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An In-Depth Study of Broadband Infrastructure in the ASEAN Region
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I. EXECUTIVE SUMMARY

Between late 2012 and mid-2013, Terabit Consulting performed a detailed analysis of the broadband infrastructure in the nine largest member countries of the Association of Southeast Asian Nations (ASEAN): Cambodia, Indonesia, Lao People's Democratic Republic, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Viet Nam. Terabit Consulting's analysis also included trans-border broadband projects extending into contiguous regions such as Yunnan Province, China.

The analysis revealed that, although extensive investment has been made in fibre and other broadband infrastructure, both domestically and internationally, there is a wide chasm between markets, with a clear "broadband divide" demonstrated when richer markets are compared with poorer ones, when major metropolitan areas are compared with smaller cities and rural areas, and when coastal markets are compared with inland ones.

This broadband inequality has manifested itself in the form of:

- widespread inaccessibility to next-generation broadband services, including fibre or fourth-generation wireless;
- unacceptably low levels of international bandwidth in many of the region's countries (with the per-capita bandwidth in the country's richest market, Singapore, more than 900 times that of its poorest market, Myanmar);
- extremely expensive prices for international bandwidth;
- lack of affordable broadband services.

The analysis also shows that international connectivity and the pricing of international bandwidth varies greatly among the nine subject ASEAN countries, and that even in the markets with lower costs, bandwidth is still significantly more expensive than in Europe and North America. A limited number of international bandwidth hubs have emerged to serve the Southeast Asian region, most notably Singapore and Hong Kong, China, offering the region's lowest international bandwidth prices and greatest overall international capacity. Much of the region's international fibre infrastructure has developed in a hub-and-spoke configuration around these two hubs, although telecommunications carriers and other investors of means have constructed their own direct interregional fibre infrastructure wherever possible.

Although trans-border terrestrial fibre optic links have been constructed across almost all international links, their actual role in the region's connectivity is limited. Most of the links are operating at extremely low capacity, usually 10 Gbps or less (by comparison, the entire international bandwidth for the nine subject countries was 3,420 Gbps as of year-end 2012). They are typically constructed on a bilateral basis by a pair of major (and often dominant) carriers from each side of the border, which often prevents their competition from cost-effectively accessing the network. The bilateral, point-to-point nature of the links, combined with the region's wide range of international bandwidth prices (IP transit in poorer markets such as Myanmar and Lao PDR costs more than ten times that of Singapore), often allows dominant operators in wealthier nations to exploit the terrestrial links by using them to sell access to their own submarine cable gateway or IP transit capacity, thereby imposing an additional intermediate layer of cost between consumers and the international Internet content that they are seeking to access.

A strong opportunity presents itself for a pan-regional terrestrial fibre optic network offering open access, a mesh configuration, and central management, constructed along the rights-of-way of the region's existing transport or energy infrastructure such as highways, railways, or power

transmission networks. The realization of such a network would likely require the intervention of governments and international organizations.

Table 1: Overview of Broadband Status by Country

	GDP per Capita, YE 2012 (PPP, USD)	Int'l Band-width per Capita (Kbps)	Int'l Connect-ivity	Domestic Connect-ivity	IP Transit Price	Competi-tiveness of Telecom Market	Fixed and Mobile Broad-band Infra-structure	Annual 1 Mbps Broadband Subscription + Installation as % of Nominal GDP per Capita
Cambodia	$2,400	0.8	Weak	Adequate	Very expensive	Reasonably competitive	Very limited	48.7%
Indonesia	$4,900	1.0	Weak	Adequate	Expensive	Competitive	Growing	5.5%
Lao PDR	$2,900	0.4	Weak	Limited	Very expensive	Less competitive	Very limited	27.4%
Malaysia	$16,400	15.6	Excellent	Adequate	Reasonably priced	Reasonably competitive	Relatively strong	4.4%
Myanmar	$1,900	0.3	Weak	Limited	Very expensive	Uncompetitive but planned liberalization	Very limited	132.8%
Philippines	$4,300	5.5	Excellent	Relatively strong	Very expensive	Less competitive	Growing	11.2%
Singapore	$59,500	258.3	Excellent	Very strong	Inexpensive	Reasonably competitive	Very strong	0.1%
Thailand	$9,240	6.6	Average	Relatively strong	Very expensive	Reasonably competitive	Average	0.5%
Viet Nam	$3,550	5.2	Somewhat weak	Limited	Expensive	Less competitive	Limited	7.9%

Table 2: Summary and Analysis of International Internet Bandwidth by Country

Country	International Internet Bandwidth (YE 2012)	10-Year CAGR (2002-2012)	Int'l Internet Bandwidth per Capita (Kbps)	Evaluation
Cambodia	**11 Gbps –** The Ministry of Posts and Telecommunications reported that international bandwidth was 8 Gbps as of the first half of 2012; Terabit Consulting's conversations with sources lead it to believe that this figure grew to 11 Gbps by year-end.	98%	0.764	**Very weak**
Indonesia	**250 Gbps –** Telkom, the country's largest international bandwidth operator, increased its international capacity to 100 Gbps in mid-2011 and is currently believed to have between 150 Gbps and 200 Gbps of international capacity.	84%	1.030	**Weak**
Lao PDR	**2.5 Gbps –** As of early 2011, the primary channels for the country's 1,359 Mbps of international bandwidth included the following: 486 Mbps via CAT of Thailand; 310 Mbps via China Telecom; 310 Mbps via Viettel of Viet Nam; and 155 Mbps via Vietnam Posts and Telecommunications (VNPT).	110%	0.383	**Very weak**
Malaysia	**400 Gbps –** Konsortium Renkaian Serantau (KRS) (Regional Network Consortium) formed in 2011 to promote Malaysian operators' purchase of international capacity.	80%	15.6	**Moderate**
Myanmar	**14 Gbps –** Most of the country's connectivity is via the SEA-ME-WE-3 cable in Pyapon.	122%	0.286	**Very weak**
Philippines	**530 Gbps –** PLDT's international capacity grew from 270 Gbps as of year-end 2011 to an estimated 400 Gbps as of year-end 2012, with 60% of demand directed toward North America and 30% to East Asia.	89%	5.450	**Moderate**
Singapore	**1.389 Tbps –** As of mid-2012, Singapore's international Internet bandwidth was 1.326 Gbps, and "total international transmission capacity owned" by Singaporean operators was 6.994 Tbps.	73%	258.3	**Very strong**
Thailand	**463 Gbps –** The country's international Internet bandwidth grew by 77% in 2012.	85%	6.622	**Moderate**
Viet Nam	**360 Gbps –** As of November 2012, reported international bandwidth was 347 Gbps, while domestic bandwidth was 460 Gbps.	119%	5.150	**Moderate**

Table 3: Summary and Analysis of International Connectivity by Country

Country	International Connectivity	Evaluation
Cambodia	1. Delayed development of international connectivity due to historical dependence on satellite. 2. Cambodia is one of the few coastal countries in the world without direct access to a submarine fibre optic cable; construction and maintenance agreement for Asia-America Gateway trans-Pacific cable (2010) did not provide for a Cambodian landing point, but a new Malaysia-Cambodia-Thailand cable is under consideration. 3. Telcotech joined AAG consortium in 2007 but was left to negotiate for bandwidth on the cable through "reasonably-priced backhaul agreements" with the cable's landing parties in Thailand and Viet Nam; Telcotech was purchased by Ezecom in 2011 and its terrestrial connectivity to AAG through Thailand and Viet Nam was expected to be increased from 10 Gbps to 100 Gbps. 4. The Greater Mekong Subregion (GMS) Information Highway Project provides terrestrial connectivity to Lao PDR, Thailand, and Viet Nam, operated by Telecom Cambodia. 5. Viettel Cambodia (Military Telecommunications Company) operates dual terrestrial fibre optic paths from Cambodia to Viet Nam. 6. The Cambodia-Viet Nam High-Speed Transmission Line was launched by Telecom Cambodia and VNPT group in April 2012. 7. The Thailand-Cambodia-Viet Nam-Hong Kong Fibre Highway initiative was announced in March 2012, with NeocomISP as the Cambodian partner, allowing access to international submarine cables in Hong Kong. 8. As of 2012, Thai operator TOT and China Telecom were reportedly exploring a partnership to build terrestrial fibre links between Cambodia, China, Lao PDR, Russia, Thailand, and Viet Nam. 9. The governments of Cambodia and Lao PDR signed a memorandum of understanding in 2013 to improve fibre optic connectivity between the two countries. 10. The proposed Cambodian submarine cable project (2008) did not move forward.	**Weak –** No direct interregional connectivity; reliance on backhaul agreements
Indonesia	1. Not well-served by interregional submarine cable systems: Indonesia's only intercontinental/interregional link is SEA-ME-WE-3, which is 14 years old and connects 33 countries in Europe, Africa, Asia, and Australia. 2. Between 2003 and 2010, six submarine cable systems were constructed between Indonesia and Singapore, and further submarine connectivity was constructed to Malaysia and Thailand. 3. As a result of the half-dozen Indonesia-Singapore links constructed within the last decade, the majority of Indonesia's international Internet bandwidth now transits through Singapore. 4. Industry observers in Indonesia have pointed to its comparative shortage of direct interregional bandwidth as potentially placing the country at a competitive disadvantage versus Malaysia and Singapore in capturing foreign IT investment. 5. The Asia-America Gateway (AAG) submarine cable entered service in January of 2010, and although it does not land in Indonesia, PT Telekomunikasi Indonesia is a member of the consortium and accesses the cable	**Weak –** Limited interregional connectivity and strong dependence on Singapore for transit capacity

	via the 55-kilometre Batam-Singapore Cable System (BSCS), constructed in 2009.	
Lao PDR	1. Lao PDR-China terrestrial cable crosses the border at Boten (linking to China Telecom at 2 Gbps) 2. Lao PDR-Thailand terrestrial cable via Friendship Bridge I (linking to CAT Telecom at 5 Gbps) 3. Lao PDR-Thailand terrestrial cable via Friendship Bridge II (linking to CAT Telecom at 2 Gbps) 4. Lao PDR-Viet Nam terrestrial cable (Dansavanh-Lao Bao) (linking to VNPT subsidiary Viet Nam Data Communication (VDC) at 5 Gbps) 5. Lao PDR-Viet Nam terrestrial cable (Namphao-Cau Treo) (linking to VDC at 5 Gbps) 6. Lao PDR-Cambodia terrestrial cable at Veun Kham (linking to Cambodia Telecom at 2.5 Gbps) 7. Trans-border links form part of China-Southeast Asia Cable and Greater Mekong Subregion Information Highway Project, thereby providing onward connectivity to Malaysia and Singapore.	**Weak –** No direct interregional connectivity; terrestrial trans-border links operate at low capacity
Malaysia	1. Benefited from Europe-Asia submarine cables (FLAG Europe-Asia and SEA-ME-WE-3) in late 1990s, SAFE cable to South Africa in 2002, and SEA-ME-WE-4 in 2005. 2. Pan-East Asian regional connectivity provided by APCN-2 (2002) and Asia Submarine-cable Express (2012); Telekom Malaysia retained two fibre pairs in the latter, which comprise “Cahaya Malaysia”. 3. The Asia-America Gateway (AAG) entered service in 2010 and provides direct connectivity from Malaysia and Southeast Asia to the United States. 4. Malaysian operator Time dotCom is a 10% shareholder in the trans-Pacific Unity system between Japan and the United States. 5. Konsortium Renkaian Serantau (KRS) (Regional Network Consortium) was formed by 24 Malaysian operators in 2011 with the goal of driving down the price of international bandwidth; KRS also considered the construction of a trans-Pacific submarine cable to the United States. 6. Regional submarine cables serving Malaysia include Malaysia-Thailand, Malaysia-Thailand East and West, the East-West Submarine Cable System, the Dumai-Melaka Cable System (DMCS), the Batam-Rengit Cable System (BRCS), and the Batam-Duamai-Malacca Cable System (BDM). 7. Terrestrial links to both Thailand and Singapore are operated by Telekom Malaysia, and the Time dotCom Cross-Peninsular Cable System (CPCS) also links to those two countries.	**Excellent** – Malaysia benefits from strong links to its regional neighbours, as well as good connectivity to Europe, Africa, and North America.
Myanmar	1. Myanmar’s primary international link is the SEA-ME-WE-3 submarine cable, on which two 10-Gbps wavelengths are reportedly lit. 2. Terrestrial links provide trans-border connectivity to China, Thailand, and India. 3. Myanmar Posts and Telecommunications (MPT) and Bangladesh Submarine Cable Company Limited (BSCCL) are implementing a terrestrial link between Myanmar and the SEA-ME-WE-4 cable station in Cox’s Bazar, Bangladesh in order for both countries to take advantage of each other’s submarine cable connections. 4. A $40 million branch to Myanmar on the proposed SEA-ME-WE-5 submarine cable has reportedly been financed by China Unicom, leading to speculation that Chinese operators may use the branch as a redundant path for westbound Chinese demand, or as a platform for future Chinese investment in Myanmar’s newly liberalized telecommunications market, or will sell transit capacity to South Asian	**Weak –** Current international connectivity is primarily through the SEA-ME-WE-3 cable, which was constructed in 1999; however, a link to SEA-ME-WE-4 via Bangladesh and the construction of a branch on the proposed SEA-

	markets such as India and Bangladesh. 5. CAT Telecom of Thailand is reportedly exploring the construction of a $41-million, 800-kilometre link between Satun, Thailand and Dawei, Myanmar, the planned site of a deepwater port and special economic zone.	ME-WE-5 cable would improve connectivity.
Philippines	1. PLDT operates three international submarine cable landing stations: Batangas City (for the APCN-2 and SEA-ME-WE-3 cables); Buang, La Union (for the trans-Pacific Asia-America Gateway cable); and Daet, Camarines Norte (for Asia Submarine-cable Express). 2. Globe Telecom operates two international submarine cable landing stations: Ballesteros, Cagayan (for TGN Intra-Asia) and Nasugbu, Batangas (for the Southeast Asia-Japan Cable). 3. Pacnet's pan-Asian EAC-C2C cable network has dual landings in the Philippines, in Capepisa, Cavite and in Nasugbu, Batangas.	**Excellent –** The country benefits from multiple submarine cable landing stations in different parts of the northern Philippines, offering single-system connectivity to Asia, Europe, Australia, Africa, and North America.
Singapore	1. Singapore is currently served by nine interregional submarine cable systems, with an additional cable under construction and scheduled for activation in 2013. 2. An additional six submarine cable systems connect Singapore to its closest neighbours: Malaysia, Indonesia, and Singapore. 3. Fibre links via Singapore's causeway and bridge connect the country to Malaysian terrestrial networks.	**Excellent –** Singapore is a regional bandwidth hub and benefits from abundant, first-class intercontinental and regional connectivity; however, from an international perspective, its concentration of undersea cables is viewed by some as a global "choke point".
Thailand	1. Thailand is served by the major Europe-Asia submarine cables (FLAG Europe-Asia, SEA-ME-WE-3, and SEA-ME-WE-4), as well as the Asia-America Gateway (AAG) trans-Pacific system. 2. To date, Thailand has not participated in any of the major pan-East Asian submarine cable projects, although CAT has invested in the proposed Asia-Pacific Gateway project, which would enter service in 2014. 3. Trans-border fibre optic links connect Thailand to each of its neighbours; its links to Malaysia, which provide onward connectivity to Singapore, are particularly popular among operators seeking to avoid the high IP transit costs charged by CAT for the country's submarine cable infrastructure.	**Average –** CAT's reported control over the country's somewhat limited intercontinental submarine infrastructure has led many operators to utilize terrestrial links to Singapore.

Viet Nam	1. Until recently, Viet Nam's primary international connection was the SEA-ME-WE-3 cable, although the activation of the TGN Intra-Asia submarine cable in 2009 and the trans-Pacific Asia-America Gateway cable the following year resulted in a dramatic increase in international capacity. 2. Viet Nam has not participated in most regional pan-Asian systems, but a new project, the Asia-Pacific Gateway, would feature the participation of three Vietnamese investors and enter service in 2014. 3. Viet Nam has terrestrial fibre optic links to each of its three neighbours (Cambodia, Lao PDR, and China), including connectivity via the Greater Mekong Subregion Information Highway Project and the China-Southeast Asia Cable.	**Somewhat weak –** Viet Nam's submarine cable connectivity is significantly less than other Asian nations.

Table 4: Summary and Analysis of Domestic Connectivity by Country

Cambodia	1. 25,000 kilometres of domestic fibre optic cable deployed. 2. Three operators lead domestic network investment: Cambodia Fiber Optic Communication Network Company (CFOCN), Metfone (a subsidiary of Viettel), and Telecom Cambodia.	**Adequate** backbone infrastructure between major cities, but **need for expansion** in the northern provinces of Oddar Meanchey and Preah Vihear, the north-east provinces of Ratanakiri and Mondolkiri, and the south-west province of Koh Kong.
Indonesia	1. 15 domestic submarine cable projects spanning 11,554 kilometres. 2. Domestic submarine cable projects led by PT Telekomunikasi, PT Indosat, and PT XL Axiata. 3. The Palapa Ring project, initially conceived as a 56,000-kilometre nationwide network, is instead being deployed in phases with limited deployment in eastern provinces so far, although Sulawesi-Maluku-Papua Cable System (SMPCS) would bring connectivity to country's poorest province, Papua. 4. VSAT connectivity is being provided to eastern provinces.	**Adequate** network between islands of western Indonesia, but **need for further expansion** in eastern provinces, particularly in Sulawesi Selatan, Sulawesi Barat, Sulawesi Tenggara, Sulawesi Tengah, Gorontalo, Sulawesi Utara, Maluku Utara, Maluku, Papua Barat, and Papua. **Challenges** lie in connecting the archipelago's 17,500 islands and 34 provinces.
Lao PDR	1. Domestic north-south backbone along the country's primary highway, Route 13, extending from Boten on the border with China to Veun Kham on the border with Cambodia. 2. Shorter east-west connectivity along Route 9 between Dansavanh on the border with Viet Nam and Savannakhet on the border with Thailand. 3. 100-kilometre metropolitan fibre network in Vientiane.	**Limited** national backbone serves only the population corridors along Route 13 and Route 9, so large areas of the country, particularly in the east, remain unserved.

