

**LIGHTING THE WAY TO BANDWIDTH EQUALITY:
THE ROLE OF SUBMARINE CONNECTIVITY
IN BRIDGING THE BANDWIDTH DIVIDE**

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Abstract: Over the last 15 years, international fiber optic bandwidth has expanded to dozens of countries and territories that had previously been served only by satellite links. The submarine communications industry has been the primary enabler of this expansion, providing backbone interregional fiber optic capacity to unserved markets in Africa, Asia, the Caribbean, Latin America, and the South Pacific. As a result, millions of individuals have benefited from faster, more reliable, and significantly less expensive connectivity. Yet despite this significant progress, the promise of next-generation connectivity has still eluded the majority of the planet's inhabitants, and the divergence of nations into groups of "bandwidth haves" and "bandwidth have-nots" has served to impede international development and cooperation, while deepening global economic inequality. By acknowledging the urgent challenges of this "bandwidth divide," proven multilateral solutions can be implemented that offer strong opportunities for public-sector developmental growth and private-sector profitability.

**1. LESS-DEVELOPED MARKETS:
KEY TO CONTINUED GROWTH
OF THE SUB-COMM INDUSTRY**

The submarine communications industry of 2016 is characterized by robustness and confidence. Over the last five years, direct investment in new systems has averaged more than \$1.5 billion and 35,000 kilometers, and the market for system upgrades has brought in an additional \$100 million annually. Terabit Consulting's analysis of submarine bandwidth supply and demand indicates that the market will continue to remain strong: between 2016 and 2025, Terabit forecasts a combined market for new submarine cable systems and upgrades in excess of \$1.7 billion annually.

Analysis and modeling indicates that the submarine communications industry owes much of its recent well-being, as well as its

continued growth, to less-developed markets.

The first intercontinental fiber optic submarine system, TAT-8, entered service in 1988 and for much of the subsequent 13 years, industry investment focused primarily on developed markets with proven track-records of bandwidth demand in North America, Western Europe, and East Asia. Sixty-nine percent (\$30.1 billion) of submarine investment between 1988 and 2003 targeted the world's wealthiest markets, and three backbone routes accounted for 53 percent of submarine cable investment: transatlantic, transpacific, and pan-East-Asian.

However, following the dot-com bubble burst of the early-2000s and the oversaturation of the industry's core transoceanic routes with multiple terabits of design capacity, investment targeting developed markets contracted

dramatically. In a remarkable shift, not a single new system entered service on the transatlantic, transpacific, and pan-East-Asian backbone routes between February, 2003 and September of 2008, representing the longest drought of investment on the three routes since the advent of submarine fiber optic connectivity.

Prior to the contraction of the submarine communications market, neither the traditional cable consortia (led by operators from wealthier markets) nor the more speculative, profit-driven private network developers of the late-1990s had shown any appetite for expanding submarine connectivity toward what were perceived to be risky, less-developed markets. There were a handful of exceptions: most notably, connectivity to markets in South Asia and the Middle East was improved in the 1990s by the Sea-Me-We and FLAG systems, the Southern Cross Cable Network brought fiber connectivity to Fiji for the first time in 2000, and in 2002 eight countries in West Africa benefited from their first fiber optic connectivity via landing points on the SAT-3 system. However, in each instance, the expansion of connectivity to unserved and underserved markets was, for all intents and purposes, a secondary consequence of more lucrative intentions: the Sea-Me-We and FLAG cables targeted the profitable long-haul demand between Western Europe and Eastern Asia; the goal of Southern Cross was to link the wealthy markets of Australia, New Zealand, and the United States; and SAT-3 was designed primarily to bring next-generation connectivity to South Africa.

For the most part, the improvement of connectivity to less-developed countries remained an afterthought on the part of the wealthy operators spearheading submarine cable development; richer operators would

often seek to leverage the investments of monopolistic operators in poorer countries only to serve the richer operators' own strategic (or technical) needs.

But the unprecedented shock of the dot-com bubble burst led to a sudden and dramatic change of heart. Multiple submarine cable operators declared bankruptcy, and a glut of submarine bandwidth (sometimes priced below cost) flooded developed markets. Annual investment in new systems fell to one-tenth of the dizzying heights of the turn of the century. In order to ensure its survival, the industry explored new, mutually-beneficial investment strategies for improving connectivity to the world's less-connected.

The last of the dot-com era's transoceanic submarine cable systems entered service in early-2003 and for the next five years there was no new deployment on the historical "backbones" of submarine communications, i.e. the transatlantic and transpacific routes. Instead, the vast majority of investment was directed toward unserved or underserved markets in Africa, the Middle East, South Asia, Southeast Asia, the South Pacific, and Latin America.

