

THE SUBMARINE COMMUNICATIONS INDUSTRY AS A GLOBAL ENABLER OF GROWTH & DEVELOPMENT, AND THE PATH FORWARD

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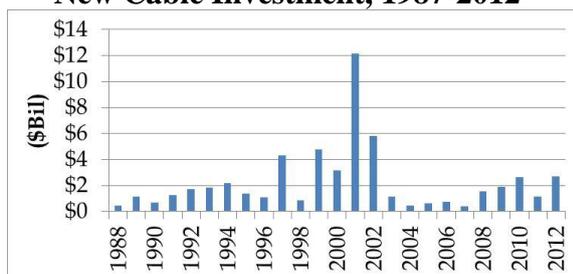
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Abstract: In 2013 the submarine fiber optic communications industry celebrates its first 25 years of linking continents. In hindsight, this quarter-century was abruptly yet precisely punctuated at its midpoint by the dot-com bubble burst, which proved to be the most determinative event in the industry's history. A complacent and at times irrational industry was forced to rethink its business models, customer relationships, financing structures, supply framework, and geographic deployment strategies. The outcome in the marketplace has been paradoxical yet stunningly effective and efficient: an industry which by measure of its investment volume is significantly more conservative, has clearly demonstrated itself to be a leading progressive force in the social, political, and economic development of the planet. Based on an analysis of market dynamics and proposed projects, the submarine communications industry seems to have achieved both stability and diversity, having provided competitive undersea cable options to the shores of most of the world's coastal markets. However, there remain significant challenges before submarine connectivity can achieve full ubiquity and ensure that the world's population is able to avail itself of cost-effective, reliable bandwidth on an equitable basis.

1. THE INDUSTRY'S FIRST 25 YEARS

Over its first quarter-century, the performance of the submarine fiber optic cable market has been mind-boggling: \$56.3 billion has been invested in new systems, billions more have been spent on capacity upgrades, and 1,250,000 route kilometers have been installed to date. On average, 50,000 kilometers and \$2.25 billion worth of new systems have been constructed every year.

New Cable Investment, 1987-2012



Source: *Undersea Cable Report 2013*
(Terabit Consulting)

The first transoceanic fiber optic cable, TAT-8, entered service in December of 1988. In the 25 years since then, the submarine fiber optic communications industry has evolved through what can be considered as four distinct cycles: the consortium-led era, which lasted from 1988 to 1997; the era of the dot-com bubble, which defined deployment between 1998 and 2002; a period of market dormancy between 2003 and 2007; and the rebirth of a more staid and rational industry in 2008 that has carried through to the present day. Each era left a distinct mark on the industry.

For almost ten years following the activation of TAT-8, the submarine fiber optic cable market was predictable and conservative, catering primarily to voice traffic as well as occasional (but manageable) bursts of demand from technologies such as ISDN and Group 4

fax machine compression. The market was dominated by consortia of operators, most of which were either monopolies or dominant in their home markets. There was also strong operator participation in the system supply, installation, and maintenance sectors.

In the late-1990s an unforeseen explosion in international Internet bandwidth demand, coupled with the liberalization of telecommunications markets in most developed countries, led to the immediate transformation of the submarine cable industry. The early success of Global Crossing's investment in the transatlantic market inspired throngs of mostly speculative investors to finance the buildout of \$25 billion worth of new systems in fewer than four years.

During the dot-com bubble, the marketplace became overcrowded and the price of international bandwidth spiraled downward, driven by intense competition on many transoceanic markets and unprecedented advancements in dense wavelength division multiplexing (DWDM) technology. As a result, by 2002 the majority of the major international wholesale network operators had declared bankruptcy. The financing of wholesale transoceanic systems became virtually impossible and telecommunications carriers (the former consortia) for the most part refrained from investment and benefited from a glut of affordable international bandwidth. The fire-sales of wholesale cable operators, the write-down of undersea cable assets, and the economics of marginal upgrade costs drove the price of international bandwidth to well below unit construction costs in most developed markets. Investment in new undersea systems came to an abrupt halt.

The last of the dot-com era's transoceanic systems entered service in early-2003 and

for the next five years there was no new deployment in the transpacific, transatlantic, between North America and Latin America, or between North America and Australia. The industry subsisted mostly on short-haul projects averaging \$23 million in value, with three exceptions (i.e. Sea-Me-We-4 and two other interregional systems in South Asia and the Middle East). The marketplace struggled to justify \$1 billion worth of investment in new systems annually.