Malaysia	1. Telekom Malaysia and Time dotCom both operate extensive domestic fibre optic networks; two entities controlled by Telekom Malaysia, Fibrecomm and Fiberail, operate 15,000 kilometres of domestic fibre networks. 2. Terrestrial fibre connectivity is concentrated on Peninsular Malaysia, but deployment on the island of Borneo (Sabah and Sarawak) is being promoted by entities such as SComm. 3. The peninsular states of Kelantan and Pahang remain underserved by fibre. 4. Telekom Malaysia's chief technical officer said in 2012 that the government's limited 20% contribution to the National Broadband Initiative (the remaining 80% was funded by Telekom Malaysia) meant that the initiative was targeted primarily toward the country's most lucrative geographic areas. "If you want to cover the whole of the country you will need much higher investment from the government", he said. 5. Domestic undersea links provide festoon connectivity to Peninsular Malaysia and also link the peninsula with Sarawak and Sabah.	**Adequate** backbone infrastructure is provided by both terrestrial and undersea links, although additional investment in terrestrial service is needed in the states of Kelantan, Pahang, Sabah, and Sarawak.
Myanmar	1. Myanmar's domestic fibre optic telecommunications network, operated by MPT, spans 2,812 kilometres and has 242 points-of-presence. 2. Its primary links are from the Chinese border (Muse) to Mandalay, which operates at 20 Gbps; Mandalay to Yangon via Nay Pyi Taw, which operates at 10 Gbps; and Yangon to the Thai border (Myawadi), which also operates at 10 Gbps. There is also reported to be a fibre link from Mandalay to the Indian border at Tamu. 3. Additional connectivity is provided by a microwave network with 342 stations and 184 links. 4. Some sources indicated that the Myanmar Ministry of Defence operates a fibre optic network for its exclusive use. At 11,446 kilometres in length, the network is reported to be more than four times as large as the MPT network, providing connectivity to almost all of the country's 21 administrative subdivisions.	**Limited** fibre optic backbone was designed primarily to accommodate demand in the population corridor between Mandalay and Yangon, as well as to connect to trans-border links; sources indicated that fibre deployment has to date been limited in the administrative subdivisions of Tanintharyi, Kayin, Kayah, Shan, Kachin, Sagain, Chin, and Rakhaing, although each of those areas is reportedly served by the fibre optic network operated by the Ministry of Defence.

Philippines	1. PLDT's domestic fibre optic network comprises 10 self-healing loops, and the operator says that its fibre deployment totals 54,000 kilometres. 2. Globe Telecom's fibre optic network, which includes two Fibre Optic Backbone Networks (FOBN and DOBN-2), as well as a five-sixths stake in the National Digital Transmission Network constructed by the Telic Phil consortium in 1999, spans 12,000 kilometres.	**Relatively strong,** due to high investment in terrestrial and submarine fibre optic infrastructure by each of the Philippines' historical operators beginning in the late 1990s, resulting in strong coverage, with the possible exception of the southern Philippines (Mindanao) and Palawan, which are the focus of increased investment in 2013.
Singapore	1. Next-generation network connectivity is nearly ubiquitous in the city-state of Singapore, with fibre-to-the-home and 4G "Long-Term Evolution" (LTE) networks available to 95% of the population.	**Very strong,** due to investment in next-generation technologies, as well as Singapore's urbanization and relatively small size (700 square kilometres).
Thailand	1. Fibre backbone coverage reaches most provinces of the country. 2. CAT reports that its domestic fibre network spans 30,000 kilometres, and includes extensive domestic undersea connectivity. 3. Economic stimulus funding in 2009 resulted in expanded fibre connectivity for the research and academic community.	**Relatively strong,** due to historical investment in both submarine and terrestrial domestic infrastructure.
Viet Nam	1. VNPT operates a domestic north-south fibre optic cable network along the path of National Route 1A and Ho Chi Minh Road. 2. There are metropolitan fibre networks in Hanoi, Ho Chi Minh City, Da Nang, and Can Tho.	**Limited** fibre connectivity needs expansion, especially in the inland northern and western provinces.

Table 5: Summary and Analysis of International Capacity Pricing by Country

Country	International Capacity Pricing (Volume Purchases of 1 Gbps or Greater)	Evaluation
Cambodia	As of late 2012, IP transit was estimated to cost $100 per Mbps per month, typically procured via Hong Kong and Viet Nam. As of 2013, Telecom Cambodia advertised IP transit in increments of 11 Mbps to 40 Mbps for $80 per Mbps per month.	**Very expensive**
Indonesia	PT Telekomunikasi's international subsidiary said that IP transit in Jakarta ranged from $100 to $160 per Mbps per month as of 2011, after having fallen by $50 per year between 2009 and 2011; sources indicated that as of year-end 2012, IP transit could be found for as low as $60-$70 per Mbps.	**Expensive**
Lao PDR	Estimated to be $100 per Mbps per month as of year-end 2012.	**Very expensive**
Malaysia	As of late 2012, IP transit in Kuala Lumpur was $30 per Mbps per month when purchased in volume, and as of 2013 it could be procured for as little as $25 per Mbps.	**Reasonably priced**
Myanmar	Estimated to be in excess of $100 per Mbps per month as of year-end 2012.	**Very expensive**
Philippines	Estimated to have fallen from well over $100 per Mbps per month in 2011 to $80 per Mbps in 2013. The high prices, which persist despite the construction of many high-capacity international submarine cables, result from the country's two largest operators' control over the marketplace.	**Very expensive**
Singapore	The price of IP transit capacity in Singapore is among the cheapest in the region, and in recent years has been closely aligned to the price of IP transit in rival market Hong Kong. As of year-end 2012, large-volume purchases of IP transit capacity were typically priced at US$10 per Mbps or below.	**Inexpensive**
Thailand	Estimated to be $80 per Mbps per month as of year-end 2012.	**Very expensive**
Viet Nam	Estimated to be $70 per Mbps per month as of year-end 2012.	**Expensive**

Table 6: Summary and Analysis of Competitiveness of Telecommunications Markets by Country

Country	Competitiveness of Telecommunications Market	Evaluation
Cambodia	1. The Cambodian telecommunications market is dominated by five groups: the Vietnamese military telecommunications operator Viettel, the Malaysian operator Axiata, CamGSM (led by Cambodian investor Kith Meng), government-owned Telecom Cambodia, and the cable and wire manufacturer KTC in the Republic of Korea. International gateways are operated by three companies: Telecom Cambodia, Royal Telecam International (a sister company of Ezecom and Telcotech), and Viettel Cambodia. 2. Fixed-line: Telecom Cambodia has a market share of 56% but Camintel is competitive with 32%. 3. Mobile: Viettel's Metfone has 38%; the merger of Axiata's Hello and Latelz's Smart Mobile yields a combined share of 32%; CamGSM's Mobitel is also strong. VimpelCom recently announced its exit from the market. 4. Internet/broadband: more than two dozen licensed ISPs, but broadband market is dominated by Telecom Cambodia, Phnom Penh Municipal Cable TV, Ezecom, and Camintel.	**Reasonably competitive**
Indonesia	1. The Indonesian telecommunications market is reasonably competitive, although PT Telekomunikasi (Telkom) holds market shares that are at least twice as large as its competitors in the fixed-line, mobile, and broadband markets. 2. Fixed-line: Telkom has 63% of subscribers and PT Bakrie Telecom has 30%; Smartfren and PT Indosat have small shares. 3. Mobile: the Indonesian mobile market is by most estimates either the fifth- or sixth-largest in the world in terms of subscribers. Telkomsel, which is majority-owned by Telkom and minority-owned by Singtel, has a 42% share, while PT Indosat and XL Axiata have shares of 18% and 16%, respectively. Several other operators are also present including Hutchison's 3 Indonesia and PT Axis Telecom. 4. Internet/broadband: PT Telekomunikasi has a 73% share of the broadband market, although several other operators are present, including FirstMedia's FastNet, Biznet Network's MetroNET, CepatNet, Max3, and i-Direct.	**Competitive,** but PT Telekomunikasi retains significant market share.

Lao PDR	1. The two government-controlled operators, LTC (which is 51% owned by the government) and ETL (which is a state-owned enterprise), collectively control 83% of the fixed-line market and 75% of the mobile market. 2. Fixed-line: LTC has a 60% share and ETL has a 23% share. Unitel's share is 18%. 3. Mobile: LTC 40%, ETL 35%, Unitel 13%, Beeline Lao 12%. 4. Internet/broadband: LTC and ETL have an estimated 75% of the broadband market with their ADSL offerings, although there are a number of competitors, with ADSL also available from Unitel and WiMax available from Beeline Lao, Planet Online, and the National Authority for Science and Technology.	**Less competitive,** due to the dominance exhibited by government-controlled operators
Malaysia	1. The Malaysian telecommunications market is competitive in the mobile telephony and mobile data sectors, although the fixed-line telephony and fixed-line broadband sectors remain dominated by Telekom Malaysia. 2. Fixed-line: Telekom Malaysia holds a near-monopoly over the country's fixed-line market, but some other operators such as Maxis have limited metropolitan fixed-line deployment. 3. Mobile: Maxis Communications, Celcom, and DiGi Telecommunications each have between 28% and 35% market shares, while a fourth operator, UMobile, serves 4%. 4. Internet/broadband: many ISPs are present but Telekom Malaysia has an estimated broadband market share of 60%. Others include Time dotCom, Packet One Networks, Celcom, Maxis Communications, DiGi Telecommunications, and UMobile.	**Reasonably competitive,** except for Telekom Malaysia's control of fixed-line infrastructure
Myanmar	1. Myanmar's telecommunications market is a near-monopoly. State-owned enterprise Myanmar Posts and Telecommunications (MPT) is the country's only fixed and mobile operator, but the market is being opened to competition in 2013. 2. Fixed-line: MPT holds a monopoly over the country's fixed-line sector. 3. Mobile: MPT monopoly, but currently considered to be one of the last "green-field" opportunities in the world. 4. Internet/broadband: there are three registered Internet service providers: MPT, Yatanarpon Teleport (in which the government owns 51% of shares), and Red Link Communications (reportedly led by investors with ties to the government). Additionally, Elite Tech and Fortune have reportedly partnered with MPT to develop fibre-to-the-home (FTTH) services.	**Uncompetitive but undergoing liberalization,** with passage of a new telecommunications law expected to occur in 2013, and 12 bidders for two new licenses shortlisted in April 2013

Philippines	1. The market is dominated by only two operators: Philippines Long Distance Telephone Company (PLDT) and Globe Telecom, in which Singtel holds a 47% stake and Ayala Corporation holds a 32% stake. 2. Fixed-line: PLDT has a 58% share after assuming a majority stake in what had been the country's third major operator, Digital Telecommunications Philippines (Digitel), migrating its landline subscribers to the PLDT brand in early 2013. Globe Telecom has a 12% share, while BayanTel, in which Globe Telecom will become the majority shareholder following a debt-to-equity conversion, has an 11% share. 3. Mobile: PLDT subsidiaries, including Smart Telecommunications, Talk 'N Text, and Sun Cellular, have a combined market share of 69%, while Globe Telecom serves the remaining 31%. 4. Internet/broadband: PLDT has an estimated 68% share of the broadband market, with Globe Telecom in second place with 24%.	**Less competitive,** effectively a duopoly, but San Miguel Corporation group is viewed as a possible competitor.
Singapore	1. The Singaporean government's sovereign wealth fund is the majority shareholder in the country's largest telecom operator, Singtel; the Singaporean government has a majority share of the second-largest operator, StarHub; and the government also has a minority stake in the third operator, M1. 2. Fixed-line: Singtel has a near-monopoly over the fixed market. 3. Mobile: Singtel has the largest share of the mobile market, with 46%; StarHub has 28%; and M1 has 26%. 4. Internet/broadband: StarHub has a majority share of the overall broadband market through its cable modem offering, but Singtel has 60%of the FTTH market, and M1 as well as smaller ISPs are also present in the broadband market.	**Reasonably competitive,** given the relatively small size of the market; however, the Singaporean government is a majority shareholder in two of the three largest operators.
Thailand	1. There are three major operators competing in each of the primary telecommunications sectors. 2. Fixed-line: TOT's share is 60%; metropolitan Bangkok operator True has 27%; and provincial operator TT&T has 12%. 3. Mobile: AIS has a 41% share, while Telenor's DTAC has 30% and TrueMove has 27%. 4. Internet/broadband: the broadband market is split between True, TOT, both tied at approximately 35%, and 3BB at 25%.	**Reasonably competitive,** with three operators in each sector
Viet Nam	1. State-owned Vietnam Posts and Telecommunications (VNPT) dominates the Vietnamese telecommunications market, with almost three-quarters of fixed-line subscribers, more than half of mobile subscribers, and more than two-thirds of the broadband market. Its primary competitor, Viettel, is controlled by the Vietnamese Ministry of Defence. 2. Fixed-line: VNPT has a 73% share, while Viettel has 26% after its merger with EVN Telecom. 3. Mobile: VNPT subsidiaries Vinaphone and Mobifone have a combined 58%, while Viettel has 37%. 4. Internet/broadband: VNPT has a 68% share, FPT 21%, and Viettel 10%.	**Less competitive,** given the dominance of state-owned VNPT group and military control over its primary competitor, Viettel.

Table 7: Summary and Analysis of Fixed and Mobile Broadband Infrastructure by Country

Country	Fixed Broadband Infrastructure	Mobile Broadband Infrastructure	Evaluation
Cambodia	65,000 fixed broadband subscribers. There is increased investment in broadband wireless, but the majority of subscribers are connected via ADSL. In addition to the key broadband market of Phnom Penh, Telecom Cambodia offers DSL service in many other areas of the country. Fibre-to-the-home (FTTH) subscribers are estimated to number approximately 2,000, concentrated primarily in Phnom Penh.	WiMax deployment in some urban centres / 4G plans announced by Emaxx (WiMax, Long-Term Evolution (LTE)) and Xinwei Technologies (TD-SCDMA).	**Very limited –** Most deployment is in Phnom Penh, and broadband is unavailable in most other parts of the country.
Indonesia	There are three million fixed broadband subscribers, primarily via ADSL, but FTTH is available in Jakarta, Bandung, and Surabaya. 2.3 GHz broadband wireless access (BWA), combined with 3G mobile, is viewed as a practical nationwide broadband solution.	High mobile data usage, with Telkomsel reporting more than 60 million mobile data users, and XL reporting approximately 25 million. There has been limited adoption of WiMax, and Telkomsel has set a goal of launching LTE in Jakarta, Bali, Medan, and Manado in late 2013.	**Growing –** Fixed broadband is only available in major cities in Java and western provinces, but 3G is being used to expand broadband to poorer provinces.
Lao PDR	As of year-end 2012, there were an estimated 40,000 fixed broadband subscribers, mostly via ADSL and mostly located in Vientiane.	LTC launched limited 3G service in 2008, followed by Unitel and Beeline Lao. In 2012, Beeline and LTC reported that they were each testing LTE, and LTC reported that it would soon launch WiMax service.	**Very limited –** Broadband penetration remains weak and is limited primarily to Vientiane.
Malaysia	2.3 million fixed broadband subscribers as of year-end 2012, mostly ADSL, but FTTH has increased to 500,000 subscribers. The National Broadband Initiative and 1Malaysia netbook initiative aim to increase broadband penetration.	3G was launched in 2005 but initially limited to Klang Valley (metropolitan Kuala Lumpur), Penang, Johor Bahru, and Kuantan; LTE was launched in 2013 but initially limited to Klang Valley.	**Relatively strong** – Although more can be done to improve penetration outside Klang Valley.
Myanmar	Estimated 50,000 fixed broadband subscribers as of year-end 2012, including between 30,000 and 40,000 ADSL subscriptions. Some sources indicated that FTTH deployment may have increased to 10,000 subscribers as of 2013.	MPT is launching 3G service in 2013.	**Very limited –** But future growth is expected once new telecommunications licenses are awarded.

Philippines	Estimated 1.5 million fixed broadband subscribers, mostly via ADSL. FTTH available in metropolitan Manila, Central Luzon, Southern Tagalog, Panay, Negros Occidental, Cebu, and Davao.	3G was launched in 2006, WiMax launched in 2009, and LTE introduced in 2012. PLDT said that as of mid-2013, it operated 1,000 LTE sites, while its 3G coverage reached 71% of the population. Globe offered LTE in metropolitan Manila, Cebu City, and Boracay Island. The Wi-tribe partnership between San Miguel Telecom and Ooredoo (Qatar Telecom) has also launched 4G.	**Growing –** Efforts are underway to expand both fixed and mobile broadband to cities outside of metropolitan Manila.
Singapore	The 1-Gbps-capable NextGen NBN fibre network reaches 95% of the population, and a reported one in five households were subscribed to fibre services as of year-end 2012. Cable modem and ADSL still account for 1.1 million of the country's 1.4 million fixed-broadband accounts.	Singapore has been at the forefront of next-generation mobile technologies. 3G was launched in 2005 and as of mid-2012 4G LTE service was available nationwide.	**Very strong –** Next-generation broadband, both fixed and wireless, has been consistently adopted by the country's Internet users.
Thailand	ADSL remains the primary fixed broadband technology of the country's 4 million broadband subscribers, although there is increasing investment in fibre-to-the-home, especially in Bangkok.	After years of delay exacerbated by the country's political crisis, 3G finally launched in 2013, and 4G services are also expected shortly thereafter.	**Average –** Greater investment is still needed in fibre-to-the-home, and mobile data services must make up for years of delay.
Viet Nam	ADSL service was first introduced in 2003 and currently serves most of the country's 4 million fixed broadband subscribers; fibre-to-the-home is reportedly under implementation in 63 provinces and cities.	3G was launched in 2009; LTE is not expected to be licensed until 2015 or later	**Limited –** Greater investment in FTTH and 4G is needed.

