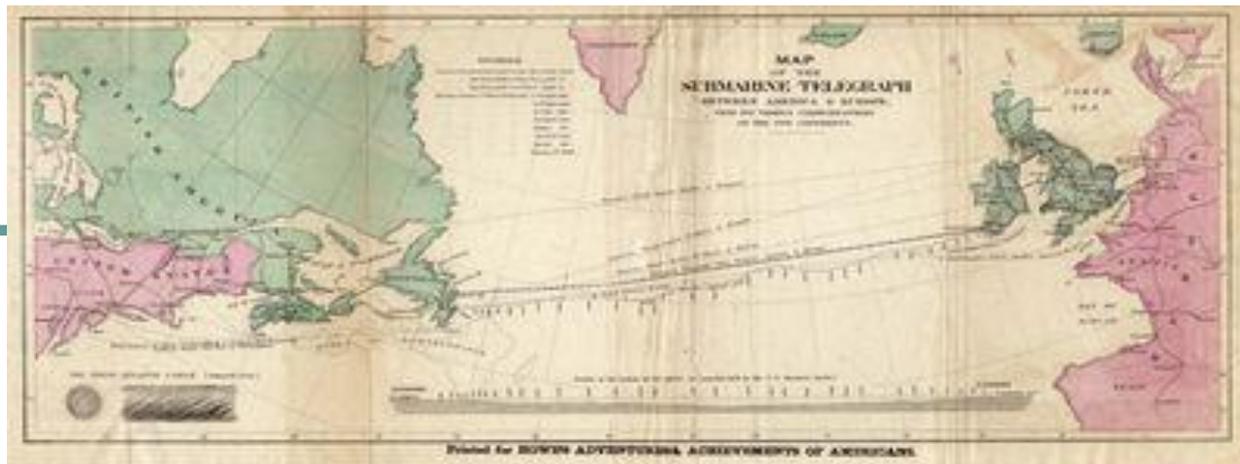


Long Distance Communications

“A Thread Across the Ocean”

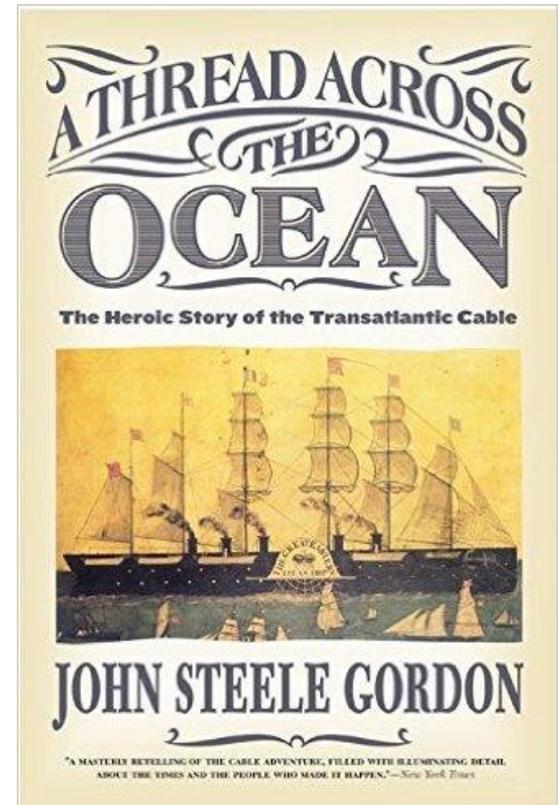
The first Transatlantic Submarine Cable



A Thread Across the Ocean

- This presentation is a summary of the first transatlantic undersea communications cable and some of the evolution of this still important 150 year old industry.
- Book Title: “A Thread Across the Ocean”
- Author: John Steele Gordon.
- An excellent story of an important, major international industrial and technological undertaking.
- By: Al Soto, KJ3Q (Feb 2016)

* Please see Credits/References on final slide.



The Idea 1

- In the mid-nineteenth century, communication between the United States and Europe -- the center of world affairs -- was only as quick as the fastest ship could cross the Atlantic.
- The USA was not a world power and this left us isolated and vulnerable.
- Almost as soon as the Telegraph was invented, the idea of an undersea telegraph lines was born. An undersea transatlantic cable is discussed as a possible triumph of the future.
- As early as 1842 Samuel Morse submerged a wire, insulated with tarred hemp and India rubber in NYC Harbor and telegraphed through it.
- In 1843, Samuel Morse, in an accurate but totally unwarranted fit of optimism, wrote "... a telegraphic communication on the electromagnetic plan may with certainty be established across the Atlantic Ocean! Startling as this may now seem, I am confident the time will come when this project will be realized."

