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Discussion Paper Series on Problems and Challenges in Transit Connectivity Routes and International Gateways in Asia

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1. Background

As the major supply lines for the Internet, the smooth functioning of the domestic and international long distance telecommunications infrastructure has never been so critical. Formerly based on older technologies such as high frequency (HF) radio links, microwave and satellite communications this infrastructure is now heavily dependant on fiber optic technology.

Introduction of optical fiber in submarine cables and long haul terrestrial networks functioned as a catalyst for the liberalization of the long distance telecom market. In 1988, the first trans-oceanic fiber-optic cable (TAT-8) was activated to link the United States with the United Kingdom and France. It outperformed satellites in terms of volume, speed and economics of data and voice communications.[1] As a result, billions of dollars were invested in trans-oceanic cable networks. In 1995, the share of traffic between satellite and submarine cables was evenly divided. Now, submarine cables carry more than 97% of global data traffic.[2] Global Internet networks carried nearly 100 gigabytes of traffic per day in 1992. Ten years later, in 2002, this figure had increased to 100 gigabytes per second (Gbps). By 2012, global Internet traffic had reached 12,000 Gbps, with 300% growth expected by 2017.[3]

These developments in long distance transmission technology have collectively influenced the adoption of International Telecommunication Regulations which included the incorporation of the sector in WTO liberalization commitments and facilitated the growth of the Internet. However, many Asian countries are still hesitant to reform their international gateways and long distance communication infrastructures, leading to higher costs and reduced global competitiveness.

These fundamental changes in the communications backbone infrastructure are necessary in order to better facilitate the provision of more efficient services, including at the consumer level. In addition to making fixed-line broadband widely available, mobile telephony is demonstrating an increasing important role. While in 2012, wired devices accounted for 59% of IP traffic, by 2017, wired devices are estimated to account for 45% compared to Wi-Fi and mobile devices at 55%[4]

Affordable smart devices and embedding Wi-Fi support in mobile networks have been instrumental to exceeding the predicted consumption of Internet bandwidth. The abundance of smart devices is stretching the ability of operators to meet the voracious appetite of consumers for bandwidth worldwide. However, after five years of high growth, the sales of high-end smart phones have slowed in many developed markets. Now, the US$2 trillion mobile industry is preparing to enter highly challenging emerging markets, primarily in Asia. "The center of gravity in the mobile ecosystem is likely to shift from the United States of America and Western Europe toward Asia."[5]

In order to support this continuing growth, investment in each highly interdependent segment of the network is necessary to sustainably deliver affordable broadband and reliable infrastructure. Individual components include:

- International backbone (satellite, submarine cables and terrestrial links)
- International gateway (toll switches, IXPs and data centres)

- National backbone (satellite, submarine cables, microwave and terrestrial links)
- National networks (mobile, PSTN and ISP)

Weakness in any of these components impacts the entire supply chain of broadband and communications services. Presently, lack of international backbone capacity and high access prices are among the biggest hurdles in achieving universal access to broadband in Asia. This paper focuses on conceptual challenges and specific national examples to examine these issues and make recommendations for the future.

2. Submarine cables

2.1 Transatlantic - United States to Europe: First generation optical fiber, with unprecedented speed and capacity, immediately started replacing the undersea networks' coaxial cables and microwave links in terrestrial transmission systems. Developed economies were the early adopters due to high costs of optical fiber and ancillaries. Like any other groundbreaking technology, know-how for commissioning optical fiber systems also remained the exclusive domain of developed countries.

According to Terabit Consulting, between 1987 and 2012, more than 1 million route-kilometers of submarine cable were deployed across the Atlantic to link the United States with Western Europe. According to another estimate, carriers have deployed some 19 million miles (30.6 million km.) of optical fiber cables across the United States of America by 2011.[6]

Currently, seven submarine cable systems are functioning between North America and Europe (table 1). They are owned by six entities: Apollo SCS Ltd. (a joint venture between Vodafone and Alcatel-Lucent), Level 3 (formerly Global Crossing), Hibernia Networks (owned by Columbia Ventures Corporation and Constellation Ventures Partners), Reliance Globalcom, Tata Communications, and the TAT-14 consortium.

