THE ECONOMICS OF UNDERSEA INTERNET CABLES

ABSTRACT

About 99 percent of intercontinental data traffic crosses the ocean floor through fiber-optic submarine cables rather than through satellites. As of 2025 the world relied on roughly 600 cable systems spanning about 1.7 million kilometers of seabed. This article traces how those systems work, how the industry moved from state telegraph monopolies to a market now funded by Google and Meta, and what it costs to build, operate, and repair a cable. A single transatlantic system runs near $250 million to build, the global network is maintained by fewer than 70 aging ships, and about 150 to 200 cable faults occur every year. The economics turn on concentration: most Europe-to-Asia capacity passes through the narrow Red Sea, and a handful of content providers now account for close to three-quarters of all used international bandwidth.

1. INTRODUCTION

The physical internet between continents is a set of glass threads on the seabed. Submarine cables carry more than 99 percent of intercontinental data traffic, a figure that TeleGeography has confirmed while noting how often it is quoted without a source [1, 5]. Satellites, including large low-orbit constellations, carry the rest. United States Federal Communications Commission data put satellites at about 0.37 percent of that country's international capacity [1]. When two cables linking Taiwan to its Matsu Islands were severed in February 2023, a backup microwave link restored only about 5 percent of the lost bandwidth [4].

The network is larger than most estimates of its importance suggest. TeleGeography's 2024 map depicted 559 cable systems and 1,636 landing points active or under construction [2]. By its 2025 edition the count had risen to 597 systems and 1,712 landings [3], and the International Cable Protection Committee put total cable length at about 1.7 million kilometers in 2025, up from roughly 1 million kilometers in 2014 [28].

This article works through the economics of that infrastructure. It covers how a cable moves light across an ocean, how the technology developed from the first telegraph lines, who pays for cables today, what construction and maintenance actually cost, the small fleet that repairs breaks, the geographic chokepoints that concentrate risk, and the outlook for a market now shaped by demand for machine-learning capacity.

2. HOW A SUBMARINE CABLE WORKS

At the center of a modern cable sits a bundle of optical fibers, each a strand of ultra-pure glass about 9 micrometers across at its core [8]. Fibers run in pairs, one for each direction, and a current system carries between 8 and 24 pairs [8]. Google's Dunant cable uses 12 pairs; the 2Africa system uses up to 16 [8]. Each pair carries many independent streams of data at once through dense wavelength division multiplexing, which sends separate colors of light down the same fiber [7].

Light weakens as it travels. At the 1,550 nanometer wavelength used in these systems the signal loses about 0.2 decibels per kilometer, so after roughly 60 to 100 kilometers it is too faint to read [8]. Cables solve this with optical repeaters spaced every 50 to 100 kilometers along the route [10, 6]. A repeater uses an erbium-doped fiber amplifier, a short doped section that boosts the light directly without converting it to an electrical signal, which lets the same seabed hardware carry future upgrades [8, 9]. A copper conductor wrapped around the fibers powers every repeater in series, fed from shore stations at both ends; voltages reach 10,000 to 15,000 volts [6, 9]. If one shore station loses power, the other can drive the whole cable [6].

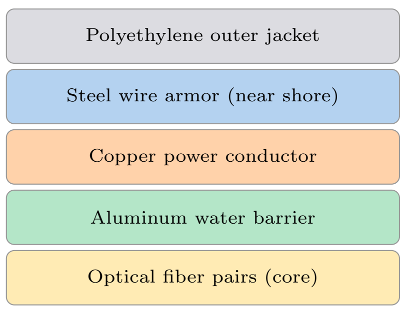

Figure 1. Layers of a deep-water submarine cable, from the glass core outward. The deep-ocean cable is about 17 to 25 millimeters across, close to a garden hose, and thickens to 50 to 70 millimeters where armor is added near shore [6, 7].

The physical cable is smaller than its role implies. In deep water it measures about 17 to 25 millimeters across, close to a garden hose, because a light cable is easier to lay under tension across thousands of kilometers [6, 8]. Near shore, where trawlers and anchors reach the seabed, steel armor thickens it to 50 to 70 millimeters [6, 7]. Figure 1 shows the concentric layers. Onshore, a landing station holds the power feed equipment and the line terminal equipment that puts traffic onto the fibers [6]. As demand rises, operators have begun adding fiber pairs through spatial division multiplexing rather than pushing each fiber harder, which raises total capacity while holding down power draw [7].