One-third of the world's countries and territories still lacked international fiber connectivity as of 2003, relying exclusively on expensive, unreliable, low-capacity satellite or microwave links. Connecting the unconnected, and improving connectivity to the under-connected, presented itself as the submarine industry's most logical way forward, but the solution necessitated an innovative new multilateral approach implicating old and new stakeholders committed to long-term strategies of investment and development.

2. THE NEW DEVELOPMENT-ORIENTED MODEL OF MULTI-LATERAL FIBER INVESTMENT

Multilateral development banks (MDBs) and other international financial institutions (IFIs) (including the World Bank, the International Finance Corporation, the Asian Development Bank, the Inter-American Development Bank, the European Investment Bank, the African Development Bank, the Islamic Development Bank, the Development Bank of Southern Africa, the Chinese Development Bank, the Agence Française de Développement, and KfW Bankengruppe) emerged as leading advocates of improved fiber connectivity to the developing world. Suppliers also played an integral role by offering innovative technical solutions which were appropriate for cost-sensitive markets, and operators from developed markets often supported projects that were perceived as improving the global connectivity and reliability of their multinational corporate clientele's private networks.

Within the less-developed markets themselves, cooperative open-access frameworks often helped to facilitate mutually-beneficial equity participation by public and private stakeholders with conflicting goals and interests, including governments, fixed-line monopolies, competitive mobile operators, and smaller ISPs.

Although serious planning for new development-oriented submarine cable projects took place as early as 2003, deployment of major new systems did not occur until several years thereafter: they included the East African Submarine Cable System (EASSy), the East African Marine System (TEAMS), Africa Coast-to-Europe (ACE), the Seychelles-East Africa System

(SEAS), and the Tonga-Fiji Submarine Cable Project, among others. Each project also included components for improving terrestrial backhaul on both a local and international basis, which had traditionally been a major obstacle in connecting the unconnected.

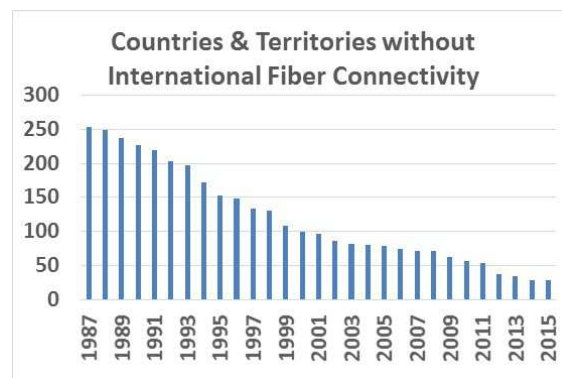
In addition to IFI-led investment, projects led by the private sector proliferated along less-developed routes, and operator consortia also increased investment toward historically underserved markets.

3. PROGRESS IN THE EXPANSION OF FIBER CONNECTIVITY TO UNSERVED COUNTRIES

On the surface, the outcome of the industry's shift toward less-developed, unconnected or under-connected markets has been impressive.

The number of civilian-inhabited countries and territories without fiber connectivity fell from 79 in 2005 to only 29 in 2015. Collectively, 99.5 percent of the world's inhabitants now live in countries served by international fiber optic networks.

Number of Countries and Territories without International Fiber Connectivity, 1987-2015



Source: *International Telecommunications Infrastructure Analysis*, Terabit Consulting, 2016

Since 2003, the percentage of investment targeting less-developed and emerging markets has increased from approximately 33 percent to more than 60 percent, with much of this investment targeting unconnected countries in sub-Saharan Africa, as well as South Asia, the Middle East, and the Caribbean. Even new transpacific investment has shifted away from Asia's richer economies and toward less-developed markets in Southeast Asia.

Investment in New Submarine Projects by Region, 2003-2015

Region	Share of Investment, 1988-2002	Share of Investment, 2003-2015
Africa	2%	22%
South Asia & Middle East	9%	21%
Transpacific	16%	11%
Europe & Mediterranean Regional	10%	11%
Pan-East Asian	13%	8%
East Asian Regional	7%	7%
Transatlantic	22%	6%
Latin America	13%	6%
Pacific Islands	1%	3%
Australia	5%	3%
Other	1%	3%

Source: *Undersea Cable Report 2016* (Terabit Consulting)

Without question, the shift in investment has brought tangible benefits to millions of individuals around the globe who have benefited from faster, more reliable, less-expensive connectivity. Where new submarine cable projects have succeeded, the benefits of connectivity have been realized far beyond the realm of telecommunications, in the form of economic growth and human development.

When submarine cables have transported the digital economy to the far reaches of the globe, they have helped to overcome many of the obstacles posed by the world's physical and political borders.