Table 8: Summary and Analysis of Typical Monthly Broadband Subscription Pricing by Country

Country	Typical Monthly Broadband Subscription Pricing	Base Package Price per Mbps (USD)	Annual 1 Mbps Subscription (USD) + Installation as a % of Nominal GDP per Capita	Evaluation
Cambodia	1. USD$35 per month + $35 installation/equipment fee for 1 Mbps ADSL *(Telecom Cambodia)* 2. USD$99 per month + $140 installation/equipment fee for 1 Mbps ADSL or WiMax *(Ezecom)*	$35	$455 / $934 = 48.7%	**Extremely expensive**
Indonesia	1. USD$66 per month + $8 install. for 1 Mbps unlimited ADSL; limited bandwidth packages $21/mo. *(Speedy)* 2. USD$62 /mo. + $103 install. for 1 Mbps unlimited FTTB *(Biznet)* 3. USD$20 /mo. + install. for 1 Mbps unlimited cable modem *(FastNet)*	$20	$260 / $4,742 = 5.5%	**Reasonable**
Lao PDR	1. USD$33 per month for 1 Mbps ADSL *(ETL, Unitel)*	$33	$396 / $1,446 = 27.4%	**Very expensive**
Malaysia	1. USD$33 per month for 1 Mbps ADSL including modem +$54 for activation and installation *(Telekom Malaysia)*	$33	$450 / $10,304 = 4.4%	**Reasonable**
Myanmar	*1.* USD$55 per month + $536 installation/equipment fee for 1 Mbps WiMax, 6 GB download limit *(Red Link Communications)* 2. USD$100 per month +$172 installation/ equipment fee for 1 Mbps *(Yatanarpon Teleport)* 3. USD$91 per month + $880 installation for 1 Mbps FTTH+VoIP *(Fortune International Ltd.)*	$55	$1,196 / $900 = 132.8%	**Unaffordable**
Philippines	1. USD$24 per month for 1 Mbps ADSL, unlimited download *(PLDT, Tattoo (Globe))* 2. USD$73 per month for 3 Mbps ADSL, unlimited download *(PLDT)*	$24	$293 / $2,614 = 11.2%	**Somewhat expensive**

Singapore	1. USD$24 per month for 6 Mbps cable modem plus free 7.2 Mbps mobile broadband *(Singtel)* 2. USD$41 per month for 150 Mbps FTTH plus free fixed telephone *(Singtel)*	$4	$48 / $51,162 = 0.1%	**Extremely affordable**
Thailand	1. USD$20 per month for 10 Mbps ADSL or Cable Modem (TrueOnline/3BB) 2. USD$41 per month for 30 Mbps FTTx (3BB)	$2	$24 / $5,678 = 0.5%	**Very affordable**
Viet Nam	1. USD$10 per month for 1 Mbps ADSL with unlimited download (VNPT) 2. USD$19 per month for 12 Mbps FTTx with unlimited download (Viettel)	$10	$120 / $1,528 = 7.9%	**Reasonable**

Table 9: Summary of Fibre Optic Connectivity Across Land Borders of the Countries Analysed in This Study

(Length of land borders and presence of trans-border fibre)

	Cambodia	Indonesia	Lao PDR	Malaysia	Myanmar	Philip-pines	Singapore	Thailand	Viet Nam	Yunnan Province, China
Cambodia			541 km Fibre: Yes					803 km Fibre: Yes	1,228 km Fibre: Yes	
Indonesia				1,782 km Fibre: No						
Lao PDR	541 km Fibre: Yes				235 km Fibre: No			1,754 km Fibre: Yes	2,130 km Fibre: Yes	423 km Fibre: Yes
Malaysia		1,782 km Fibre: No					C'way/ Bridge Fibre: Yes	506 km Fibre: Yes		
Myanmar			235 km Fibre: No					1,800 km Fibre: Yes		1,997 km Fibre: Yes
Philippines										
Singapore				C'way/ Bridge Fibre: Yes						
Thailand	803 km Fibre: Yes		1,754 km Fibre: Yes	506 km Fibre: Yes	1,800 km Fibre: Yes					
Viet Nam	1,228 km Fibre: Yes		2,130 km Fibre: Yes							1,281 km Fibre: Yes
Yunnan Province. China			423 km Fibre: Yes		1,997 km Fibre: Yes				1,281 km Fibre: Yes	

A total of 13 bilateral terrestrial borders exist between the subject countries (including the border between Malaysia and Singapore, which is linked by the Johor-Singapore Causeway and the Malaysia-Singapore Second Link). Terabit Consulting identified trans-border terrestrial fibre optic connectivity across all borders, with two exceptions: the Indonesia-Malaysia land border on the island of Borneo, and the border between Lao PDR and Myanmar.

1. **Cambodia-Lao PDR**: Greater Mekong Subregion Information Highway Project/Cambodia-Lao PDR link;
2. **Cambodia-Thailand**: Thailand-Cambodia-Viet Nam/Greater Mekong Subregion Information Highway Project; Telcotech (Ezecom) AAG backhaul network;
3. **Cambodia-Viet Nam**: Thailand-Cambodia-Viet Nam/Greater Mekong Subregion Information Highway Project; Telcotech (Ezecom) AAG backhaul network; Viettel Cambodia-Viet Nam; Cambodia-Viet Nam High-Speed Transmission Line;
4. **Indonesia-Malaysia**: Terabit Consulting was unable to identify direct connectivity;
5. **Lao PDR-Myanmar**: Lao PDR-Myanmar link identified by Myanmar Posts and Telecommunications but could not be confirmed by Terabit Consulting;
6. **Lao PDR-Thailand**: China-Southeast Asia Cable/Lao PDR-Thailand links;
7. **Lao PDR-Viet Nam**: China-Southeast Asia Cable/ Lao PDR-Viet Nam links;
8. **Lao PDR-Yunnan Province, China**: Lao PDR-China link;
9. **Malaysia-Singapore**: Malaysia-Singapore Causeway links; Time dotCom Cross-Peninsular Cable System;
10. **Malaysia-Thailand**: Malaysia-Thailand links;
11. **Myanmar-Thailand**: Myanmar-Thailand link;
12. **Myanmar-Yunnan Province, China**: China-Myanmar link;
13. **Viet Nam-Yunnan Province, China**: China-Southeast Asia Cable connects Viet Nam and China, but not directly via Yunnan Province.

Table 10: Analysis of Cross-Border Connectivity and Identification of Priority Trans-Border Projects

International Border (and border length)	Analysis	Recommendation
Cambodia to Lao PDR (541 kilometres) *Low Priority*	Existing fibre infrastructure is weak and capacity is controlled by Telecom Cambodia; however, traffic demand between the two countries is minimal and Lao PDR offers no international submarine connectivity.	Additional fibre connectivity between Cambodia and Lao PDR would increase accessibility for non-incumbent operators, but demand along the route is minimal and the link would likely have little traffic.
Cambodia to Thailand (803 kilometres) ***Medium Priority***	The route provides one of Cambodia's primary paths to international submarine connectivity and has limited competition, with both Telecom Cambodia and Telcotech operating infrastructure.	Because the development of submarine connectivity to Cambodia is uncertain, the country is strongly dependent on its terrestrial links, and consumer prices remain extremely high, in part because of limited infrastructure competition.
Cambodia to Viet Nam (1,228 kilometres) *Low Priority*	One of Cambodia's primary paths to international submarine connectivity; multiple operators and networks are present.	Demand will depend on development of Cambodia's own submarine network, as well as Thai submarine capacity pricing.
Indonesia to Malaysia (1,782 kilometres) ***High Priority***	Although undersea connectivity exists between Indonesia and Malaysia, no direct connectivity is present between the countries' states on the island of Borneo.	A new terrestrial fibre link between Indonesia and Malaysia would greatly improve the region's connectivity and is warranted by the countries' linguistic, economic, and cultural ties. Such a link would also improve connectivity to the Malaysian states of Sabah and Sarawak, which have traditionally relied upon transit capacity through Peninsular Malaysia.
Lao PDR to Cambodia (541 kilometres) ***Medium Priority***	Existing fibre infrastructure is weak and capacity is controlled by Enterprise of Telecommunications of Lao (ETL). There are no submarine cables in Cambodia but future projects are under consideration.	Demand between the two countries is weak but transit traffic from Lao PDR via Cambodia could increase if a new Cambodian submarine cable is constructed.

International Border (and border length)	Analysis	Recommendation
Lao PDR to Myanmar (235 kilometres) ***Medium Priority***	Demand between the two countries is weak but Myanmar hosts the SEA-ME-WE-3 cable.	Access to Myanmar's SEA-ME-WE-3 landing point could improve Lao PDR's options for connectivity.
Lao PDR to Thailand (1,754 kilometres) *Low Priority*	ETL's primary international connection is via Thailand, and ISPs Sky Telecom and Planet have fibre to Thailand.	The Lao-PDR Thailand route appears to be well-served by existing infrastructure.
Lao PDR to Viet Nam (2,130 kilometres) *Low Priority*	ETL and Lao Asia Telecom (LAT) each operate fibre links to Viet Nam.	Capacity between Lao PDR and Viet Nam appears to be sufficient.
Lao PDR to Yunnan Province, China (423 kilometres) ***High Priority***	ETL operates a fibre link to Yunnan Province, China via Boten.	The Lao PDR-China route would benefit from greater competition.
Malaysia to Indonesia (1,782 kilometres) ***High Priority***	Although undersea connectivity exists between Indonesia and Malaysia, no direct connectivity is present between the countries' states on the island of Borneo.	A new terrestrial fibre link between Indonesia and Malaysia would greatly improve the region's connectivity and is warranted by the countries' linguistic, economic, and cultural ties. Such a link would also improve connectivity to the Malaysian states of Sabah and Sarawak, which have traditionally relied upon transit capacity through Peninsular Malaysia.
Malaysia to Singapore (Causeway & Bridge) *Low Priority*	There is sufficient fibre capacity between Malaysia and Singapore.	There is no need for additional fibre capacity between Malaysia and Singapore.
Malaysia to Thailand (506 kilometres) *Low Priority*	Although there is limited competition among operators, there is sufficient trans-border bandwidth between Malaysia and Thailand.	From Malaysia's perspective, there is no need for additional fibre capacity between Malaysia and Thailand, but the crossing is of increasing importance to Thai operators who use it to access cheaper bandwidth and IP transit in Malaysia and Singapore.

International Border (and border length)	Analysis	Recommendation
Myanmar to Lao PDR (235 kilometres) *Low Priority (Medium Priority in opposite direction)*	Demand between the two countries is weak, but Myanmar hosts the SEA-ME-WE-3 cable and could provide a useful path to international connectivity for landlocked Lao PDR.	Access to Myanmar's SEA-ME-WE-3 landing point could improve Lao PDR's options for connectivity, but from the perspective of Myanmar there is little requirement for improved connectivity.
Myanmar to Thailand (1,800 kilometres) ***Medium Priority***	As the Myanmar telecommunications market opens to competition, there will be increased demand for additional international paths.	Additional Myanmar-Thailand capacity should be considered, especially in light of high consumer broadband costs in Myanmar (132.8% of per-capita GDP per Mbps).
Myanmar to Yunnan Province, China (1,997 kilometres) ***Medium Priority***	As the Myanmar telecommunications market opens to competition, there will be increased demand for additional international paths.	Additional Myanmar-China capacity should be seriously considered, but relations between the two nations have weakened since 2011.
Singapore to Malaysia (Causeway & Bridge) *Low Priority*	There is sufficient fibre capacity between Malaysia and Singapore.	There is no need for additional fibre capacity between Malaysia and Singapore.
Thailand to Cambodia (803 kilometres) *Low Priority (Medium Priority in opposite direction)*	Although of little importance to Thailand, the route provides one of Cambodia's primary paths to international submarine connectivity and is competitive, with both Telecom Cambodia and Telcotech operating infrastructure.	From Thailand's perspective, the Thailand-Cambodia route has sufficient capacity.
Thailand to Lao PDR (1,754 kilometres) *Low Priority*	Laotian operator ETL and ISPs Sky Telecom and Planet have fibre across the border.	The Lao-PDR Thailand route appears to be well-served by existing infrastructure.
Thailand to Malaysia (506 kilometres) *Low Priority*	Although there is limited competition among operators, there is sufficient trans-border bandwidth between Malaysia and Thailand.	There is currently sufficient capacity, but the route is critical as an outlet to cheaper international bandwidth.

International Border	Analysis	Recommendation
Thailand to Myanmar (1,800 kilometres) *Low Priority (Medium Priority in opposite direction)*	Carries little traffic from Thailand, but as the Myanmar telecommunications market opens to competition, there will be increased demand for additional international paths.	Thai operators and ISPs are unlikely to require additional bandwidth to Myanmar, but the route will be of great importance to Myanmar operators.
Viet Nam to Cambodia (1,228 kilometres) *Low Priority*	One of Cambodia's primary paths to international submarine connectivity; multiple operators and networks are present	Existing infrastructure is sufficient to support Vietnamese demand toward Cambodia
Viet Nam to Lao PDR (2,130 kilometres) *Low Priority*	VNPT operates links in correspondence with both ETL and LAT of Lao PDR.	Capacity between Lao PDR and Viet Nam appears to be sufficient.
Viet Nam to Yunnan Province, China (1,281 kilometres) ***Medium Priority***	VNPT and China Telecom operate a link between Viet Nam and China within the aegis of the China-Southeast Asia Cable.	The existing link is believed to follow the Youyiguan Pass; additional connectivity via Yunnan Province should be considered in order to improve regional connectivity.

➢ High Priority Trans-Border Projects

1. **Indonesia to Malaysia and Malaysia to Indonesia** – There is currently no direct terrestrial connectivity between the two countries.

2. **Lao PDR to Yunnan Province, China** – Better access to China's international infrastructure would improve Lao PDR's weak international connectivity.

➢ Medium Priority Trans-Border Projects

1. **Cambodia to Thailand** – This is a key route, as Cambodia remains without direct undersea connectivity.

2. **Lao PDR to Cambodia** – If a new Cambodian submarine cable is developed, Cambodia will serve as an important outlet for Laotian international traffic.

3. **Lao PDR to Myanmar** – Better access to SEA-ME-WE-3 via Myanmar would improve Lao PDR's options for connectivity.

4. **Myanmar to Thailand** – Improved connectivity from Myanmar to Thailand could help reduce Myanmar's high consumer broadband costs (currently 132.8 per cent of per-capita GDP per Mbps).

5. **Myanmar to Yunnan Province, China** – Better international connectivity via China could also help to reduce Myanmar's Internet costs, but the weakened state of relations between the two countries could prove problematic.

6. **Viet Nam to Yunnan Province, China** – Although there is existing fibre infrastructure between Viet Nam and China, it does not pass through Yunnan Province.

II. POLICY OPTIONS FOR ENHANCING TERRESTRIAL CROSS-BORDER CONNECTIVITY

The analysis of broadband markets and infrastructure in the ASEAN-9 subregion and adjoining provinces revealed that low-cost, high-speed, and high-quality broadband services are typically concentrated in markets that are wealthy, urban, and/or coastal, while poor, rural, and/or inland markets are often neglected. The analysis showed that the chasm between the broadband "have" and "have-not" markets results in vast differences in international fibre connectivity, domestic connectivity, the pricing of IP transit capacity, the competitiveness of telecommunications and Internet markets, fixed and mobile broadband infrastructure, and the affordability of consumer broadband services.

Although the identification of network "black holes" and border crossings in need of increased network investment will indeed promote regional connectivity, Terabit Consulting believes that over the long term, a more holistic approach to network development is required. Particularly, any regional network development must be driven by the fact that the majority of the region's international traffic continues to exit the region, bound for North America and Europe. Even traffic that some sources have identified as "intra-Asian" is, in reality, IP demand transited via the region's Internet hubs of Singapore and Hong Kong, China and ultimately bound for destinations outside the region.

Almost all of the borders analysed within this study are served by fibre capacity, and the traffic volume for distinctly bilateral, non-transit demand across borders is minimal. Instead, the pan-Asian network should be considered as a means for improving intercontinental connectivity and providing cheaper and more reliable access to destinations throughout Asia, Europe, and beyond; Terabit Consulting believes that only an intercontinental, open-access network will be able to achieve true telecommunications equality across all markets in the region.

Terabit Consulting is of the opinion that the network should most logically be integrated with the Asian Highway initiative promoted by UNESCAP; as detailed in this report's country chapters, many Asian Highway segments already support existing fibre optic networks.

Beyond the challenge of securing funding, the primary impediment to the development of a pan-Asian terrestrial fibre optic network will be the desire of incumbent operators (many of which are government-owned) to protect their existing network investments and prevent competition. However, UNESCAP is in a strong position to convince governments to promote the development of a coherent, open-access, pan-regional network on the basis that it will greatly benefit consumers, spur economic growth, increase government revenue, and encourage regional stability through better international and intercultural relations.

Overall Weakness of Existing Terrestrial Cross-Border Connectivity

Terrestrial cross-border fibre infrastructure is the most obvious option for combating the clear inequality between the region's markets. However, the utility of Asia's current international terrestrial fibre optic infrastructure is limited due to the following factors:

- **Limited geographic scope:** The study region's existing international terrestrial infrastructure consists primarily of bilateral, point-to-point, trans-border links that offer limited geographic coverage. The few existing multi-national networks in the region, such as the Greater Mekong Subregion Information Highway Project and the China-Southeast Asia Cable, were depicted by sources as functioning essentially as "patchworks" of the national backbones of dominant telecommunications carriers rather than as coherent, purpose-built pan-regional networks, and their impact on the pricing or more equitable distribution of the region's international bandwidth was considered to be minimal.

- **Little or no network redundancy:** Unlike international submarine cables, which are often constructed in geographic ring configurations that provide immediate in-system restoration in the event of a cable cut, the study region's terrestrial network infrastructure is rarely designed with efficient options for restoration, reducing the links' reliability and limiting their functionality. Typically, traffic can only be placed over the region's terrestrial trans-border fibre links by those carriers that have sufficient undersea capacity in place to use as an alternative path in the event that the terrestrial link suffers an outage.

- **Low transmission capacity:** The study region's international terrestrial infrastructure typically operates at 10 Gbps or less, preventing economies of scale and failing to compete with Asia's international submarine cables, which collectively provide many terabits per second worth of bandwidth to the region.

- **Lack of open access and prohibitive bandwidth pricing:** The region's international terrestrial fibre optic links are almost exclusively operated for the benefit of the dominant telecommunications carriers that own them. Due to the low bandwidth of the links, as well as carriers' general desire to avoid offering cost-effective capacity to their competition, it is difficult for third-party carriers to purchase capacity on the region's international terrestrial links. (There are limited exceptions, such as the competitive Thailand-Malaysia terrestrial capacity market, which offers a comparatively cost-effective arbitrage transit path to Singapore in order to avoid Thailand's expensive submarine cable gateways.)