3. FROM TELEGRAPH TO FIBER

The first transatlantic telegraph cable reached completion in 1858 under Cyrus Field, carried a congratulatory message between Queen Victoria and President Buchanan, then failed within about three weeks after excessive voltage destroyed it [11]. A durable link waited until 1866, when the ship Great Eastern laid a working cable between Ireland and Newfoundland [11]. For a century the seabed carried telegraph signals only.

Voice arrived in 1956. TAT-1, the first transatlantic telephone cable, opened on 25 September of that year with 36 channels and handled 588 London-to-United-States calls in its first day [12]. It used coaxial technology and stayed in service until 1978 [12]. The shift to glass came in 1988 with TAT-8, the first fiber-optic cable across the Atlantic. It ran about 6,705 kilometers from New Jersey to England and France, carried 280 megabits per second, and supported the equivalent of 40,000 voice circuits, far beyond the coaxial systems it replaced [13, 11]. Figure 2 sets out these milestones.

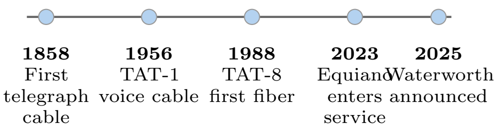

Figure 2. Selected milestones in transoceanic cables, from the 1858 telegraph line to the private fiber systems of the 2020s [11, 12, 13, 20, 40].

Fiber capacity has grown fast enough that most cables reach the end of their useful economic life in about 25 years, when newer systems deliver far more capacity per dollar and older cables become uneconomical to keep running [17].

4. THE CAPACITY BOOM

Demand has climbed steadily. TeleGeography measured used international bandwidth at 3.9 petabits per second at year-end 2022, about 5 petabits per second at year-end 2023, and more than 6.4 petabits per second at year-end 2024 [16, 15, 14]. That last figure represents a 32 percent compound annual growth rate since 2020, roughly a tripling in four years [14]. Figure 3 plots the series.

The annual pace is slowing even as the total rises. Year-on-year growth fell from about 45 percent in 2020 to about 29 percent in 2024 [14]. Growth is not even across the map. Africa continued to lead at about 41

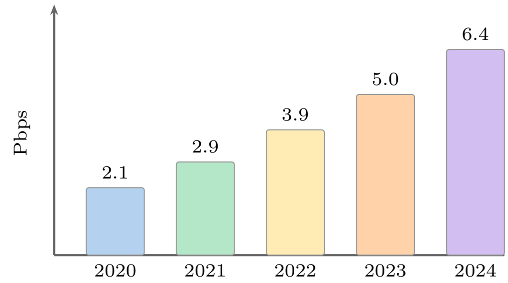

Figure 3. Used international bandwidth by year-end, in petabits per second. Figures for 2022, 2023, and 2024 are TeleGeography measurements; 2020 and 2021 follow the reported 32 percent compound growth [16, 15, 14].

percent compound annual growth over 2020 to 2024, while mature markets such as the United States grew nearer to 30 percent [15, 14]. That demand is now concentrated in a few networks, a point the next section develops.

5. WHO OWNS AND FUNDS THE CABLES

For most of the cable era the buyers were telephone companies. In 2010, carriers such as AT&T and Telstra used about 75 percent of international bandwidth and built most cables through consortiums that shared the cost and the fibers [17]. That arrangement has inverted. By 2024 content and cloud providers, chiefly Google, Meta, Microsoft, and Amazon, accounted for close to three-quarters of all used international bandwidth [14, 17]. On the busiest trans-Atlantic, trans-Pacific, and intra-Asian routes those networks take at least 80 percent of demand [14]. Content networks passed traditional backbone providers as the largest users of capacity in 2017, and their capacity nearly quadrupled between 2019 and 2023 to reach 3.6 petabits per second [18].

Ownership followed use. TeleGeography's list of content-provider cable holdings grew from 20 systems in 2017 to more than 60 [18]. Verdict, drawing on the same data, counted content providers in 59 cables by 2024, with Google involved in 33 (17 owned outright and 16 as a part owner), Meta in 16, Microsoft in 6, and Amazon in 4 [19]. Figure 4 shows those shares.

