EXECUTIVE SUMMARY

TeleGeography Transport Networks Research Service

Executive Summary

For much of the world, COVID is largely seen in the rear-view mirror, along with the COVID-driven bump in bandwidth deployments. The bandwidth market now continues merrily along as demand grows across nearly all networks. The *Transport Networks Research Service* assesses the state of the global telecom transport industry and evaluates the factors that shape long-term demand growth and price erosion. We assess market conditions on both a global level and on a regional level, focusing on critical submarine cable routes.

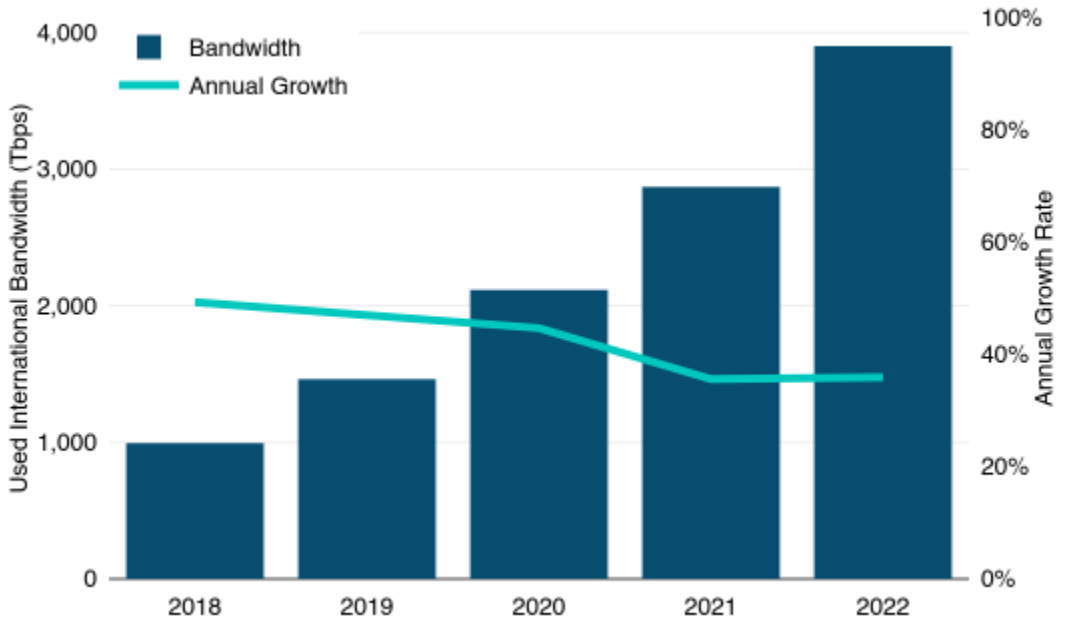
Those who subscribe to our transport networks research have access to:

- Robust market datasets that can be found in the Summary Data and Charts section of the report.
- Detailed profiles of over 400 network service providers and over 500 submarine cable systems.
- Downloadable database materials found in profile excel exports. These allow customers to delve into their own analysis of our full dataset.
- A regularly-updated table of Planned Submarine Cables, containing ownership, landings, cost, and other critical information, and divided by route deployment.
- Several search portals, allowing customers to find carriers and submarine cables by location.
- The Submarine Cable Map including tools to search for systems by cable owner, a feature not available in our free map.

Demand Trends

By any measure, the global bandwidth market is thriving. International bandwidth demand has nearly doubled from 2020 to 2022, and has now reached 3.9 Pbps (petabits per second).

FIGURE 1
Worldwide International Bandwidth Growth



Source: TeleGeography

Let's break this demand growth down to a more granular level. If you look at the figure "Used International Bandwidth Growth by Region," two observations should jump out at you. The first is that demand growth has been strongest on links connected to Africa, which experienced a compound annual growth rate of over 50% between 2018 and 2022. The second is that growth in the rest of the world remains strong. Even Latin America saw a 36% compounded annual growth rate over the last five years. While trailing the pack, keep in mind that this annual growth rate implies a doubling of bandwidth every 27 months.