The supply community undertook a critical course of action by shutting down major submarine cable plants and reducing annual production capacity to approximately one-third of its all-time high of 200,000 kilometers. The industry's marine installation fleet was also reduced as installation and repair vessels sought opportunities in more lucrative sectors. Meanwhile, capacity markets remained in disarray and even those cable operators who had acquired distressed cables for pennies on the dollar saw their competitive advantage eliminated by the waves of upgrade capacity entering the market.

In response to the industry's contraction, attention was shifted away from the key transoceanic markets that had historically controlled most undersea investment. Suppliers, operators, financiers, development institutions, and governments refocused their energy toward the badly-neglected markets of the developing world, which in many cases were served exclusively by high-cost, low-bandwidth satellite connections that had kept Internet penetration rates at negligible levels. At the same time, new transoceanic opportunities began to emerge, dominated by demand from what Terabit Consulting identified as the "BICS" markets (Brazil, India, China, and South Africa).

By 2008 the submarine industry had

seemingly found a new comfort zone in which both investors and suppliers remained cautious, but in which there emerged a strong focus on bringing connectivity to underserved routes and regions. Since then, investment in new systems has returned to historical averages, and the upgrade market, driven by the shift to 40G and 100G transmission technology, has been a source of consistent growth.

2. THE REDEFINED SUBMARINE CABLE MARKETPLACE OVER THE LAST FIVE YEARS

Between the beginning of 2008 and the end of 2012, \$10 billion worth of new submarine cable systems entered service. Average investment has been \$2 billion per year and average annual deployment has been 53,000 kilometers, in line with historical norms.

What is striking about the submarine cable marketplace over the last five years is the geographic distribution of investment. Almost \$3 billion was invested in Sub-Saharan Africa, including four long-haul systems on the continent’s western coast and three in East Africa; this was more than three times the amount that had been invested in the continent over the previous 20 years. Investment in new systems connecting India and the Middle East was \$1.8 billion and three new transpacific systems were constructed at a cost of \$1.7 billion. The majority of investment over the last five years has in some way targeted the markets in and around Sub-Saharan Africa (with South Africa as its largest market), China, and India: three of the five “BRICS” economies. Much investment was also directed toward markets that had been without fiber optic connectivity.

Investment in New Submarine Projects by Region, 2008-2012

Region	Share of Investment, 2008-2012
Sub-Saharan Africa	29%
South Asia and Middle East	18%
Transpacific	17%
East Asia	12%
Europe and Mediterranean	9%
Australia	4%
Pacific Islands	4%
Latin America and Caribbean	3%
North American Regional	3%

Source: *Undersea Cable Report 2013* (Terabit Consulting)

3. THE PIPELINE OF NEW PROJECTS

Terabit Consulting’s analysis evaluated a total of 177 new projects that are either under construction or proposed, for a total investment value of \$28.5 billion. Each of the proposed projects, which totaled 162, were classified into three categories, “high activity,” “medium activity,” and “low activity,” according to various evaluation criteria as to the development stage and credibility of the project. These criteria included supply contracts, funding, licenses, carrier commitments, and market opportunities, as well as the completion of marine surveys, desktop studies, and feasibility studies.

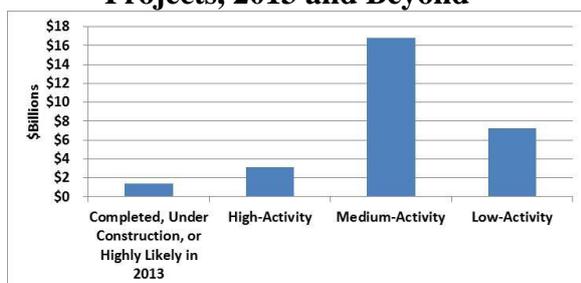
The analysis identified 15 new cables, valued at \$1.4 billion, which either entered service in early-2013 or are credibly scheduled for completion this year.

The “high-activity” category comprised 24 new projects that are perceived to have a high probability of activation in 2013 or 2014. These cables were collectively valued at \$3.1 billion.

Consequently, if there are no significant construction delays or other obstacles then there is a strong probability that over the next two years the market will continue to adhere to its historical average of \$2 billion worth of new investment annually.

