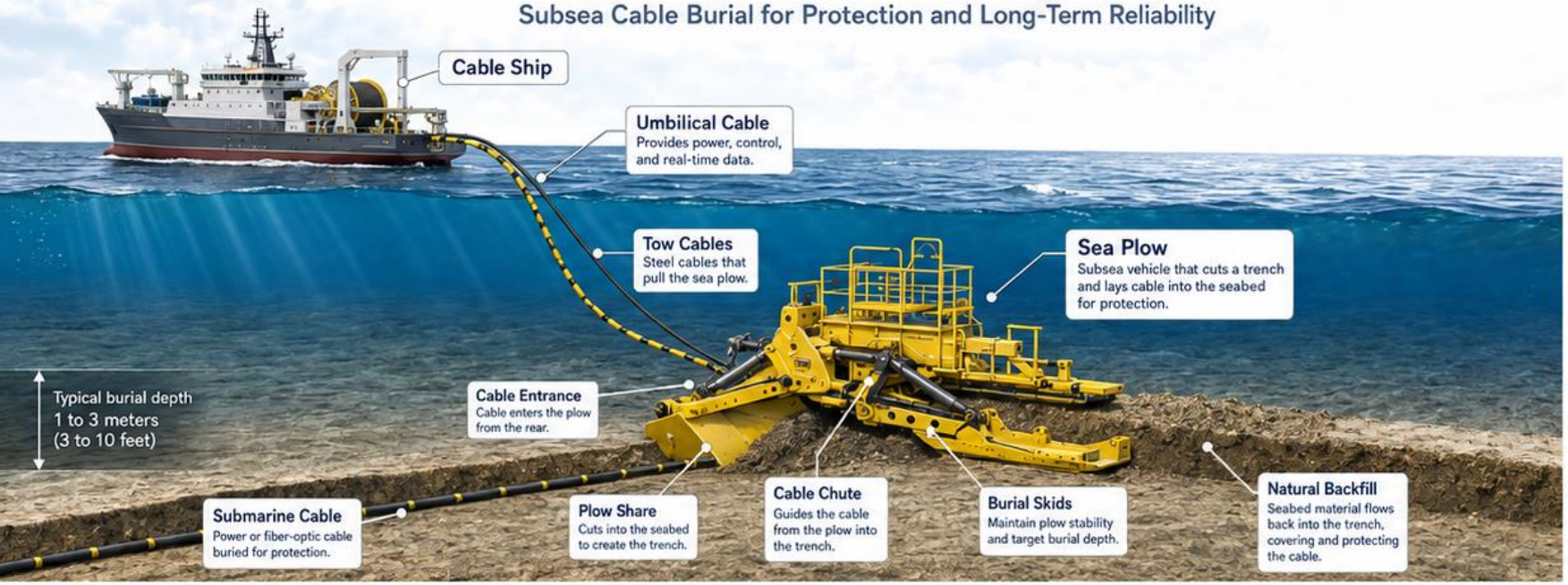
POST-LAY BURIAL (ROV OR DIVER)

ROV or divers use tools or water jets to bury the cable after installation.

THE RIGHT PROTECTION METHOD IS SELECTED BASED ON SEABED CONDITIONS, WATER DEPTH, ENVIRONMENTAL FACTORS, AND CABLE RISK ASSESSMENT.

Submarine Cable Sea Plow

SEA PLOW
Submarine Cable System
Subsea Cable Burial for Protection and Long-Term Reliability



TYPICAL PLOW OPERATION

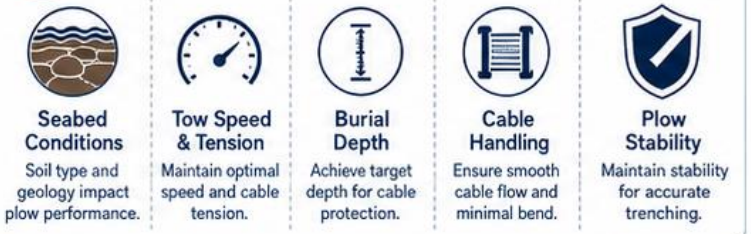
OVERVIEW

A submarine cable sea plow is a specialized subsea vehicle towed behind a cable ship that buries submarine power or fiber-optic cable beneath the seabed during installation. Its primary purpose is to protect the cable from external damage while ensuring long-term reliability.