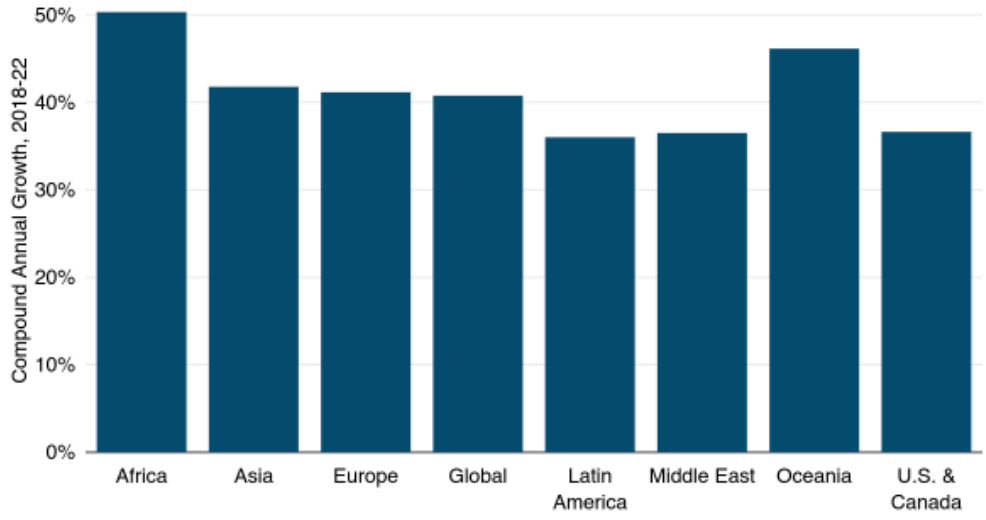
The Role of Content Providers

Who's gobbling up all this international capacity? Historically, it's been carrier networks, provisioning public internet services. As the internet has evolved, major content and cloud service providers—in particular Google, Meta, Amazon, and Microsoft—have become the main sources of demand. Companies like these are *the* dominant users of international bandwidth, accounting for 71% of all used international capacity in 2022.

The capacity requirements for companies such as these vary in scale and by route. Content providers prioritize the need to link their data centers and major interconnection points. As such, they often deploy massive amounts of capacity on core routes, while focusing much less than traditional carriers do on secondary long-haul routes. To get a sense of this contrast, note that in 2022, content providers accounted for 92% of used capacity on the trans-Atlantic route but just 31% on the Europe-East Asia route.

FIGURE 2

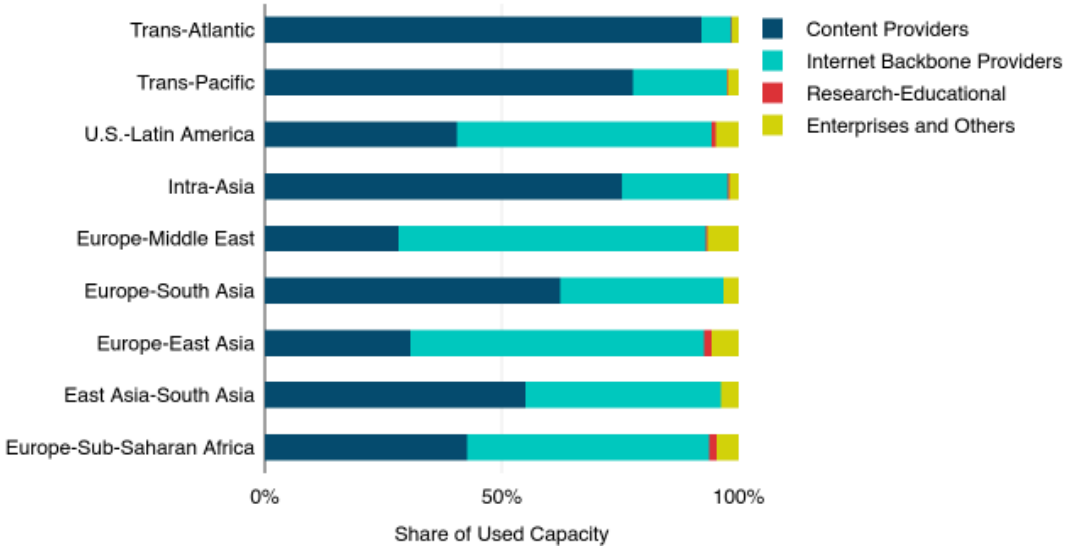
Used International Bandwidth Growth by Region