Beyond these under-construction and high-activity projects, Terabit Consulting identified an additional 95 “medium-activity” projects, totaling \$16.8 billion worth of investment, and 43 “low-activity” projects, totaling \$7.2 billion of proposed investment. The size of the “medium-activity” pool, which provides a solid indication of mid-term deployment beyond 2014, is encouraging and provides strong comfort that at least \$2 billion worth of annual investment will continue for the next five years. The potential upside of the market, which Terabit Consulting believes to be strong, is determined on a market-by-market basis.

Proposed and Under-Construction Projects, 2013 and Beyond



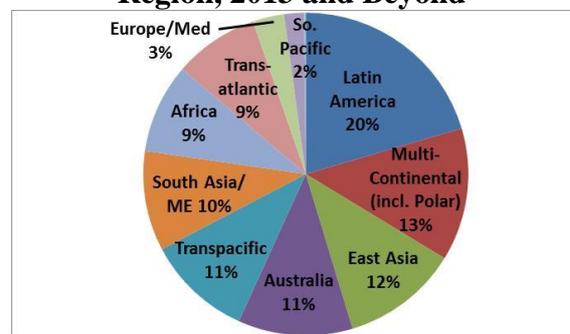
Source: *Undersea Cable Report 2013* (Terabit Consulting)

Geographically, after having targeted India, China, and South Africa over the last five years, the pipeline of proposed projects shows a strong focus on Latin America, in particular the Brazilian market which is the fourth of the high-priority “BICS” markets identified by Terabit Consulting. Among the proposed or under-construction projects are four new cable systems between Brazil and the United States, two between Brazil and

Europe, and five between Brazil and Africa, for a total of \$5.5 billion. This represents more than one-fourth of all credible projects (i.e. in the “medium-activity” category or above).

Overall, credible proposed investment demonstrates a strikingly high degree of geographic diversity.

Credible (“High-Activity” and “Medium-Activity”) Proposed Submarine Fiber Optic Projects by Region, 2013 and Beyond



Source: *Undersea Cable Report 2013* (Terabit Consulting)

More than two thirds of the “high-activity” and “medium-activity” projects would take place in developing or unconnected markets. However, there is still strong interest in traditional transoceanic markets. Overall, Terabit Consulting believes that future submarine cable investment will be balanced and sustainable, and will contribute toward a more geographically-equitable global infrastructure.

4. SYSTEM SUPPLY LANDSCAPE

The market for supplying submarine cable systems was historically divided between three groups, i.e. the predecessors of Alcatel-Lucent, the predecessors of TE SubCom, and the supply community in Japan.

Within the last 10 to 15 years, the obstacles encountered by Japanese suppliers such as

KDD-SCS, Hitachi Cable, and OCC led to an overall decline in Japan’s share of new contracts, and while both Alcatel-Lucent and TE SubCom saw significant reduction in their production capacities, each retained relatively strong market shares of between one-third and one-half.

Suppliers’ Market Share of New Projects, Excluding Subcontracts, 2003-2013

	Market Share
Alcatel-Lucent	47%
TE SubCom	30%
NEC	12%
Fujitsu	4%
Huawei Marine	2%
NSW	2%
Nexans	1%
Ericsson	1%
Others	2%

Source: *Undersea Cable Report 2013* (Terabit Consulting)

Much of the supply community’s attention in recent years has been focused on Huawei Marine Networks, which was formed as a joint venture between Huawei Technologies and Global Marine Systems in 2008 with the goal of becoming a major turnkey supplier. By most accounts the technical expertise of the both partners is very strong, bolstered in particular by Global Marine’s 150 years of experience on the installation and maintenance side of the industry. However, the submarine industry’s barriers to entry are significantly higher than most telecommunications markets, and Huawei Marine’s dependence on others for the fabrication of cable has been an impediment in competing for transoceanic projects.

Huawei Marine’s initial entry into the market was aggressive, with some observers accusing the company of “buying” market share through low-value

bids. The company has deployed a handful of repeaters and is aggressively seeking to improve its presence in the long-haul repeatered market.

However, over the last year, Huawei and other Chinese telecom suppliers such as ZTE have come under attack from critics mostly in the United States and Australia, to the detriment of Huawei Marine. Hibernia Networks, the developer of a high-profile transatlantic project known as Project Express, announced in February of 2013 that it had “halted work with Huawei” on the cable due to U.S. government concerns,* highlighted by a 2012 investigation by the U.S. House of Representatives’ Permanent Select Committee on Intelligence. The chairman of the committee, Republican Congressman Mike Rogers, summarized the report of that investigation by saying that “If I were an American company today...and you are looking at Huawei, I would find another vendor if you care about your intellectual property, if you care about your consumers' privacy, and you care about the national security of the United States of America.”

