Submarine Cables: Critical Infrastructure for Global Communications

BY DOUG BRAKE | APRIL 2019

Submarine cables use fiber-optic technology, whereby information is encoded onto waves of light transmitted by lasers across thin glass at up to 200 terabits per second.

Submarine cables play a critical role in global interconnected networks, carrying about 99 percent of international communications traffic.[1] Sharp growth in demand for data, fueled by bandwidth-intensive applications such as video and a proliferation of cloud-based services, has driven a considerable uptick in global submarine cable deployments. The last five years have seen an average 26 percent increase in available capacity per year on major routes.[2] This policy briefing presents a snapshot of key facts about submarine cables. After a brief introduction, it addresses the growth in demand for submarine cables, common financing methods, major suppliers, and closes with other important dynamics in the submarine cable industry.

THE BASICS OF SUBMARINE CABLES

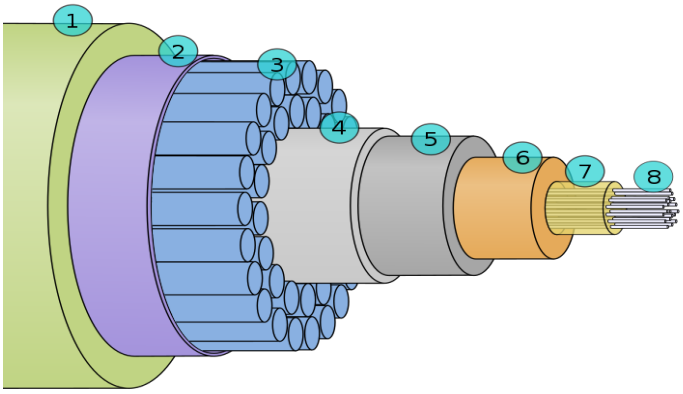
The history of submarine communications cables goes back to 1850, when the first cable was laid across the English Channel to allow telegraph communications between the United Kingdom and continental Europe.[3] Today, submarine cables use fiber-optic technology, whereby information is encoded onto waves of light transmitted by lasers across thin glass fibers. The throughput varies with optical technology used, but today's most advanced fiber links are capable of transmitting over 200 terabits per second. The capacity actually used—the "lit capacity"—is generally much lower, allowing cable owners to scale up the use to meet customer demand over time, or to accommodate large shifts in Internet traffic if another cable is cut or damaged.

There were approximately 378 submarine cables in service as of early 2019, traversing roughly 1.2 million kilometers, connecting virtually all countries with a coastline.[4] The cables run along the ocean floor joining nations that have large volumes of traffic to exchange. Near to shore, the cables are shielded and buried to protect against potential run-ins with anchors, wildlife, fishing trawlers, etcetera. However, in deeper parts of the ocean, where damage is less likely, cables run along the surface of the ocean floor and are as thin as a garden hose. Even with shielding and burying, each year sees more than 100 cable faults on average, usually due to fishing trawlers or anchors, but occasionally from natural disasters such as earthquakes. The risk of other types of disruption are low, but material given the importance of undersea cables.[5]

One area where there are more disruptions than average is the Strait of Malacca. This busy shipping corridor contains more than a dozen cables connecting a large majority of the traffic between Asia, India, the Middle East, and Europe.[6] The Strait of Malacca is one of several chokepoints where geographic constraints, or political or territorial constraints limit potential cable routes. Other key chokepoints include the Strait of Luzon (between Taiwan and the Philippines, the Red Sea), and the crossing of Egypt.[7]

Submarine cables are predominantly owned by consortiums of telecommunications carriers that join together to pay for these expensive projects. In the late 20th century, during the "dot-com" bubble, entrepreneurs took on some private projects, reselling the capacity once it was completed. In recent years, major web companies, such as Google, Facebook, Microsoft, and Amazon have increasingly invested in their own cables, outpacing the traditional Internet backbone providers.