Source: TeleGeography

FIGURE 3

Share of Used Bandwidth by Category for Major Routes



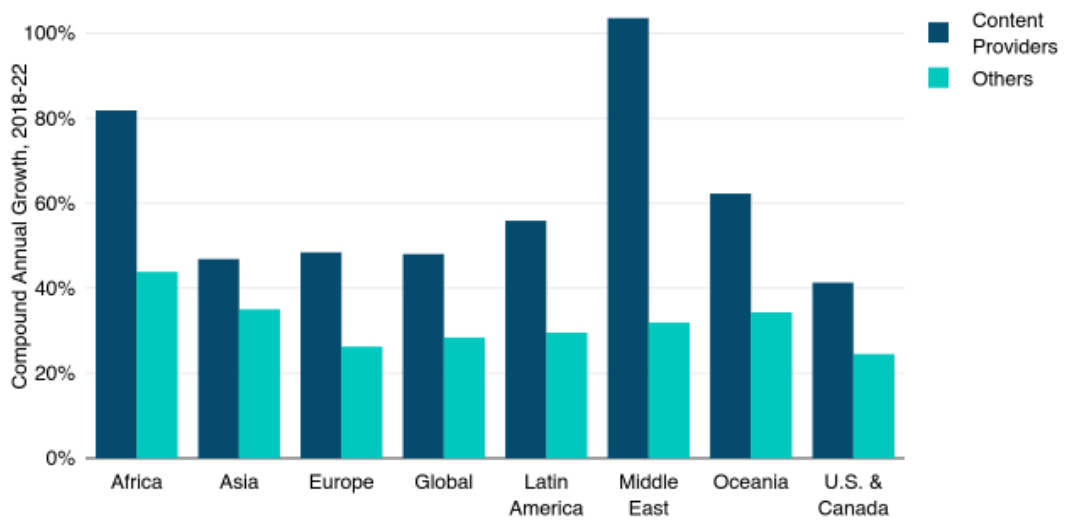
Notes: Data shows used bandwidth as of year-end 2022.

Source: TeleGeography

While the share of content provider capacity on some routes may be much lower than on others, the growth in their demand across all routes has been relentless. A comparison of content providers' international capacity demand growth compared to that of all other networks in the following figure reveals a stark contrast. Across *every region*, content providers added capacity at a compound annual rate of at least 41% between 2018 and 2022, compared to a rate no higher than 44% for all the others.