KEY FUNCTIONS

- Cuts a trench in the seabed during cable installation
- Guides the cable into the trench for burial
- Protects the cable from anchors, fishing gear, and external hazards
- Allows natural backfill to cover and protect the cable
- Improves cable security and long-term system reliability

KEY CONSIDERATIONS



SEA PLOW INSTALLATION PROVIDES ESSENTIAL CABLE PROTECTION FOR SAFE AND RELIABLE SUBMARINE NETWORK OPERATIONS.

Remote Operated Vehicle (ROV)

REMOTE OPERATED VEHICLE (ROV)

Submarine Cable System

Inspection, Monitoring, Burial, and Repair Support

OVERVIEW

A Remotely Operated Vehicle (ROV) is a highly maneuverable underwater robot used throughout the life of a submarine cable system. Unlike a sea plow, which is designed primarily for continuous cable burial during installation, an ROV performs precision underwater tasks where human divers cannot operate safely or efficiently.

PRIMARY PURPOSES

- Cable Route Inspection
- Cable Installation Monitoring
- Post-Lay Inspection
- Cable Burial
- Cable Repair
- Recovery of Equipment
- Environmental Monitoring

KEY CAPABILITIES

- High-definition video inspection
- Precise positioning and maneuvering
- Tool skid / manipulator support
- Real-time surface control
- Operation in deep or hazardous waters

TYPICAL ROV OPERATIONS

1. Deploy from Vessel
2. Inspect Cable Route
3. Monitor / Survey Seabed
4. Perform Intervention or Repair
5. Confirm Condition & Recover ROV

ROVs provide precision subsea intervention for safe and reliable submarine cable operations.

Post Lay Inspection & Burial (PLIB)

Post Lay Inspection & Burial (PLIB)

ENSURING THE PROTECTION & RELIABILITY OF SUBMARINE CABLE SYSTEMS

PLIB operations verify cable integrity and ensure adequate burial for long-term protection. Remotely Operated Vehicles (ROVs) and advanced technologies are used to inspect, assess, and bury the cable along the route.

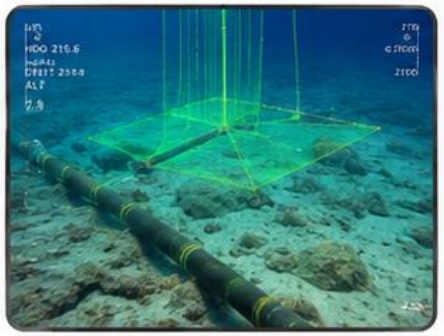
- VERIFY CABLE INTEGRITY
- CONFIRM ROUTE ACCURACY
- ACHIEVE TARGET BURIAL DEPTH
- PROTECT ASSET & ENSURE RELIABILITY

ROV CAPABILITIES

- HD Cameras
- Multi-beam Sonar
- Cable Tracking (Tone Tracking or Magnetometer)
- High Thrust Capabilities
- Laser Scalers
- Environmental Sensors

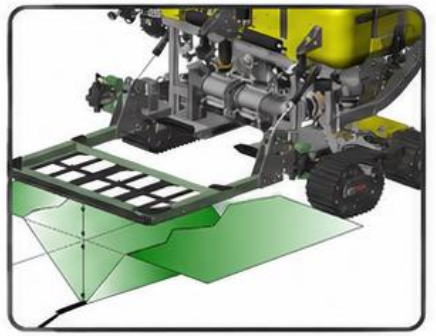
PLIB OPERATIONS

- Cable & Pipeline Crossings
- Plow Up/Down Locations
- Splice Locations
- Sensitive / Environmental Areas
- Route Deviation Analysis
- As-Built Reporting



BURIAL OPERATIONS

- Jetting / Fluidization
- Mechanical Plows
- Trenching Tools
- Target Burial Depth Verification
- Seabed Restoration



- DETAILED DATA COLLECTION
- ACCURATE ASSET RECORDS
- RISK MITIGATION & COMPLIANCE
- LONG-TERM CABLE PROTECTION

INSPECT. ASSESS. PROTECT.

DELIVERING RELIABILITY BENEATH THE SURFACE.