Table 1: Existing transaltantic (United States to Europe) cable systems

Submarine Network Name	RFS Year	Length (km)	Lit Capacity (Gbps)	Max Capacity (Gbps)	Owner(s)
Apollo	2003	13,000	3,650	38,400	Vodafone/Alcatel-Lucent
Atlantic Crossing-1 (AC-1)	1998	14,301	1,760	4,480	Level 3
Atlantis-2	2000	8,500	40	160	Consortium
Columbus-3	1999	9,833	160	320	Consortium
FLAG Atlantic-1 (FA-1)	2001	14,500	2,840	26,400	Reliance Globalcom
Hibernia Atlantic	2001	12,200	2,950	15,360	Columbia Ventures Corp.
TAT-14	2001	15,295	1,870	8,960	Consortium
Tata TGN-Atlantic	2001	13,000	2,810	20,480	Tata Communications
Yellow	2000	7,001	3,120	11,200	Level 3

Source: TeleGeography and Terabit Consulting.

“A number of events have brought about the commoditization of bandwidth between most European and North American endpoints. In the late-1990s, hundreds of fiber pairs were deployed to metropolitan areas on both continents, making point-to-point connectivity both economical and practical, and at the same time retail markets were fully liberalized. Then, more importantly, in the early-2000s the dot-com bubble burst drove many cable operators into bankruptcy, allowing investors to acquire transoceanic networks at pennies on the dollar and unleashing a downward price spiral that saw erosion of up to 75 percent per year and the “dumping” of bandwidth onto the market. In the same decade, new industries emerged offering data center and content delivery services that further streamlined international connectivity for both operators and end-users. By the mid-2000s transatlantic bandwidth had become extremely cheap (sometimes cheaper than its construction cost) and end-to-end services between North America and Europe were efficiently and competitively managed, to the point where even small- and medium-sized enterprises could be characterized as viable bandwidth clientele.”[7]

As an example of this effect, Hybernia Networks acquired trans-atlantic fiber optic infrastructure during this period at a significant pricing discount, but has since announced an ambitious new project focused on delivering lower latency to high frequency traders (table 2). Emerald Express is another example of an approach to connectivity which seeks to deliver faster transit times, instead of focusing primarily on throughput and cost criteria. In both of these cases, operators seek to obtain a competitive advantage and price premium by offering lower latency connections. Neither of these projects has come in to service at this time.

Table 2: Planned Transatlantic Cable Systems	
System	Owner
Altantic Cable System - Europe	Telebras
Emerald Express	Emerald Networks
Europe Link with Latin America (ELLA)	Research community
Project Express	Hibernia Networks
Transatlantic Consortium System (TAT-15)	Consortium
WASACE North (WASACE Phase III)	WASACE Cable Company
Source: TeleGeography	

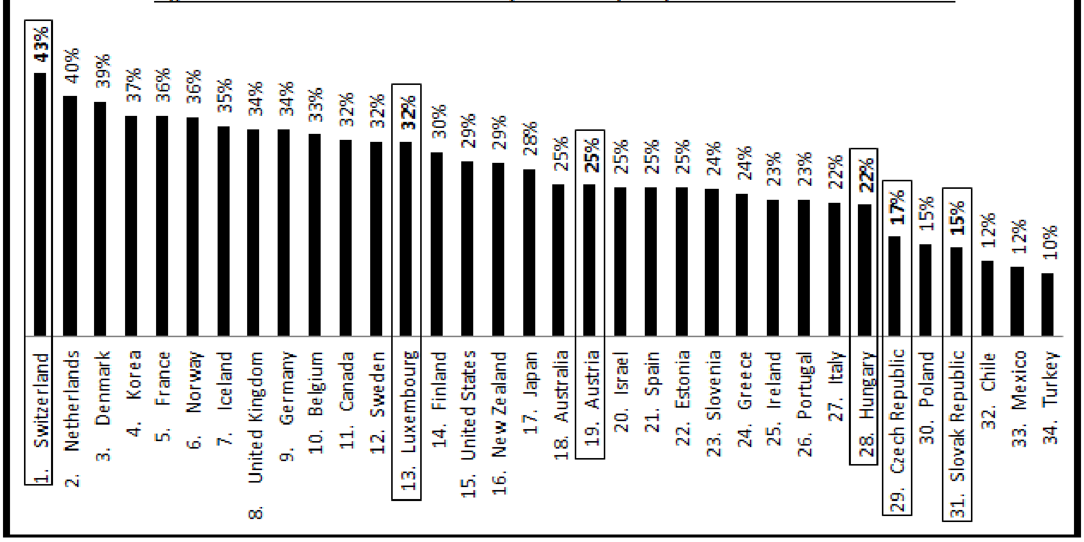
Meanwhile, deregulation and market liberalization in Europe has drawn massive domestic investments from the United States, which deployed 6 million kilometers of fiber across the continent in 1999 and added more than 10 million kilometers of fiber by 2002. The number of pan-European metropolitan area networks (MAN) also increased from just one in 1993 to 35 in 1999. Between 1998 and 2002, 90% of the backbone fiber was installed by the new entrants in European long-haul markets.