The Idea 2

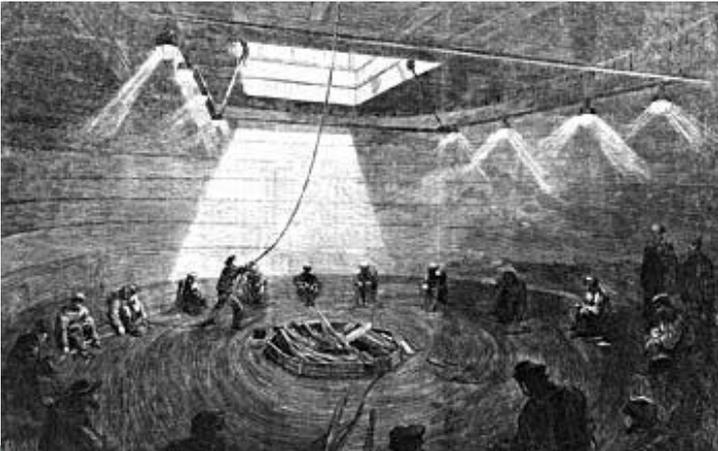
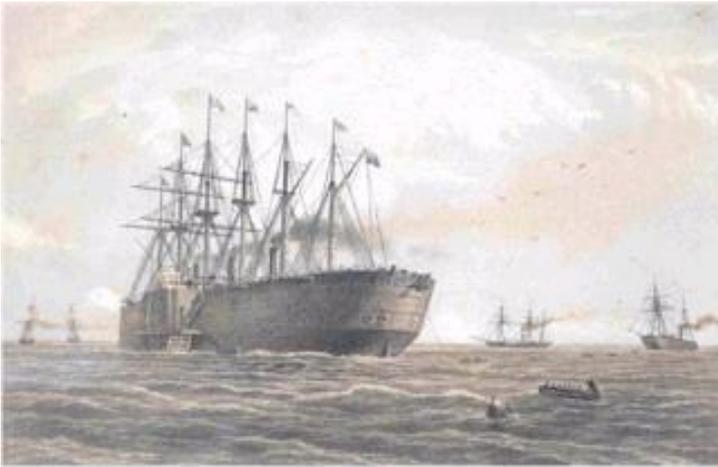
- In the early 1850's several attempts were made to lay a cable across the English Channel. Some succeeded and helped drive the development of undersea cable technology.
- The first successful undersea cable in 1850 between Britain and France was only 20 miles long. The materials were poor and the theory and processes unwritten. Yet 4 years later, plans for a transatlantic cable 100x longer were underway.
- One of the main challenges was to find a good insulator. This was required to cover the conductive wire and prevent the electric current from leaking into the water. The best result found in the 1850's was Gutta Percha.
- in 1849, American naval vessels began systematic deep-sea soundings in the Atlantic. Based on their findings, the Naval Observatory suggested there was an undersea plateau between Newfoundland and Ireland which would be the ideal route for laying a telegraph cable.

The First Try



- Cyrus Field was a businessman and member of the “Cable Cabinet”.
- Grew a network of telegraph cables to compete with Western Union.
- This included a working undersea line from Nova Scotia to New Foundland.
- In 1854, Cyrus Field started the project of the first transatlantic cable.
- After 4 years and 4 failed expeditions, in 1858 he finally succeeded.
- It only worked for 3 weeks but proved its worth and proved it was possible.

A Working Cable is Achieved



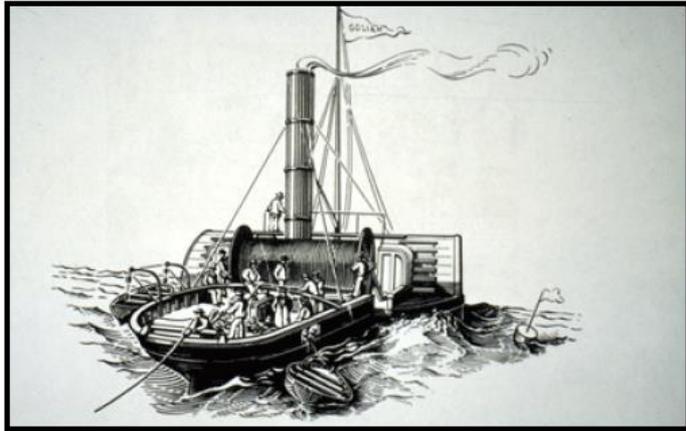
- Six years later, Cyrus Field made a new cable (length was 2,730 nm)
- Cable Ship “Great Eastern”
- Jul 13, 1866: laying begins
- Jul 27, 1866: the first transatlantic cable between two continents begins operating
- It was a single wire
- It could transfer 8 words a minute, and it cost \$100 to send 10 words (\$10/word and a 10 word minimum)
- That’s like \$1,500 today. Ouch!!!

Let's do it again!

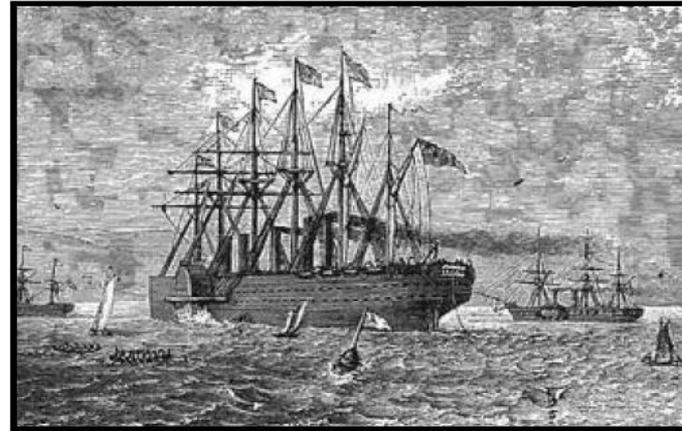


- The dream of Cyrus Field was realized.
- Investors needed a working cable.
- He immediately sent the Great Eastern back to sea to lay a second cable.
- The second cable allowed the prices to be cut in half....only \$50 per message (\$750 today).
- All messages were in Morse Code.
- The transatlantic telegraph circuits operated nearly 100 years.
- It wasn't until 1958 that we could send analog voice telephony across the atlantic (TAT-1).

Early Cable Ships



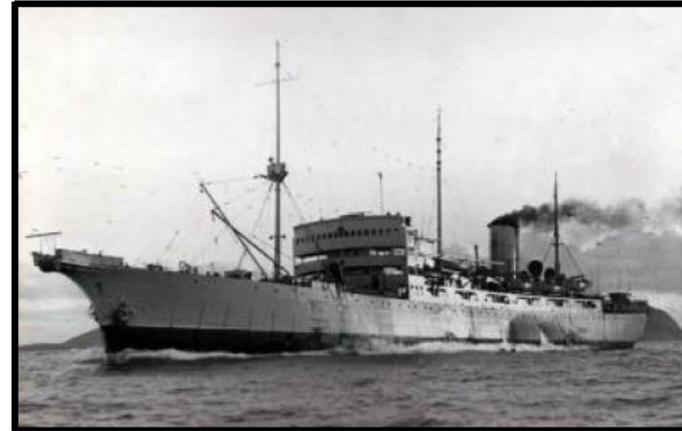
Goliath: lays 1st international cable, UK-France, 1850-1
Source: Illustrated London News