SUBMARINE CABLE SYSTEM NETWORK OPERATIONS CENTER (NOC)

24/7 Monitoring • Reliable Connectivity • Global Impact

PRIMARY FUNCTIONS OF A SUBMARINE CABLE SYSTEM NOC

1. Continuous Network Monitoring
2. Fault Detection and Alarm Management
3. Performance Management
4. Power Feed Equipment (PFE) Monitoring
5. SLTE Management
6. Network Provisioning
7. Cybersecurity
8. Maintenance Coordination
9. Marine Repair Coordination
10. Customer Support

24/7 Monitoring
Continuous monitoring of cable performance and system health

Alarm Management
Proactive alerting and rapid incident response to minimize downtime

Performance Analysis
Real-time analysis of optical signals, power levels, and traffic

Secure & Reliable
Redundant systems and secure networks ensure uninterrupted service

Expert Team
Experienced NOC engineers dedicated to network excellence

A Network Operations Center (NOC) is the centralized command and control facility responsible for **24/7 monitoring, operation, and management** of a submarine cable system. Its primary purpose is to ensure the network remains available, secure, and operating at peak performance, while rapidly responding to faults or service degradations.

OPTICAL TIME DOMAIN REFLECTOMETER (OTDR)

Submarine Cable System

Fiber Testing, Characterization, and Fault Location

TYPICAL OTDR TEST PROCESS

1. Connect to fiber → Launch test pulse → Analyze trace → Identify loss events or breaks → Document results

OVERVIEW

An Optical Time Domain Reflectometer (OTDR) is a diagnostic instrument used to test, characterize, and troubleshoot optical fiber cables. It sends short pulses of laser light into a fiber and measures the small amount of reflected or scattered light that returns. From this information, it creates a graphical trace of the fiber link.

WHAT AN OTDR MEASURES

- **Fiber length** — Measures the total length of the optical fiber
- **Fiber attenuation** — Calculates signal loss (dB/km) along the cable
- **Splice loss** — Measures insertion loss at fusion or mechanical splices
- **Connector loss and reflectance** — Identifies poor connectors or dirty interfaces
- **Break locations** — Pinpoints the exact distance to a fiber break or severe bend
- **Macro-bends and micro-bends** — Detects bends that cause excessive optical loss
- **End of fiber** — Identifies where the cable terminates

KEY APPLICATIONS

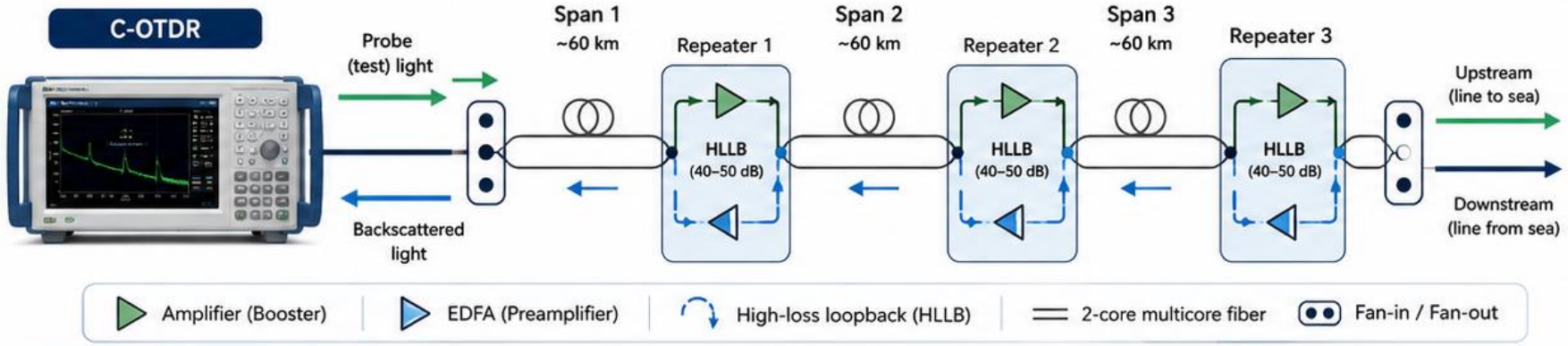
- Commissioning new fiber links
- Troubleshooting submarine cable segments
- Splice verification
- Routine maintenance testing
- Fault localization

OTDR testing helps ensure reliable optical performance and fast fault localization in submarine cable systems.