The long-haul networks typically had 96 fibers, while 144 fiber cables were installed in MANs. All of these networks were equipped with dense wavelength-division multiplexing (DWDM) systems, which was a revolutionary feature at that time.[8] The United States and Europe have been bolstering their underground and undersea fiber networks to maintain a competitive edge in the global economy. According to Terabit Consulting, lit transatlantic capacity was 19.8 terabits per second (Tbps) by the end of 2012 with 27% compound annual growth rate during the preceding five years. As of 2013, the available transatlantic fiber optic capacity is 15% utilized, compared to a 34% utilization rate for the transpacific. While growth rates cannot be linearly projected, it is clear that there is less growth room available in the existing transpacific infrastructure.

2.2 Europe demystifies infrastructure: Cross-border terrestrial connectivity is widely perceived to be less effective than submarine cables. However, higher broadband indicators of landlocked OECD countries, solely depending on terrestrial fiber networks, address this fallacy. Six out of the 34 OECD countries are landlocked and they are all connected through terrestrial links. Yet, fixed wired broadband penetration in those six countries is better than many countries having the world's highest numbers of submarine cables and Internet bandwidth (figure 1).[9]

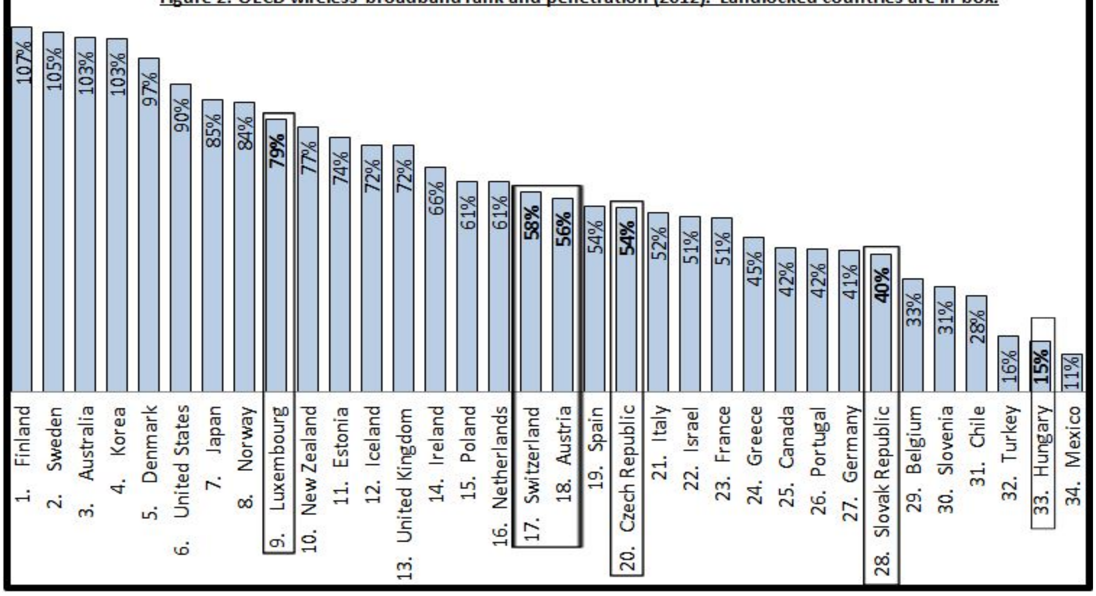
Switzerland has topped the OECD countries in fixed broadband ranking. It is far ahead of France (5), United Kingdom (8), Germany (9), Canada (11) and Sweden (12). Landlocked Luxembourg (13) and Austria (19) have also outranked the United States (15), Australia (18), Greece (24), Portugal (26) and Italy (27) in fixed broadband penetration.

Figure 1: OECD fixed broadband rank and penetration (2012). Landlocked countries are in box.



Landlocked OECD countries are also ahead in fixed and mobile wireless broadband penetration (figure 2).

Figure 2: OECD wireless broadband rank and penetration (2012). Landlocked countries are in box.



Data centres are simultaneously the factories and warehouses of Internet. Despite being landlocked, several OECD countries have emerged as a new generation of IP transit wholesalers and data centre providers. Diverse cross-border connectivity coupled with highly reliable world class data centres is central to the rise of this new leadership.