4. THE REGRESSIVE DYNAMICS OF INTERNATIONAL BANDWIDTH DISTRIBUTION

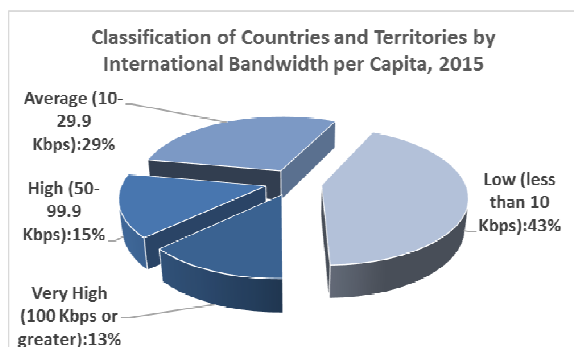
Yet despite the best efforts of the submarine communications industry, the majority of the world's population has still been denied access to affordable, reliable, high-speed bandwidth. While global submarine infrastructure has laid the basic foundation for global connectivity, much progress needs to be made in facilitating the complex, multi-layered connection between submarine cable and end-user.

An examination of the current dynamics of international bandwidth distribution reveals the formidable challenge.

Terabit Consulting's analysis indicates that 28 percent of the world's countries and territories have levels of per-capita international bandwidth that are either "high" (between 50 Kbps and 99.9 Kbps) or "very high" (100 Kbps or greater), while those countries with an "average" level of per-capita bandwidth (between 10 Kbps and 29.9 Kbps) account for 29 percent.

However, of urgent concern is the fact that 43 percent of the world's countries and territories have international per-capita bandwidth levels of 10 Kbps or less, a level which was determined to be a serious obstacle to economic and human development, based network analytics and Terabit Consulting's discussions with stakeholders around the globe.

Classification of Countries and Territories by International Bandwidth per Capita, 2015



Source: Terabit Consulting International Bandwidth Databank

The analysis revealed a strong correlation between per-capita international bandwidth and per-capita gross domestic product (in PPP terms). The countries with the highest international bandwidth per capita are invariably the world’s richest, while most of the countries with bandwidth levels lower than 10 Kbps per capita have low per-capita GDP and rank among the world’s least developed, according to the United Nations Human Development Index (HDI).

Average Per-Capita GDP of Countries and Territories in Each International Bandwidth Classification, 2015

Terabit Consulting International Bandwidth Classification, 2015	Average GDP per Capita, 2015 (PPP terms)
Very High (100+ Kbps)	\$45,776
High (50-99.9 Kbps)	\$38,582
Average (10-29.9 Kbps)	\$22,126
Low (less than 10 Kbps)	\$6,839

Source: Terabit Consulting International Bandwidth Databank

5. THE IMPACT OF WEAK INTERNATIONAL BANDWIDTH

The data very clearly indicate the existence of a “bandwidth divide” that blocks the inhabitants of 43 percent of the world’s countries and territories from basic levels of access. Additionally, even within countries with average, high, or very high levels of per-capita bandwidth, reliable and affordable bandwidth is often limited in its geographic reach, typically clustered among affluent, coastal, and urban locales.

The bandwidth divide has denied the majority of the world’s population from realizing the economic, social, and political benefits of reliable and affordable broadband.

At the macroeconomic level, weak international infrastructure and low international bandwidth is a major obstacle to both economic and human development. With insufficient international connectivity, bandwidth-poor markets will likely become further detached from the global digital economy and fail to benefit from its accompanying economic efficiencies. The lack of affordable and reliable international bandwidth has also stunted countries’ social development by preventing the effective implementation of scientific and research networks, distance education, and telemedicine.

Research indicates that efficient trans-border “flows” – including finance, trade, and transportation, but perhaps most crucially digital communications – are a key element of countries’ economic success, increasing global GDP growth by hundreds of billions of dollars per year. Meanwhile, the increasing interconnection of the global economy will inevitably penalize those markets with constricted

access to the global community. Although economic development in less-developed countries has historically been impeded by political and geographic obstacles, the digitization of the world economy presents a unique opportunity to overcome these disadvantages by improving international telecommunications infrastructure.

At the consumer level, abundant and affordable international bandwidth drives the improved quality, increased reliability, and lower pricing of end-user telecommunications and Internet services. Improved access to international bandwidth is also a boon to ICT development and overall economic growth, through increased demand for the output of other industries, new opportunities for production in other industries, and the development of new goods and services for consumers. Improved ICT infrastructure also increases firms' innovation capabilities and increases the probability of technological advancements. At the political level it encourages regional stability through better international and intercultural relations, fostered by more efficient routing of trans-border traffic and greater accessibility to neighboring markets, as well as the enabling of bandwidth-intensive social initiatives in the education, research, and healthcare sectors that would not otherwise be possible.