FIGURE 4

Content Providers versus Others Bandwidth Growth by Region



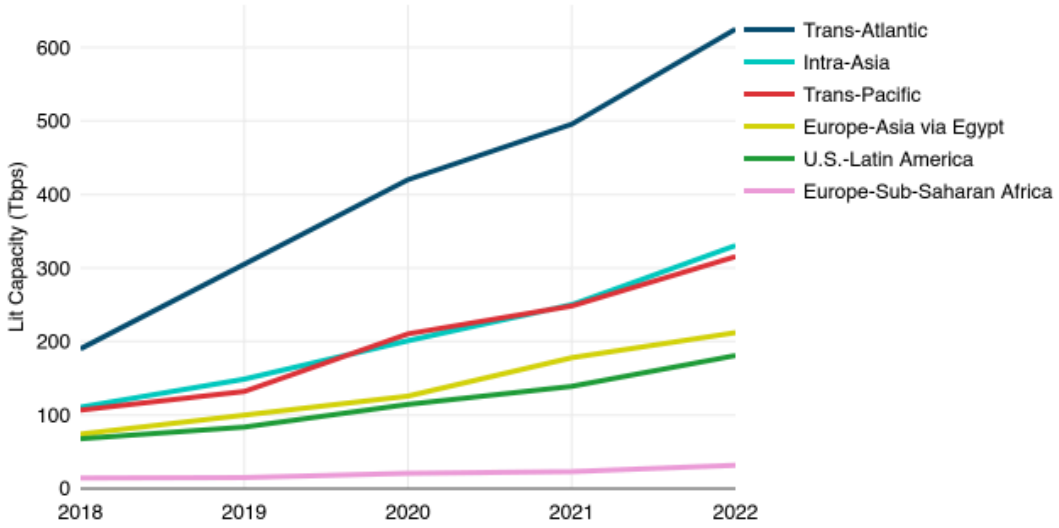
Source: TeleGeography

Meeting Demand Requirements

Demand for international bandwidth is nearly doubling every two years. To meet this demand, companies are investing in existing networks and in new infrastructure. The lit capacity on major submarine cable routes continues to soar, keeping pace with demand. Between 2018 and 2022, lit capacity tripled on several routes. The pace of growth was the most rapid on the trans-Atlantic route, where lit capacity increased over 3-fold between 2018 and 2022.

FIGURE 5

Lit Submarine Cable Supply by Route



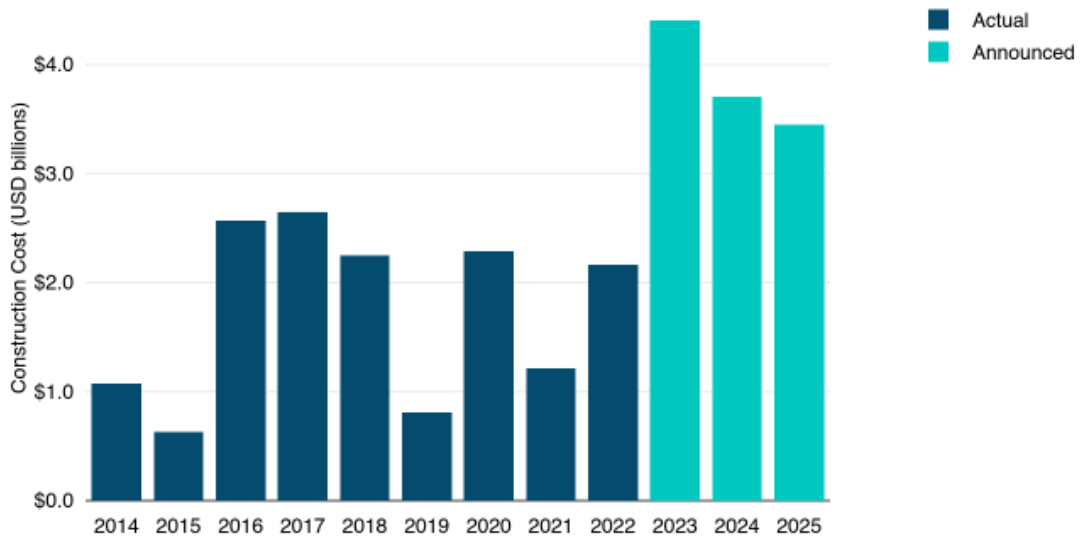
Notes: Data reflects lit capacity in unprotected terms at the end of the respective year. Intra-Asia capacity only includes cables with landings in both Hong Kong and Japan. Trans-Pacific capacity refers to the north Pacific. Trans-Atlantic capacity refers to the north Atlantic.

Source: TeleGeography

Submarine cable operators are lighting additional capacity on existing systems. Not only that, but new systems are coming online across all routes. The year 2016 initiated a period of significant global investment in the sector. Cables with a combined construction cost of $8.8 billion entered service between 2018 and 2022, and every major subsea route saw new cables deployed during this timeframe. Investment is expected to surge across all global routes. Based on publicly-announced planned cables, over $11 billion worth of new cables are expected to enter service between 2023 and 2025.

FIGURE 6

Construction Cost of Submarine Cables



Notes: Total construction costs of all international and domestic submarine cables entering service in designated years. Construction costs exclude the cost of subsequent capacity upgrades and annual operational costs. 2023-2025 construction costs based on announced contract values and TeleGeography estimates. Not all planned cables may be constructed.