Great Eastern: laying cable off Newfoundland, 1866
Source: Canadian Government



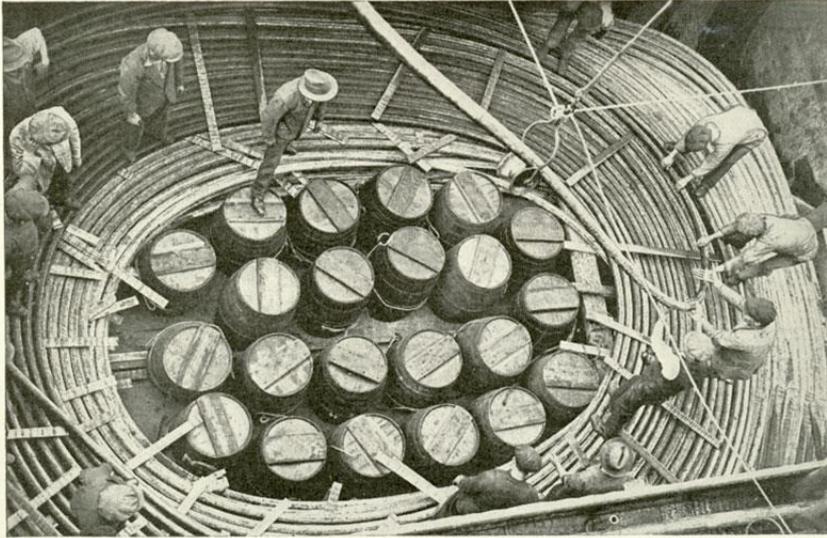
John Pender, named after pioneer cable maker, 1900
Source: Cable & Wireless



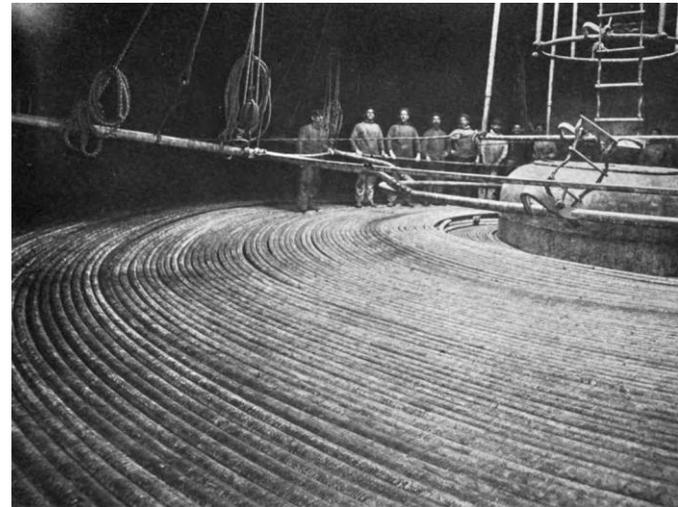
Monarch: laid 1st transatlantic telephone cable, 1955/6
Source: www.atlantic-cable.com

www.iscpc.org

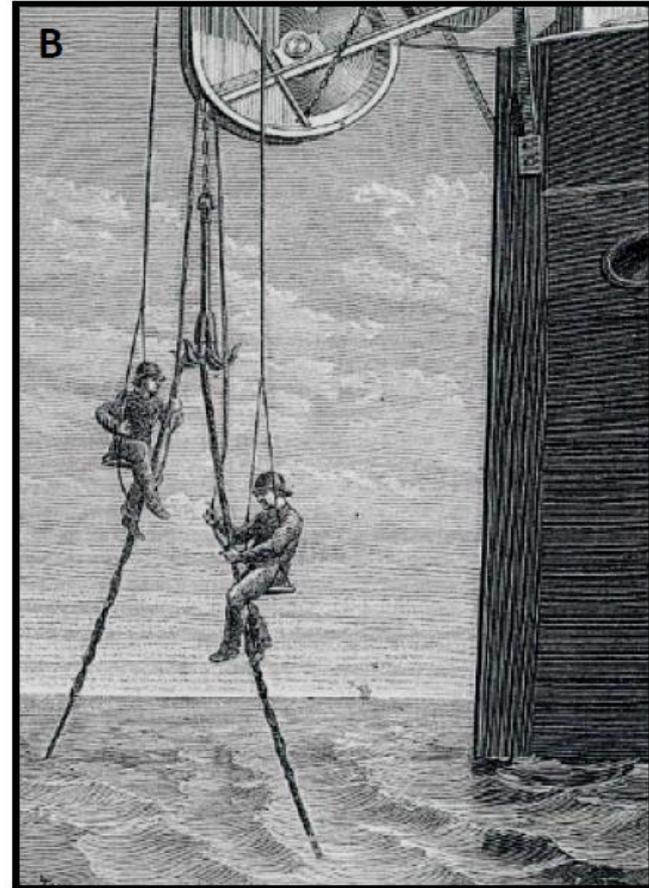
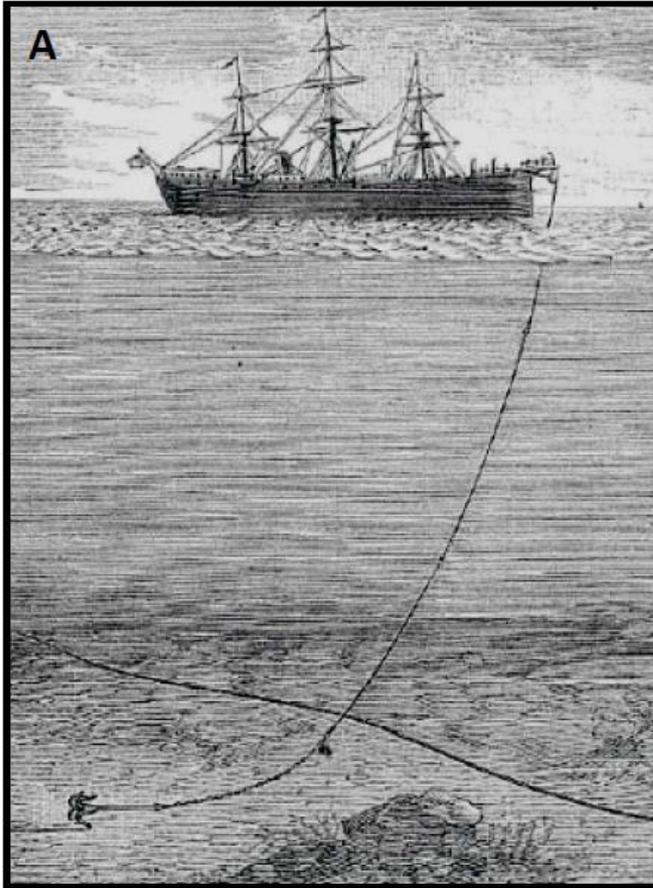
Miles of Cable



