Marine Construction Overview

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Chris Carobene – 26 years at SubCom…!
Agenda

Process Overview

Construction Activities

Vessels and Tools

CURIE Examples
Process Overview
Building the Network

Install the equipment and infrastructure necessary for the undersea network

Maximize network performance by protecting submarine cables using a robust construction process

Managing and mitigating risk throughout the construction process
Construction Activities
Scope of Marine Construction

- **Pre-Laid Shore End**
  - shallow water vessel
  - route clearance
  - cable lay
  - cable burial
  - split pipe

- **Main Lay**
  - cable loading
  - route clearance
  - cable burial
  - surface lay
  - ROV inspection / burial

- **Direct Landing**
  - cable landing
  - beach splice
  - cable positioning
  - diver burial
  - Uraduct

- **Terrestrial**
  - land cable
  - ocean ground
  - station splice
  - OSP construction

- **Terminal**
  - Equipment installation
Four main phases of construction process:

- Planning
- Data Collection & Validation
- Execution
- Support & Maintenance
Planning - Risk Identification

Key Risk Areas:

- **Personnel** – Dangerous environment with high tensions and heavy machinery

- **Vessel, Tools & Equipment** – Break-down causes delay and budget overrun

- **Cable System** – Systems need to survive in a harsh environment for 25yrs

The majority of cable failures are the result of interaction with other human activity.
80% of all cable faults are the result of external aggression (e.g. fishing & anchoring).

ICPC Plenary 2019, A. Palmer-Felgate et al, Cape Town, April 2018. Averages over between 5 to 10 years of data depending on maintenance zone.
Submarine Cable Protection

Given the economic and national-security importance of submarine cables, it’s critical to protect them from physical damage.

- An undersea cable repair can cost in excess of US $1 million and typically takes 2+ weeks to return the cable to service—or more, depending on permitting requirements, weather, and other factors.

Ship anchors and commercial fishing gear pose—by far—the most significant risks of damage to undersea cables.

- Fishing practices and patterns continue to be a **primary consideration** in undersea cable projects.

- >90% of cable faults (2010-2015) are caused by external aggression; of this percentage, ~75% are attributed to fishing or anchoring.

- Regional variation in fishing risks are analyzed to tailor marine liaison analyses and outreach strategies.
Initial Design - Desktop Study

**Identify a safe and economical cable route**

**Design Considerations:**
- Landing Points
- Maritime Boundaries
- Geopolitics - Contested Areas
- Cable Fault Data Base
- Deep Burial
- Pre-Laid Shore Ends & Direct Landings
- Horizontal Directional Drilling
- 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

Agreement with other seabed users is critical to the survivability of the system
Risk Management

Risk Identification & Assessment

• Identify each risk
• Determine the threat level

Avoidance – Primary mitigation is to simply avoid

• Routing directly to deep water
• Avoiding areas of intense fishing and anchorages

Mitigation – When the risk can’t be avoided

• Burial
• Cable Armoring

Risk Management balances cost of mitigation against the risk of future system downtime.
Planning Activities - Permitting

• Landing Permits License – Permission to operate a telecom network

• Proprietary Permits
  • Rights of way, easements, wayleaves and seabed lease agreements
  • Cable Crossing Agreements
  • Pipeline Crossing Agreements
  • Hydrocarbon and Mineral Lease Blocks/Concession agreements
  • Environmental Impact Assessments
  • EEZ notifications

• Operational Permits
  • Notices to mariners
  • Navy/coastguard permits/notifications
  • Local authorities and municipalities
  • Work Visas

• Other Permissions may be Prerequisites
  • Fisheries
  • Native communities

Early due diligence with all stakeholders is critical to minimizing the permitting interval.
Data Collection - Cable Route Survey

Data Collection – Survey & Inspections

✓ Bathymetry, geotechnical, sub-bottom, and side scan data to support route engineering, cable selection, installation and burial

Analysis of Results – Results

✓ Revised RPL & SLD
✓ Cable Armoring & Protection
✓ Burial Conditions
✓ Recommendations for Installation Procedures
Design Validation - Cable Route Engineering

Installation Planning – Methods of Procedure

Modelling
GIS environment to display bathymetry, geophysical information, nautical charts, global maritime boundaries, oil and gas lease blocks.

Cable Route Engineering
Slack, cable type transition, repeater and joint body locations. Any changes to the route are calculated automatically and results are updated.

Software modeling of the cable as it is deployed allows validation of the plan before heading to sea.