Figure 1: Typical submarine cable cross-section: (1) polyethylene, (2) mylar tape, (3) stranded metal (steel) wires, (4) aluminum water barrier, (5) polycarbonate, (6) copper or aluminum tube, (7) petroleum jelly, and (8) optical fibers



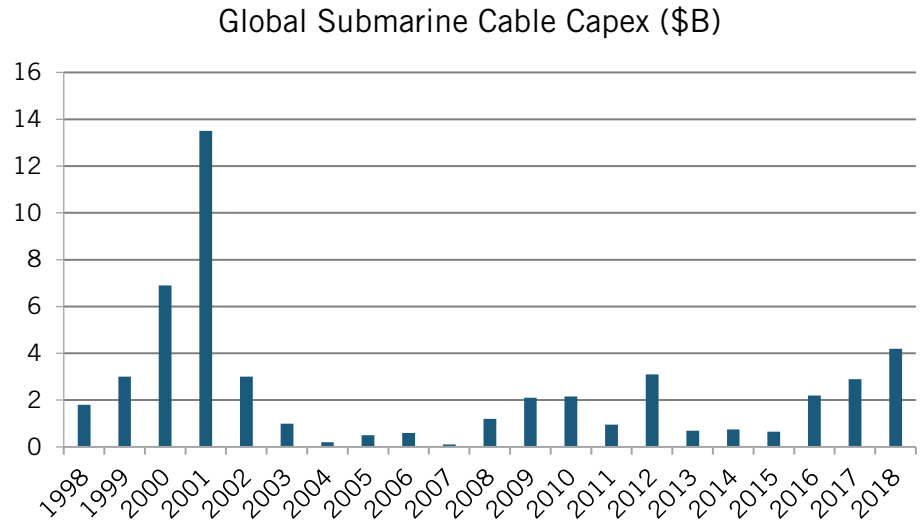
DEMAND AND GROWTH

Cable construction has picked up in recent years, after a period of very slow growth. More cable was deployed in 2017 (over 100,000 kilometers) than in all of 2014–2016

combined.[8] Some of the largest growth in recent years has been in the Americas, with the total capacity along major routes nearly doubling since 2014.[9]

Alongside the dot-com bubble, the submarine cable industry saw "irrational exuberance" of investment through 2001. With the recent growth in submarine capital expenditures, some question whether the industry is in another bubble.[10] Experts believe the answer to that question is no, and they point to key differences between the investment today and that of 20 years ago. For example, the dot-com bubble saw many of the cables, if not most, built by private parties looking to resell capacity, often investing in speculative builds along duplicative routes. Today's investment is driven to considerable extent by large web-based companies that understand their demand curve and are not overbuilding existing routes to the same extent as in the dot-com bubble.[11]

Figure 2: Approximate global submarine cable construction investment[12]



Demand growth is built into cable deployments. Most submarine cables are designed with a significant buffer between total capacity and actual lit capacity. On average, only 15 to 30 percent of submarine cable capacity is lit, allowing for large spikes in demand to be accommodated, if, for example, another cable would be damaged and global traffic rerouted.

Over 2019–2021, more than 50 submarine projects have been proposed so far, worth a total investment of $7.2 billion.[13] About 30 percent of the expected deployments will be in the Pacific region, with many projects aiming to increase capacity and reduce latency between Asia, Australia, and the United States.[14] The region with the next-largest amount of activity are the Atlantic, with 21 percent of the planned investment, and then the Indian Ocean, which is expected to see about 17 percent of the investment in coming years.[15]

FINANCING

Deploying and maintaining submarine cables is an expensive undertaking. Since 1990, nearly $48 billion has been invested in submarine cables, with almost half of that focused

on the Americas.[16] Submarine cables are a complicated business, with risks not well understood by the average lending institution. These cables are also, of course, hidden from view, challenging normal due diligence.[17] The expense and obscurity of submarine cable has required unique financing models compared to other infrastructure projects.