Source: TeleGeography

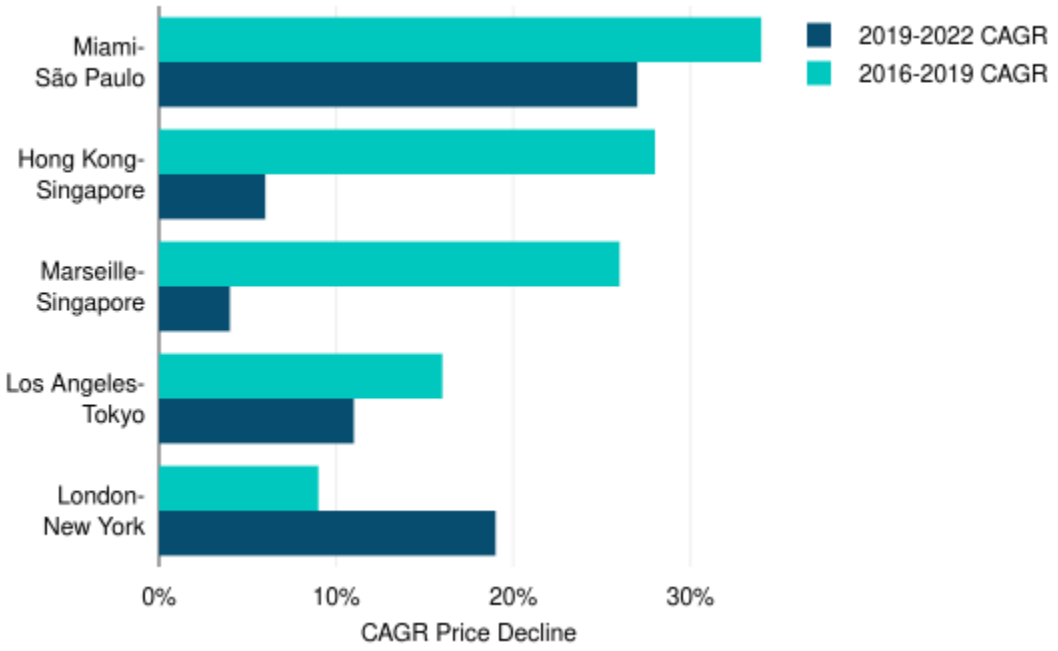
Pricing

Prices continue to decline (somewhat), but the biggest story recently has been how the pace of price erosion compares to previous years. For many key global routes, it has been notably slower— a reflection of different levels of market maturity and delays in supply due to geopolitical challenges and global supply chain issues. Capacity upgrades, which historically took 6-12 weeks from order to installation, rose to 50+ weeks for some vendors.

While this improved over the course of 2022, delays are anticipated to continue throughout 2023. The figure below highlights the compound annual price decline for 100 Gbps wavelengths from 2019 to 2022 (the dark blue bars) versus the prior three years, 2016-2019 (turquoise bars). Across all the routes featured here, 100 Gbps wavelength prices decreased an average of 13% between 2019 and 2022. That's compared to 23% over the prior three years (2016-2019). Trends do, of course, vary by market. Let's take a closer look.

FIGURE 7

Weighted Median Monthly 100 Gbps Wavelength Price Erosion



Notes: Each bar represents the percentage decline of the weighted median price calculated as a three year compound annual growth rate for the listed route and time period.

Source: TeleGeography

On routes with more ample supply, we see higher rates of price erosion. For example, the U.S.-Latin America route continues to fall at a brisk pace, still feeling the effects of new cables and upgrades to existing systems. While price erosion on Miami-São Paulo was certainly less over the past three years than the historical trend, it is still above the range of 15-20% annual price erosion that we tend to see on most key global routes. In comparison, on routes with continued delays in new supply, price erosion has stalled. Marseille-Singapore and Hong Kong-Singapore are key examples of this. Wavelength prices on both routes are already extremely competitive and don't have as much room to fall, but the Europe-Asia and intra-Asia routes have also been especially impacted by recent delays in supply and for the time being available inventory is going for 2022 prices or potentially higher.

Outlook

What does the future hold for the global bandwidth market? The two most predictable trends are persistent demand growth and price erosion. Beyond that, operators will have to navigate the major uncertainties of an evolving sector. Here are a few of the key trends, among many, that will affect the long-haul capacity market in the coming years.