- **No intercontinental terrestrial bandwidth:** Terrestrial fibre optic infrastructure in the ASEAN-9 region does not provide intercontinental connectivity; instead, any intercontinental traffic placed over the links is aggregated for interconnection to the region's extremely vulnerable undersea fibre optic infrastructure. In this way, Southeast Asian nations are at the mercy of cables that pass through multiple geographic "choke points", which have in the past experienced multiple simultaneous cable outages, specifically the Luzon Strait between the Philippines and Taiwan Province of China, the Strait of Malacca between Indonesia and Malaysia, and the Egypt/Red Sea region. Given the political instability in Egypt, as well as recent outages of simultaneous cables off Egypt's Mediterranean coast attributed to sabotage, telecommunications carriers around the globe have indicated a strong desire for a terrestrial alternative to Egypt, but recent efforts by network developers to provide paths through Syria, Iraq, and Iran have not been viewed as viable substitutes owing to the region's political risk.

The Need for Intervention by Governments and/or International Organizations in Order to Ensure Implementation of a Pan-Asian Terrestrial Fibre Optic Network

Intervention by governments and/or international organizations is required to ensure the implementation of a pan-Asian terrestrial fibre optic network for five reasons:

1. To overcome the vast broadband inequality that has been identified in the region;
2. To ensure that the region receives broadband services on a par with more developed markets;
3. To finance or assist in financing a multi-billion dollar capital project that is unlikely to be fully financed by the private sector;
4. To pool and leverage private-sector resources which are disparately insufficient;
5. To stimulate and facilitate future private investment through market maturation.

The fact that there is no viable pan-regional terrestrial fibre optic alternative to the region's submarine infrastructure indicates that the private sector perceives the risk/return profile of any pan-Asian terrestrial fibre optic network to be unworkable without some form of public support or bureaucratic facilitation. The provision of ubiquitous, affordable, and reliable broadband capacity on an equal basis to all of the region's markets will be a requirement in order for the entire region to move forward and promote its overall economic and social development. The participation of the region in the global digital economy will require sufficient international bandwidth and broadband delivery to end users in excess of that which current infrastructure allows.

In 2012, the United States Federal Communications Commission (FCC) announced that it was re-evaluating its definition of "advanced telecommunications capability", or broadband, which it had classified since 2010 as being 4 Mbps download and 1 Mbps upload speeds. Following a period of public consultation, the threshold was expected to be increased considerably. The 2010 National Broadband Plan unveiled by the United States government in March of 2010 recommended that the FCC ensure that 100 million American households have access to affordable broadband Internet with download speeds of at least 100 Mbps and upload speeds of at least 50 Mbps by 2020. Within the study region, none of the countries, aside from Singapore, is likely to achieve similar coverage, affordability, or speed thresholds.

From a developmental perspective, a democratized and equitable broadband infrastructure throughout the region would be a tremendous boon, enabling major advancements in education, telemedicine, scientific research, broadcasting, general government, and entrepreneurialism that would not be otherwise possible.

Available Public-Private Partnership Options for Financing a Pan-Asian Terrestrial Fibre Optic Network

Based on fibre network development models employed by governments through assistance from the World Bank and other development financial institutions, the available options for a public-private partnership are as follows.

1. Special-Purpose Vehicle (SPV) Model with Government/Organizational Shareholding

- Network operators form a special-purpose vehicle to assume full responsibility for the development, operation, and maintenance of the pan-Asian terrestrial network.
- Government, organizational, and/or developmental entities make capital contributions to the SPV and receive equity stakes and/or capacity on the network.
- The contributors receive a seat on the board of the SPV, thereby ensuring that policy goals are achieved.
- A regulatory framework is adapted to ensure that the SPV's outcome fulfils policy goals and improves the overall welfare of the region.
- The contributors' equity stake may be divested once certain milestones are achieved, or alternatively may be held until the winding-down of the SPV.

2. Special-Purpose Vehicle (SPV) Model with Government/Organizational Contribution

- Network operators form a special-purpose vehicle with full responsibility for the pan-Asian terrestrial fibre optic network.
- The government, organizational, and/or developmental entities make capital contributions to the SPV.
- The contributors do not receive equity or capacity on the network.
- However, the contributors do participate in the creation of the SPV's governance framework, and receive a seat on the board of the SPV.
- Mechanisms are instituted to ensure that policy goals are met.

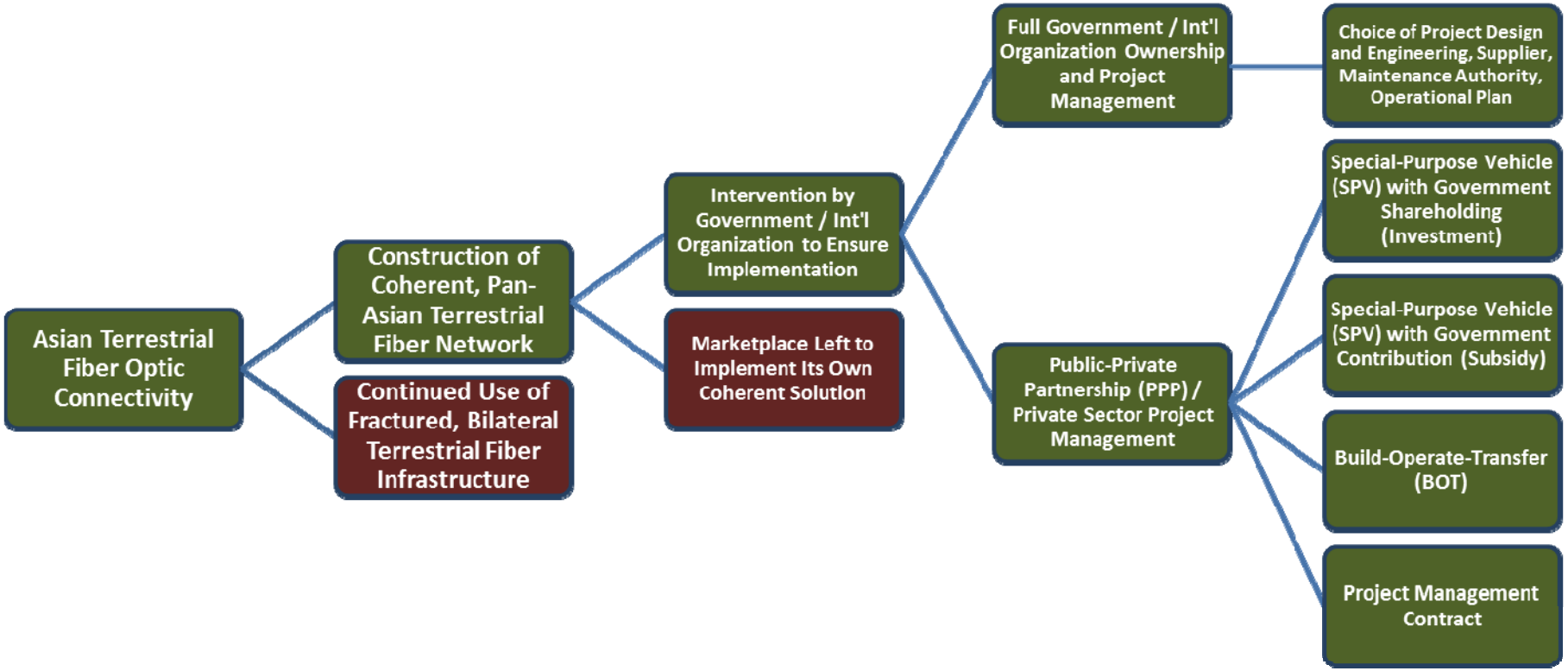
3. Build-Operate-Transfer (BOT)

- Following an open tender process, a concession is granted to one or more network operators for a fixed long-term duration (typically 20 years).
- The network operators are assigned full responsibility for financing, operating, and maintaining the cable.
- Certain market privileges may be accorded to the network operators.
- The operators are allowed to retain all revenues during the period of its concession.
- Once the concession agreement expires, ownership of the network is assigned to the government at no cost.

4. Awarding of Project Management Contract

- A tender is issued to select one or more network operators responsible for the construction, operation, maintenance, and commercialization of the pan-Asian terrestrial fibre optic network.
- The contract recipient is paid to manage the cable and assume these responsibilities, including the sale of capacity to operators. The contract recipient's management fees may be fixed or based on a percentage of revenue.
- The network remains the property of the government, and it collects all profits (less management fees).

Options for Participation by Government and International Organizations in the Implementation of Pan-Asian Terrestrial Fibre Network Connectivity



Stakeholder Analysis

The development of any open-access fibre optic network in the region should be done in collaboration with the following stakeholders.

- National Regulatory Authorities

Cambodia	Telecommunications Regulator of Cambodia (TRC)	*Reassignment of regulatory responsibility from MPTC to TRC in 2012 was reportedly welcomed by many Cambodian stakeholders.*
Indonesia	Indonesian Telecommunications Regulatory Body (BRTI)	*BRTI assumed its regulatory role in 2004.*
Lao PDR	National Authority of Posts and Telecommunication (NAPT/ANPT)	*NAPT was assigned its mandate in 2007.*
Malaysia	Malaysian Communications and Multimedia Commission (MCMC)	*In addition to MCMC, the Performance Management and Delivery Unit (Pemandu) may also be interested in initiatives to improve international connectivity.*
Myanmar	Ministry of Communications and Information Technology (MCIT) – Posts and Telecommunications Department (PTD)	*The Myanmar regulator will play an increasingly critical role as the market undergoes liberalization.*
Philippines	National Telecommunications Commission (NTC)	*Guidelines issued by the Philippines Securities and Exchange Commission affect foreign telecommunications investment in the Philippines.*
Singapore	Infocomm Development Authority of Singapore (IDA)	*The Singaporean market is strongly influenced by the government, via the IDA as well as governmental investment in operators.*
Thailand	National Broadcasting and Telecommunications Commission (NBTC)	*NBTC was established in 2004.*
Viet Nam	Viet Nam Telecommunications Authority (VNTA)	*VNTA was established in mid-2011.*

- Incumbent Telecommunications Operators and Major International Gateway Operators

Cambodia	Telecom Cambodia (Gov't of Cambodia), Ezecom (formerly Telcotech)	*Telecom Cambodia is the incumbent operator, but Ezecom (member of the AAG submarine cable consortium) also has international links.*
Indonesia	PT Telekomunikasi Indonesia (Gov't of Indonesia 54%), PT Indosat (MNC Media), XL Axiata (sister company of Celcom Malaysia)	*Although PT Telkom remains the country's largest telecom group, PT Indosat and XL Axiata also operate international gateways.*
Lao PDR	Enterprise of Telecommunications of Lao (ETL) (Gov't of Lao PDR), Lao Telecommunications Co. Ltd. (Gov't of Lao PDR 51%)	*ETL and LTC together control 83% of the fixed-line market, 75% of the mobile market, and 75% of the Internet market, as well as international infrastructure.*
Malaysia	Telekom Malaysia, Time dotCom, Celcom (Axiata Group)	*Telekom Malaysia and Time dotCom have large investments in both terrestrial and undersea infrastructure; the Axiata Group has also invested in undersea networks.*
Myanmar	Myanmar Posts and Telecommunications (MPT) (Gov't of Myanmar), Yatanarpon Teleport (Gov't of Myanmar 51%)	*The government maintains control over most international infrastructure but change is expected as foreign investors enter the market.*
Philippines	PLDT, Globe Telecom (Singtel 47% stake)	*The Filipino telecommunications market is effectively a duopoly.*
Singapore	Singtel (Temasek/Gov't of Singapore), StarHub (STT/Gov't of Singapore)	*Singtel is the country's primary international gateway operator but StarHub has network investments, including the AAG submarine cable.*
Thailand	Communications Authority of Thailand (Gov't of Thailand), True (Charoen Pokphand Group), Jasmine International Group, Telecommunications Organization of Thailand (Gov't of Thailand)	*CAT, True, and Jasmine have international connectivity, while TOT is responsible for domestic infrastructure.*
Viet Nam	Vietnam Posts and Telecommunications Group (VNPT) (Government of Viet Nam), Viettel/EVN Telecom (Vietnam Military Telecommunications Company)	*The Vietnamese government and military control the lion's share of the Vietnamese telecommunications market.*

- Competitive Telecommunications Operators and ISPs

Cambodia	Camintel (KTC, Republic of Korea), Mobitel (CamGSM), Metfone (Viettel), Hello (Axiata) & Smart Mobile (Latelz), Beeline Cambodia, Excell (GT-Tell), QBMore (Cambodia Advance Communications)	*The mobile sector has seen increased foreign investment, including the launch of Viettel Cambodia in November of 2008 and the acquisition of Camintel by wire and cable manufacturer KTC in 2010.*
Indonesia	3 Indonesia (Hutchison Charoen Pokphand Telecom) (Hutchison Group), PT Axis Telekom Indonesia (Axis), PT Bakrie Telecom (Bakrie Group), PT Smartfren Telecom (Sinar Mas Group), Ceria (PT Sampoerna Telekomunikasi Indonesia) (Sampoerna Strategic Group), FastNet (FirstMedia), MetroNET (Biznet), CepatNet, Max3, i-Direct	*The international bandwidth infrastructure market is competitive, offering smaller operators good choice for connectivity through Singapore or Malaysia.*
Lao PDR	Unitel (Star Telecom JV Co.: Ministry of Defence of Lao PDR and Viettel), Beeline Lao (VimpelCom Lao)	*Privately owned competition is minimal in the Laotian telecommunications market.*
Malaysia	Maxis Communications (Usaha Tegas Group), DiGi Telecommunications (Telenor 49% stake), Umobile, Packet One (Green Packet Bhd)	*The Malaysian telecommunications market is among the region's most competitive.*
Myanmar	Red Link Communications, Elite Tech, Fortune International Ltd.	*Private-sector competition is currently limited but increased foreign investment is imminent.*
Philippines	Currently no major competitors, but San Miguel Corporation is expected to become more aggressive in the telecommunications sector.	*PLDT and Globe dominate the market.*
Singapore	M1, SuperInternet, LGA Telecom	*Singtel, StarHub, and M1 serve most of the country's telecommunications and Internet subscribers.*
Thailand	TT&T, Advanced Info Service, DTAC (Telenor 62% stake)	*The fixed-line, mobile, and broadband markets are each served by three operators.*
Viet Nam	Saigon Post and Telecommunications Services Corporation (SPT), Viet Nam Mobile, GMobile (formerly Beeline) (GTel Mobile), Sphone, FPT Telecom	*Private operators are challenged by the strong market positions of Vietnamese government- and military-owned operators.*

- Road and Railway Authorities/Operators

Cambodia	Ministry of Public Works and Transport (highways and rail), Toll Holdings (Australia) (rail concessionaire)	*Toll Holdings won a rail concession following funding from AusAID; China Railway Group is reportedly considering development of a north-south railway in 2017.*
Indonesia	Ministry of Public Works/ Directorate General of Highways, PT Jasa Marga (highways), PT Kereta Api (rail)	*Ministry of Public Works would likely be the appropriate agency for collaboration on Indonesia-Malaysia terrestrial link.*
Lao PDR	Ministry of Public Works and Transport Department of Planning and Cooperation, Lao Railway Authority	*New China-Lao PDR rail in service and another planned; short 3.5-km link to Thailand in service; Giant Consolidated Limited (Malaysia) planning construction of new Lao PDR-Viet Nam link by 2017.*
Malaysia	Malaysian Highway Authority, PLUS Expressway Bhd, Linkedua Malaysia Bhd (highway concessionaires), KTM Berhad (rail)	*North-South Expressway links to Singapore and Thailand, while the Ministry of Works would likely be responsible for roads between Malaysia and Indonesia on Borneo.*
Myanmar	Ministry of Transport, Myanmar Railways	*Highways provide best international linkage; international rail linkage is currently weak.*
Philippines	Department of Public Works and Highways, Philippines National Railways	*As an archipelago, the Philippines can be served internationally only via undersea cable and satellite.*
Singapore	Land Transport Authority	*The Land Transport Authority is responsible for highway and mass transit, including the Causeway and Second Link, but KTM Berhad of Malaysia operates the rail link.*
Thailand	Department of Highways, Department of Rural Roads, State Railway of Thailand	*New India-Myanmar-Thailand highway planned for 2016*
Viet Nam	Ministry of Transport, Viet Nam Railways	*Kunming–Hai Phong Railway track connects Viet Nam and Yunnan Province, China.*

Principles to Guide Future Network Development

Given the shortcomings of the existing terrestrial fibre optic infrastructure in ASEAN-9 countries and adjoining regions, the analysis revealed a strong opportunity for the construction of an international terrestrial fibre optic network providing open, cost-effective access on both an intra-regional and intercontinental basis. In order to ensure the success of such a project, Terabit Consulting believes that the network should adhere to the following principles:

- **Fully integrated and coherent:** The unified network should provide connectivity across the region's borders and throughout the population, and be constructed in a mesh configuration that allows for in-network healing in the event of physical cable outages or political instability that may affect network connectivity in specific countries.

- **Functioning and monitored as a single, uniform network:** Beyond issues of low bandwidth and high cost, many sources indicated that existing international terrestrial networks currently cannot compete with submarine cables because international terrestrial networks are unable to offer uniform quality of service between endpoints. Because they function as connected "patchworks" of telecommunications carriers' domestic networks, the quality and utility of international terrestrial fibre optic connections are restrained by their weakest segments; typically, telecommunications carriers in neighbouring countries will offer vastly different terms and service guarantees for transmission over each carrier's segments of the same international terrestrial network.

- **Leveraging existing infrastructure:** In order to remain cost-effective, any pan-regional terrestrial network would require streamlining of right-of-way procurement, as well as the use of uniform construction techniques and parameters; such efficiency can be realized only through a partnership with existing long-distance infrastructure such the Asian Highway network, the Pan-Asian Railway project, or power transmission networks.

- **Cost-effective:** If constructed on the proper scale in terms of both geographic coverage and transmission capacity/fibre count, a pan-regional terrestrial network could effectively compete with submarine infrastructure on both a regional and intercontinental basis. In particular, a terrestrial network dimensioned around 100 Gbps transmission technology would benefit from a "last-mover's advantage" that should carry over for several years due to 100G's relatively nascent status and the recent step changes from 10G and 40G technology.