Wide World.

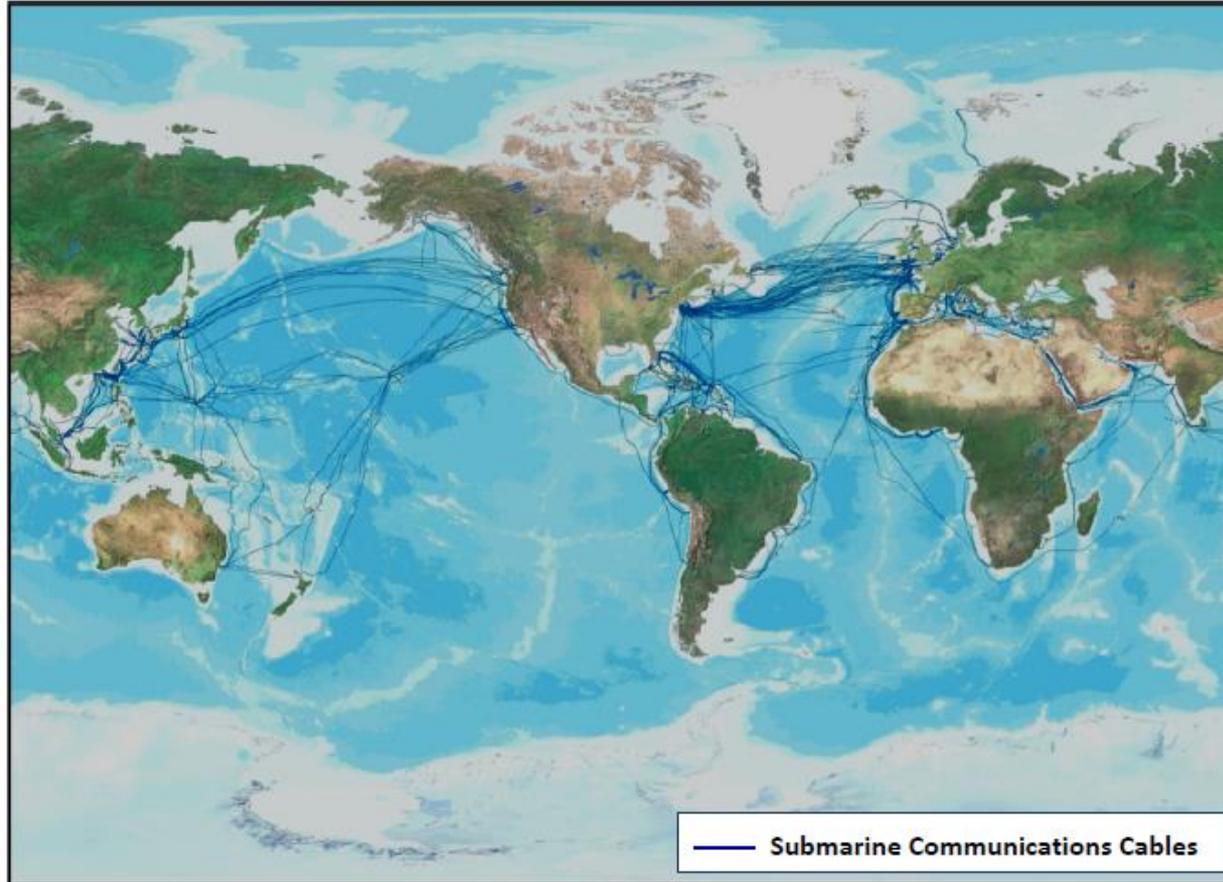


Cable Repair in 1888



[A] Cable ship trailing grapnel to retrieve cable followed by [B] securing of the cable ready for repair
Source: Traité de Télégraphie Sous-Marine by E. Wüschendorff, 1888

Undersea Cable Development



A brief history....1800's

- **1840:** Telegraph cables start to be laid across rivers and harbours, but initially had a limited life
- **1843-1845:** Gutta-percha (a type of gum found in a Malaysian tree) was brought to Britain and starts to replace other materials that were used for electrical insulation, thus extending the life of the cable
- **1850:** 1st international telegraph cable laid between UK and France, followed by a stronger cable in 1851
- **1858:** 1st transatlantic cable laid between Ireland and Newfoundland by Great Eastern. This failed after 26 days.
- **1866:** Great Eastern lays another working cable in 1866.
- **1884:** 1st underwater telephone cable - San Francisco to Oakland

A brief history....1900's

- **1920s:** Short-wave radio superseded cables for voice and telex traffic, but capacity limited and affected by atmosphere
- **1940s:** Invention of repeaters for improved long haul transmission
- **1956:** TAT-1, the first transatlantic telephone cable (36 ckts).
 - This began an era of rapid and reliable transoceanic communications
- **1961:** Beginning of a high quality global network
- **1966:** After the initial breakthrough, progress was rapid. Just ten years later, TAT-6 had 4000 telephone channels.
- **1986:** First international fiber-optic cable connects Belgium to the UK
- **1988:** TAT-8, the 1st transoceanic fiber-optic cable system, connects the USA to the UK and France with 40,000 voice circuits.