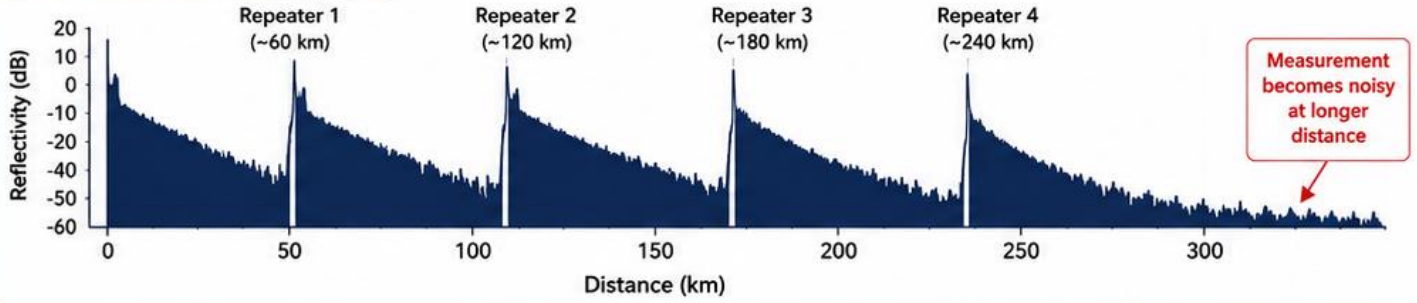
COHERENT OPTICAL TIME DOMAIN REFLECTOMETER (C-OTDR)

Submarine Cable System

Long-Haul Fiber Monitoring, Fault Localization, and Repeatered System Testing



C-OTDR BACKSCATTER TRACE



OVERVIEW

A C-OTDR is an advanced fiber-optic test instrument designed to monitor, characterize, and localize faults in long-haul repeatered submarine cable systems. Coherent detection enables highly sensitive measurements over very long distances.

ROLE OF HIGH LOSS LOOPBACK (HLLB)

A repeater includes a High Loss Loopback (HLLB) that connects the transmit and receive fibers through very high optical attenuation, typically 40–50 dB.

This allows the C-OTDR to:

- Launch a test signal from one landing station.
- Pass through multiple repeaters.
- Loop back at a selected repeater.
- Return the signal to the originating landing station.
- By selecting different loopback points, engineers can verify span performance and identify the location of degradation.

KEY APPLICATIONS

Fault Localization | Fiber Health Monitoring | Repeater Verification | Marine Repair Support | Acceptance Testing

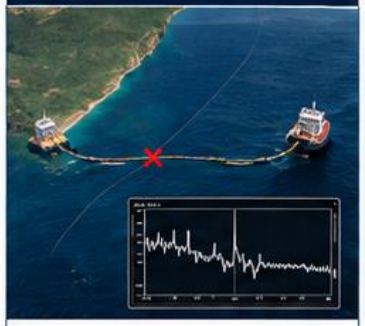
1. Launch test signal
2. Measure coherent backscatter
3. Verify repeater spans
4. Locate faults or degradation
5. Support repair and restoration

C-OTDR TESTING ENABLES LONG-DISTANCE VISIBILITY INTO REPEATERED SUBMARINE CABLE SYSTEMS.

SUBMARINE CABLE REPAIR WORKFLOW

END-TO-END PROCESS FROM FAULT DETECTION TO RETURN TO SERVICE

1 FAULT LOCALIZATION



- Identify the precise location of the fault on the submarine cable system and anchor.
- HVDC / acoustic readings to pinpoint performance.
- OTDR / C-OTDR measures distance to fault, location, or both ends.
- Determine type and severity of cable fault.
- Data analysis, environmental and route data and bathymetry.
- Repair method mobilized.

EQUIPMENT

OTDR / C-OTDR · PFE · GIS & Route Data

2 CABLE RECOVERY

- Locate and recover the damaged cable to the surface.
- Deploy specialized gear: fish, grapnels, flotation and lift.
- ROV or grapnel access cable.
- Cable end recovery using grapnel or ROV.
- End is hauled on board.
- Damaged section isolated and retrieved.