6. POLICY SOLUTIONS FOR ADDRESSING THE BANDWIDTH DIVIDE

The challenges of bringing affordable, reliable, low-cost bandwidth to all corners of the globe are formidable. Economic obstacles appear throughout the bandwidth distribution chain, from the challenges of financing submarine and terrestrial networks, to the lack of competition in

international gateway and backhaul markets, to the unaffordability of consumer broadband and ICT equipment. Political issues such as government shareholding, international conflict, and content restrictions impact the quality of broadband around the globe. And physical network bottlenecks are present at almost every level, most discernibly at the access level, where the mix of competitive markets and government intervention has so far shown only limited success in bringing equality to broadband markets.

In order to achieve the efficient deployment of international connectivity, Terabit Consulting makes the following specific policy recommendations, which apply to the coordinated improvement of submarine, international terrestrial, domestic backbone, and local access network infrastructure:

- **Pursue multilateral network development solutions which identify and involve key international, public-sector, and private-sector stakeholders.** These stakeholders include international financial institutions and international organizations able to provide coordination, guidance, and financing for the project; national regulatory authorities; incumbent operators and major international gateway providers; competitive telecommunications operators and ISPs; and the owners and overseers of complementary linear infrastructure assets such as highway, rail, and power distribution infrastructure, which can be used for the deployment of improved terrestrial fiber networks. Potential suppliers and contractors should also be consulted early in the project's development stage, in order to ensure cost-sensitive, project-specific technological solutions. A constructive dialog should be initiated with all public- and private-sector stakeholders, ensuring that the concerns of

each are fully considered, while at the same time clearly identifying the specific benefits that improved connectivity would provide.

- **Encourage greater regional cooperation in the telecommunications and Internet sectors, with specific focus on the coordination of submarine and terrestrial fiber optic network development and investment, as well as pan-regional harmonization of telecommunications and Internet regulation and markets.** In developing regions of Africa, Asia, Latin America, the Caribbean, and the South Pacific, governments should explore the possibility of harmonizing regional telecommunications regulatory, licensing, and interconnection regimes to provide a uniform economic environment and reduced risk profile for both internal and external telecommunications infrastructure investors. Governments could also promote growth by creating pan-regional telecommunications market agreements, allowing network operators and other investors to expand their economies of scale by increasing their addressable market size. Most immediately, regional cooperation could be fostered through the creation of regional working groups that could work to explore the feasibility of greater regional cooperation.

- **Harness the potential of international connectivity by ensuring open access and non-discriminatory pricing, and by eliminating competitive and technological obstacles that may hinder the full exploitation of international and domestic networks.** In order for international connectivity to most effectively reach end users, it is imperative that purchasers of capacity on bandwidth infrastructure projects be able to access capacity on equal, non-discriminatory

terms. The concept of non-discrimination should also be carried over on a geographic basis so that countries can receive bandwidth at equal prices in an effort to overcome the paradoxically high pricing of bandwidth in poorer (particularly landlocked) markets. Admittedly, the implementation of non-discriminatory pricing and access frameworks is only likely in infrastructure projects with government or MDB involvement, but even operators of privately-financed infrastructure should evaluate the role of equitable customer terms might have in maximizing revenue and market share.

- **Eliminate “downstream” obstacles to bandwidth utilization.** In the market segments between the international network and the end-user, and at each of the intervening network elements, governments must ensure that “downstream” obstacles do not limit the full potential of improved international bandwidth. In developing regions where next-generation international fiber connectivity has been greatly improved over the last decade, for example in Sub-Saharan Africa, there have often been obstacles that have prevented the end-user from fully benefitting. These obstacles include restricted access to international cable bandwidth and international gateways, exorbitant backhaul and interconnection fees, expensive domestic transit prices, and weak or uncompetitive broadband access infrastructure. Governments should therefore have a strong commitment to open access, non-discriminatory tariff frameworks, and competition, particularly at the levels of international bandwidth, IP transit, interconnection, and backhaul. In countries where it has not yet occurred, local-loop unbundling, as well as antenna and tower site sharing, ensure competitive service offerings to end-users. Also,

throughout the developing world, the promotion of public internet exchanges can more efficiently interconnect domestic operators and prevent the “hairpinning” of domestic traffic via uneconomical international transit paths. Governments can foster the growth of IXPs not only by providing participation incentives to private Internet service providers, but also by requiring that government (and possibly educational and research) networks be interconnected via IXPs.

7. CONCLUSION

The submarine communications industry has made tremendous progress in bringing cost-effective international connectivity to the shores of almost all the world’s countries and territories, resulting in a significant increase in Internet access. However, the submarine communications industry cannot continue to operate in a vacuum that ignores the ongoing failure of the marketplace to effectively distribute affordable, reliable, low-cost bandwidth, particularly in developing regions. Coordinated, policy-driven, multilateral approaches involving both the public and private sectors are necessary in order to ensure the development of a coherent, efficient telecommunications ecosystem that seamlessly transports data and communications under the seas between end users in all regions of the globe.