The token “RF” slide

Advantages of cables

- High reliability, capacity and security
- Insignificant delay compared to satellite
- Most cost-effective on major routes, hence rates cheaper than satellites

Carry >95% of transoceanic voice and data traffic

Advantages of satellites

- Suitable for regions that are vulnerable to disasters
- Provide wide broadcast coverage, e.g. for TV
- Suitable for minor routes such as links between small island nations

Carry <5% of transoceanic voice and data traffic

Comparing Old and New

- **Early Cable Systems:**

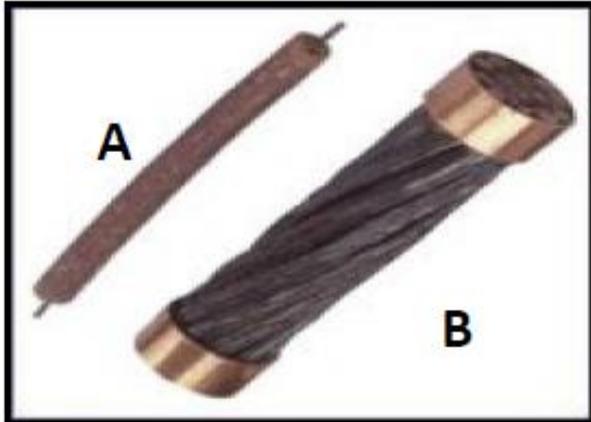
- **1866:** 1st transatlantic cable carried telegraph messages at seven words a minute and cost \$200 for 20 words
- **1948:** Telegram cost reduced to 12 cents a word for transmission across the Atlantic
- **1956:** The TAT-1 telephone cable initially had capacity of 36 voice calls at a time. Each call cost US\$12 for the first 3 minutes.

- **Modern Cable Systems:**

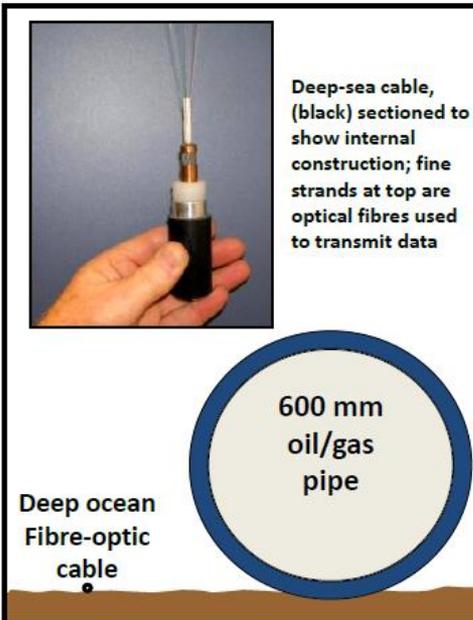
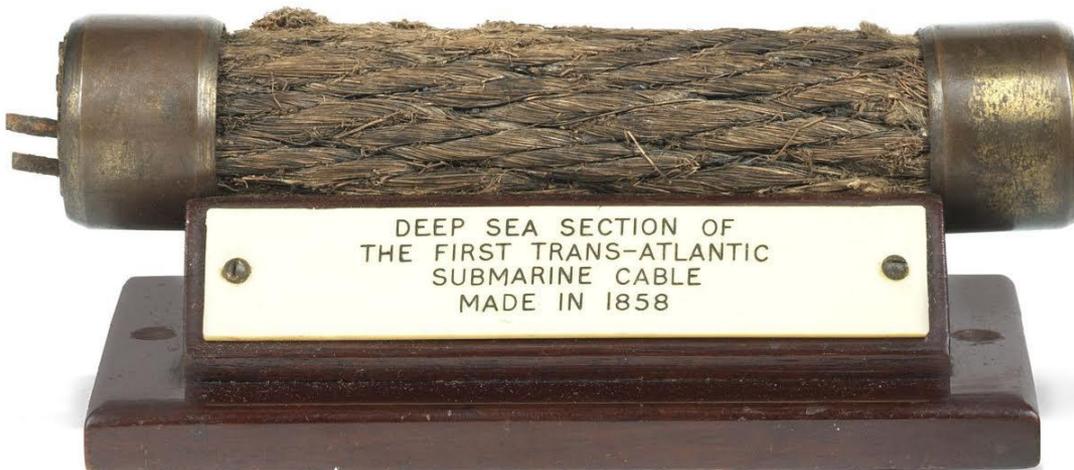
- 1988: 1st transatlantic fibre-optic cable, TAT-8, carried 40,000 simultaneous phone calls, 10x that of the last copper cable
- Today, a single cable can carry millions of telephone calls, together with huge amounts video and internet data

Cable Technology 1

UK-France Cables
A: 1850 B: 1851
Source: BT



Atlantic cable 1866
Source: Porthcurno Telegraph Museum



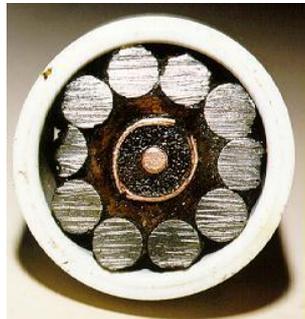
Modern fibre-optic cable in hand (for scale) and relative to 600 mm diameter subsea pipe