EQUIPMENT

DP System · ROV & Grapnels · Winches & A-Frame

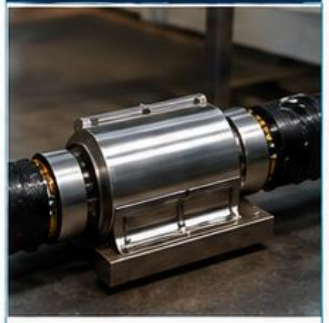
3 FIBER SPLICING

- Remove cable sheath to expose the fibers and armors.
- Clean ends, prepare and align optical fibers.
- Fusion splice to establish a perfect joint.
- Fusion splice with fiber.
- Test each splice for loss and reflectance.
- Organize fibers in splice tray.

EQUIPMENT

Fusion Splicer · OTDR · Optical Power Meter

4 SPLICE MOLD / JOINT ASSEMBLY



- Rebuild the cable joint to ensure mechanical strength and protection.
- Clean and dry jointed splice.
- Strength members compressed.
- Copper conductors reconnected if required.
- Armor wires re-terminated.
- Mold cleaned and semi-aligned.
- Mold is set in the joint pressurizer, vacuum, waterproof joint.
- Joint integrity: electrical and mechanical testing.

EQUIPMENT / MATERIALS

Splice Mold & Cradle · Joint Pressurizer · Vacuum Pump

5 SPLICE TESTING

- Verify the caality of the completed splice before redeployment.
- OTDR test for splicd loss, return loss and reflectance.
- Continuity verification resistance tests.
- Multimode check (if joint).
- Results recorded and acceptance confirmed.

EQUIPMENT

OTDR · Optical Power Meter · Test Set

6 REDEPLOYMENT

- Return the repaired cable to the seabed and restore to service.
- Redeployment carefully lowered back to seabed.
- Tension controlled during lay.
- Route follow original cable plan and burial depth.
- ROV verifies proper placement.
- Post-lay survey, documentation and system returned to service.

EQUIPMENT

Cable Ship · ROV · Sea Plow (If required)

7 END-TO-END FINAL TESTING

- Confirm full system performance and final return-to-service.
- End-to-end OTDR test to confirm cable integrity, location to fault, and signal quality.
- Optical performance and signal power validation.
- Service and power test.
- System and link validated.
- Full system report completed.

EQUIPMENT

OTDR / C-OTDR · PFE · Test System

MOBILIZE REPAIR VESSEL
Assemble crew, equipment, and spare cable. Transit to fault location.

→ **SURVEY DAMAGE SECTION**
Cut out damaged length and prepare cable ends for splicing.

→ **MECHANICAL & OPTICAL TESTING**
Verify joint integrity, optical performance, and cable continuity.

→ **ROV INSPECTION**
ROV inspects cables/route and validates burial/ proper installation.