Computerized Cable Lay Plan
Installation Activities - Terrestrial

Shore End & Terrestrial
- Shallow water installation
- Cable landing operations
- Land cable installation
- Ocean ground bed installation
- Station cable terminations

Terminal Installation
- Station layout
- PFE installation
- SLTE installation
- ODF installation
- Fiber Guide installation
- Power and data cabling
Installation Activities – Marine

Route Clearance
– Clears out-of-service cables / discarded fishing nets
– Reduces risk to burial equipment
– Accommodates future maintenance

Main Lay & Burial
– Cable loading
– Cable installation
– Slack to cover seabed contours
– Burial to mitigate fishing & anchors
– Splicing and Testing

Post Lay Inspection & Burial
– Supplements the sea plow burial
– Verifies the installation
Critical Angle “alpha” is the entry angle that the cable makes with the surface of the water.

\[
\alpha = \arccos \left( \sqrt{1 + \frac{1}{4} \left( \frac{H\pi}{V_s \times 180} \right)^4} - \frac{1}{2} \left( \frac{H\pi}{V_s \times 180} \right)^2 \right)
\]

For critical angles less than 30°, alpha can be closely approximated:

\[
\alpha = \frac{H}{V_s}
\]
Matching Alfa to the angle of the seabed ensures that the cable properly follows the seabed contours.
Sea plow used to bury cable

Note: distance of the plow from the ship, and lengths of the fiber-optic cable and tow cable, vary depending principally on sea-floor depth.
Burial Tools - Plows

- Modern **Subsea Telecom Cable Plow** - simultaneous cable lay & burial
- 3m burial capability
- Tow force of **80 tons** or greater
The ROV can be operated on tracks or in free-fly mode.

Post main-lay the ROV deploys to the seabed.

The cable is located using cameras, sonar or specialized cable detection equipment.

The cable is inspected and/or buried using water jets on deployable jetting swords.

Burial takes place to target depth or a maximum of 3 jetting passes.

When jetting is complete, a final inspection pass is conducted to record burial results.

The ROV can also be used to cut, recover and bury cables during cable repair operations.
ROV Submarines

- Cable Burial **ROV** (Remotely Operated Vehicle)
- **2 or 3 meter** burial capability
- **Water jets** bury cable
Cable Ship Features
Installation – Cable Ships

Modern Cable Ship

- Multi-function cable lay vessel
- Worldwide operations
- 140m LOA, 21m Beam, 8.4m Draft
- Berthing for 80 personnel
- 60 day endurance
- Install, bury and maintain cables
Main Lay Capabilities

Propulsion

- Rolls-Royce Diesel Electric
- Five (5) KRGB-9 Ulstein Bergen 1990kW Engines
- Ulstein Bow & Stern Thrusters (2 x Bow, 2 x Stern)
Main Lay Capabilities

**Navigation & Positioning**

- Kongsberg SDP22 DP2
- Bandak MK12 Taut-wire for shallow operations
- Fanbeam & Radius for ranging to platform
- Kongsberg HIPAP 500
- EA500 Echosounder
- Trimble Redundant DGPS
Main Lay Capabilities

Cable Stowage

- Three (3) Main Lay Tanks
- 5500mt Capacity
- May be outfitted with:
  - loading arms
  - turntable
Main Lay Capabilities

Cable Lay

- 20 Wheel-Pair Linear Cable Engine
  - 16t Capacity
  - Controllable Pinch Pressure
- 2 x 30t Cable Drum (4m diameter)
- 3 x WAMAC Dynamometers
- 3.5m dia stern sheaves
- Can be equipped with various quadrants and tensioners
Main Lay Capabilities

Cable Jointing
- Interior jointing and testing area
- Specialized jointing equipment can be mobilized on cable highway or on stern
Main Lay Capabilities

Cable Protection

- Storage interior/exterior to the vessel
- Sufficient rear deck space to install and deploy various protective elements
- Uraduct, bend stiffeners, concrete mattresses
Post Installation - Cable Awareness & Support

To capture fishing risks, different tools are utilized to spatially and temporally identify fishing profiles to inform system design and ensure maximized cable awareness outreach strategies.
Curie Project Highlights
Curie Cable System – Concept
Curie Cable System – Initial vs Final Routing
Curie Cable System: Segment 1 DTS Changes

Based on advice from the Navy to avoid an underwater range

Route East of this Line

Other Cable

Areas to avoid

Original (Post Contract) Segment 1 Magenta Line

New Segment 1 Green line
Curie Cable System: Segment 1 DTS Changes

Top 1/3 - no go

Charted Wreck

Original (Post Contract) Seg1

Seg1 re-route
Curie Cable System: Segment 1 Mexico Bio Reserve Changes
CURIE – ROV Survey (Touch Down Monitoring)

Cable was recovered and re-laid away from obstructions.
CURIE – Jointing & Testing

20 at sea joints performed including:

• 1 final splice
• 1 Ship to Ship splice
• 3 branching unit installation
• 5 Tank to Tank
• 7 cuts / joints for Gain Tilt measurement testing
• 3 for weather and other operational events
CURIE – Jointing & Testing
CURIE – Landing in Chile

Direct Landing - 350m to shore
CURIE – Horizontal Directional Drill (California)

Dockweiler Park, Los Angeles, California

- 1,300m bored conduit
- County Harbor and Parks Scheduled events required all work to stop
- Hard and rocky conditions
- Weather delays
- High surf conditions
- Reduced work site
CURIE – Conduit Construction in Los Angeles

- Approx. 25,000ft of conduit installation with Manholes and Handholes
CURIE – Outside Plant (OSP)

City of Los Angeles Conduit Construction

Open Trench Construction

Directional Drilling

Terrestrial Cable Installation
Questions?

Thank You!

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