- **Open access and non-discriminatory pricing:** For the network to achieve development and policy goals, as well as to best serve the region's consumers, all purchasers of capacity must be able to access the network 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 and landlocked markets.

- **Developed and managed by a special-purpose vehicle:** The neutrality and efficiency of the network would be ensured by a special-purpose vehicle (SPV) shareholding arrangement that would allow participation by all stakeholders while still maintaining arm's-length terms over all capacity sales and leases.

Based on its involvement with telecommunications infrastructure projects around the world, Terabit Consulting believes that from a commercial perspective, the most successful international networks are those which feature the participation of multiple telecommunications operators and Internet service providers. Although the initial obstacles are often considerable, and development of a multi-party network usually takes much longer than if the project were to be developed by one or two entities, the long-term commercial viability and utility of the system is greatly improved in projects where multiple operators are allowed to participate on equal equity terms.

By contrast, privately financed projects face significant challenges, particularly in those developing markets where consumer market share is concentrated among a few operators, or where government-owned entities maintain dominant market positions, as is the case in some of the

markets analysed in this study. Terabit Consulting believes that for the most part, privately financed fibre optic network projects will succeed only in extremely competitive, transparent, and commoditized routes, such as those serving North America or Western Europe.

On the other hand, cable infrastructure projects developed by one or two operators are generally intended to serve those operators' own traffic requirements rather than to function as wholesale sellers of capacity, because other competing operators are unlikely to purchase capacity on the projects for fear of subsidizing the projects' owners, who are also their competitors.

Consequently, Terabit Consulting believes that the most successful Asian terrestrial network would be one in which all of the region's operators are invited to participate in a consortium on equal terms.

The primary obstacle to forming such a consortium is the desire of incumbent operators to maximize the value of their own existing infrastructure and prevent competition at both the domestic and international level, as well as the goal of operators in developed markets to serve as hub operators for the region and discourage the proliferation of international network outlets that do not aggregate traffic through their home markets.

As previously discussed, the chances for success in the development of Asian terrestrial connectivity would be greatly improved if the project were to be promoted and facilitated by an independent international organization such as UNESCAP. The commission should start by convincing regional governments of the advantages of the project, including the following:

- **Benefits to consumers:** In Cambodia, Lao PDR, and Myanmar, 1 Mbps of consumer broadband Internet access costs 48.7 per cent, 27.4 per cent, and 132.8 per cent of per-capita gross domestic product, respectively. Of the countries analysed in this study, only Singapore and Thailand offer broadband Internet access that is considered to be truly affordable. Better connectivity in the region will greatly reduce costs in less developed markets and bring improved and more reliable broadband services across the region.

- **Economic growth:** According to the Organization for Economic Cooperation and Development (OECD), improvement in ICT infrastructure has the following impacts:

  - ✓ Increased demand for the output of other industries (demand multiplier);
  - ✓ New opportunities for production in other industries (supply multiplier);
  - ✓ New goods and services for consumers (final demand).

  The OECD has additionally indicated that ICT improvements achieve the following:

  - ✓ "Increase firms' innovation capabilities";
  - ✓ "Increase the probability to introduce a new product both in manufacturing and services";
  - ✓ "Have a significant effect on the probability to introduce a process innovation";
  - ✓ "Increase the probability to introduce a new organization";
  - ✓ "Increase the probability to innovate in marketing".

- **Increased government revenue:** Growth in economic output as a result of ICT investment will result in greater tax revenue; in addition, governments can expect increased employment in the telecommunications sector and greater collections from telecommunications licenses and excise.

- **Regional stability through better international and intercultural relations:** Because much of the region's telecommunications bilateral, trans-border traffic demand is currently routed outside of the region, direct connectivity is expected to bring better relations among South-East Asian nations and offers the possibility to promote trans-border initiatives in the education and healthcare sectors that would not otherwise be possible.

From a commercial perspective, UNESCAP can convince private-sector stakeholders of the project's viability by focusing on the cost advantages of constructing reliable, high-capacity international fibre optic paths across all borders (compared with the relatively low-capacity and less-reliable links currently in service). Furthermore, UNESCAP should encourage the development of more robust terrestrial connectivity as a response to telecommunications operators' increasing fear of network outages in undersea networks' geographic "choke points", including the Luzon Strait, the Strait of Malacca, and the Egypt/Red Sea region.

The primary impediments to the construction of new open-access fibre connectivity in the region will likely be the acquisition of funding and opposition from stakeholders with investments in existing networks. Terabit Consulting is strongly convinced that the commercial viability of a pan-Asian terrestrial network can be proven through further consultation with stakeholders and suppliers. Support from certain incumbent operators wary of increased facilities-based competition will likely be won only if those operators can be presented with clear commercial arguments for the network's development.

Roadmap / Next Steps for Pan-Asian Terrestrial Fibre Optic Network Development

Among the items which should be undertaken in order to ensure the successful development of pan-regional terrestrial infrastructure are the following:

- **Evaluation of broadband infrastructure and state-of-play across the entire UNESCAP region and strategy development for linkage to Europe and other intercontinental bandwidth destinations:** In order to be successful, any pan-Asian terrestrial fibre network should be envisioned as a continent-wide initiative providing transit capacity to Europe, North America, and other international destinations, with a particular focus on direct linkages to low-cost Internet hubs in Europe; fibre infrastructure investment confined to the ASEAN region without clear outlets for low-cost intercontinental connectivity would serve a limited purpose and could actually exacerbate broadband inequality by strengthening the position of the region's submarine-cable hubs.

- **Completion of a detailed feasibility study (DFS):** Once the basic parameters of the network's route and design are determined, a detailed economic, financial, and technical analysis of the network's feasibility should be completed.

- **Preliminary rough order of magnitude (ROM) costing exploration with potential suppliers:** The project's proponents should begin engaging with potential network suppliers as soon as possible to derive preliminary budgetary estimates. The ROM costing exploration can be performed within the context of the detailed feasibility study.

- **Determination of support for the project among stakeholders:** The stakeholders in the project – which would include international organizations such as UNESCAP, the region's governments, telecommunications operators, and Internet service providers as identified in each of the country profiles of this report, and operators of complementary infrastructure such as highways, railways, and power transmission networks – should be interviewed to determine levels of support, as well as to solicit possible commitments for participation in the project. This element can also be completed within the context of the detailed feasibility study.

- **Identification of financing options:** Private financing of the project is unlikely and public participation will probably be necessary. Regional governments and other stakeholders should be interviewed to determine available funding based on the findings of the detailed feasibility study.

III. COUNTRY ANALYSIS: CAMBODIA

	YE 2012
Population	14,400,000
Population Growth Rate	*1.2%*
Gross Domestic Product (PPP)	USD$35 billion / $2,400 per capita
GDP Growth Rate	*6.5% in 2012, 6.7% in 2013 (forecast)*
Human Development Index	0.543
HDI Ranking	*138th out of 187 ("Medium")*
Literacy Rate	78%
Fixed-Line Subscribers	600,000
Fixed-Line Operators	1. Telecom Cambodia (Government of Cambodia) 2. Camintel (KTC, Republic of Korea) 3. Mobitel (CamGSM)
Mobile Subscribers	22,000,000
Mobile Operators	1. Metfone (Viettel) 2. Hello (Axiata) / Smart Mobile (Latelz) (Signed merger agreement in Dec. 2012) 3. Mobitel (CamGSM) 4. Beeline Cambodia (Vimpelcom exited by selling shares to local investor in April 2013) 5. Excell (GT-Tell) 6. QBMore (Cambodia Adv. Comm. (CadComms))
Mobile Broadband	WiMax deployment in some urban centres / 4G plans announced by Emaxx (WiMax, Long-Term Evolutrion (LTE)) and Xinwei Technologies (TD-SCDMA)
Regulatory Agency	Regulatory authority transferred from the Ministry of Posts and Telecommunications of Cambodia (MPTC) to the Telecommunications Regulator of Cambodia (TRC)
International Internet Bandwidth	11 Gbps
Int'l Internet Bandwidth per Capita	*0.764 Kbps*
Internet Service Providers	1. Telecom Cambodia 2. Phnom Penh Municipal Cable TV (PPCTV) 3. Ezecom 4. Camintel (KTC)
Broadband Subscribers	65,000 fixed broadband subscribers (>256 Kbps); 1 million mobile broadband subscribers (est.)
Fixed Broadband Technologies	ADSL, fixed wireless, cable modem, FTTH
Typical Monthly Broadband Subscription	1. USD$35 per month + $35 installation/equipment fee for 1 Mbps ADSL (Telecom Cambodia) / 2. USD$99 per month + $140 installation/equipment fee for 1 Mbps ADSL or WiMax (Ezecom)

Telecommunications Market Overview

The Cambodian telecommunications market is dominated by five groups: the Vietnamese military telecommunications operator Viettel, the Malaysian operator Axiata, CamGSM (led by Cambodian investor Kith Meng), government-owned Telecom Cambodia, and the cable and wire manufacturer KTC, Republic of Korea. The Cambodian government indicated its intention to float Telecom Cambodia shares in an initial public offering sometime in 2013, but as of mid-2013 it appeared that the IPO might be delayed due to the company's poor financial health.

International gateways are operated by Telecom Cambodia, Royal Telecam International (a sister company of Ezecom and Telcotech), and Viettel Cambodia.

Despite the strong investment in fibre optic connectivity, the country's national backbone is still considered underdeveloped. Internet costs are excessive in comparison with international norms. The country's unreliable and limited supply of electricity is also a major impediment to widespread adoption of the Internet.

The total annual value of the Cambodian telecommunications market is estimated to be USD$750 million.

Regulation and Government Intervention

The Ministry of Posts and Telecommunications of Cambodia (MPTC) was separated from Telecom Cambodia in January of 2006 and established as the industry's independent policy maker and regulator. In 2012 the Cambodian government passed legislation enabling the creation of the Telecommunications Regulator of Cambodia (TRC) to assume regulatory responsibility from the MPTC. Many operators welcomed the move, pointing to the allocation of overlapping frequency licenses awarded to telecommunications operators and broadcasters in 2005 and 2010.

In 2003 the Cambodian government announced a policy to promote information and communication technologies (ICT) as an enabler of social and economic development. The government subsequently established the National ICT Development Authority (NiDA), which was given responsibility for ICT policy and strategies, especially those projects seeking to promote e-government, including the government administrative information system (GAIS) and the provincial administrative information system (PAIS). As of 2012, NiDA was actively developing a national legal and regulatory ICT framework.

Fixed-Line Telephony Market

There are a total of seven licensed fixed-line operators: Camintel, Telecom Cambodia, Viettel Cambodia (Metfone), and the wireless local loop operators CamGSM, Hello, Mfone, and Sotelco.

Mobile Telephony Market

There are ten licensed mobile operators serving the Cambodian market: Cadcomms (QBMore), CamGSM (Mobiltel), Camintel, Mfone, GT-Tell (Excell), Hello, Latelz (Smart Mobile), Sotelco (Beeline), Viettel Cambodia (Metfone), and Xinwei. As of 2013, average revenue per user (ARPU) was estimated to be less than USD$2.50 per month.

GSM services operating in the 900 MHz band were introduced in 1992 and 3G was launched in 2008; within three years more than two-thirds of mobile users had migrated to 3G. An Internet service provider, Emaxx, announced in 2011 that it was developing the country's first 4G network, starting with WiMax technology and then expanding its network with Long-Term Evolution (LTE) technology. The mobile licensee Xinwei has also announced an investment in TD-SCDMA technology, and in 2010 a Russian investor, Alltech Telecom, had announced its intention to invest as much as $100 million in a 4G network, although it did not follow through.

The Cambodian mobile industry has seen an influx of foreign investment, including the launch of Viettel Cambodia in November of 2008 and the acquisition of Camintel by wire and cable manufacturer KTC in 2010.

The industry has also undergone significant consolidation within the last year, beginning in late 2012 when the Malaysian operator Axiata Group, the parent company of Hello, announced that it would purchase the holding company controlling Latelz and merge the operations of Latelz and Hello. This was followed by the insolvency of Mfone in early 2013; Mfone had been a subsidiary of satellite operator Thaicom, and its subscribers were transferred to Mobitel. In April of 2013 the Russian investor VimpelCom announced that it had exited the Cambodian market after selling its shares in the Beeline Cambodia operation to its local investor Huot Vanthan.

Internet and Broadband Market

There are more than two dozen licensed Internet service providers in Cambodia. They include AngkorNet, Camintel, Camnet, CityLink, Emaxx, Ezecom, Hello/Smart, Metfone, NeocomISP, Online, Phnom Penh Cable Television (PPCTV), Telecom Cambodia, Telesurf, and WiCAM.

Although there has been increased investment in broadband wireless deployment, the majority of broadband users in Cambodia are connected via DSL. In addition to the key broadband market of Phnom Penh, Telecom Cambodia offers DSL service in many other areas of the country, including along National Highway 1 in Bavet City, Svayrieng Province and Naekleang District; along National Highway 2 in Kamndal City; along National Highway 5 in Kampong Chhang, Posta, Battambang, and Banteay Meanchhey; and along National Highway 6 in Siem Reap Province. Nationwide, fibre-to-the-home (FTTH) subscribers are estimated to number approximately 2,000, and there are also at least a thousand subscribers to broadband satellite services offered via the Thaicom-4 (IPStar) satellite. Fibre-to-the-home and fibre-to-the-building networks are becoming increasingly prevalent in Phnom Penh.

International Internet Bandwidth and Capacity Pricing in Cambodia

Figure 1: International Internet Bandwidth and Capacity Pricing in Cambodia, 2012

International Internet Bandwidth	International Internet Bandwidth per Capita	International Capacity Pricing

11 Gbps	0.764 Kbps	IP Transit: USD$100 per Mbps per month in 2012; $80 in 2013

Source: Terabit Consulting research, Operator data and interviews

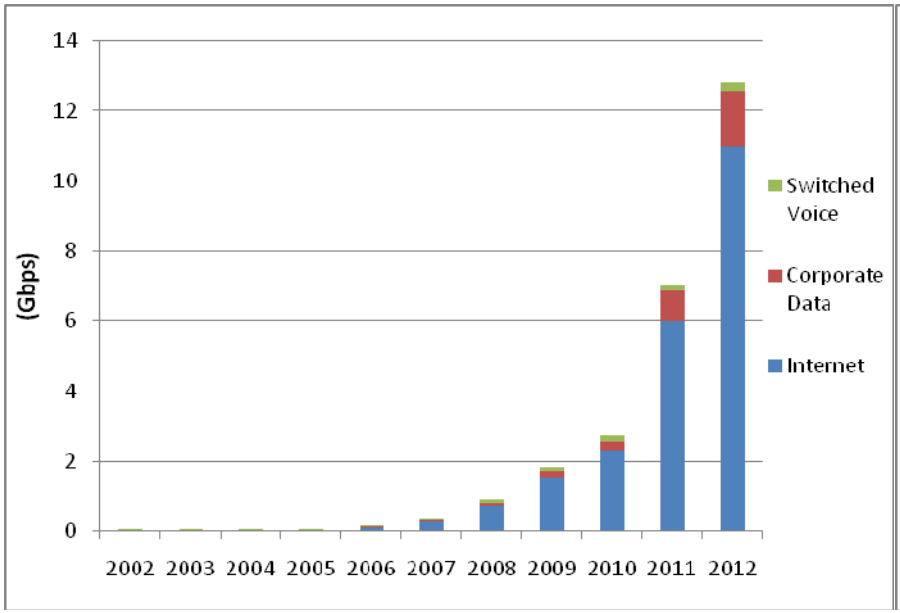
The Ministry of Posts and Telecommunications of Cambodia reported that international bandwidth was 8 Gbps as of the first half of 2012; Terabit Consulting's conversations with sources lead it to believe that this figure grew to 11 Gbps by year-end.

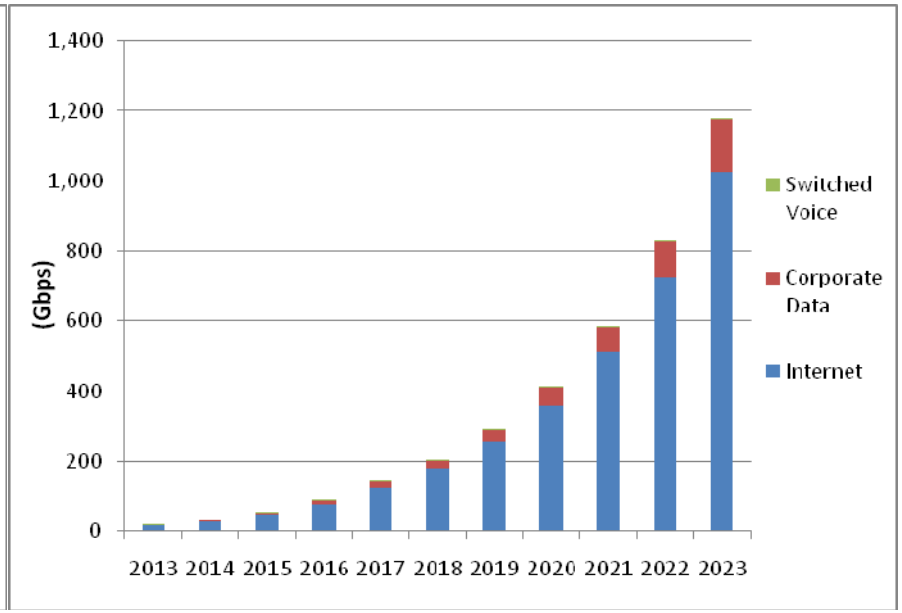
Sources indicated that Cambodian IP transit capacity cost approximately $100 per Mbps as of late 2012, with capacity typically procured to Hong Kong via Viet Nam. As of 2013, Telecom Cambodia advertised IP transit in increments of 11 Mbps to 40 Mbps for $80 per Mbps per month. Price erosion is estimated to have been between 25 and 35 per cent in recent years, with quotes as high as $400 per Mbps per month in 2009.