In Australia, meanwhile, Huawei reported that the Australian government had told the company that “there is no role for Huawei” in the supply of Australia’s \$38 billion National Broadband Network due to security concerns. The government’s fears also reportedly carried over into submarine projects. The American and Australian governments provided little in the way of scientific or technical evidence to substantiate their espionage fears, pointing mostly to Chinese suppliers’ failure to “provide clear answers” and “supporting

*Project Express, like other proposed transatlantic projects, had already fallen well behind its original development schedule, reportedly due to the industry’s difficult financing environment.

documentation,” or to “alleviate Committee concerns.” The U.S. congressional committee did claim that more detailed information could be found in the classified annex to its report, but it asserted that the information “cannot be shared publicly without risking U.S. national security.”

Terabit Consulting believes that the submarine supply landscape will be dependent on three major considerations: the future strategy of Huawei Marine Networks (which Terabit Consulting expects may include the possibility of partnering with Chinese cable manufacturers), the possible sale of Alcatel-Lucent’s submarine networks division, and the growth of equipment-only undersea suppliers such as Ciena, Infinera, Mitsubishi, and Xtera.

5. SYSTEM OWNERSHIP LANDSCAPE

The ownership and financing of submarine cable systems has historically been dominated by the generators of bandwidth themselves, i.e. telecommunications operators. More than 70 percent of undersea fiber optic investment has been led by consortia of operators, smaller groups of operators, or single operators. Private, non-telecom investors have financed 22 percent of all investment, although most of this investment came during the dot-com bubble. Suppliers have financed 5 percent of investment, with most of this also coming during the dot-com bubble in the form of the Tyco Global Network and Alcatel’s investment in the Apollo cable.

The investment patterns of the last five years are likely more indicative of future investment. Telecommunications operators have increased their stake in all projects to 80 percent. Investor-led

projects have fallen to 14 percent of total investment, and financing from governments and multilateral development banks (MDBs) has risen to third place with 5 percent. It is noteworthy that although government and MDB financing has traditionally been directed toward unconnected or underserved markets, future investment in the category is also under consideration along developed routes such as North America-Europe.

6. MARKET OPPORTUNITIES

Terabit Consulting believes that in the near-term, the strongest project-finance opportunities in the submarine industry will fall into two categories: first, focused investments in regions where bandwidth and IP transit prices remain high and operators have been unwilling or unable to invest in next-generation submarine infrastructure, and second, larger investments on new, unconnected routes that address the increasingly urgent need for geographic diversity. On the leading transoceanic routes – northern transatlantic, northern transpacific, North America-South America, and Australia-US – Terabit Consulting expects the top-tier operators of Europe, North America, Asia, and Australasia to remain in the driver’s seat with respect to new submarine projects.

Overall, submarine cable deployment between 2010 and 2020 will have been driven by the “BICS” markets – Brazil, India, China, and South Africa.[†] Within the last 12 months, as construction has wrapped up on two of Africa’s largest

[†] Terabit Consulting’s analysis has also identified undersea investment opportunities in the fifth of the BRICS economies, Russia, particularly for a long-haul project from its eastern shores, but Russia’s total volume of undersea investment is ultimately expected to remain low as a result of its terrestrial connectivity to Europe.

submarine cable projects to date, the industry's geographic focus has shifted westward toward Latin America, with investors emboldened not only by the organic economic growth and middle-class success of the Brazilian market but also that country's hosting of the 2014 FIFA World Cup and the 2016 Summer Olympics.

More than 20 nations and territories are still without fiber connectivity. However, with support from governments and development banks, there is a credible economic argument to be made for connecting even the smallest and most distant communities. With a number of credible proposals already on the table, Terabit Consulting believes that most of the remaining countries and territories will finally achieve fiber connectivity within the next five years.

Further investment opportunities present themselves in those markets that have access to only a single fiber optic undersea connection.[‡]

To differentiate themselves from carrier-led projects on the major transoceanic routes, private investors have increasingly promoted low-latency advantages, particularly targeting the high-frequency trading (HFT) sector. The low-latency advantages of new projects along well-served routes - in some cases proposing a gain of only a few milliseconds by routing through previously uncrossed undersea bathymetry - do not in and of themselves offer a compelling investment case where projects will be competing head-to-head with the operators controlling most of the

traffic. In contrast, another business plan promoted by investor-led projects - the integration of cable systems with data centers - seems more promising, as over-the-top (OTT) and content delivery network (CDN) traffic continues to grow and many of the proposed data centers propose competitive advantages including access to renewable or cost-effective energy sources, stricter privacy regulations than those available in major markets such as the United States, and proximity to bandwidth consumers in respective markets. The growing popularity of data centers does carry with it a risk of market saturation, however.