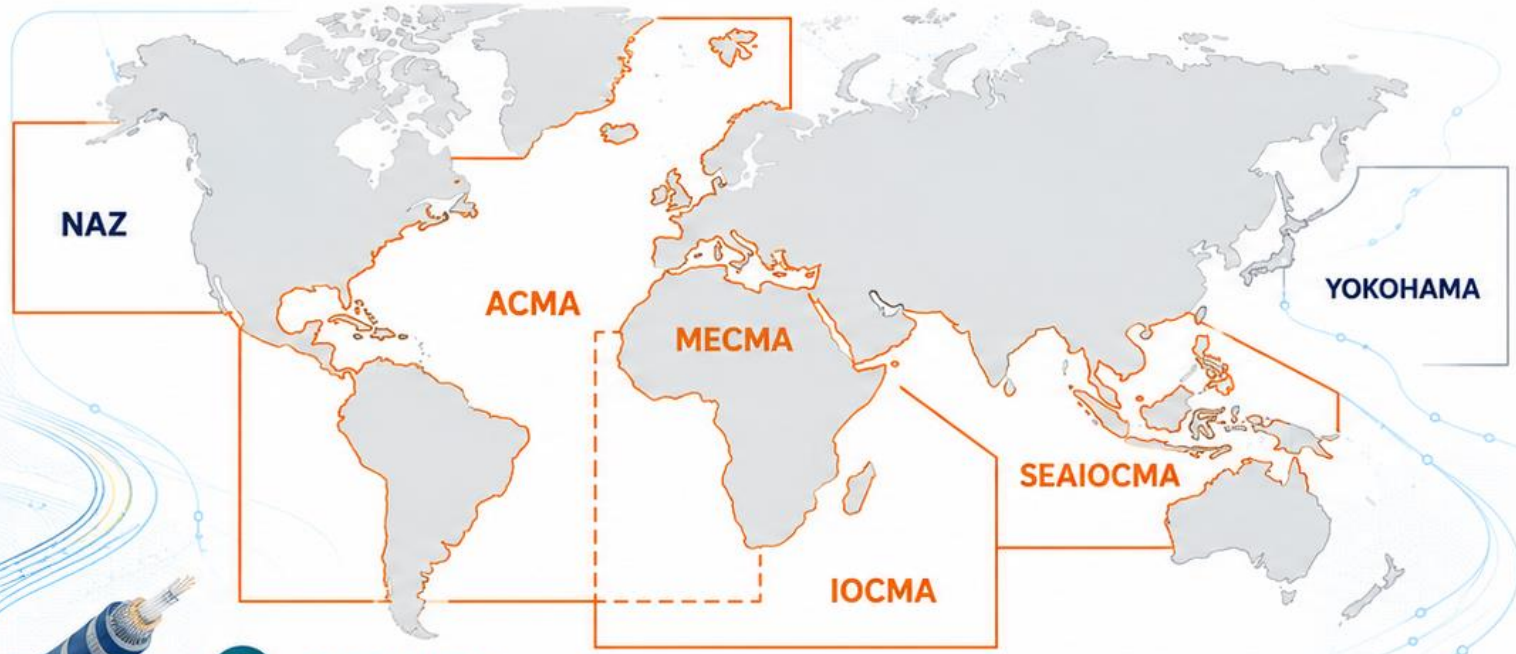
→ **RETURN TO SERVICE**
Network service fully restored. Monitoring continues.

Global Repair & Maintenance Zones

GLOBAL REPAIR & MAINTENANCE ZONES

Submarine Cable System

Regional Maintenance Authorities, Fault Response, and Marine Repair Support



OVERVIEW

The global submarine cable industry is organized into regional repair and maintenance zones. Each zone is covered by a maintenance authority or consortium that contracts one or more cable ships on standby to respond to cable faults. International cable owners including cloud companies, telecom carriers, and governments typically purchase maintenance coverage through these agreements.

HOW THE SYSTEM WORKS

A maintenance zone typically provides:

- One or more dedicated cable ships
- Remotely Operated Vehicles (ROVs)
- Sea plows and burial equipment
- Grapnels and recovery equipment
- Spare submarine cable
- Spare repeaters and branching units
- Jointing engineers and marine crews
- 24/7 fault response coordination

TYPICAL RESPONSE SEQUENCE

1. Cable owner reports a fault.
2. Fault is localized using OTDR/C-OTDR and network telemetry.
3. The maintenance authority dispatches the assigned cable ship.
4. The cable is grappled or accessed by ROV.
5. The damaged section is recovered.
6. A new cable section, repeater, or branching unit is installed if required.
7. End-to-end optical and electrical testing is completed.
8. The repaired cable is reburied where appropriate.

Global maintenance agreements enable rapid repair of submarine cable faults and improve network resilience worldwide.

Typical Submarine Cable System Services

1. Infrastructure Products

Dark fiber pair IRUs → fiber-pair segment IRUs → spectrum

2. Capacity Products

1T / 800G / 400G / 100G wavelengths → lit capacity IRUs → short/medium-term leased capacity

3. Connectivity Products

Ethernet → CLS-to-data-center backhaul → cross-connects → interconnection

4. Support Services

Colocation → SLTE hosting → NOC/monitoring → O&M → testing/fault localization → restoration

SUBMARINE CABLE SYSTEM CAPACITY & DARK FIBER PAIR PURCHASERS

– CONNECTING THE WORLD – ENABLING HIGH-CAPACITY, LOW-LATENCY GLOBAL COMMUNICATIONS –

SUBMARINE CABLE SYSTEM CAPACITY

Massive bandwidth delivered by advanced submarine cable technology

MULTIPLE FIBER PAIRS	HIGH CAPACITY	FLEXIBLE SERVICES	RELIABLE & SECURE
8, 12, 16 or more fiber pairs per cable	18+ Tbps per fiber pair with latest SLTE	Dark Fiber, Spectrum, Wavelengths, Ethernet, IP Transit	Built for 25+ years of resilient, secure performance