Figure 2: Historical and Forecasted International Bandwidth in Cambodia (Mbps), 2002-2023

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
International Internet	12	18	18	18	115	270	700	1,500	2,270	6,000	11,000
International Corporate Data	2	3	3	3	16	39	100	215	326	861	1,578
International Switched Voice	44	44	41	45	57	73	94	120	154	197	252
Total International Bandwidth	58	64	61	65	189	382	894	1,835	2,750	7,058	12,830
CAGR (2002-2012)	72%										

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
International Internet	17,941	29,262	47,726	77,841	126,959	179,900	254,919	361,220	511,849	725,290	1,027,736
International Corporate Data	2,574	4,197	6,846	11,166	18,212	25,806	36,567	51,815	73,422	104,039	147,424
International Switched Voice	323	413	529	678	867	1,110	1,421	1,819	2,329	2,981	3,816
Total International Bandwidth	20,838	33,873	55,101	89,684	146,038	206,817	292,907	414,855	587,600	832,311	1,178,976
CAGR (2012-2023)	51%										


14
12
10
8
6
4
2
0
(Gbps)
2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012
Switched Voice
Corporate Data
Internet


1,400
1,200
1,000
800
600
400
200
0
(Gbps)
2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023
Switched Voice
Corporate Data
Internet

International Network Connectivity in Cambodia

➢ Initial Satellite Connectivity

Prior to the advent of fibre optics, Cambodia's international connectivity was provided primarily by satellite earth stations, including the Phnom Penh Intersputnik Earth Station, which was constructed in 1987 on the grounds of Phnom Penh's Roman Catholic cathedral. In 1990 the Australian operator Telstra was awarded a ten-year "business cooperation contract" with the Cambodian Ministry of Posts and Telecommunications (MPTC) and constructed the MPTC 001 international satellite gateway. In 2000 the Takmau Earth Station, located in the capital city of Kandal Province, was constructed by the MPTC in cooperation with Millicom International of Sweden and Royal Group International. In addition, Tele2 (Royal Telecom International) constructed its own 007 international satellite gateways with connectivity via the Thaicom-2 and Apstar-2A satellites.

➢ Thailand-Cambodia-Viet Nam (TCV) (Terrestrial Fibre Optic Network)

Thailand-Cambodia-Viet Nam (TCV)	
Date	Late 1990s
Length	600 kilometres within Cambodia
International Connectivity	- Cambodia-Thailand (Poipet, Cambodia and Aranyaprathet District, Sa Kaeo, Thailand via National Highway 5) - Cambodia-Viet Nam (Bavet, Svay Rieng via National Highway 1)
Main Nodes	Phnom Penh
Capacity	Initial capacity of STM-1 (155.52 Mbps); 4 to 6 fibre pairs per segment
Network Technology	SDH / DWDM
Developers / Owners / Operators / Suppliers	- Commissioned by Ministry of Posts and Telecommunications of Cambodia - Operated by Telecom Cambodia - Developed in partnership with the Communications Authority of Thailand and VNPT - Constructed by ALCO Deutschland - Fibre supplied by Alcatel
Continuity with Rail/Highway	- From Thai border to Phnom Penh via National Highway 5 - From Phnom Penh to Vietnamese border via National Highway 1
Notes	- Funded in part by a USD$9 million grant from the German government (KfW) - Subsequently integrated into the Greater Mekong Subregion (GMS) Information Highway Project

In the late 1990s, the Ministry of Posts and Telecommunications commissioned the construction of a 600-kilometre fibre optic trunk line spanning Cambodia from the Thai border to the Vietnamese border. The network was designated a "Friendship Project" and was funded in part by a USD$9 million grant from the German government through its financing agency KfW.

Constructed in partnership with the Communications Authority of Thailand and VNPT of Viet Nam, TCV crosses the Thai-Cambodian border (at Aranyaprathet District, Sa Kaeo, Thailand and Poipet, Cambodia) via National Highway 5 to Phnom Penh, from which it continues eastward along National Highway 1 to the Vietnamese border at Bavet, Svay Rieng, where it interconnects with VNPT's network.

The contract for the network's construction was awarded to ALCO Deutschland, and fibre was supplied by Alcatel; the network was completed in 1999. TCV initially operated at STM-1 capacity and comprises either four or six fibre pairs, depending on the segment. The system was subsequently expanded to Lao PDR and integrated into a larger, regional network known as the Greater Mekong Subregion (GMS) Information Highway Project, connecting Cambodia, Thailand, Viet Nam, Lao PDR, Myanmar, and Yunnan Province, China.

- Greater Mekong Subregion (GMS) Information Highway Project (Terrestrial Fibre Optic Network)

Greater Mekong Subregion (GMS) Information Highway Project	
Date	December 2007 to June 2009
Length	650 new kilometres within Cambodia (expansion of Thailand-Cambodia-Viet Nam cable)
International Connectivity	- Cambodia-Lao PDR - Cambodia-Thailand - Cambodia-Viet Nam
Main Nodes	Phnom Penh
Capacity	2.5 Gbps initial capacity
Network Technology	SDH / DWDM
Developers / Owners / Operators / Suppliers	- Operated by Telecom Cambodia - Developed in partnership with the Communications Authority of Thailand and VNPT - Supplied by Huawei
Continuity with Rail/Highway	- From Siem Reap via National Route 6 - To the Laotian border via National Route 7
Notes	$17.5 million project partly financed by the Chinese Export-Import Bank

The Thailand-Cambodia-Viet Nam cable installed in the late 1990s was subsequently expanded and integrated into the Greater Mekong Subregion (GMS) Information Highway Project, thereby providing trans-border connectivity to each of Cambodia's three neighbours (Lao PDR, Thailand, and Viet Nam). The new Cambodian segments of the GMS Information Highway Project were installed between December of 2007 and June of 2009; the new work comprised 650 kilometres of new cable and 15 new points-of-presence within Cambodia, following a path from Siem Reap along National Route 6 and National Route 7 to the border with Lao PDR. The $17.5 million network was partly financed by the Export-Import Bank of China and supplied by Huawei. Its initial capacity was 2.5 Gbps. The GMS Information Highway Project includes trans-border links between Cambodia, China, Lao PDR, Myanmar, Thailand, and Viet Nam.

As of 2013, the international links of the GMS Information Highway Project, as well as the Thailand-Cambodia-Viet Nam cable, are operated by Telecom Cambodia.

➢ Telcotech (Ezecom) Connectivity to the Asia-America Gateway Submarine Cable (Terrestrial Fibre Optic Network)

Date	2009-2010 (est.)
Length	570 km within Cambodia (est.)
International Connectivity	- Cambodia-Thailand (Poipet, Cambodia) - Cambodia-Viet Nam (Ponhea Kraek District)
Main Nodes	Phnom Penh
Capacity	Initial capacity of 10 Gbps, upgrade to 100 Gbps announced
Network Technology	SDH / DWDM
Developers / Owners / Operators / Suppliers	- Developed and operated by Telcotech (now Ezecom)
Continuity with Rail/Highway	- National Highway 5 (unconfirmed)
Notes	- Provides access to AAG submarine cable via Thailand and Viet Nam

Cambodia is one of the few coastal countries in the world without direct access to a submarine fibre optic cable. The Asia-America Gateway (AAG) trans-Pacific cable, which entered service in 2010, was initially expected to land in Cambodia, but the original Cambodian member of the consortium, Pacific Communications (PCP Co. Ltd.), was reportedly "removed" from the AAG consortium in February of 2007, and because the AAG construction and maintenance agreement was signed only two months later, the proposed Cambodian landing point was dropped from the project's final configuration.

In November of 2007 a new Cambodian investor, Telcotech (controlled by Cambodian businessman Huot Vanthan), replaced Pacific Communications as the Cambodian member of the AAG consortium. Given the lack of a Cambodian landing point, Telcotech was left to negotiate for AAG bandwidth through "reasonably-priced backhaul agreements" with the cable's landing parties in neighbouring Thailand and Viet Nam.

In order to access those countries' landing points, Telcotech operates an international fibre connection to Thailand which crosses the border at Poipet, Cambodia and continues to the AAG cable station in Si Racha, Thailand operated by CAT Telecom. Telcotech's eastward fibre connection into Viet Nam crosses the border in the Ponhea Kraek District and connects to the AAG cable station in Vung Tau, Viet Nam.

In May of 2011 Telcotech was purchased by the Cambodian Internet service provider Ezecom (a subsidiary of Royal Group); Ezecom's chief executive officer Paul Blanche-Horgan said that "the main reason for buying the company was the AAG cable, which is really important for Cambodia". In 2012 the transborder capacity of Ezecom's network was reported to be 10 Gbps, but Mr. Blanche-Horgan indicated that an upgrade to 100 Gbps was expected.

➢ Viettel Cambodia-Viet Nam (Terrestrial Fibre Optic Network)

Viettel Cambodia (the Vietnamese operator also known as the Military Telecommunications Company) operates an international fibre connection to Viet Nam that consists of dual paths to Phnom Penh, with one segment along National Highway 2 and another along National Road 21.

- Cambodia-Viet Nam High-Speed Transmission Line (Terrestrial Fibre Optic Network)

Telecom Cambodia and VNPT subsidiary Vietnam Telecom International (VTI) announced the launch of the Cambodia-Viet Nam High-Speed Transmission Line (also known as the Cambodia-Viet Nam Super Highway) in April of 2012, comprising a 260-kilometre fibre optic link between Phnom Penh, Cambodia and Ho Chi Minh City, Viet Nam. The initial capacity of the link was 10 Gbps.

- Proposed International Connectivity

The Thailand-Cambodia-Viet Nam-Hong Kong Fibre Highway initiative was announced in March of 2012 as a partnership between NeocomISP of Cambodia (a subsidiary of NTC), Donghwa Telecom of Hong Kong, China (a subsidiary of Chunghwa Telecom of Taiwan Province of China), Vietnam Telecom International (VTI, a subsidiary of VNPT), and TCC Technology of Thailand. The initiative integrates the existing fibre networks of each investor under a single network management system, providing a ring architecture operating at multiple STM-64 (10 Gbps) wavelengths. The network would allow access to international submarine cables in Hong Kong, China.

Local media reported in June of 2012 that the Thai operator TOT had formed a partnership with China Telecom to construct terrestrial fibre optic connectivity between Thailand, Cambodia, and Viet Nam as part of a network that would also serve Lao PDR, China, and Russia. Other potential partners in the project include AT&T (via its joint venture with China Telecom, known as Shanghai Symphony Telecom) and NTT DoCoMo.

In January of 2013 the Ministries of Posts and Telecommunications of both Cambodia and the Lao People's Democratic Republic signed a memorandum of understanding for the improvement of fibre optic connectivity between the two countries.

In addition to the proposed terrestrial projects, a new Cambodia Submarine Cable Project has been proposed since 2008. The project was first publicly announced in June of 2008 when the chairman of Telcotech, Huot Vanthan, told the Phnom Penh Post that in partnership with an American investor he would "spend [his] own money and help connect Cambodia to the world". At the time, the project was planned as a link between Sihanoukville, Cambodia and Japan with a target ready-for-service date of mid-2010. In the years that followed, there was little news of the project except a *Phnom Penh Post* article published in 2009 claiming that the project may have morphed into an extension of the Asia-America Gateway (AAG) trans-Pacific submarine cable project. In mid-2013, Telcotech's successor Ezecom indicated that it would construct a 1,425-kilometre submarine cable from Sihanoukville, Cambodia to Kuantan, Malaysia at a cost of USD$80 million. Ezecom said that the cable would interconnect with AAG and be constructed in partnership with Telekom Malaysia as well as an as-yet unnamed Thai operator, with ready-for-service expected in late 2014.

Domestic Network Connectivity in Cambodia

Approximately 25,000 kilometres of domestic fibre optic cable has been deployed in Cambodia. Three operators account for the vast majority of deployment: Cambodia Fibre Optic Communication Network Company (CFOCN), Metfone (a subsidiary of Viettel), and Telecom Cambodia.

Telecom Cambodia's primary backbone includes the segments of the Thailand-Cambodia-Viet Nam cable linking (from west to east) Poipet, Battambong, Pursat, Kampong Chhnang, Phnom Penh, Neak Leung, Svay Rieng, and Bavet, as well as the Greater Mekong Subregion Information Highway Project linking (from west to north) Siem Reap, Dom Dek, Kampong Thom, Kampong Thom, Kampong Cham City, Kratie, and Stung Treng.

A fibre network connecting Phnom Penh south to the port city of Sihanoukville (on the Gulf of Thailand) and north to Kampong Cham was financed by the Japanese Bank for International Cooperation (JBIC).

The Metfone (Viettel) domestic network follows National Highway 2 from Viet Nam to Phnom Penh via Takeo, while an eastern path follows National Road 21. From Phnom Penh the network follows National Highway 5 to Siem Reap.

Cambodia Fibre Optic Communication Network Company's network consists of a fibre optic backbone approximately 5,000 kilometres in length, as well as a 150-kilometre duct-based metropolitan network in Phnom Penh. CFOCN, a subsidiary of International Telecommunications Holdings Limited (which in turn seems to be controlled by Chinese investors) claims to have invested approximately USD$100 million in the construction of the network.

Evaluation of Trans-Border Network Development and Identification of Missing Links

Fibre connectivity is present on each of Cambodia's three international borders and is operated by Telecom Cambodia, Viettel Cambodia (Metfone), and Ezecom; the latter is a leading provider of wholesale bandwidth to smaller Internet service providers and operators. The volume of bilateral international traffic between Cambodia and its neighbours is minimal, but Cambodian international transit traffic via Thailand and Viet Nam is considerable, as Cambodia is without direct submarine connectivity and can only access international submarine cable infrastructure via those two countries. However, terrestrial transit demand via Thailand and Viet Nam is expected to decrease if Ezecom or another entity succeeds in constructing direct submarine connectivity to Cambodia.

Currently, connectivity between Cambodia and its neighbours Thailand and Viet Nam is considered to be well-developed and fairly competitive. The border between Cambodia and Lao PDR, on the other hand, is served by only one link, owned by Telecom Cambodia. Other Cambodian operators should be consulted as to whether there is demand for additional fibre infrastructure along the Cambodia-Lao PDR route; Terabit Consulting's analysis indicates that only a small percentage of Cambodian demand is directed toward Lao PDR, while the vast majority of Cambodian demand is directed toward North American and European destinations.

There are good highway links between Cambodia and all three of its neighbours; an inactive rail link connects Cambodia and Thailand, while a link between Cambodia and Viet Nam is under consideration.

Figure 3: Evaluation of Trans-Border Networks in Cambodia and Recommendations for Improvement

International Border (and border length)	Existing Fibre Infrastructure	Analysis	Recommendation	Linkage with Rail & Highway Networks	Stakeholders
Cambodia to Lao PDR (541 kilometres) *Low Priority*	• Greater Mekong Subregion Information Highway Project (Cambodia-Lao PDR segment)	Existing fibre infrastructure is weak and capacity is controlled by Telecom Cambodia; however, traffic demand between the two countries is minimal and Lao PDR offers no international submarine connectivity.	Additional fibre connectivity between Cambodia and Lao PDR would increase accessibility for non-incumbent operators, but demand along the route is minimal and the link would likely have little traffic.	Rail: No direct links (service via Thailand) Highway: Cambodia National Highway 7 and Lao PDR Route 13	Competitive operators without capacity on the route (i.e. non-Telecom Cambodia) should be consulted as to demand for connectivity.
Cambodia to Thailand (803 kilometres) *Medium Priority*	• Thailand-Cambodia-Viet Nam / Greater Mekong Subregion Information Highway Project • Telcotech (Ezecom) AAG backhaul network	The route provides one of Cambodia's primary paths to international submarine connectivity and has limited competition, with both Telecom Cambodia and Telcotech operating infrastructure.	Development of Cambodian submarine connectivity is uncertain, so the country is strongly dependent on its terrestrial links, and consumer prices remain extremely high, in part due to limited infrastructure competition.	Rail: Direct link, no longer active Highway: Cambodia National Highway 5 at Poipet	Both Telecom Cambodia and Ezecom own fibre to Thailand, but the route's role as Cambodia's primary outlet means that other operators should be consulted as to capacity accessibility and affordability.
Cambodia to Viet Nam (1,228 kilometres) *Low Priority*	• Thailand-Cambodia-Viet Nam / Greater Mekong Subregion Information Highway Project • Telcotech (Ezecom) AAG backhaul network	One of Cambodia's primary paths to international submarine connectivity; multiple operators and	Demand will depend on development of Cambodia's own submarine network, as well as Thai submarine capacity pricing.	Rail: None; direct link may be funded by Chinese gov't	Smaller carriers could be consulted but wholesale offerings from Ezecom, Telecom Cambodia, and Viettel Cambodia provide

	• Viettel Cambodia-Viet Nam • Cambodia-Viet Nam High-Speed Transmission Line	networks are present.		Highway: NH 1	multiple options for capacity purchasers.

IV. COUNTRY ANALYSIS: INDONESIA

	YE 2012
Population	242,800,000
Population Growth Rate	*1.2%*
Gross Domestic Product (PPP)	USD$1.2 trillion / $4.900 per capita
GDP Growth Rate	*6.3% in 2012, 6.8% in 2013 (forecast)*
Human Development Index	0.629
HDI Ranking	*121st out of 187 ("Medium")*
Literacy Rate	93%
Fixed-Line Subscribers	40,000,000
Fixed-Line Operators	1. PT Telekomunikasi Indonesia (Telkom) (Gov't of Indo. 54%) 2. PT Bakrie Telecom (subsidiary of Bakrie Group) 3. PT Smartfren Telecom (subsidiary of Sinar Mas Group) 4. PT Indosat (Indosat)
Mobile Subscribers	290,000,000
Mobile Operators	1. Telkomsel (PT Telekomunikasi 65%, Singtel 35%) 2. PT Indosat (Indosat) (subsidiary of MNC Media) 3. XL Axiata (XL) (Sister company of Celcom (Malaysia)) 4. 3 Indonesia (Hutchison Charoen Pokphand Telecom) (subsidiary of Hutchison Group) 5. 5. PT Axis Telekom Indonesia (Axis) 6. PT Bakrie Telecom (subsidiary of Bakrie Group) 7. PT Smartfren Telecom (subsidiary of Sinar Mas Group) 8. Ceria (PT Sampoerna Telekomunikasi Indonesia, a subsidiary of Sampoerna Strategic Group)
Mobile Broadband	High mobile data usage, with Telkomsel reporting more than 60 million mobile data users, and XL reporting approximately 25 million. There has been limited adoption of WiMax, and Telkomsel has set a goal of launching LTE in Jakarta, Bali, Medan, and Manado in late 2013.
Regulatory Agency	Indonesian Telecommunications Regulatory Body (Badan Regulasi Telekomunikasi Indonesia (BRTI))
International Internet Bandwidth	250 Gbps
Int'l Internet Bandwidth per Capita	*1.030 Kbps*
Internet Service Providers	1. Speedy (PT Telekomunikasi Indonesia – Telkom) 2. FastNet (FirstMedia) 3. MetroNET (Biznet) 4. CepatNet 5. Max3 6. i-Direct
Fixed Broadband Subscribers	3,000,000 fixed broadband subscribers (>256 Kbps); 30 million mobile broadband subscribers (est.)
Fixed Broadband Technologies	ADSL, fixed wireless, cable modem, FTTH, broadband satellite
Typical Monthly Broadband Subscription	1. USD$66 per month + $8 install. for 1 Mbps unlimited ADSL; limited bandwidth packages $21/mo. (Speedy) / 2. $62 /mo. + $103 install. for 1 Mbps unlimited FTTB (Biznet) / 3. $20 /mo. + install. for 1 Mbps unlimited cable modem (FastNet)

Telecommunications Market Overview

The Indonesian telecommunications market is reasonably competitive, although PT Telekomunikasi (Telkom) holds market shares that are at least twice as large as its competitors in the fixed-line, mobile, and broadband markets. The Indonesian mobile market is by most estimates either the fifth- or sixth-largest in the world in terms of subscribers.