Rising Utilization

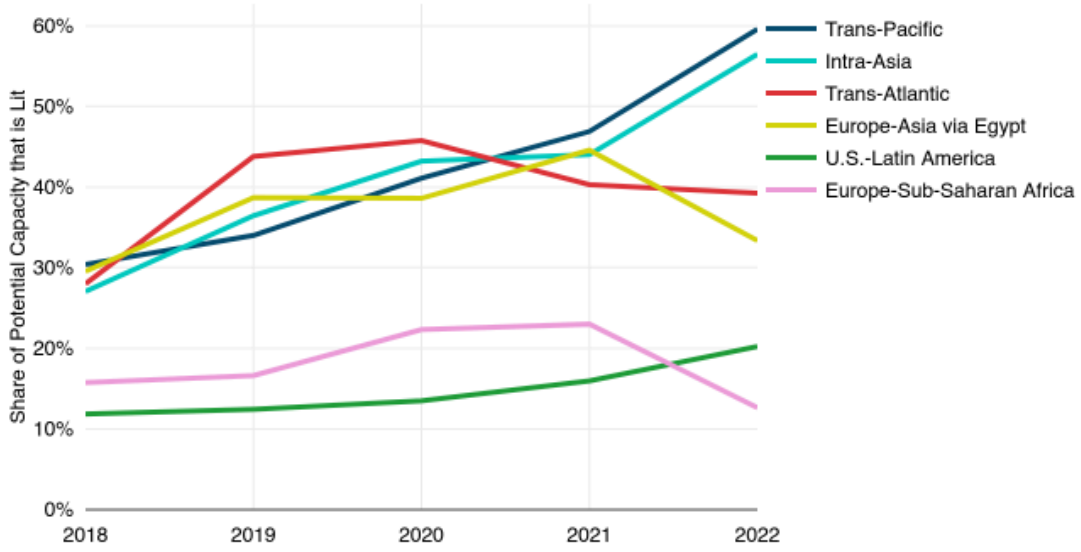
The most fundamental driver for new cable construction is the limited availability of potential capacity. On the surface, this issue may not appear important on major cable routes, where the percentage of potential capacity that is lit has only recently exceeded 50%. However, demand continues to rise at an exponential rate and could soon lead to capacity exhaustion without new cable investment.

Even with the introduction of many new cables and the ability for older cables to accommodate more

capacity, the growth of potential capacity has failed to outpace that of lit capacity. As you can see in the figure "Percentage of Potential Capacity that is Lit on Major Submarine Cable Routes," this means that the share of capacity that is lit on major routes has begun to rise.

FIGURE 8

Percentage of Potential Capacity that is Lit on Major Submarine Cable Routes



Notes: Data reflects the percentage of potential capacity that was lit at the end of the respective year. Potential capacity figures are based on operators' view of theoretical maximum capacity as of year-end. Intra-Asia capacity only includes cables with landings in both Hong Kong and Japan. Trans-Pacific capacity refers to the north Pacific. Trans-Atlantic capacity refers to the north Atlantic.

Source: TeleGeography

Looking at the lit share of potential capacity is not the only way to measure utilization. In fact, the availability of fiber pairs is emerging as a key metric on routes where content providers are involved. Thus, when gauging potential supply on a route it's important to bear in mind not just how much unlit capacity remains but whether unlit fiber pairs are available as well.

Uncertain Growth for Content Providers

Content providers' international capacity has grown at a rapid rate in recent years, but how long can this last? The recent layoffs at major content providers and declining stock prices have created some questions about these companies' network investment. Thus far, these issues do not appear to have a material impact on the bandwidth demand growth forecasted by these companies.

Most network planners in these companies focus on meeting expected growth for a 2- to 3-year planning horizon. In our discussions with content providers, all of them have indicated challenges in forecasting their longer-term demand requirements. None of them foresee a decline in demand and continue to anticipate the need for future cable investments. A few aspects that influence growth rates include the following.

- **Maturing networks.** The law of large numbers dictates that a large entity growing rapidly cannot maintain that pace of growth forever. We are certainly seeing evidence of this on major routes. For example, across the Atlantic, annual growth for content providers had been in excess of 80% but has now dipped below 30%. This is a typical pattern for networks as they mature. Even with slowing cumulative growth rates, the incremental volume of bandwidth added each year is still massive. So while global content provider bandwidth growth slowed to "only" 39% in 2022, this still equates to an incremental increase of 783 Tbps.

