Life Cycle Of A Subsea Cable Project
Life Cycle of a Subsea Cable Project

Lecture 10.1
Michael D Francois - Google Network Infrastructure Development

1. Background
2. Initial Concept
3. From Concept to Project
4. System Financing
5. Supplier Negotiations
6. Guarantees
Background
A Brief History

- 1837 - Telegraph invented
- 1849 - England to France subsea cable
  ○ Fails after 8 days
- 1851 - England to France commercial success
  ○ Gutta-percha insulation
- 1858 - First transatlantic cable
  ○ Fails after 3 weeks as it is operated at voltages too high for the insulation
- 1861 - First US transcontinental telegraph cable completed
- 1868 - First commercially successful transatlantic cable
- 1876 - Bell patents telephone
- 1877 - Transatlantic phone call on Telegraph cable fails
- 1883 - Calls placed over 5 miles of underwater cable
- 1884 - San Francisco-Oakland phone service on Gutta-percha insulated cable
- 1920 - Chesapeake Bay cable uses loading cools underwater
- 1915 - Transcontinental US phone service begin
- 1950 - Repeated cable using polyethylene from Florida to Havana
- 1956 - TAT-1 goes into service
- 1967 - HAW-1 goes into service
- 1980s - WDM systems begin to appear
- 1986 - First international submarine cable, UK-Belgium
- 1988 - First fiber optic submarine cable, TAT-8

Source: ICPC, Wikipedia
Global Subsea Network

~ 378 cables in service
~100,000 km new cable each year

Source: Telegeography
153 years ago - the **SS Great Eastern**

The **SS Great Eastern** took 14 days to sail from Ireland to Newfoundland and lay the 2nd transatlantic cable; the first transatlantic cable was in service for 3 weeks.
Transpacific Telephone Cable

55 years ago - TPC-1

The first transatlantic Telephone cable was TAT-1, and was laid in 1956.

The first Transpacific submarine telephone cable was the aptly named Trans Pacific Cable (TPC-1), which went into service on June 19, 1964. It was a coaxial cable linking Hawaii, Midway Atoll, Wake Island, Guam, and Japan.

In Hawaii it connected to Hawaii No. 1 (HAW-1), to complete a path to the US mainland in Point Arena, CA. HAW-1 was built in 1957, and was the first telephone cable to connect Hawaii to the continental 48 states.
Submarine Cable Ships

Today
Submarine Cable

- Optical Fibers
- Silicon Gel
- Ultra-High Strength Steel Wires
- Buffering Material (Plastic/Steel)
- Copper Sheath
- Polyethylene Insulator
- Nylon Yarn Bedding
- Galvanized Armor Wires
- Tar-Soaked Nylon Yarn
Building And Deploying Wet Plant
Landing A Submarine Cable
Landing A Submarine Cable

A direct beach landing is the easiest way to land, but it is not always possible

TPC-1 (1964年開通)

SJC (2013年開通)

Japanese Film on TPC 1: http://www.kagakueizo.org/movie/industrial/78/
Transition from Sea to Land & Shore Plant
Beach Manhole (BMH) Construction
Background

- **Submarine Cables have a Technical Complexity**
  - They are composed of various high tech components which require engineering knowledge to design, evaluate, operate and maintain

- **There is also an Administrative Complexity**
  - Multi-national constraints
  - Long term supplier relationships
  - Geopolitical considerations

- **Specific Skills** are required for various aspects of a successful project
  - Marine Operations, Legal, Optical Engineering, Finance, Permitting, Planning, Negotiating, etc

- **And the Timescale is significant**
  - From Concept to Contract-In-Force: 6 – 24 months
  - Construction: 12 – 24+ months
  - Operation: 25 years (technical), ~15 years (commercial)
Background

- **Price range of a subsea cable**
  - From $10m
    - Point-to-point repeaterless system short distance, though can still be international
  - To $10b
    - Intercontinental transoceanic multipoint system

- **System Quality Has To Meet Requirements**
  - Outages
  - Planned System Life
  - High reliability
  - Technical Must Haves (Latency, Redundancy, Reliability, Capacity, etc)

Source: Telegeography

Causes of Cable Faults
Initial Concept
How Do We Plan Cables?