Perhaps the greatest challenge facing the Indonesian telecommunications industry is providing connectivity throughout the archipelago's 17,500 islands and 34 provinces, particularly in rural areas and less economically developed provinces in the country's east. Recent initiatives such as the Palapa Ring have sought to provide more equitable broadband connectivity to each of the country's provinces.

In May of 2012 it appeared as though Indonesia's largest operator might become a key player in the region's submarine cable and wholesale capacity markets when PT Telekomunikasi indicated that it would submit an offer for Pacnet, Asia's largest submarine cable operator and owner of the C2C and EAC undersea systems. PT Telkom said that it expected financial closure of the transaction by mid-year. However, in late May, shortly after PT Telkom's announcement, Pacnet abruptly issued a statement that its long-time CEO Bill Barney "is no longer serving as chief executive officer and the board of directors thank him for his service to Pacnet". Just as abruptly, the CEO of PT Telekomunikasi said on 5th June that "we cancel our plan to buy Pacnet because it doesn't bring added value to the company". So ended a brief courtship that would have had the potential to significantly alter the Asian telecommunications landscape; rumours abound as to the circumstances that shaped the events.

The Indonesian telecommunications market is estimated to be worth $15 billion annually.

Regulation and Government Intervention

The Indonesian telecommunications market is regulated by the Indonesian Telecommunications Regulatory Body, known in Indonesian as the Badan Regulasi Telekomunikasi Indonesia (BRTI).

Fixed-Line Telephony Market

The country's largest fixed-line operator is PT Telekomunikasi Indonesia (Telkom), in which the Government of Indonesia retains a 54 per cent stake. PT Telkom is estimated to have a 63 per cent share of the fixed-line market. Other fixed-line operators include PT Bakrie Telecom, a subsidiary of the Bakrie Group, which is estimated to serve 30 per cent of fixed lines, Smartfren (formerly Mobile 8) with 5 per cent, and PT Indosat with 2 per cent.

Mobile Telephony Market

Telkomsel, a partnership that is 65per cent owned by PT Telekomunikasi and 35 per cent owned by Singtel, is the leading mobile operator with 42 per cent of subscribers. PT Indosat, a subsidiary of MNC Media, has an 18 per cent market share; XL Axiata, a sister company of the Malaysian operator Celcom, has 16 per cent; Hutchison's subsidiary 3 Indonesia has an 8 per cent share; and PT Axis Telekom Indonesia has 6 per cent. Other operators include PT Bakrie Telecom, PT Smartfren

Telecom (a subsidiary of Sinar Mas Group), and Ceria (also known as PT Sampoerna Telekomunikasi Indonesia, a subsidiary of Sampoerna Strategic Group).

Average revenue per user (ARPU) is estimated to be approximately USD$3.50 per month.

Internet and Broadband Market

PT Telekomunikasi's broadband offering, Speedy, has an estimated 73 per cent share of the fixed broadband market, primarily via ADSL connections. Other Indonesian broadband operators include FirstMedia's FastNet, Biznet Network's MetroNET, CepatNet, Max3, and i-Direct.

Fibre-to-the-home (FTTH) is available in Jakarta, Bandung, and Surabaya, but Indonesian authorities have increasingly promoted 2.3-GHz broadband wireless access (BWA) and 3G/HSPA services as a solution for providing nationwide broadband connectivity.

In 2012 the commissioner of the Indonesian telecommunications regulator BRTI, Heru Sutadi, said that all of the nation's 72,000 villages and half of the Indonesian population would be connected to the Internet, in compliance with the country's World Summit on the Information Society (WSIS) commitments.

International Internet Bandwidth and Capacity Pricing in Indonesia

Figure 4: International Internet Bandwidth and Capacity Pricing in Indonesia, 2012

International Internet Bandwidth	International Internet Bandwidth per Capita	International Capacity Pricing
250 Gbps	1.030 Kbps	IP Transit: USD$60 to $70 per Mbps per month

Source: Terabit Consulting research, Operator data and interviews

Indonesia's total international Internet bandwidth was 250 Gbps as of year-end 2012. Telkom reported that it had increased its international capacity to 100 Gbps in mid-2011. The largest tier-1 Internet service providers in Indonesia, in descending order of international bandwidth, are as follows:

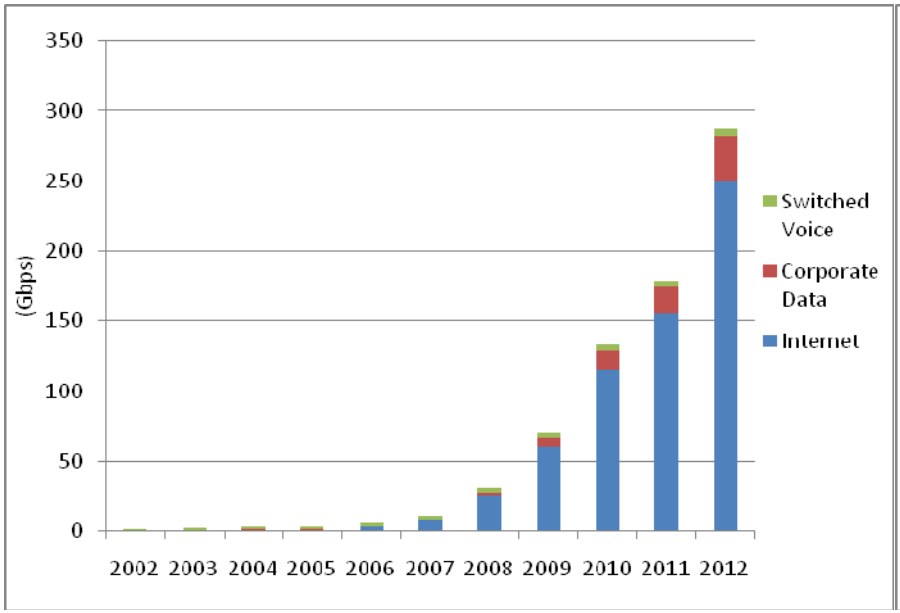
- PT Telekomunikasi Indonesia Tbk (Telkom);
- PT Indosat Tbk (Indosat);
- PT Mora Telematika Indonesia (Moratelindo);
- PT NAP Info Lintas Nusa (NAP Info);
- PT XL Axiata Tbk (XL).

PT Telkom's international subsidiary, Telin, indicated that in 2009 the price of IP transit in Jakarta ranged from USD$200 to $300 per Mbps per month, but in 2009 the range fell to $150-$250, and in 2011 it ranged from $100 to $160. As of year-end 2012, sources indicated to Terabit Consulting that IP transit capacity could be procured for as low as $60 to $70 per Mbps.

Figure 5: Historical and Forecasted International Bandwidth in Indonesia (Mbps), 2002-2023

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
International Internet	573	1,059	1,507	1,507	3,472	7,883	25,096	60,000	115,000	155,000	250,000
International Corporate Data	72	134	191	191	439	997	3,173	7,587	14,541	19,599	31,611
International Switched Voice	1,304	1,500	1,725	1,983	2,281	2,623	3,016	3,469	3,989	4,588	5,276
Total International Bandwidth	1,950	2,693	3,422	3,681	6,192	11,503	31,286	71,056	133,530	179,187	286,887
CAGR (2002-2012)	65%										

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
International Internet	362,250	524,900	760,580	1,102,081	1,584,793	2,278,932	3,277,104	4,712,475	6,776,540	9,744,664	14,012,827
International Corporate Data	45,805	66,371	96,172	139,353	200,389	288,160	414,373	595,869	856,860	1,232,164	1,771,852
International Switched Voice	6,067	6,977	8,024	9,227	10,611	12,203	14,033	16,138	18,559	21,343	24,545
Total International Bandwidth	414,122	598,248	864,776	1,250,661	1,795,793	2,579,294	3,705,511	5,324,483	7,651,958	10,998,171	15,809,223
CAGR (2012-2023)	44%										


350
300
250
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150
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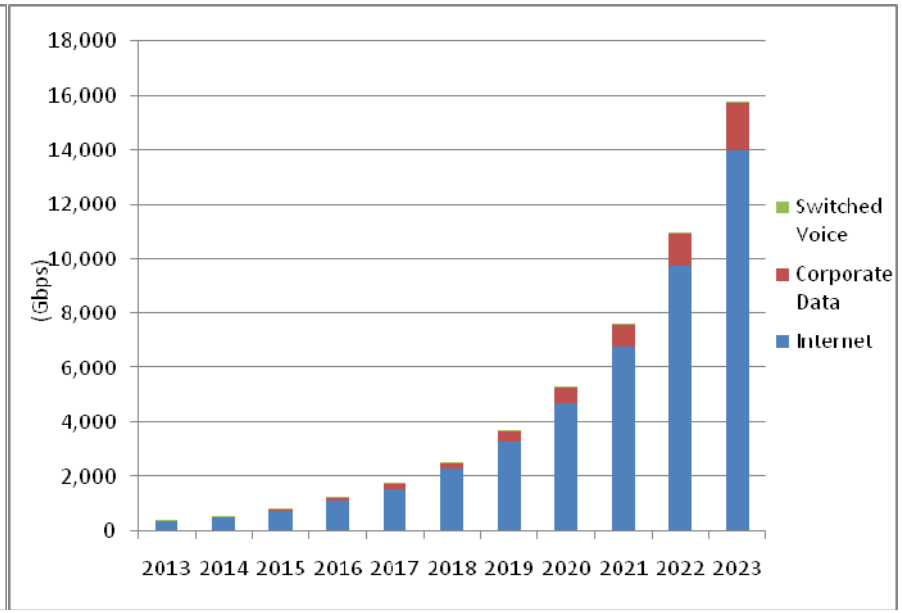
(Gbps)
2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012
Switched Voice
Corporate Data
Internet


18,000
16,000
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4,000
2,000
0
(Gbps)
2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023
Switched Voice
Corporate Data
Internet

International Network Connectivity in Indonesia

Indonesia's interregional fibre optic capacity has remained limited; as of 2013 only SEA-ME-WE-3 provides intercontinental connectivity. However, between 2003 and 2010 six submarine cable systems were constructed between Indonesia and Singapore, with an additional three undersea cables constructed to Malaysia and Thailand. As a result of the half-dozen systems constructed between Indonesia and Singapore within the last decade, the majority of Indonesia's international Internet bandwidth now transits through Singapore. This trend was reinforced by the construction of the Asia-America Gateway (AAG) system, a trans-Pacific cable with landing points in Singapore and throughout South-East Asia, in which PT Telkom is a major investor but which includes no direct landing point in Indonesia. PT Telkom accesses AAG via its Batam-Singapore Cable System (BSCS), a 55-kilometre link constructed in 2009.

Increasingly, industry observers in Indonesia have pointed to a comparative shortage of direct interregional bandwidth as potentially placing the country at a competitive disadvantage versus Malaysia and Singapore in capturing foreign IT investment.

Figure 6 shows all interregional fibre optic submarine cable systems serving Indonesia.

Figure 6: Interregional Submarine Fibre Optic Systems Serving Indonesia

	Ready-for-Service Date	Status	Route (km)	Finance Type	Owner(s)	Cost ($Mil)	System Lit Capacity (Gbps)	System Design Capacity (Gbps)
SEA-ME-WE-2 (SMW2)	1994	Retired	18,337	Consortium	International consortium of carriers	$780	0	[1]
Asia-Pacific Cable Network (APCN)	1997	Retired	12,083	Consortium	International carrier consortium	$644	10	10
Jasaurus	1997	Retired	2,809	Consortium	PT Indosat, Telstra, Optus	$65	5	5
SEA-ME-WE-3 (SMW3)	1999	Active	39,000	Consortium	International consortium of carriers	$1,300	200	600

As noted above, PT Telkom is also a consortium member in the trans-Pacific **Asia-America Gateway (AAG)** system, which lands in Singapore and entered service in January of 2010.

The country is served by nine regional submarine systems, which provide connectivity primarily to Singapore and Malaysia:

- **Thailand-Indonesia-Singapore,** which entered service in 2003 and was constructed by CAT, PT Telekomunikasi Indonesia, and Singtel;
- Sacofa Sdn Bhd's **East-West Submarine Cable System,** which entered service in 2004 between Peninsular and Sarawak Malaysia, with intermediate landing points in Indonesia;

- The **Dumai-Melaka Cable System (DMCS),** which entered service in 2005 as a joint project between PT Telekomunikasi and Telekom Malaysia;

- The **Batam-Rengit Cable System (BRCS),** which entered service in 2007 and was developed by Indonesian mobile operator PT XL Axiata and Telekom Malaysia;

- The **Matrix Cable System (MCS),** which connected Jakarta and Singapore in 2008 and was constructed by PT NAP Info Lintas Nusa of Indonesia and its affiliate Matrix Networks of Singapore;

- The **Moratelindo International Cable System-1 (MIC-1),** which entered service in 2008 connecting Batam, Indonesia to Singapore, constructed by PT Mora Telematika Indonesia and ViewQwest (a Singaporean operator that began operations in 2001 as a subsidiary of the Comcraft Group, an East African mining company);

- PT Telekomunikasi Indonesia's **Batam-Singapore Cable System (BSCS),** which entered service in 2009;

- PT Indosat's **Jakabare (Java-Kalimantan-Batam-Singapore**) system, which entered service in 2009;

- The **PGASCOM Java-Sumatra-Batam-Singapore** system, which entered service in 2010 and is operated by Indonesia's largest natural gas company, PT PGAS Telekomikasi Nusantara, also known as PGASCOM;

- The **Batam-Dumai-Malacca Cable System (BDM)**, which was activated in 2011 and constructed by the Indonesian operators PT XL Axiata and Moratelindo (PT Mora Telematika) in partnership with Telekom Malaysia.

Other regional submarine cable systems are either under construction or have been proposed, including the following:

- The **BIMP-EAGA submarine cable system,** which would connect Malaysia, Indonesia, Brunei, and the Philippines and which has been proposed by the Brunei Darussalam-Indonesia-Malaysia-Philippines-East ASEAN (Association of Southeast Asian Nations) Growth Area (BIMP-EAGA) initiative, with support from ten organizations, including PT Telekomunikasi Indonesia International, the subsidiary responsible for PT Telkom's overseas investments;

- Proposed cables that would connect **Singapore, Indonesia, and Australia** currently being promoted by several investors, including **ASSC-1** (JPC International)**, Leighton Contractors Telecommunications**, **Matrix Networks, PT NAP Info Lintas Nusa,** and subpartners.

Domestic Network Connectivity in Indonesia

Domestic Indonesian submarine cables, totalling 11,554 kilometres in length, include:

- **Surabaya-Banjarmasin (Packet-1)** (1992);
- **Java-Bali** (1995);
- **Jakarta-Surabaya (SKKL-JS)** (1997);
- **Pangkalpinang-Pontianak** (1997);
- **Surabaya-Ujung Pandang-Banjarmasin** (1999);
- **Kalianda-Anyer** (2000);
- **XL Axiata Phase 1 Submarine Cable Project** (2004);
- **XL Axiata Phase 2 Submarine Cable Project** (2005);
- **Sumatra Backbone Project** (2005);
- **Jasuka Backbone Ring (Jakarta-Sumatra-Kalimantan)** (2006);
- **Jakasusi (Java-Kalimantan-Sulawesi)** (2007);
- **Jasutra (Java-Sumatra)** (2007);
- **Sumatra-Java-Java-Kalimantan (SJJK)**(2009);
- **JaKa2LaDeMa** (2010);
- **Mataram-Kupang Cable System (MKCS)**(2011).

The Palapa Ring, also known as the Nusantara Super Highway Project, would bring fibre optic connectivity throughout Indonesia. The plans for the project call for an ultimate investment of $700 million and deployment of 35,278 undersea kilometres and 20,737 terrestrial fibre optic kilometres. Construction of the Eastern Ring, connecting the Indonesian provinces of Papua, Maluku, and East Nusa Tenggara, had originally been scheduled to begin in 2008 and to be completed by 2012. The Middle Ring, connecting Sulawesi, West Nusa Tenggara, and Kalimantan, was to have begun construction in 2013 and to have been completed by 2016. The final segments of the network, connecting Java and Sumatra, were to have been upgraded during the period between 2017 and 2020.

As of early 2009 it appeared as though the first phase of the network would comprise undersea segments connecting the following landing points throughout Indonesia: Waingapu, East Nusa Tenggara; Ende, East Nusa Tenggara; Makassar, South Sulawesi; Maumere, Flores; Kupang, East Nusa Tenggara; Ambon, Maluku; Watampone, Sulawesi Tengah; Kendari, Sulawesi Tenggara; Kolaka, Sulawesi Tenggara; Kwandang, Gorontalo; Gorontalo, Gorontalo; Parigi, Sulawesi Tengah; Manado, North Sulawesi; Bitung, North Sulawesi; Ternate, North Maluku; Weda, North Maluku; Sorong, West Papua; Manokwari, West Papua; Biak, Papua; Sarmi, Papua; Jayapura, Papua; Timika, Papua; Merauke, Papua; Bulukumba, South Sulawesi; Fak-Fak, West Papua; Mataram, West Nusa Tenggara; and Raba, Sumbawa.