There are three main financing models. The most common by far is the consortium. This model sees a group of firms interested in capacity along a particular route pool their resources to build the cable, then share capacity. Roughly 90 percent of undersea cable funding in the last three decades has come from consortia, amounting to $43 billion.[18]

Multilateral development banks, such as the World Bank, also fund some submarine projects. These development banks offer lower interest rates, more flexible terms, and are more forgiving in the case of default compared to commercial debt alternatives. Most of the $3.2 billion funded through development banks has been devoted to connecting African nations.[19] Development banks account for about 5 percent of undersea cable financing.[20]

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The third financing model is private ownership. Here a private company is able to finance the expense of a cable, either for its own use, or to resell capacity to others. Submarine cables offer tremendous economies of scale, so often it is worth investing in the optical technology to support significantly more capacity than a single firm needs, then reselling that capacity to others. This model has historically seen about 5 percent of investment, but it has grown in recent years.[21]

MAJOR SUPPLIERS

The three largest companies offering to build submarine cables are Alcatel Submarine Networks of Alcatel-Lucent, based in France; TE SubCom of TE Connectivity, out of Switzerland; and NEC Corporation of Japan.[22] These companies tend to dominate the larger international systems, with TE SubCom having a sizeable lead in the market in terms of number of systems and miles of fiber laid.[23] Smaller and mid-size submarine communications companies tend to focus on smaller projects in their own regions, with the exception of Huawei Marine, the fourth-largest provider, which has produced six projects in recent years, mostly in Africa.[24] Many suppliers also participate in projects for offshore oil and gas projects, undersea electrical cables, and other marine infrastructure.

OTHER IMPORTANT DYNAMICS

Given the central role submarine cables play in connecting global networks, several policy topics are worthy of attention. For example, the popular press recently focused attention on the possibility of Russian sabotage of undersea cables after submarines were observed near key transatlantic cables.[25] Most experts agree this is a relatively minor threat, considering the unlikelihood of sabotage, the redundancy built into systems, and the Internet's fault-tolerant nature.[26] There are also concerns as to whether submarine cables have adequate protections under existing international law, such as the UN Convention on the Law of the Sea, which was written before submarine cables gained their critical role.[27] Three other areas of note are the rapid growth of cloud-based investment in submarine infrastructure,

the expansion of Chinese purchasing and supplying of submarine networks, and persistent potential for surveillance.

Cloud Firm Investment

Historically, the vast majority of submarine cables capacity (about 80 percent) was used by Internet backbone and transit providers.[28] However, since 2012, submarine capacity devoted to major cloud service and over-the-top providers has grown significantly. Google, Facebook, Amazon, and Microsoft in particular have begun significant investment in submarine cables since 2016.[29] These four companies now either own or lease more than half the undersea cable capacity.[30]

By recent estimates, Google now has partial ownership of roughly 8.5 percent of submarine cable miles, and sole ownership of roughly 1.4 percent.[31] The longest of Google's cables is its Curie cable, named after Marie Curie, which runs from Chile to Los Angeles.[32] Google is unique in its private ownership and use of significant amounts of cable, but these tech firms participate in submarine cable consortiums with other companies. Another prominent project is the JUPITER cable from the United States to Asia, constructed in a partnership between Facebook and Amazon.[33] So far, the tech firms are not reselling capacity on cables they have financed themselves. This level of investment has put significant downward pressure on the price of submarine capacity, which continues to decline at about 25 to 28 percent per year.[34]

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Chinese Actor Activity

Chinese actors have rapidly expanded activity around submarine cables, both in the supplier side, through Huawei Marine, and the purchaser side, with state-owned communications companies purchasing cable through a consortium. Chinese actors also participate in financing projects, with both the Chinese ExIm Bank financing several projects in developing countries.[35] Huawei Marine, a joint venture established in 2008 between Huawei (51 percent ownership) and a subsidiary of established U.K. firm Global Marine Systems (49 percent), has been active around the world, particularly in Africa.[36]

