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« Submarine cables : an overlooked sector of the maritime industry »

Subsea cables are henceforth indispensable within an increasingly interconnected world, handling both commercial cargo and digital flows. The number of internet users worldwide is estimated at 4 billion. Our demand for digital services expands continuously, heavily driven by the leading actors of the internet: Google, Apple, Facebook, Amazon, and Microsoft (GAFAM), alongside Netflix, Airbnb, Tesla, and Uber (NATU). Indeed, these market players, responsible for 70% of global traffic growth according to Cisco, play a paramount role by investing massively in deploying their own infrastructures to interconnect their data centers. Subsea cables act as accelerators of economic mutation while concurrently becoming high-value targets during asymmetric warfare, whether classified as telecommunication or energy cables.

Context and historical background

Telecommunication cables have been present on the seabed since the installation of the very first transatlantic telegraph cable in the mid-19th century between Dover and Cape Gris-Nez, designed to link the London and Paris stock exchanges. In 1858, an initial transatlantic cable connected Ireland to Newfoundland. By 1870, London and Bombay were connected. In 1900, the network aggregated 200,000 km of cables. In 1902, a transpacific cable was deployed between Australia, New Zealand, and Canada. Originally, these subsea links predominantly connected Europe to its colonies (India, Asia, Africa, South America) as well as to the United States.

The administration of these cables was delegated to the International Telegraph Union (ITU) in 1865, later renamed the International Telecommunication Union. Its core mission was to ensure the interconnection of all national networks and respond to ongoing technological evolutions.

Historically, the technological upgrade of subsea cables was achieved through the cables themselves. Copper-pair cables, utilized for nearly a century, were replaced by coaxial cables starting in 1956, the year marking the installation of the first transatlantic telephone cable (TAT-1). These cables enabled multiple simultaneous telephone circuits but had to be substituted in turn by fiber-optic cables starting in 1988 with the deployment of TAT-8.

Fiber optics ensure a significantly higher efficiency of the bandwidth required for international communications. These cables house a laser that transmits waves to a receiver at the opposite end. The optical fibers have the diameter of a human hair, protected within a heavy-duty resistant sheath. The completed cables have the thickness of a standard garden hose.

The expansion of cables was deeply boosted in the 2000s with the advent of the internet. Today, subsea cables transport approximately 97% of our digital data (internet traffic, phone calls, banking transactions, and financial exchanges between stock markets); consequently, a mere 3% of our global communications transit via satellite. Data flows swell continuously: in 1992, 100 gigabytes of data circulated per day; by 2002, the exact same volume was transmitted in a single second; and by 2016, 260 times more data was transmitted per second.

The transmission of information is equally vital for monitoring critical infrastructure, such as dams, drinking water plants, or power stations, whose management systems are frequently automated. Modern fiber-optic technology is more reliable, faster, and more economical than its satellite alternative. There is currently no competitor to subsea cables. The effective operational lifespan of a cable is estimated at an average of 25 years.

Annually, approximately one hundred faults are recorded worldwide due to ship anchors, trawl nets, earthquakes, and underwater landslides—accounting for 70% of the cuts encountered on the seabed. Cable positions are thoroughly mapped, and the data is freely accessible to the relevant parties. Cable owners attempt to mitigate the threat of fishing interference through cable awareness programs, where

information is provided to fishermen across Europe. Within 24 hours following cable damage, a vessel is dispatched for repairs. Cable shipowners maintain emergency agreements with operators of cable repair vessels, either on an individual corporate basis or under a specialized consortium framework. An intervention requires five to ten days to reach the damage point, depending on sea conditions and potential permit requests. Authorizations must also be secured from the various government agencies responsible for operations at landing sites and within territorial waters. Numerous agreements are forged between operators to re-route disrupted traffic over alternative subsea cables, and between shipowners to intervene swiftly within the zone.

What is their distribution?