Cable Technology 2



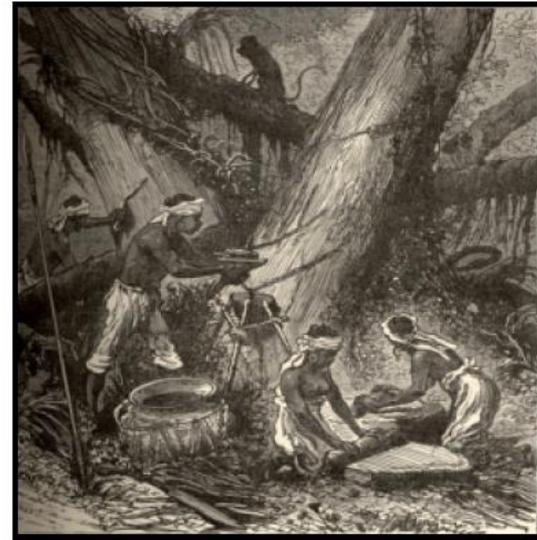
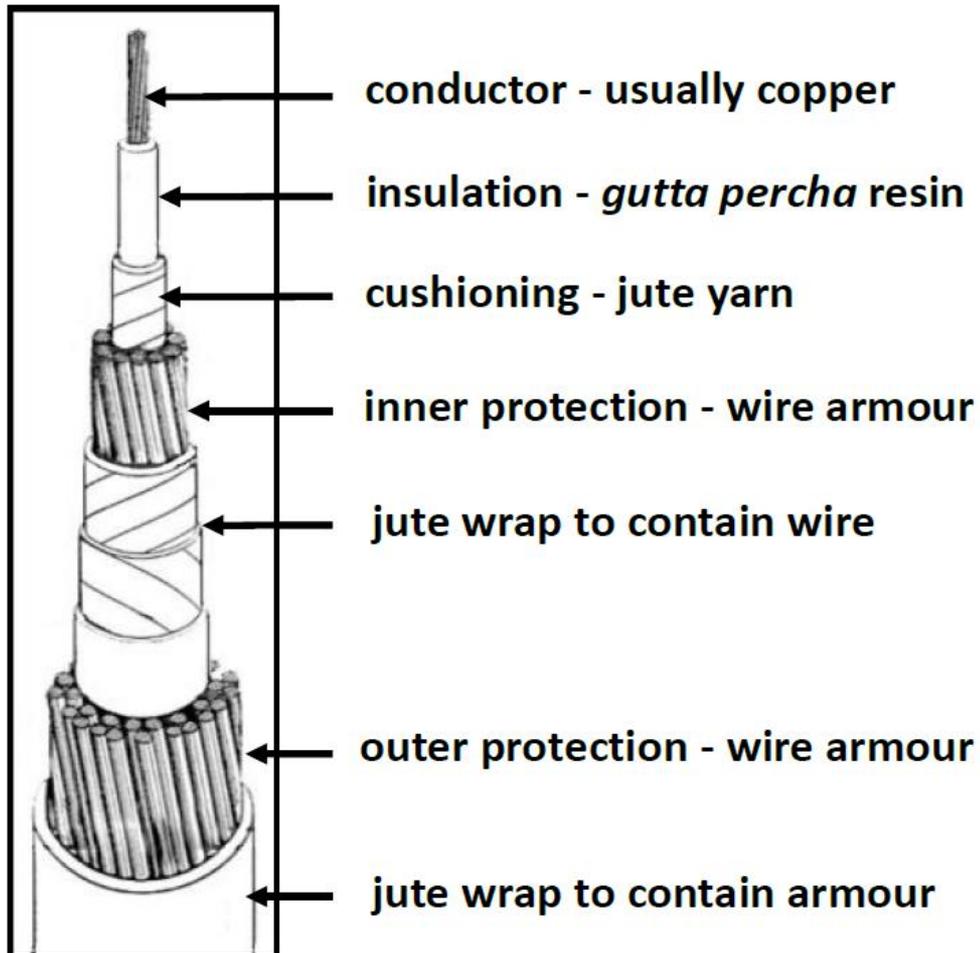
Atlantic cable 1866

Source: Porthcurno Telegraph Museum



Source:
www.w1tp.com (see credits)