Business Case
- Traffic Forecast & Capacity Planning
- Strategic considerations
- Regional Considerations
- Decision Analysis
- Budget Approvals

Design+Pre-Build
- Design Engineering
- Supplier Selection
- Construction Build Agreement
- Permitting and Compliance
- Contract-in-Force

Cable Deployment
- Marine Survey
- Cable Lay
  - Trunk
  - Branches
- Cable Landings
- Ready for Service

Cable Maintenance
- Ongoing Marine Maintenance
- Terrestrial Network Integration
- Upgrades
Business Case

- What are the drivers for a new submarine cable?
- Connectivity analysis
  - Connecting countries across oceans
    - Population
    - Internet penetration
    - Existing connectivity - Does it scale?
    - Interconnection within global network - Does it fit?
  - Financial Analysis
    - Is there a return on the investment?
    - In what timeframe?
- Metcalfe’s Law
  - The value of a telecommunications network is proportional to the square of the number of users of the system.
Markets & Traffic

Market Types for Subsea Cable Systems

- Transoceanic:
  - Higher demand, potentially many capacity sellers
  - Capacity tends to become a commodity

- Regional:
  - Less demand, potentially fewer sellers
  - Less price pressure, long term purchase
  - Capacity remains a strategic resource

Market Analysis

- Existing and planned resources with common connectivity and capacity analysis
  - Source and Destination

- SWOT Analysis
  - Strengths, Weaknesses, Opportunities, and Threats
  - Local partnerships, average capacity cost, marginal capacity cost analysis, market size
Technical Design Decisions

Technology analysis
- Impact on capacity availability & costs
- Pace of technology evolution
  - Advantages & availability of next generation
  - Is a major breakthrough expected?
- Which technology is best adapted to market?
  - Do you need a plane or a car to travel 60km?
  - Tailored to needs
- What is the best value for the money?
  - Return on Investment
  - Upgrades
Maintenance Decisions

Maintenance Clubs

- SEAIOCMA - South East Asia and Indian Ocean Cable Maintenance Agreement
- ACMA - Atlantic Cable Maintenance Agreement
- PIOCMA - Pacific and Indian Ocean Cable Mutual Agreement
- NAZ - North American Zone
- MECMA - Mediterranean Cable Maintenance Agreement
- Yokohama Zone Agreement
- SPMMA - South Pacific Marine Maintenance Agreement
- 2OCMA - Two Oceans Cable Maintenance Agreement

Private Maintenance

- Arrangements between individual cable owners and ship owners
Why You Need One

Preparing the business case involves an assessment of:

- The opportunity
- Potential benefits/revenues
- Risks and mitigations
- Technical solutions available
- Costs (WACC/NPV)
- Timeline
- Impact on current operations, and
- Capability to deliver the project

Is The Project Worth Doing?

- Executive Summary
- Deal Summary
  - Financial Appraisal
  - Sensitivity Analysis
  - Revenue Opportunity
- Project Definition
  - Background Information
  - Business Objective
  - Benefits and Limitations
  - Legal/Policy Risks and Mitigation Plan
  - Market Assessment
  - Technical/Network Risk and Mitigation Plan
  - Capacity Planning/Marketing Plan
  - Project/Purchasing Strategy
- Project Organization
  - Project Governance
  - Progress Reporting
Consortium Cables

Legal Structure
- No or lightweight legal entity
- Relationship based on a Construction and Maintenance Agreement (C&MA) or a Joint Build Agreement (JBA)
- Negotiated capacity allocation and usage rules
- Landing Rights

Relationship Management
- Various committees are formed to reach consensus on issues
- Can be UN-like

Come In Many Flavors
- Large Consortiums of International Carriers
  - SMW-3, AAE-1
- Mid-sized Consortiums of Various Partners
  - Indigo, Havfrue
- Small Consortiums of Specialty Partners
  - JGA
- Partnership Cables
  - Havfrue
- Shared Interests are Key to Success
- Decisions by consensus
- Voting right based on various factors
  - Mostly investment level
Private Cables

- Built by Telecom Operators to address specific requirements and/or seize opportunities
  - Telstra’s Endeavour
- Built by Non-Carriers to address specific traffic flows, scalability and resiliency requirements
  - Google’s Curie
- Business case needs to be strong to cover the level of investment
  - Risk and revenues are weighted differently by debt and equity providers