Cushman & Wakefield, Hurleypalmerflatt and Source8 have ranked Switzerland (11) ahead of the Republic of Korea (13), France (14), Singapore (15) and Japan (26). Another landlocked country, the Czech Republic (22), has also outranked Australia (23), the Russian Federation (24), China (25), Japan (26) and India (29) in terms of data centre reliability.[10] Their risks are mostly related to physical, economic and social issues. Other factors, however, such as high energy costs, poor international Internet bandwidth and protectionist legislation are also risks examined by the authors. The emergence of these countries as datacentre providers illustrates the potential of even landlocked countries to compete at the global level against current market leaders in the global IP transit wholesale market.

2.3 Transpacific route between the United States and Asia: Sparsely located landing points at prime Asian destinations and longer intercontinental distances have made the construction of transpacific submarine cable systems an expensive affair. Cable projects connecting the west coast of the United States with Japan, China, Singapore and the Republic of Korea are, therefore, less attractive to institutional investors. Unlike the transatlantic markets, Asian long distance carriers have been the historical investors in transpacific submarine cable systems. Investment in new transpacific systems has been, however, more consistent than investment in the transatlantic market. New transpacific cables began entering into service less than six years after completion of the last cable from the "dot-com" investment boom (table 3).

Table 3: Existing transpacific (United States to Asia) cable systems

Submarine Network Name	RFS Year	Length (km)	Lit Capacity (Gbps)	Max Capacity (Gbps)	Owner(s)
Asia-America Gateway (AAG) Cable System	2009	20,000	1,880	6,000	Consortium
China-U.S. Cable Network (CHUS)	2000	30,476	160	160	Consortium
Japan-U.S. Cable Network (JUS)	2001	22,682	4,000	9,000	Consortium
Pacific Crossing-1 (PC-1)	1999	20,900	2,060	3,360	NTT
Tata TGN-Pacific	2002	22,300	3,710	15,360	Tata Communications
Trans-Pacific Express (TPE) Cable System	2008	17,000	1,600	3,200	Consortium
Unity/EAC-Pacific	2010	9,620	3,500	12,000	Consortium

Source: TeleGeography and Terabit Consulting.

The Republic of Korea (98%) and Japan (94%) lead the world in terms of FTTx coverage[11] and LTE penetration.[12] Meanwhile, Singapore (2) has outranked the Republic of Korea (11) while Hong Kong, China (14) is ahead of Japan (21) in World Economic Forum's Global Network Readiness Index.[13] These are but two of the indicators demonstrating the digital might of these Asian powers in global stage.

The growth of Chinese Internet and telecommunications markets will primarily drive transpacific and Asian submarine markets. As of June 2013, Chinese international bandwidth exceeds 6 Tbps, with more than 2.4 Tbps directed toward the United States[1]. International bandwidth of China has also exceeded Japan's 4.3 Tbps at that time.[14]

Under the 12th Five-Year Plan, the Chinese government will invest 2 trillion yuan (US$323 billion) to comprehensively improve its broadband infrastructure by 2020. With the aim of taking the nearly entire population online, the government has aimed to boost the average broadband speed in cities to 20 Mbps by 2015, which is less than what Internet users in Hong Kong, China and Singapore currently enjoy. In rural areas of China, where Internet penetration is very low, broadband speeds would hit 4 Mbps by 2015. The broadband strategy of China will ensure that the number of 3G and LTE users will increase by four fold to 1.2 billion by 2020.[15]

Singapore and Hong Kong, China historically have evolved into Asia's hubs of global trade and commerce. In the telecommunications sectors as well, they have reformed their respective policies and positioned themselves as regional hubs of wholesale Internet bandwidth.

2.3.1 Singapore: Singapore liberalized its telecom sector in 2000, including the reform of its regulatory framework. Establishing a "Code of Practice for Competition in the Provision of Telecommunication Services" was one of the most important steps it took. Singapore's Info-communications Development Authority (IDA) determined that the dominant carrier, SingTel, should allow collocation at its submarine cable landing stations. This requirement was incorporated into the mandated Reference Interconnection Offer (RIO) that SingTel was instructed to prepare, which also contained cost-based rates for collocation. IDA has, however, left connection services to be negotiated commercially between SingTel and its competitors.

The regulator also kept receiving feedback, on the impact of its newly introduced framework from industry stakeholders. Two years later, in 2002, IDA added connection services to the mandated offerings included (again, at cost-based rates) in SingTel's RIO. In 2004, it further allowed the operators to access the capacity that is owned or leased on a long-term basis on any submarine cable at the submarine cable landing station. IDA also gave operators more flexibility in accessing backhaul and transit services.

IDA has also streamlined the cable landing authorization procedures by setting up a "one-stop shop" for regulatory approval. In the past, it was necessary to receive approvals from two separate authorities, one for the undersea segment and one for the inward cable system. By combining these processes, IDA has streamlined the previously cumbersome procedure,