WHAT CUSTOMERS PURCHASE

PRODUCT / SERVICE	DESCRIPTION
DARK FIBER PAIRS (IRU)	Exclusive, long-term use of one or more fiber pairs (end-to-end)
SPECTRUM IRU	Exclusive use of optical spectrum across the cable system
WAVELENGTHS	100G / 400G / 800G+ wavelengths for high-capacity connectivity
ETHERNET SERVICES	Layer 2 connectivity (E-Line, E-LAN)
IP TRANSIT	Global internet connectivity and IP transport services
MANAGED CAPACITY	Managed bandwidth with SLAs and performance guarantees

BUILT FOR THE FUTURE

High-capacity submarine cables form the backbone of the digital world, connecting continents, communities, and industries.

WHO BUYS SUBMARINE CABLE CAPACITY & DARK FIBER?

Diverse customers rely on submarine cables for their critical connectivity needs

HYPERSCALE CLOUD PROVIDERS
- Drive global traffic growth
- Invest in and purchase fiber pairs
- Build private cable systems

Google, aws, Microsoft, Meta, ORACLE

INTERNATIONAL TELECOMMUNICATION CARRIERS
- Global voice, data and wholesale services
- Purchase fiber pairs, spectrum and wavelengths

AT&T, verizon, LUMEN, NTT, orange

MOBILE NETWORK OPERATORS
- International roaming
- Backhaul and gateway traffic
- Interconnect islands, countries and regions

T-Mobile, verizon, AT&T, vodafone, orange

GOVERNMENT & DEFENSE AGENCIES
- Secure communications
- Disaster recovery
- Research & education networks

U.S. GOVERNMENT AGENCIES, NATO OTAN

INTERNET SERVICE PROVIDERS (ISPs)
- International internet access
- Content delivery
- Wholesale & retail services

COMCAST, Spectrum BUSINESS, COGENT COMMUNICATIONS

DATA CENTER OPERATORS
- Increase capacity to meet tenant demand
- Improve connectivity and diversity

EQUINIX, DIGITAL REALTY, CORESITE, DRFORTRESS

CONTENT DELIVERY NETWORKS (CDNs)
- Deliver content globally
- Improve performance and user experience

CLOUDFLARE, Akamai, fastly

FINANCIAL INSTITUTIONS
- Low-latency trading
- Secure data transport
- Global operations

LARGE ENTERPRISE CUSTOMERS
- Global connectivity for multi-national operations
- Backup, diversity and business continuity

ENERGY | HEALTHCARE | MANUFACTURING | TECHNOLOGY | AEROSPACE

GLOBAL REACH — Connecting continents and communities

MASSIVE CAPACITY — Multi-terabit per second per fiber pair

RELIABLE & RESILIENT — Engineered for 25+ years of continuous service

OPEN ACCESS — Carrier-neutral, competitive and future-ready

POWERING THE DIGITAL FUTURE — Enabling innovation, commerce and connection worldwide

Industry Acronyms

General Submarine Cable System

Acronym	Meaning
SCS	Submarine Cable System
SFOC	Submarine Fiber Optic Cable
CLS	Cable Landing Station
BMH	Beach Manhole
OGB	Ocean Ground Bed
HDD	Horizontal Directional Drilling
DWDM	Dense Wavelength Division Multiplexing
WDM	Wavelength Division Multiplexing
SDM	Space Division Multiplexing
FP	Fiber Pair
OF	Optical Fiber
BU	Branching Unit
RLU	Reconfigurable Line Unit
RU	Repeater Unit
HLLB	High Loss Loopback
ILA	In-Line Amplifier
PFE	Power Feed Equipment
SLTE	Submarine Line Terminal Equipment
NMS	Network Management System
EMS	Element Management System
OSS	Operations Support System
NOC	Network Operations Center
DCN	Data Communications Network