Google traces the pattern most clearly. It first joined a cable consortium, Unity across the Pacific, around 2008 to 2010 [22, 18]. In 2018 it announced Curie, its first wholly owned and self-financed cable, running to Chile [22, 20]. It then named a series of private systems after historic figures: Curie, Dunant, Equiano, Grace Hopper, and Firmina [22, 5]. These are not small links. Equiano runs about 15,000 kilometers from Portugal toward South Africa, Firmina about 14,517 kilometers along the Americas, and Grace Hopper about 6,500 kilometers with 16 fiber

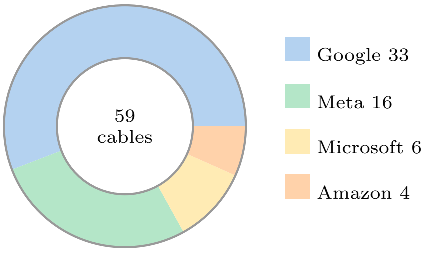

Figure 4. Content-provider participation in the 59 submarine cables they held stakes in as of 2024, counted by number of cable investments per company [19].

pairs [20]. Google funds systems such as Firmina without any telecom partner, at an estimated $200 million or more per cable [21].

This shift changes the market's shape as much as its scale. On the Atlantic, every planned new cable is content-provider-led, and about 80 percent of Pacific investment is too [17]. Yet these firms do not sell capacity commercially. They build for their own data centers rather than to become carriers, which removes demand from the wholesale market without adding competing supply to it [17]. Table 1 compares the two funding models.

Feature	Carrier consortium	Hyperscaler private
Funding	Costs split among telecom partners	Single firm self-finances
Main use	Sell wholesale capacity	Carry own data-center traffic
Example	SEA-ME-WE 4, TAT-8	Curie, Dunant, Firmina
Route choice	Broad market coverage	Links between owner's regions
Sells to others	Yes, core business	Rarely

Table 1. Two models for owning a submarine cable. Consortiums shared cost and capacity across carriers; content providers build private systems for internal traffic [17, 22, 20].

6. THE ECONOMICS OF BUILDING AND OPERATING

A cable is a large capital project with a long lead time. The cable itself costs between $6,000 and $20,000 per kilometer, depending on the number of fiber pairs and the amount of armor [23]. A transatlantic system of about 7,000 kilometers runs near $250 million, while a longer trans-Pacific route can reach $400 million [23]. Repeaters add about $200,000 each, and a transoceanic route needs dozens of them [23]. Landing stations cost millions more unless an operator reuses an existing site, and running a cable, from staff to powering the landing station, costs millions per year [23]. Table 2 lists several systems by length and service date.

System	Length (km)	In service
TAT-8	6,705	1988
Curie	10,500	2019
Dunant	6,400	2021
Grace Hopper	6,500	2021
Equiano	15,000	2023
Firmina	14,517	2025
2Africa	45,000	2025
Project Waterworth	>50,000	planned

Table 2. Selected submarine cable systems by route length and ready-for-service year [13, 20, 42, 40].

Prices for capacity track supply and competition more than distance. The heavily served transatlantic route commands lower prices than the Pacific, even though the Pacific costs more to build and spans more water, because new cables create waves of supply that push prices down [17]. Aggregate spending shows the cycle. Cables worth about $8.7 billion entered service between 2018 and 2022, and TeleGeography expected more than $10 billion of new cables between 2023 and 2025 [24]. Its later work put new construction above $14 billion for 2025 to 2027, driven mainly by Google and Meta, with the trans-Pacific alone above $3 billion [25]. Over the past nine years, new construction has averaged more than $2 billion per year [25].

7. THE REPAIR-SHIP ECONOMY

Cables break often, and a small fleet keeps them running. About 150 to 200 faults occur worldwide each year, and 70 to 80 percent come from fishing gear and ship anchors rather than sabotage or natural events [26, 28]. The network absorbs most of this by rerouting traffic, so a single fault rarely reaches users. When two Baltic cables were damaged in November 2024, both were repaired within two weeks with no service interruption [28].

The engineering record is strong. Total cable length grew about 77 percent from 2013 to the mid-2020s, from roughly 1.0 million to 1.8 million kilometers, yet annual repairs stayed near 199, and the fault rate per kilometer has fallen more than 40 percent since 2010 [29]. The strain sits in the fleet that does the work.

Fewer than 70 vessels serve more than 600 cable systems, and fewer than 20 of those ships are dedicated to repair [26, 29]. Many were bought secondhand from the oil and gas industry rather than built for the job [26, 29].

The fleet is also aging. A 2025 study by TeleGeography and Infra-Analytics projected a 48 percent net increase in cable kilometers by 2040, while about two-thirds of maintenance ships reach the end of their service life over the same period [27, 29]. Closing that gap would take about 15 replacement ships and 5 additional ships, an investment near $3 billion, simply to hold service at current levels [27, 29]. A couple of repair ships in the Pacific sit on standby for long stretches while other regions wait, so the shortfall is partly about placement as well as numbers [26].