7. MARKET CHALLENGES

Overall, the submarine cable industry has recovered quite well from its post-dot-com-bubble crash, which led most of the global submarine cable network operators to declare bankruptcy, suppliers to shutter plants on three continents and lay off thousands of employees, and investors to virtually abandon the market for five years in light of a glut of potential bandwidth. But in the end, an unprecedented global *autobahn* of reliable, high-capacity, low-cost, and timely pathways were constructed for all of the Internet hubs that needed them most, laying the foundation for the rebirth of the industry several years later with a distinct focus on providing international connectivity to underserved societies. The result is a surprisingly healthy marketplace.

But challenges still remain. As of 2013, the majority of the world's population is denied access to adequate Internet connectivity. Admittedly, in all but a handful of countries, the obstacle to proper connectivity can be attributed to issues inland from the submarine cable landing station - e.g., mismanagement of international gateways, lack of open-access

[‡] Including Bangladesh, Belize, Republic of the Congo, Democratic Republic of the Congo, Equatorial Guinea, French Guiana, The Gambia, Guinea, Guyana, Liberia, Mauritania, Myanmar, Namibia, Nicaragua, Sierra Leone, Suriname, and some island economies.

backhaul, obsolete domestic transport networks, absence of broadband access infrastructure, or lack of computing facilities. For 99.7 percent of the world's population, the required international fiber component of a user's Internet experience is in place and more than capable of accommodating his or her network requirements by the time it reaches the country's borders.

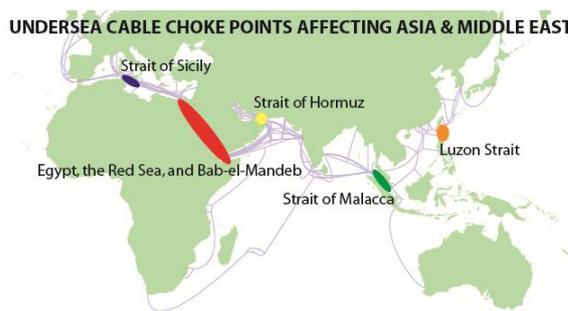
But a persistent shortcoming of the submarine communications industry has been its inability (either through helplessness or apathy) to ensure the full exploitation of the submarine bandwidth that it has constructed to almost all of the world's coastlines. Too often, submarine infrastructure to less-developed countries remains underutilized or mismanaged. The industry must also beware of efforts by hub operators to exert oversized influence over their surrounding region, typically to the detriment of poorer secondary and tertiary markets. This phenomenon has been particularly disconcerting in certain parts of Asia, Africa, and Latin America.

The global inequity in bandwidth prices is another challenge facing the submarine industry. In the United States, IP transit can be had for as little as \$1 per Mbps per month. However, in some less developed markets, IP transit can exceed \$100. This paradox has had a devastating impact on Internet development in less-developed countries, as the world's highest international bandwidth prices are passed along to the world's poorest consumers. Typically, ISPs and operators in less developed countries have responded by simply refusing to procure sufficient bandwidth, thereby impairing Internet experiences to such a point that high-volume downloads are virtually impossible and user experiences with foreign video content are unacceptable. Many of the worst-affected markets have fallen into a

downward spiral whereby bandwidth demand has remained depressed due to excessively high prices, thereby preventing the construction of any additional international infrastructure or even the implementation of international capacity upgrades.

From the perspective of telecommunications operators, perhaps the most pressing challenge facing the undersea cable sector is the vulnerability of infrastructure passing through geographic choke points, particularly between Asia and Europe, and specifically through Egypt.

Undersea Cable Choke Points Affecting Asia & the Middle East



Source: *Undersea Cable Report 2013*
(Terabit Consulting)

Despite past hardships and a continuing need to address connectivity and redundancy challenges, the submarine communications industry can look back with pride on its first quarter-century of linking continents, having efficiently connected most of the world's population with an advanced next-generation international infrastructure. It can also look forward to its next quarter-century with the confidence of knowing that the industry has the experience and resources to both ensure a healthy marketplace and at the same time provide a strong platform for economic and human development in all corners of the globe.