Optical Components

Acronym	Meaning
EDFA	Erbium-Doped Fiber Amplifier
EDF	Erbium-Doped Fiber
VOA	Variable Optical Attenuator
VOAU	Variable Optical Attenuator Unit
OADM	Optical Add-Drop Multiplexer
ROADM	Reconfigurable Optical Add-Drop Multiplexer
MUX	Multiplexer
DEMUX	Demultiplexer
OSC	Optical Supervisory Channel
OSA	Optical Spectrum Analyzer
OTDR	Optical Time Domain Reflectometer
C-OTDR	Coherent Optical Time Domain Reflectometer
BER	Bit Error Rate
FEC	Forward Error Correction
OSNR	Optical Signal-to-Noise Ratio
SNR	Signal-to-Noise Ratio
PMD	Polarization Mode Dispersion
CD	Chromatic Dispersion
DCF	Dispersion Compensating Fiber
GFF	Gain Flattening Filter
ASE	Amplified Spontaneous Emission
Raman	Raman Amplification
DSP	Digital Signal Processor

Industry Acronyms (Continued)

Marine Installation

Acronym	Meaning
CS	Cable Ship
CLV	Cable Laying Vessel
ROV	Remotely Operated Vehicle
AUV	Autonomous Underwater Vehicle
CPT	Cable Plow Tow
PLGR	Plough Grapnel Run
PGR	Pre-Lay Grapnel Run
PLIB	Post-Lay Inspection and Burial
LBL	Long Baseline Navigation
USBL	Ultra Short Baseline
DGPS	Differential GPS
MBES	Multibeam Echo Sounder
SSS	Side Scan Sonar
SBP	Sub-Bottom Profiler
TMS	Tether Management System
RPL	Route Position List
RPLM	Route Position List Marker
KP	Kilometer Point
ECR	Engineering Change Request

Testing & Commissioning

Acronym	Meaning
FAT	Factory Acceptance Test
SAT	Site Acceptance Test
PAT	Power Acceptance Test
ATP	Acceptance Test Procedure
IOT	Integrated Operational Test
ORT	Operational Readiness Test
BERT	Bit Error Rate Test
OPM	Optical Power Meter
VFL	Visual Fault Locator

Industry Acronyms (Continued)

Power System

Acronym	Meaning
HVDC	High Voltage Direct Current
CC	Constant Current
CV	Constant Voltage
SE	Sea Earth
MEA	Marine Earth Electrode
HV	High Voltage
LV	Low Voltage
CPC	Copper Power Conductor

Network & Capacity

Acronym	Meaning
IRU	Indefeasible Right of Use
SLA	Service Level Agreement
QoS	Quality of Service
MPLS	Multi-Protocol Label Switching
OTN	Optical Transport Network
SDH	Synchronous Digital Hierarchy
SONET	Synchronous Optical Network
Ethernet	IEEE 802.3 Ethernet
100GE	100 Gigabit Ethernet
400GE	400 Gigabit Ethernet
800GE	800 Gigabit Ethernet
Tbps	Terabits per Second
Gbps	Gigabits per Second

Reliability & Maintenance

Acronym	Meaning
MTBF	Mean Time Between Failures
MTTR	Mean Time To Repair
RFS	Ready For Service
O&M	Operations & Maintenance
PM	Preventive Maintenance
CM	Corrective Maintenance
RCA	Root Cause Analysis
MOP	Method of Procedure
SOP	Standard Operating Procedure

Industry Acronyms (Continued)

Industry Organizations

Acronym	Meaning
ICPC	International Cable Protection Committee
ITU	International Telecommunication Union
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
ISO	International Organization for Standardization
NEC	Network Equipment Center (vendor-specific)
TE SubCom	TE Connectivity SubCom
ASN	Alcatel Submarine Networks
NEC	NEC Corporation (Submarine Networks)

Commercial & Regulatory

Acronym	Meaning
EPC	Engineering, Procurement & Construction
CAPEX	Capital Expenditure
OPEX	Operating Expenditure
EBITDA	Earnings Before Interest, Taxes, Depreciation & Amortization
MSA	Master Services Agreement
NDA	Non-Disclosure Agreement
LOI	Letter of Intent
MOU	Memorandum of Understanding
PPA	Project Participation Agreement
SPA	Supply Purchase Agreement
RFP	Request for Proposal
RFQ	Request for Quotation
PO	Purchase Order