Cables can be laid at depths of up to 8,000 meters. The longest subsea cable spans 20,000 km—the Asia-America Gateway (AAG), which links the United States to Malaysia. There are no fewer than 486 subsea cable systems alongside 1,306 landing points currently active or under construction, and these metrics expand continuously. In 2016, 27,000 km of cables were laid, a figure that tripled in 2017. More than 1.3 million kilometers of cables traverse the oceans, equivalent to encircling the Earth 32 times. Although technology evolves, cable routing closely mirrors the primary global maritime trade lanes: the Transatlantic axis, the Transpacific axis, and the Asia-Europe axis.

Their geographical distribution is highly unequal, characterized by areas of extreme density such as the Suez Canal and the Bab-el-Mandeb Strait, alongside strategic cable hubs in Cornwall, Marseille, New York, the United Arab Emirates, Mumbai, Singapur, and Hong Kong. Conversely, alternative regions or nations remain severely under-connected, including the South Pacific, the South Atlantic, the Indian Ocean, Bangladesh, or Mozambique.

According to the NSA (National Security Agency), 80% of global internet traffic transits through the United States, regardless of its final destination. The United States dominates this global web due to its powerhouse digital services industry, acting as both primary designer and contractor. Ten of the thirteen "root servers" are located on United States soil, sorting and directing our global internet navigation.

International domain names (such as *.org* and *.com*) are allocated by **ICANN** (*Internet Corporation for Assigned Names and Numbers*), an internet regulatory authority headquartered in Los Angeles.

The multiplicity of digital data traffic entry points is vital for a State to ensure resilience in the event of a disruption at one of its connecting nodes. Africa represents the continent where cable installation is accelerating the fastest, driven notably by private infrastructure investment funds. Concurrently, South-South links are intensifying due to the geopolitical rise of the **BRICS** (Brazil, Russia, India, China, and South Africa) and shifting global balances of power.

Stakeholders and industry dynamics

Until the mid-2000s, the installation and control of these cables were predominantly managed by major European and, above all, American corporate consortiums. Since then, greenfield actors have emerged within this highly strategic market for information control: this is the case for the GAFAM conglomerates, alongside Russia, and most decisively, China.

The arrival of the GAFAM players has radically altered our digital usages. Furthermore, as heavyweight investors, they have disrupted the economics of subsea cables, triggering a profound restructuring of legacy market operators—particularly telecommunication companies, which are no longer positioned to supply end-to-end cable networks independently. For any single cable project, competition has intensified among these diverse stakeholders. Concurrently, the total volume of active cables expands alongside capital fundraising rounds reaching hundreds of millions of dollars—funding that proves significantly easier to secure for these new tech entrants. Meta (Facebook), Google, and Microsoft seek to extend their market grip with proprietary, wholly-owned cables. However, they do not manage end-user internet service provision, which remains the restricted domain of telecommunication operators. Digital routes are also more diversified than in the past, as GAFAM investments have powerfully catalyzed research and development across the sector, dramatically multiplying cable bandwidth capacities.

Structurally, three distinct categories of actors operate within the market:

- Subsea system turnkey suppliers: dominated by the American firm *TE SubCom*, the French corporation *Alcatel Submarine Networks* (ASN, a subsidiary of Nokia), and the Japanese giant *NEC*.

- Cable owners: typically traditional telecommunication operators grouped into international consortiums.
- Specialized cable-laying shipowners: managing fleets dedicated to data and/or power cable marine operations.

According to the ICPC (*International Cable Protection Committee*), the global cable-laying fleet comprises approximately sixty vessels scattered across the primary oceans and seas. This specialized fleet is aging significantly, with an average vessel age hovering between 20 and 30 years. Data compiled by the *Submarine Telecoms Forum* indicates that while investments peaked during the dot-com bubble of the early 2000s, no greenfield vessels were constructed between 2004 and 2010, and a mere five ships were delivered globally between 2011 and 2020. The massive expansion of the internet network during the 2000s triggered an intense, rapid demand for new subsea cable infrastructure. To absorb this market overpressure, numerous offshore supply vessels (*navires supply*) were temporarily retrofitted into makeshift cable ships. Today, the acute shortage of specialized vessels relative to market demand—coupled with operational breakdowns from aging ships—means that ongoing infrastructure projects can face up to six months of delay. These macro-projects typically command capital expenditures ranging between \$200 million and \$300 million. The primary cable-laying fleets are logically concentrated among the four nations commanding a world-class domestic cable manufacturing industry: the United States, Japan, France, and the United Kingdom.