Undersea Telegraph Cable



Harvesting *gutta percha* resin

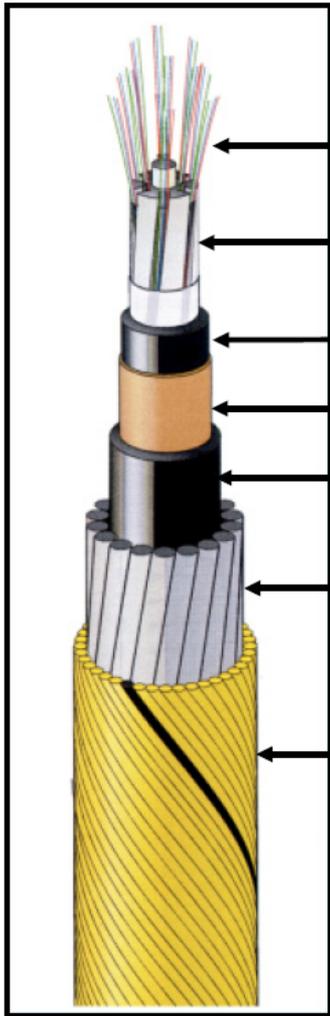
Source: Porthcurno Telegraph Museum



Atlantic cable 1866

Source: Porthcurno Telegraph Museum

Modern Submarine Cable



optical fibres - silica glass

core for strength and fibre separation - polyethylene/fibreglass

jacket - polyethylene

conductor - copper

jacket - polyethylene

protective armour - steel wire

outer protection and wire containment - polypropylene yarn

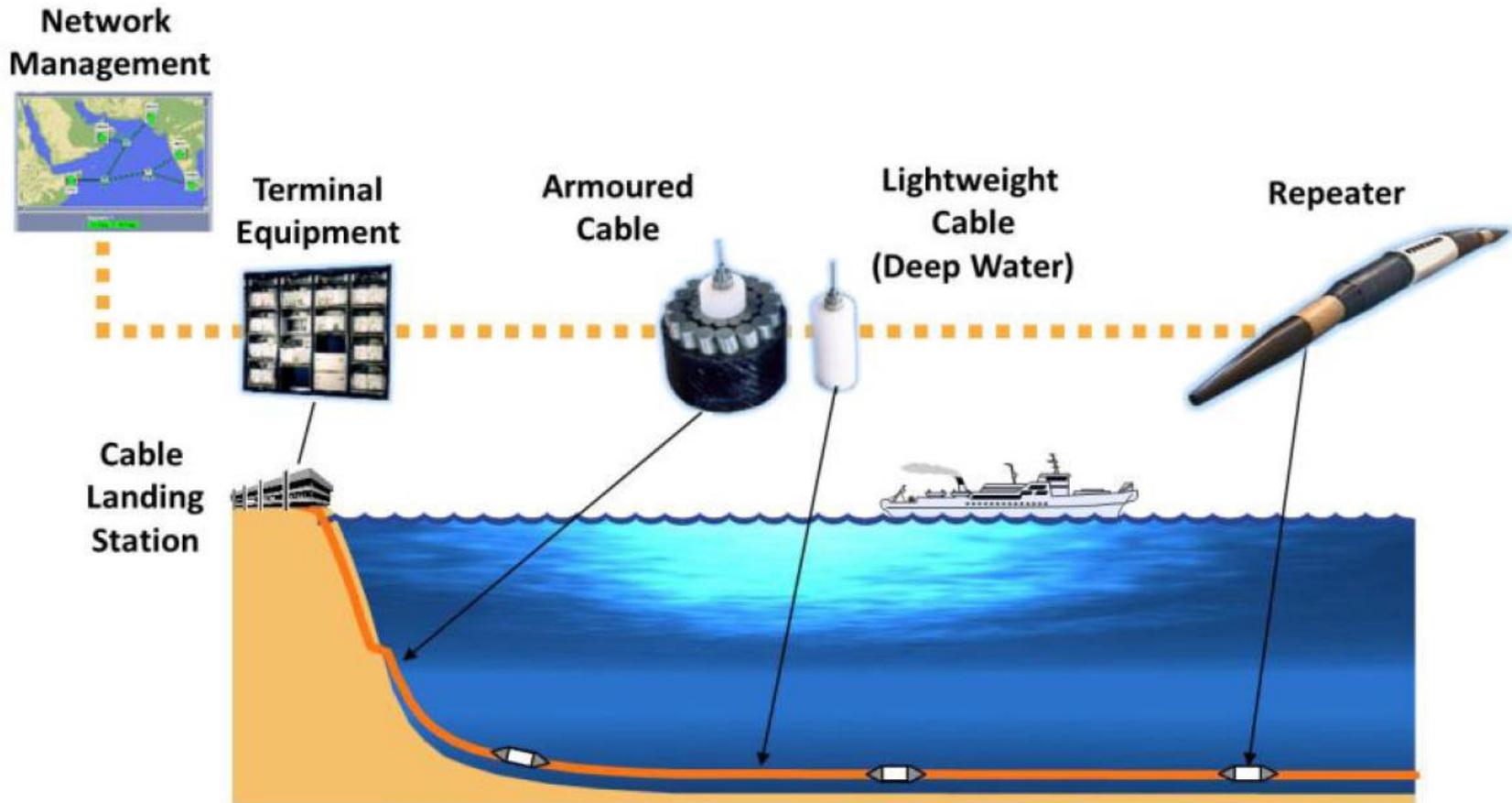
- Construction varies with manufacturer and seabed conditions
- Cables may have no armour in stable, deep-ocean sites or one or more armour layers for energetic zones, e.g. coastal seas

Source: Ericsson

Installing a Submarine Cable

- **Installing a submarine cable involves:**
 - Selection of a provisional route
 - Obtaining permission from relevant authorities
 - Full survey of route and finalize route plan
 - Design cable system to meet route conditions
 - Laying the cable, including burial in selected areas
 - Post-lay inspection and testing
 - Notification of cable position to marine users