Legal Structure
- Entity structure based on tax/legal/regulatory policies
- Often involves partners for permits and landing rights
- Owned capacity allocation and negotiated usage rules
- Landing Rights/Permits

Relationship Management
- Bilateral relationships with Customer and Supplier

Maintenance
- Several options available to cover marine maintenance
Forming A Consortium

If Your Analysis Leads You To A Consortium

- Each partner will have to build their own business case
- The economics and costs of capital may be different for each party
- The upside and risks will be different for each party
- Hopefully everyone’s plan is NOT built on the same customer base
- Forming the consortium itself, and getting other parties interested, takes negotiations and an outcome that allows each party to pass their own hurdles
Market Assessment

• What is the addressable market for the cable?
• Why is the cable needed?
• Where does this cable go?
• Who will make use of this cable?
• When will this cable be Ready for Service?
• How will this cable meet requirements now, and in the future?

• Capacity need projections (3–10 years)
  • Most sales occur early in system life
• Competition (existing, planned and future)
  • Who else is serving or looking at serving this route?
• Capacity pricing (now & after)
  • How much capacity exists now, and how much later?
  • What is the effect of bringing the new capacity to market?
Market Data Points

Data Points
- GDP/Distribution of Wealth
- Population
- Internet Penetration Rate
- IP Usage
- Age of Population
- Education/Literacy
- New Applications
- Mobile vs Broadband vs Leased Line
- Number of Businesses

Example Sources
- UN-ITU
- Telegeography
- Market Analytic Firms
- Consultants
System Features

Design Considerations

- Ultimate Capacity
- Topology of System
- Fiber Count
- Traditional or SDM systems
- Wavelengths per Fiber Pair
- Type of Fiber
- Type of Armoring
- Repeated or Unrepeatered
- Branches and Type
- Number, type and spacing of repeaters
- Power Budget & Design
- Environmental Considerations
- Types of Landings
- SLTE
- Open Systems
Topologies

**Ring** - *Southern Cross Cable System*
- Provides high reliability at a higher cost

**Semi Collapsed Ring** - *Australia Japan Cable*
- Protects close to shore, where most damage occurs

**Point to Point** - *CeltixConnect-1*
- Least Expensive, No Protection
System Features

**Cable configuration**: Fault history should be taken into account

- **Channel system type**
  - $\geq$ fault per winter (6 months) per 400 km
  - Ring and double landing (2 x 200 km in shallow water)
  - **Unavailability**: 0.3 day/year (single landing ~ 7.5 d/y)

- **Mediterranean system type**
  - 1 fault every two years 1000 km (shallow water)
  - Single landing (200 km but < 50 km in shallow)
  - **Unavailability**: 0.4 day/year (double landing ~ 0.01 d/y)

**Initial Cable Route**

It’s a question of today’s money vs future hedwins

Marine & Landing risk assessment: it’s a business of experience

- In 150 years, you’ll probably not be the first to go there
- Don’t hesitate to call on the people who know
- Learn from past catastrophes (and success)

Beware: Regulatory Authorities, Ecologists and Fishermen love subsea systems (time & money consuming)

Some routes are better than others
System Features

Initial Cable Route

Landing selection
  • Marine suitability (onshore, offshore activities)
  • Backhaul connection (Is there someone out there?)
  • Station size (DWDM upgrade !!!)

Route selection: Don’t be pound wise and penny foolish: it is often better to protect once now, than repair ten times later
  • Cable type and armor
  • Burial (plough preferred)
  • Shore ends
  • Cable and Pipe crossings

Price estimates

  • In-house
    • Determine equipment BoQ
    • Use previous unit prices
    • Estimate other costs
    • Always prepare data before engaging supplier
    • Try to understand their current position

  • Rough Orders of Magnitude (ROM)
    • Most suppliers are happy to provide it
    • Not always very accurate
    • Should be a not to exceed cost

  • First firm offers
Commercial Aspects To Consider

**Product Design**
- 10g/100g, Spectrum, Fiber Pairs, Protected, Unprotected, Upgrade rights,
- Upgrade rights
- Ownership or IRU
- Use Restrictions, Rights Transfer, Portability