Shipowners are relatively few in this highly specialized sector. The installation and maintenance of subsea cables require engineering experts to optimize the routes chosen for the cables: mastering bathymetric surveys, subsea trenching via ROVs (Remotely Operated Vehicles piloted from the vessel), plowability tests, offshore surveys, documentation, and cartography. The activity calls for specialized jointing experts trained internally by the shipping company, alongside experts in cable works and measurement methods.

France boasts two global leaders in subsea cable installation and maintenance:

- Alcatel Submarine Networks (ASN), a French corporation belonging to the Finnish Nokia Group.
- Orange Marine, a subsidiary of the Orange Group.

ASN owns a fleet of seven cable ships, which are managed by Louis Dreyfus Armateurs (LDA). The group also carries out ship management operations on behalf of OMS (Indonesia) with two vessels registered under the French International Register (RIF). Finally, through LD Travocean, LDA executes cable-laying and burial works by chartering specialized vessels or barges.

Market demand is exceptionally high; contracts signed today with telecom operators already extend beyond 2024. Consequently, cable shipowners routinely resort to chartering to expand their capacity and absorb this market pressure. Orange Marine operates six cable ships, two of which belong to its subsidiary Elettra. In 2010, the French group acquired the Italian company, fully integrating its fleet management into Orange Marine. The group also maintains a specialized subsidiary based in Mauritius, Chamarel Marine Services. Collectively, this represents 15% of the global fleet, supplemented by a dedicated survey vessel tasked with exploring new subsea routes from its marine bases or foreign ports. The cable ship *Sophie Germain* is currently under construction, with delivery scheduled for 2023. It will replace the *Raymond Croze*, launched in 1983, which executed more than one hundred cable repairs, primarily across the Mediterranean, Black, and Red Seas. The *Sophie Germain* is designed to repair both fiber-optic and power cables. The group's previous newbuild asset was the *Pierre de Fermat*, constructed in 2014. The capital investment per vessel is estimated between \$60 million and \$100 million, and a newbuild project requires at least two years.

The financial capacity here does not match that of the global container shipping giants, for instance. Numerous cable shipowners and operators are hesitant to commit such heavy capital expenditures into greenfield newbuilds, as the costs and business case can be challenging to justify. Retrofitting smaller existing vessels can serve as a temporary solution to meet demand. Nonetheless, the demand for digital services expands continuously, and the determination of Western governments to phase out fossil energies fuels structural optimism across the sector.

Subsea power cables

As a direct corollary of the rising expansion of Marine Renewable Energies (MRE / EMR), the installation and maintenance of subsea power cables have formed a highly dynamic sector for two decades, a momentum that intensifies today amid the global energy crisis.

In 2020, the installed offshore wind capacity within the EU-27 was estimated at 12 GW. The European Commission deems it viable to achieve a capacity of 300 GW of offshore wind by 2050, with an intermediate milestone of 60 GW locked in for 2030. This implies a massive, unprecedented scaling up for renewable energies, as the current deployment pace would only yield 90 GW by 2050. The total required capital investment is estimated at a monumental €800 billion.

The expansion of offshore wind in British and German waters progressed very rapidly until 2012. Within the domestic landscape, France recently inaugurated its first offshore wind farm in Saint-Nazaire. Nevertheless, the Government's strategic roadmap envisions the construction of fifty offshore wind farms by 2050, targeting a cumulative capacity of 40 GW. France possesses one of the world's leading cable manufacturers with Nexans. Its specialized maritime branch operates as a Norwegian subsidiary commanding two cable-laying vessels registered under the Norwegian International Ship Register (NIS). Crucially, offshore wind farms only represent the third-largest commercial outlet for power cable manufacturers and installers: the primary driver remains the interconnection of separate national grids across the sea, while the second centers on serving and interconnecting offshore oil and gas platforms.