Similar to other concerns around rapidly expanding influence of Chinese firms globally, including Huawei's prominence in next-generation 5G wireless networks, there are concerns that Huawei would be subject to pressure from the Chinese government to facilitate espionage or build in security vulnerabilities.[37] The infrastructure investment is also seen as a component of China's broader strategy to expand its global influence. It's not immediately clear if these projects are purely soft-power projections, or installations of powerful tools potentially leveraged for political abuse, undermining cybersecurity, and enabling espionage.[38] Huawei denies this and claims it would resist pressure from the Chinese government to undermine its customers' trust.[39] These concerns were raised by Australian intelligence officials, who disallowed a Huawei installation to connect the Solomon Islands to Sydney.[40]

Rivals claim that Huawei Marine receives subsidies from the Chinese government, allowing it to sell below cost and offer incentives for contracts that can't be matched on a market

basis.[41] Several projects Huawei has participated in have been financed by the Export-Import Bank of China.[42]

Huawei Marine has a relatively small share of business compared to more established players, laying about 5,000 kilometers of cable compared to leader TE SubCom's nearly 80,000 kilometers over the last five years.[43] The company is focused on more, smaller projects, with six projects to TE SubCom's nine over the same period.[44]

Surveillance Potential

There is a long history of surveillance of submarine cables, both at the landing site and splicing into cables undersea.[45] Today, the potential for surveillance of some sensitive content by network operators has been somewhat mitigated by the rise of encryption, but the access to metadata still provides granular information useful for nation-state or commercial espionage.[46] The management systems of submarine networks provide centralized, software-based control over the physical components of the networks, creating unique risks.[47] These software controls of submarine networking infrastructure are prime targets for hacking by bad actors and intelligence agencies.[48] The immense power that comes with the convergence of so much information makes trust and security paramount.

APPENDIX I: MAPS

These maps are sourced from TeleGeography's interactive Submarine Cable Map, available at submarinecablemap.com. The map contains a great deal of information on each cable and its landing points.

Figure 3: Existing submarine cables near India[49]