8. CHOKEPOINTS AND VULNERABILITY

The network's redundancy has a limit: geography funnels many cables through a few narrow passages. The clearest example is the Red Sea. More than 90 percent of Europe-to-Asia capacity runs through it, and about 17 percent of global internet traffic passes through Egypt and the 14-mile Bab al-Mandab Strait at its southern end [31, 30, 32]. TeleGeography estimates that over half of many countries' interregional bandwidth to Europe depends on Red Sea cables [32]. Cable routes deliberately avoid the Suez Canal itself, because halting the ship traffic that moves about $1 trillion of goods a year to lay or fix a cable would be prohibitive [30].

That concentration turned into disruption in 2024. In February and March, four cables in the Red Sea, including SEA-ME-WE 4, IMEWE, EIG, and the regional FALCON system, were cut near Yemen [33, 30]. The damage disrupted an estimated 25 percent of traffic between Asia, Europe, and Africa [30]. Ghana suffered an internet blackout of nearly 10 days, and repairs stretched into the following quarter because the conflict made the repair grounds hard to reach [34]. Rerouting around the whole of Africa adds about 15,000 kilometers to a path, which raises latency and eats into capacity [33]. Further cuts in the Red Sea in September 2025 degraded connectivity again across the Middle East and South Asia [30].

9. SECURITY AND SABOTAGE

Attacks on cables are hard to separate from accidents, and that ambiguity is itself a problem. Because more than 70 percent of faults are unintentional, a deliberate cut can hide among the ordinary ones, which suits an actor operating below the threshold of open conflict [31]. Two clusters of incidents have raised the stakes. Recorded Future's Insikt Group counted four Baltic Sea incidents involving eight cable damages and five incidents around Taiwan involving five damages across 2024 and 2025, with at least five tied to anchor dragging and four involving vessels linked to Russia or China [35].

In November 2024, the Baltic cables C-Lion1 and BCS East-West Interlink were severed near-simultaneously [37]. European warships surrounded the Chinese bulk carrier Yi Peng 3, which investigators suspect dragged its anchor across roughly 100 miles of seabed [36, 37]. A German minister called the episode sabotage, though no court has conclusively attributed it [37]. Near Taiwan, the cables serving the Matsu Islands were cut in 2023, leaving about 14,000 residents offline, and were damaged again in early 2025 [38, 39]. Proving intent remains difficult, because a ship can plausibly claim an accident and sail away [39, 35]. NATO responded to the Baltic incidents with an operation called Baltic Sentry, deploying frigates, patrol aircraft, and naval drones to watch the seabed [38]. United States officials have separately raised concern about the Chinese firm Huawei's role in many seabed projects [31].

10. OUTLOOK

The next wave of cables is being built for machine-learning workloads and is funded by the firms that run them. In February 2025 Meta announced Project Waterworth, a system of more than 50,000 kilometers across five continents, longer than the Earth's circumference and built with 24 fiber pairs, more than double the count in most current cables [40]. Reporting put the investment above $10 billion, and a United States-India statement noted India's plan to help finance the Indian Ocean segment [41]. Meta frames the project around the data movement that AI services require [40].

The open-access model is advancing in parallel. The 2Africa cable, a consortium led by Meta with China Mobile International, Orange, Vodafone, and others, runs about 45,000 kilometers around the African continent to 33 countries, with a design capacity of 180 terabits per second; its core was completed in late 2025 [42, 43, 44]. Investment overall is set to rise above $14 billion for 2025 to 2027 [25]. The open question is not supply of cable but the ability to protect and repair it. The same period that will add nearly half again as much cable to the seabed will also retire much of the fleet that fixes it, and closing that gap will take roughly $3 billion and coordination between governments and industry [27].

11. CONCLUSION

Submarine cables are cheap relative to what depends on them. A transatlantic system costs about $250 million, less than a large office tower, yet it carries a share of the traffic between two continents. The economics have moved from carriers selling wholesale capacity to content providers building private systems for their own data centers, a group that now uses close to three-quarters of international bandwidth and funds most new Atlantic and Pacific cables. The remaining risks are concentration and maintenance rather than raw capacity. Most Europe-to-Asia traffic still threads through the Red Sea, the 2024 cuts there disrupted about a quarter of traffic across three continents, and the global repair fleet is both small and old. Building more cable is straightforward for firms spending tens of billions of dollars a year. Keeping the existing network repairable is the harder problem, and it will cost about $3 billion in ships that no single content provider has an obvious reason to buy.

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