Subsea cables as instruments of geopolitical power

International maritime law governs the utilization of subsea cables through the 1982 Montego Bay Convention (UNCLOS), which recognizes the sovereign right of States to lay subsea cables within both their territorial waters and the high seas. States are concurrently mandated to ensure their security. Article 113 explicitly establishes that: *"Every State shall adopt the laws and regulations necessary to cause the breaking or injury by a ship flying its flag or by a person subject to its jurisdiction of a submarine cable beneath the high seas done wilfully or through culpable negligence and causing the interruption or obstruction of telegraphic or telephonic communications to be a punishable offence (...)."*

As early as 1955, the NSA forged a secretive intelligence alliance with its Canadian, British, Australian, and New Zealand counterparts, creating the "Five Eyes"—an institutional agreement aimed at monitoring global data exchanges. The true extent of this surveillance network was revealed in 2013 by Edward Snowden, a former NSA infrastructure contractor. Cable landing points were particularly targeted by these operations.

Modern fiber-optic telecommunication cables are, however, inherently secure. The physical structure of the cable and the complex operations required to bend and intercept the light signal of exposed optical fibers render the underwater tapping of a subsea cable exceptionally difficult, if not impossible, to execute without being instantly detected and without structurally damaging the fiber. While global security agencies effectively monitor the internet, they access the data streams at alternative terrestrial landing points rather than at the bottom of the ocean. Nevertheless, during the Cold War, specialized American submarines successfully tapped underwater cables linking unencrypted Soviet naval bases. Around 200 subsea cables were historically spied upon to harvest data relating to terrorism, international politics, and macroeconomic intelligence. In direct reaction to these vulnerabilities, Brazil financed the construction of a \$185 million direct subsea cable linking its coast to Europe (*EllaLink*) to bypass United States territory entirely.

Russia has systematically insulated its infrastructure from this American digital hegemony. Only four subsea cables link the Russian Federation to the global network: one running to Finland, one to Georgia, and two connecting to Japan. Furthermore, Moscow relies on its domestic internet ecosystem and proprietary digital platforms, which are significantly easier for the State to monitor.

Concurrently, China exerts a rigid control over its domestic internet and seeks to extend its surveillance oversight over strategic international cable corridors. The specialized Chinese equipment manufacturer Huawei Marine Networks (rebranded as *HMN Tech*) aggressively built and upgraded major cable networks, notably across Greenland, the Maldives, the Comoros, between South Africa and the United Kingdom, and linking Brazil to Cameroon. Within a single decade, Huawei propelled itself among the world's primary cable-laying operators. Consequently, the Chinese contractor faces strict commercial boycotts led by the United States and Australia over digital sovereignty and national security concerns. These two nations furthermore allied with Japan to counter China's rising influence across the Pacific theater, reinforcing shared intelligence frameworks and mobilizing brand-new public financing capacities to fund alternative cable infrastructure projects.

The coordinated sabotage attacks against the Nord Stream 1 and Nord Stream 2 gas pipelines in the Baltic Sea in September 2022 took place within a hyper-tense geopolitical context, yet occurred remarkably within a zone of peace—a structural event completely unprecedented in modern history.

This major disruption carries sweeping, permanent consequences for the global energy architecture. Future geopolitical conflicts will increasingly be fought through subsea infrastructures. Subsea cables represent the next primary frontier and target for asymmetric hybrid warfare. This paradigm is not entirely greenfield: in 1939, Allied forces cut the subsea telegraph cables linking Germany to Spain, Portugal, and the Azores to structurally isolate their enemy. Far from constituting neutral logistics channels, subsea cables are today placed under intense strategic military surveillance. Their operational integrity and geographical routing depend on highly strategic political decisions made by sovereign States, especially since the concept of zero risk does not exist for these critical networks. The integrity of subsea grids has become a rising national security preoccupation for multiple governments. France stands among those nations that have formalized an acute, high-level surveillance policy for subsea cable infrastructure. Mastering civilian maritime tools has become a vital, mandatory complement to conventional naval defense assets and aerospace intelligence satellite constellations.

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