- **Artificial Intelligence (AI).** The most frequently cited future application that will drive demand is AI. Google, Meta, Microsoft and Amazon have all invested heavily in their own AI models which will increase demands on their network infrastructure. Microsoft's infrastructure is also supporting OpenAI, the company behind ChatGPT. While training AI models requires substantial compute power, the degree to which AI will impact international bandwidth demand remains unclear.
- **Multiple product lines and users.** Content providers' bandwidth demand comes from a large number of services within each company. In the case of Google, there is search, YouTube, maps, cloud, and many more. It's also worth noting that the bandwidth demand for Google Cloud, AWS, and Microsoft Azure isn't related to these companies' internal demand, but rather has to do with enterprises' implementation and usage of their cloud platforms.
- **Timing of new cables.** In recent years, major content provider investments have reduced reliance on carriers and focused on securing enough wholly-owned fiber pairs to achieve sufficient route diversity. Increasingly, new capacity is added largely through the introduction of new cable systems. Thus, annual capacity growth rates observed on some routes could appear lumpy as they are largely influenced by when new submarine cables enter service.

Supply Limitations

The global shortage of chips is continuing to lead to some delays in network upgrades. These issues are improving but may not be fully resolved until 2024. However, other supply side factors could throttle the pace of demand growth in the longer term. There is a limit to how many new submarine cables can be added each year. Cable factories can only produce so many kilometers of cable a year. In addition, there are a limited number of cable laying ships and experienced crews to engage in marine installation. Increasing factory size, the number of installation vessels, and crews will certainly occur, but it takes several years for these measures to be implemented.

Geopolitical Concerns

While geopolitical concerns have always played a role in determining which companies deploy long-haul networks and where they do so, several recent developments are reshaping network deployment trends. In one example, thawing relations between Israel and other Middle Eastern countries has allowed the potential for systems connecting Europe, the Middle East, and Asia to transit across Israel. Several planned projects, including the Blue and Raman cables, hope to capitalize on this opportunity.

In contrast, cable builders find it increasingly difficult to receive Chinese permits for cable deployment in the South China Sea. Operators of the planned Apricot cable hope to avoid this problem by building a cable from Japan to Singapore that runs to the east side of the Philippines. In addition, U.S. government opposition to direct China-to-U.S. cables has encouraged the development of several cables from Southeast Asia to the U.S. These include Echo, Bifrost, ACC-1, and Hawaiki Nui.

The Europe-Asia route has also been impacted by contemporary geopolitics. China Telecom and China Mobile opted to leave the SeaMeWe-6 consortium cable when American-supplier SubCom was selected as the supplier instead of Chinese-supplier HMN Tech. As a result, the Chinese carriers that left SeaMeWe-6 along with other carriers in Europe and the Middle East are rumored to be planning another cable called Europe-Middle East-Asia (EMA) that HMN Tech would build. The precise landing points and expected activation date are not yet available.

Wholesale Market Challenges

The rapid expansion of major content providers' networks has caused a shift in the global wholesale market. Google, Microsoft, Meta, and Amazon are investing in new submarine cable systems and purchasing fiber pairs. This removes huge sources of demand from the addressable wholesale market. On the other hand, it drives scale to establish new submarine cable systems and lower overall unit costs.

Many submarine cable business models actually rely on this capital injection, allocating fiber and network shares to the largest consumers to cover initial investment costs, then selling remaining shares of system capacity as managed wholesale bandwidth. Unit cost savings of large investments are a great incentive to investment for operators, but they don't want to be left with *too* much excess bandwidth. It's often a race to offload wholesale capacity before a new generation of lower-cost supply emerges. The carriers most likely to succeed are those with massive internal demand and less

dependence on wholesale market revenues.

Both content and carrier network operators are reckoning with massive bandwidth demand growth, driven by new applications and greater penetration into emerging markets. The sheer growth in supply will drive lower unit costs for bandwidth. In the face of price erosion, the challenge for wholesale operators is to carve out profitable niches where demand trumps competition.

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