**Review of Market Prices**
- vs existing: pricing higher would require no supply, is very hard to do
- vs planned: keep same level or lower if supply exists

**Special offers**
- Pre-sales
- Bulk purchase
- Can be driven by system configuration

**Consortia - Carrier Perspective**
- Notional capacity = capacity required to be sold to finance the initial system investment
- During the pre-sales process, pricing can be often be negotiated to cost-place basis
- Upgrade capacity
  - There are variety of solutions
  - Forward pricing on wavelengths
  - Spectral pricing on fractional IRUs
    - Alien SLTE
  - Access to uplifts to system capacity can be negotiated for at a cost+ basis
  - Be aware that consortium sometimes need to work together to complete upgrades and establish timelines

**Consortia - Non-Carrier Perspective**
- Want to ensure swap/resale rights
- Want to control upgrade timing
Commercial Aspects To Consider

Private cables

- Pre-sales (before CIF)
  - Demonstrate there is a market & reduces financial risk
  - Generally only covers part of the investment in the system cost
- Post-CIF capacity pricing
  - The Market Is Always Right
  - Also, Sometimes The Market Is Wrong
    - Be prepared to adapt your pricing
    - Someone buys, someone sells, each wants to feel they got a good deal
- Price Elasticity of Demand ($E_d$)
  - How much demand is there if nothing changes but the price?
Permitting

Landing & Operating
- Working permits: usually supplier’s responsibility
- Authorizations in principle: right to land/own a system on national territory, RoW, etc. Usually cable owner’s responsibility
- Telecom licenses: Cable owner/operator’s responsibility (possibly through local partnership)

Exclusive Economic Zone / International Waters
  - Also Called Montego Bay Convention
- 167 nations have ratified as of 2016
  - The US Situation: Part XI: Minerals
- Waters are still disputed
  - South China Sea

Agreements with other seabed users
- Cable & pipe owners
- Oil exploration & platforms
- Sand dredgers
- Fishermen
System Financing
Financial Structures

Consortia are “full-equity/no-debt” schemes
- There is no debt to be repaid
- Cash flow must be budgeted
- The restrictions that can come with debt are avoided
- Step in rights may be part of the agreement

Private Cable can have different types of funding sources
- Some companies self-fund
- Some may involve a mix of debt and equity
- This mix of funding can carry risk, that needs to have a mitigation plan

Different tranches may be needed over time, based on project success and market conditions
Financing

- Consortiums
  - Government Financing
  - Supplier Financing
  - Banks/Private Equity/Debt
  - Carrier Financing
  - Non-Carrier Financing

- Private Cables
  - Government Financing
  - Supplier Financing
  - Banks/Private Equity/Debt
  - Carrier Financing
  - Non-Carrier Financing

Expectations of Financing Entities
- Government Financing
  - Sometimes a grant to open access to an underserved market
  - Sometimes research driven
- Supplier Financing
  - Sometimes to cover a gap
- Banks/Private Equity/Debt
  - Looking for a return on investment
- Carrier Financing
  - Looking for a return on investment
- Non-Carrier Financing
  - Looking for ROI, but not necessarily on telecom products
The weighted average cost of capital (WACC) is the rate that an entity (Consortium or Company) is expected to pay on average to all its security holders to finance the asset of the submarine cable.

The WACC is the minimum return that a Company or Consortium must earn on the submarine cable to satisfy its creditors, owners, and other providers of capital.

WACC helps in understanding the overall return of the investment. It is commonly used by Finance teams to evaluate the best opportunities for future endeavors.

**WACC**

\[
\text{WACC} = \left( \frac{E}{V} \times Re \right) + \left( \frac{D}{V} \times Rd \times (1 - Tc) \right)
\]

**The Formula for WACC**

*where:*

- \(E\) = Market value of the firm’s equity
- \(D\) = Market value of the firm’s debt
- \(V\) = \(E + D\)
- \(Re\) = Cost of equity
- \(Rd\) = Cost of debt
- \(Tc\) = Corporate tax rate

Source: Investopedia

Generally used as the discount rate in an NPV calculation, and shown as percentage. Based on public filings, Walmart had a WACC of \(~6.1\%\) in 2016, was paying that amount for capital raised via debt and equity.
**NPV**

- Net present value (NPV) is the difference between the present value of cash inflows and the present value of cash outflows over a period of time. NPV is used in capital budgeting and investment planning to analyze the profitability of a projected investment or project.