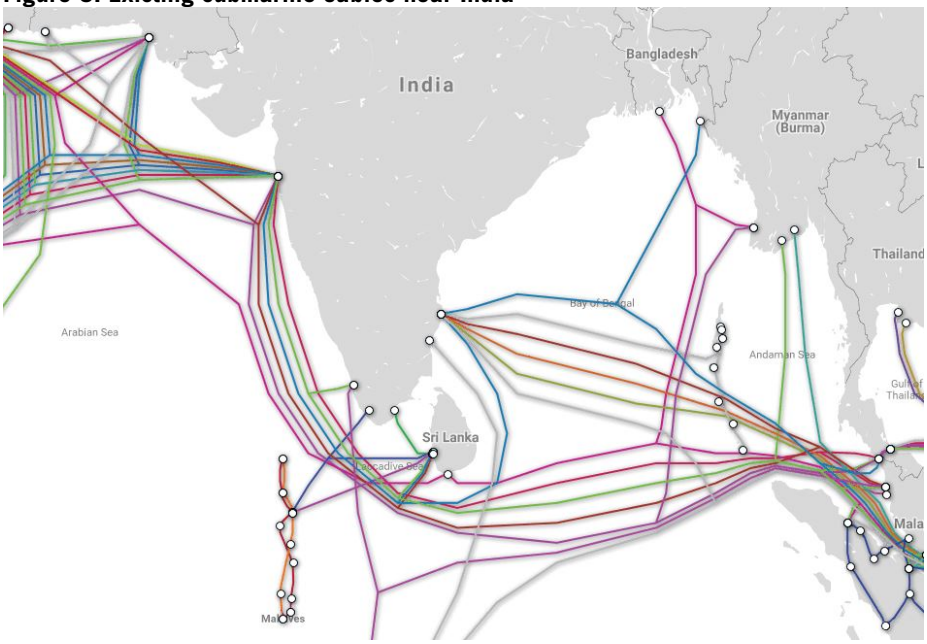


Figure 4: Submarine cables near the United States

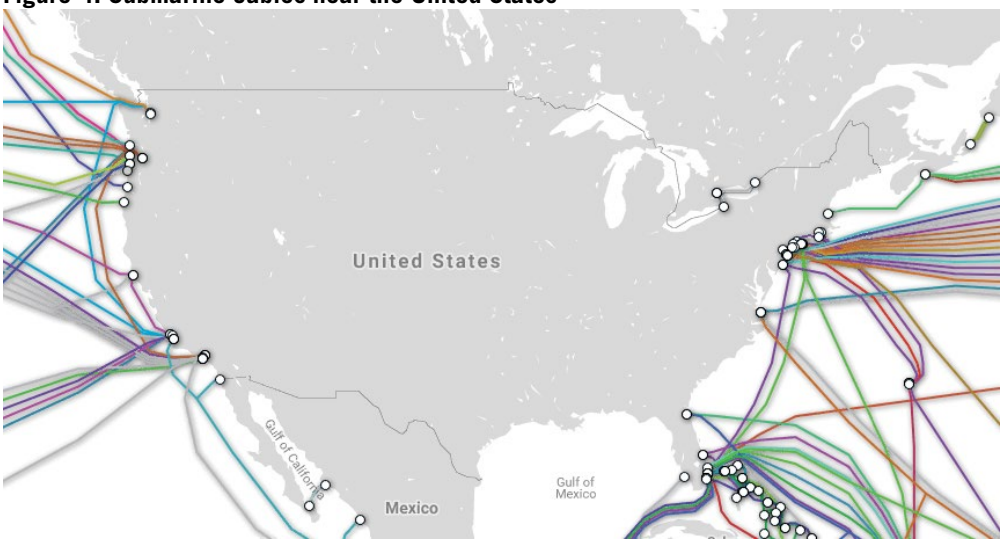
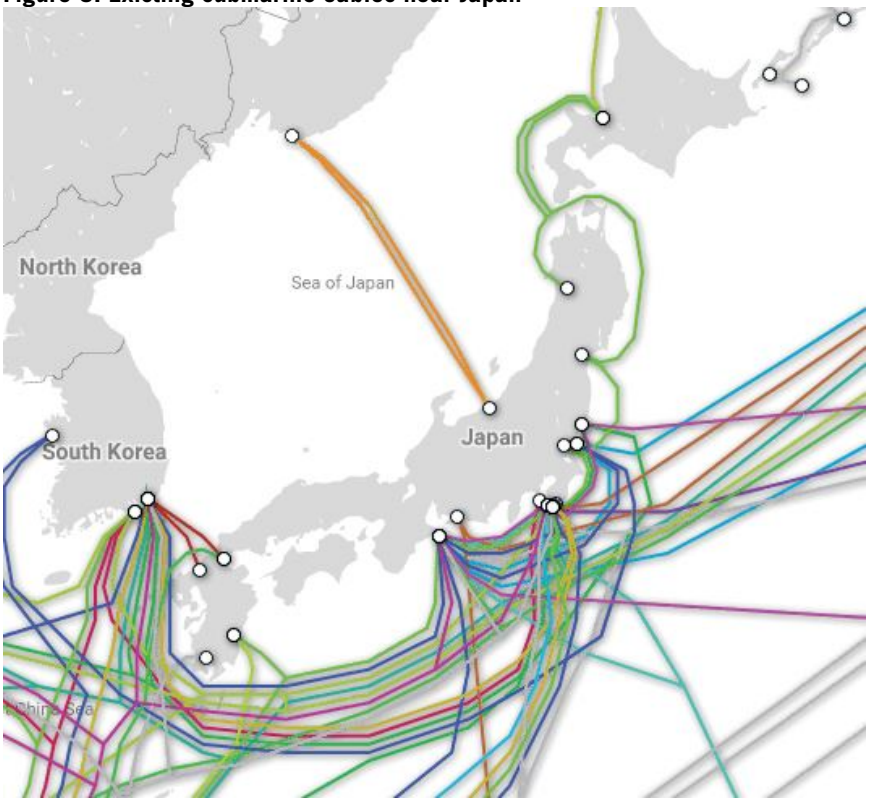


Figure 5: Existing submarine cables near Japan[50]



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