Typical Submarine Cable System

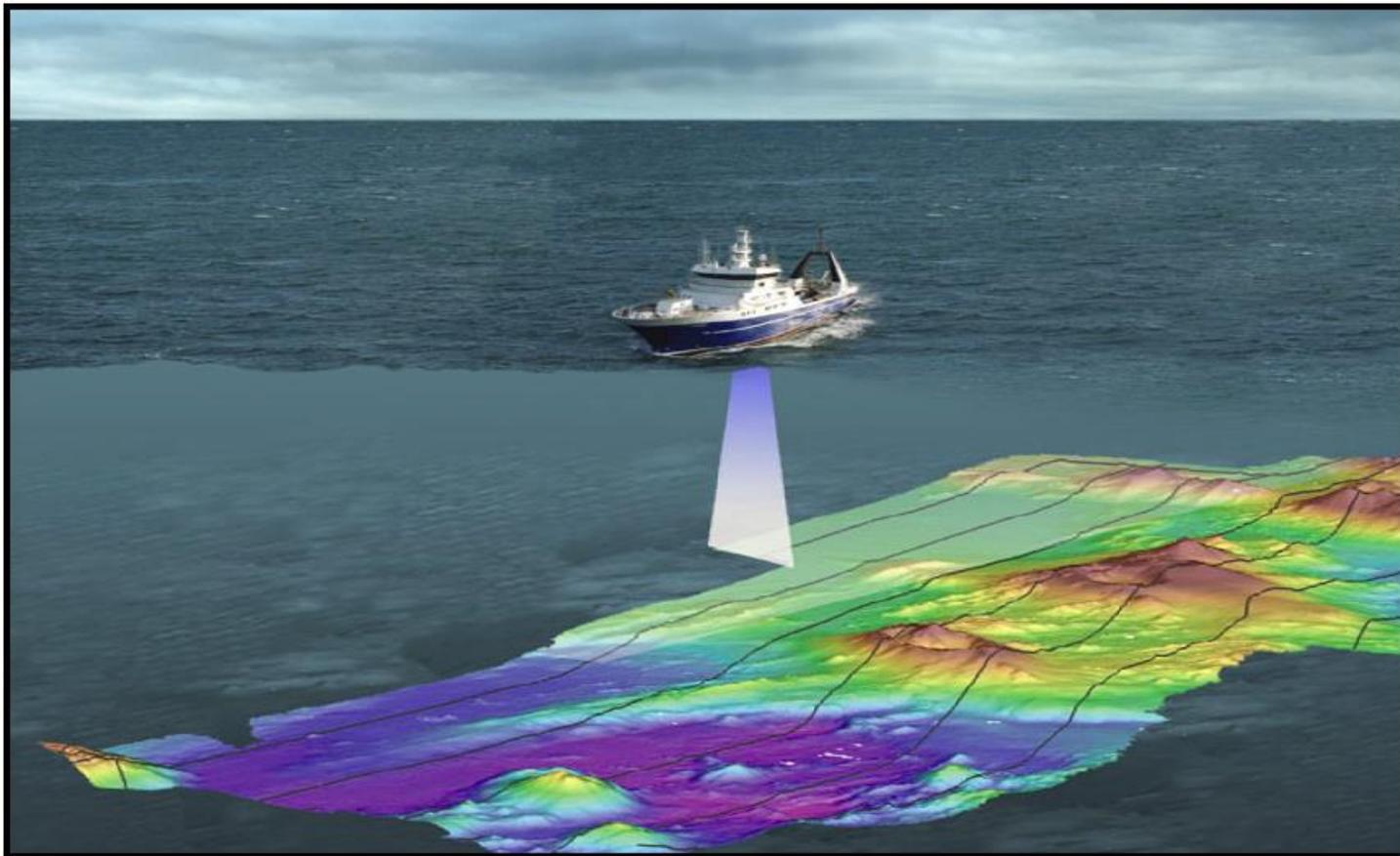


NOT TO SCALE

Source: UK Cable Protection Committee and Alcatel-Lucent Submarine Networks

Modern Route Survey

Cable routes are carefully surveyed and selected to minimize environmental impacts and maximize cable protection



Seabed mapping systems accurately chart depth, topography, slope angles and seabed type

Modern Cable Ships



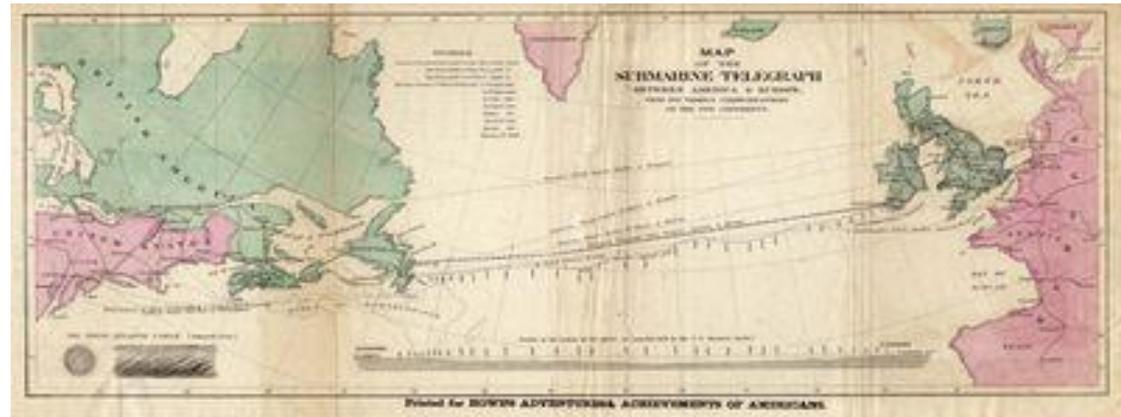
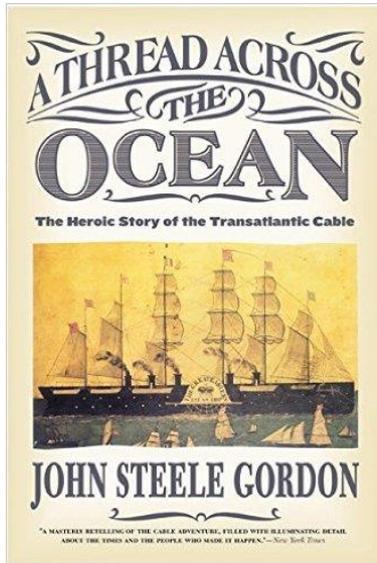
Undersea Cables and the Law 1

- Recognizing the value to humanity of international communications, undersea cables are protected by international treaties:
 - 1884: The International Convention for the Protection of Submarine Cables
 - 1958: The Geneva Conventions of the Continental Shelf and High Seas
 - 1982: United Nations Convention on Law of the Sea (UNCLOS)
- Modern international law extends the special status of international cables to all uses:
 - Telecommunications, Power, Scientific and Military

Undersea Cables and the Law 2

- The international treaties establish universal norms:
 - Freedom to lay, maintain and repair cables outside of a nation's 12 nautical mile territorial sea
 - National obligations to impose criminal and civil penalties for intentional or negligent injury to cables
 - Special status for ships laying and repairing cables
 - Indemnification for vessels that sacrifice anchors or fishing gear to avoid injury to cables
 - Obligations of cables crossing earlier laid cables and pipelines to indemnify repair costs for crossing damage
 - Universal access to national courts to enforce treaty obligations

Thank You



CREDITS:

- Undersea cable pictures from W1TP Telegraph & Scientific Instruments Museum at www.w1tp.com.
- International Cable Protection Committee (ISCP.C.ORG) "About Submarine Telecommunications Cables"
- Book: "A Thread Across the Ocean" by John Steele Gordon