- The NPV rule says that only investments with a positive NPV should be invested in.

- A NPV that is positive indicates the projected earning/return exceed the costs that are anticipated to be incurred.

\[
NPV = \sum_{t=1}^{n} \frac{R_t}{(1+i)^t}
\]

**where:**
- \(R_t\) = Net cash inflow-outflows during a single period \(t\)
- \(i\) = Discount rate or return that could be earned in alternative investments
- \(t\) = Number of timer periods

Source: Investopedia
Supplier Negotiations
Negotiations

- Be dispassionate: Emotions tend to blow up negotiations
- Prepare, and do you research, and prepare some more
- Make sure you are negotiating with the person able to actually make the decision
- Focus on your goal, and not on who is right
- Make human contact
- Acknowledge the suppliers position and the ability
- Embrace difference; different can be good, can be profitable, and leaves room for creativity

- When people become irrational (it happens), use empathy to reduce the emotion. Otherwise no one will hear anything
- Try to understand the supplier’s position; you need to know their motivation and goal if you are to persuade them
- Incremental steps are best; trying to solve everything at once usually leads to failure
- Know the standards! A powerful tool, and you can hold all sides to them
- Be transparent, and not manipulative. This will be a long term relationship.
Supply Contract

- The end result of the business plan, engineering, project plan, financing and vendor negotiations is the Supply Contract.
- The Supply Contract represents the common understanding between the cable owner(s) and builder.
- When signed, this is generally when you are Contract-in-Force, and pre-sales end.
- The contract’s outcome is the submarine cable system.
- The supply contract specifies the CAPEX that will be spent on the system.

- A good Supply Contract is they key to a smooth implementation & a system that performs as designed.
- Gives parameters so that the project has a timeline and budget.
- It is key to maintain a good relationship with the supplier during implementation and beyond.
- A fine contract should make lawyers unnecessary down the road.
Suppliers

- Suppliers love Contract Variances
- Suppliers don’t love commitments as much as CVs
- Make sure to speak to all suppliers, because more data points and knowledge helps when developing your business plan
- In the end, you will be in partnership with your supplier for decades, most likely
- Different suppliers are, of course, good at different things
- You can have multiple suppliers, but this can create complexities, and all relationships and responsibilities, handoffs and acceptance criteria need to be well documented and understood
Steps to the Supply Contract

- Rough order of Magnitude (ROM)
- RFQ/ITT (Request for Quote/Invitation To Tender)
  - Needs to be prepared to allow a good comparison of offers
- Clarification and Follow Up
  - Have them sharpen pencils, be more specific
- Trim number of bidders
- Request Best and Final Offer (BAFO)
- Select your supplier based on best fit to all requirements
Supply Contract Contents

- General Terms & Conditions
- Supplier responsibilities: Scope of Work, permits, custom clearance
- Purchaser protection: warranties & guarantee, liquidated damages
- Payment procedures
- Contract variations process
- Termination clause
- Force Majeure
- Transfer of Title upon meeting Acceptance Criteria

- Technical Specifications
  - Detailed technical description
  - Functionalities of equipment/system
  - Availability & reliability requirements
  - Safety/environmental requirements
  - Quality Assurance
  - Commissioning (tests & procedures)
    - Provisional Acceptance
  - Long-term assistance over system life
    - Including software
Guarantees
Guarantees & Warranties

- **Parental Guarantee**
  - Protects against insolvency of contractor

- **Performance Guarantee**
  - Protects buyer if system doesn’t perform as promised

- **Advance Payment Guarantee**
  - Protect buyer who make payments at milestones of project doesn’t complete

- **Warranty**
  - A financial guarantee to ensure satisfactory quality during a specific period

- **Expressed Warranties**
  - Written in the contract

- **Implied Warranties**
  - Nor written, but still binding
For more info on submarine cables
  • Watch on YouTube: A Journey To The Bottom Of The Internet