The "management committee of the Palapa Ring consortium", with a listed address at the offices of PT Telekominkasi, issued a request for proposals in early 2008, at which time a ready-for-service date of late 2009 or early 2010 was set.

PT Telkom considers the Mataram-Kupang Cable System (MKCS), a 1,041-kilometre undersea cable combined with 810 kilometres of new fibre deployment, as the first phase of deployment of the Palapa Ring. A supply contract for the MKCS system was signed in late 2009 and the system entered service in April of 2011. Undersea segments connect Mataram, West Nusa Tenggara; Sumbawa Besar, West Nusa Tenggara; Raba, Sumbawa, West Nusa Tenggara; Waingapu, East Nusa Tenggara; and Kupang, East Nusa Tenggara.

In August of 2010, the chief executive officer of PT Telkom, Rinaldi Firmansyah, told analysts during an earnings conference call that the Palapa Ring project had been "open to all operators", but that the number of operators participating in the consortium shrank from nine to three, "and when we decided to build, the number declined again only to us, to one".

In December of 2010 the Indonesian Minister of Communications and Information Technology, Tifatul Sembiring, said that the Palapa Ring project had been delayed due to financing difficulties but that "the Finance Ministry has approved the plan" and the project was expected to be completed by 2012.

In mid-2012 PT Telkom issued a tender for the construction of what it identified as Palapa Ring's second phase, a 5,600-kilometre undersea link between Manado and Papua known as the Sulawesi-Maluku-Papua Cable System (SMPCS), estimated to cost $250 million and be ready-for-service in 2013. In late 2012, Mr. Sembiring, the Communications and IT minister, said that the Palapa Ring project would be completed by 2014, thus finally bringing broadband connectivity throughout Indonesia's eastern provinces, including Papua.

The Indonesian government has overseen the implementation of very small aperture terminals (VSATs) to provide satellite connectivity to a total of 7,773 villages in 10 eastern provinces (Sulawesi Selatan, Sulawesi Barat, Sulawesi Tenggara, Sulawesi Tengah, Gorontalo, Sulawesi Utara, Maluku Utara, Maluku, Papua Barat, and Papua).

Evaluation of Trans-Border Network Development and Identification of Missing Links

Indonesia has only three terrestrial borders; the only one which it shares with another ASEAN country is its 1,782-kilometre border with Malaysia on the island of Borneo (Indonesia's other two borders are shared with Timor-Leste and Papua New Guinea).

Terabit Consulting was not able to identify any existing terrestrial fibre optic connectivity between Indonesia and Malaysia and believes that a new fibre link between West Kalimantan, Indonesia and Sarawak, Malaysia would be a boon to the region's connectivity, given the strong linguistic, economic, and cultural links between the two countries. Given the poor state of highway and rail infrastructure between the two countries, Terabit Consulting recommends that the link be pursued within the context of the proposed Trans Borneo Power Grid's West Kalimantan-Sarawak segment.

Figure 7: Evaluation of Trans-Border Networks in Indonesia and Recommendations for Improvement

International Border (and border length)	Existing Fibre Infrastructure	Analysis	Recommendation	Linkage with Rail & Highway Networks	Stakeholders
Indonesia to Malaysia (1,782 kilometres) *High Priority*	• No fibre connectivity identified	Although undersea connectivity exists between Indonesia and Malaysia, no direct connectivity is present between the countries' states on the island of Borneo.	A new terrestrial fibre link between Indonesia and Malaysia would greatly improve the region's connectivity and is warranted by the countries' linguistic, economic, and cultural ties. Such a link would also improve connectivity to the Malaysian states of Sabah and Sarawak, which have traditionally relied upon transit capacity through Peninsular Malaysia.	<u>Rail:</u> No direct links <u>Highway:</u> Secondary highway crossing between Entikong, Indonesia and Tebedu, Malaysia	The Asian Development Bank is reportedly exploring the feasibility of constructing a West Kalimantan-Sarawak segment on the proposed Trans Borneo Power Grid and should be consulted, as should the region's operators.

V. COUNTRY ANALYSIS: LAO PEOPLE'S DEMOCRATIC REPUBLIC

	YE 2012
Population	6,523,000
Population Growth Rate	*1.8%*
Gross Domestic Product (PPP)	USD$19 billion / $2,900 per capita
GDP Growth Rate	*8.2% in 2012, 7.5% forecasted in 2013*
Human Development Index	0.543
HDI Ranking	*138th out of 187 ("Medium")*
Literacy Rate	78%
Fixed-Line Subscribers	300,000
Fixed-Line Operators	1. Lao Telecommunications Company Ltd. (Laotel/LTC) (Government of Lao PDR 51%, and Shenington Investments (Thaicom) 49%) 2. Enterprise of Telecommunications Lao (ETL) (Government of Lao PDR) 3. Unitel (Star Telecom Joint Venture Company formed by Lao-Asia Telecom Company (LAT) (Ministry of Defence of Lao PDR) and Viettel))
Mobile Subscribers	5,800,000
Mobile Operators	1. Lao Telecommunications Company Ltd. (Laotel/LTC) 2. Enterprise of Telecommunications Lao (ETL) (Government of Lao PDR) 3. Unitel (Star Telecom Joint Venture Company) 4. Beeline Lao (VimpelCom Lao)
Mobile Broadband	LTC launched limited 3G service in 2008, followed by Unitel and Beeline Lao. In 2012, Beeline and LTC reported that they were each testing LTE and LTC reported that it would soon launch WiMax service.
Regulatory Agency	National Authority of Posts and Telecommunication (NAPT/ANPT)
International Internet Bandwidth	2.5 Gbps
Int'l Internet Bandwidth per Capita	*0.383 Kbps*
Internet Service Providers	1. Lao Telecommunications Company Ltd. (Laotel/LTC) 2. Enterprise of Telecommunications Lao (ETL) (Government of Lao PDR) 3. Unitel (Star Telecom Joint Venture Company) 4. Beeline Lao (VimpelCom Lao)
Fixed Broadband Subscribers	40,000 fixed broadband subscribers (>256 Kbps); 300,000 mobile broadband subscribers (est.)
Fixed Broadband Technologies	ADSL, fixed wireless, broadband satellite
Typical Monthly Broadband Subscription	USD$33 per month for 1 Mbps ADSL (ETL, Unitel)

Telecommunications Market Overview

The Laotian telecommunications market is served largely by four groups: Lao Telecommunications Company (LTC or Laotel), Enterprise of Telecommunications Lao (ETL), Unitel, and Vimpelcom Lao.

LTC and ETL are both government-controlled, and collectively they control 83 per cent of the fixed-line market, 75 per cent of the mobile market, and as much as 75 per cent of the Internet market.

Lao Telecommunications Company was formed in 1996 and is currently 51 per cent owned by the Government of Lao PDR and 49 per cent owned by Shenington Investments, a subsidiary of satellite operator Thaicom.

Enterprise of Telecommunications Lao was incorporated in its most recent form in 2000 as a fully state-owned enterprise.

Unitel, also known as the Star Telecom Joint Venture Company, was formed by Lao-Asia Telecom Company, with 51 per cent, and Viettel Global with 49 per cent. Lao-Asia Telecom Company is controlled by the Laotian Ministry of Defence, while Viettel is operated by the Vietnamese Ministry of Defence.

Vimpelcom Lao was originally formed in 2003 as Millicom Lao, a partnership between Millicom with 78 per cent and the Government of Lao PDR with 22 per cent; in 2009 VimpelCom of Russia announced its intention to purchase Millicom's stake for $65 million and the transaction was approved by the Laotian government in 2011. The company was subsequently renamed under the Beeline brand.

The Laotian telecommunications market is estimated to be worth USD$300 million annually.

Regulation and Government Intervention

The National Authority of Posts and Telecommunication (NAPT/ANPT) was given its mandate in 2007 and the country's telecommunications market currently operates within the context of the 2011 Telecommunications Law.

Fixed-Line Telephony Market

Official figures indicate that fixed-line subscriptions tripled from 100,000 in 2008 to 300,000 in 2011. Lao Telecommunications Company has an estimated market share of 60 per cent, while Enterprise of Telecommunications Lao has an estimated 23 per cent share, and Unitel has 18 per cent.

Mobile Telephony Market

The first Laotian mobile service was launched in Vientiane in 1993 using an AMPS network; GSM was introduced the following year. LTC began offering a WDCMA-based 3G service in 2008 with speeds of up to 114 Gbps and was followed by the nation's mobile operators. In 2012, both Beeline and LTC reported that that they were testing a Long-Term Evolution (LTE) service in Vientiane, and LTC reported that it would soon launch WiMax service.

In 2011 each of the mobile operators in which the government has ownership stakes (LTC, ETL, and Unitel) blocked interconnection with Vimpelcom Lao's Beeline as part of a boycott over what the three operators perceived to be aggressive discounts being offered by Beeline in breach of an order issued by the Ministry of Posts and Telecommunications.

As of year-end 2012, the estimated shares of the mobile market were LTC with 40 per cent, ETL with 35 per cent, Unitel with 13 per cent, and Beeline Lao with 12 per cent.

Internet and Broadband Market

The country's largest ISPs are LTC, ETL, Unitel, and Beeline Lao. Other ISPs include Planet Online, which was formed by private Laotian investors in 1997 and Sky Telecom, which was established in 2005 by Sky Telecom Thailand, with 70 per cent, and the Government of Lao PDR with 30 per cent. The Laotian government's National Authority for Science and Technology also acts as an Internet service provider.

LTC, ETL, and Unitel (Star Telecom Joint Venture) each offer ADSL. Beeline Lao, Planet Online, and NAST offer WiMax. Sky Telecom offers leased line service.

ADSL was launched in 2003 and by early 2011 there were approximately 20,000 ADSL subscribers. There were also 300 subscribers to Thaicom's IPStar satellite service and 60 leased line subscribers. A wireless broadband service was launched in Vientiane in 2005, and WiMax trials first took place in the city in 2008.

International Internet Bandwidth and Capacity Pricing in Lao PDR

Figure 8: International Internet Bandwidth and Capacity Pricing in Lao PDR, 2012

International Internet Bandwidth	International Internet Bandwidth per Capita	International Capacity Pricing
2.5 Gbps	0.383 Kbps	IP Transit: USD$100 per Mbps per month in 2012

Source: Terabit Consulting research, Operator data and interviews

Lao PDR's international Internet bandwidth was 2.5 Gbps as of year-end 2012.

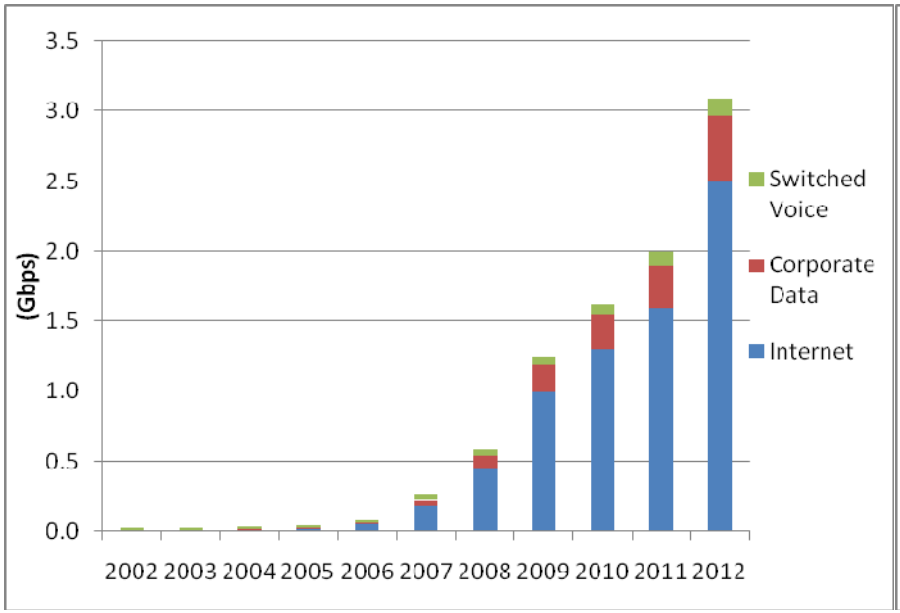
As of early 2011, the primary channels for the country's 1,359 Mbps of international bandwidth included the following: 486 Mbps via CAT of Thailand, 310 Mbps via China Telecom, 310 Mbps via Viettel of Viet Nam, and 155 Mbps via VNPT of Viet Nam.

IP transit bandwidth was estimated to cost $100 per Mbps per month as of year-end 2012.

Figure 9: Historical and Forecasted International Bandwidth in Lao PDR (Mbps), 2002-2023

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
International Internet	2	2	14	20	50	188	455	1,000	1,300	1,600	2,500
International Corporate Data	0	0	3	4	9	35	85	186	242	298	466
International Switched Voice	22	22	20	22	29	37	47	60	77	99	126
Total International Bandwidth	24	24	37	46	88	260	587	1,247	1,619	1,997	3,092
CAGR (2002-2012)	63%										

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
International Internet	4,055	6,577	10,668	17,549	28,869	47,489	78,119	128,506	183,892	263,149	376,566
International Corporate Data	756	1,226	1,989	3,272	5,382	8,854	14,565	23,959	34,286	49,063	70,209
International Switched Voice	162	207	265	339	434	555	711	910	1,165	1,491	1,908
Total International Bandwidth	4,973	8,010	12,922	21,160	34,685	56,898	93,394	153,375	219,342	313,702	448,683
CAGR (2012-2023)	57%										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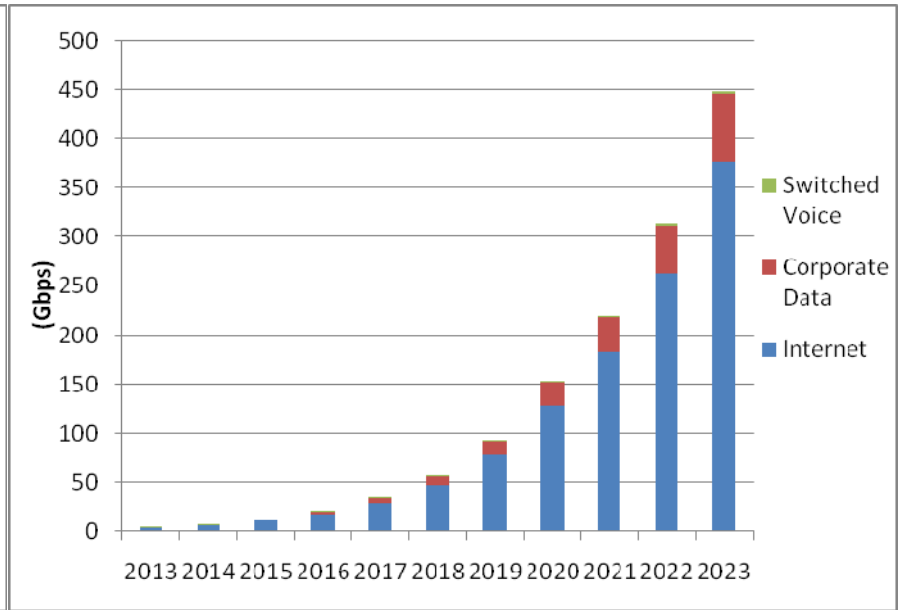
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2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023
Switched Voice
Corporate Data
Internet

International Network Connectivity in Lao PDR

➢ Initial Satellite and Microwave Connectivity

The Vientiane earth station, which features an Intelsat A-standard antenna, was donated by the Japanese government and installed in 1998. The Intelsat antenna offers direct circuits to Australia, China, Germany, Japan, Malaysia, the Republic of Korea, Singapore, and Viet Nam, as well as Hong Kong, China and Taiwan Province of China. The complex also houses an Asiasat antenna offering circuits to Hong Kong. A previous earth station, offering connectivity to an Intelsat 5A satellite, was installed by Telstra of Australia under a 10-year business cooperation contract which lasted from 1990 to 2000. However, once the business cooperation contract expired, the earth station was removed from use.

In addition to satellite connectivity, there is a 2-GHz microwave link between LTC's facilities in Vientiane and the Telecommunications Organization of Thailand (TOT) in Bangkok, Thailand. It offers a capacity of 34 Mbps.

➢ Summary of Bilateral International Terrestrial Fibre Optic Connections

According to the Ministry of Posts and Telecommunications, as of 2012 there were six international fibre optic links providing connectivity to Lao PDR, including the trans-border components of the China-Southeast Asia Cable and the Greater Mekong Subregion Information Highway Project. They were:

- **Lao PDR-China,** which crosses the border at Boten (linking to China Telecom at 2 Gbps)
- **Lao PDR-Thailand** via Friendship Bridge I between Vientiane, Lao PDR and Udon Thani, Thailand (linking to CAT Telecom at 5 Gbps)
- **Lao PDR-Thailand** via Friendship Bridge II between Mukdahan, Thailand and Savannakhet, Lao PDR (linking to CAT Telecom at 2 Gbps)
- **Lao PDR-Viet Nam** (Dansavanh-Lao Bao) (linking to VNPT subsidiary Vietnam Data Communication (VDC) at 5 Gbps)
- **Lao PDR-Viet Nam** (Namphao-Cau Treo) (linking to VDC at 5 Gbps)
- **Lao PDR-Cambodia** at Veun Kham (linking to Cambodia Telecom at 2.5 Gbps)

Myanmar Posts and Telecommunications has also identified a Lao PDR-Myanmar link but its existence was not confirmed by any Laotian operators.

- China-Southeast Asia Cable (Terrestrial Fibre Optic Network)

China-Southeast Asia Cable (CSC)	
Date	February 2001
Length	430 kilometres in Cambodia (7,000 kilometres total)
International Connectivity	- Lao PDR-Viet Nam via Khamkeut, Lao PDR - Lao PDR-Thailand at Vientiane
Main Nodes	Vientiane
Capacity	2.5 Gbps initial capacity
Network Technology	SDH / DWDM
Developers / Owners / Operators / Suppliers	- Developed by a consortium including Enterprise of Telecommunications Lao (ETL)
Continuity with Rail/Highway	- Follows Highway 8 in the east and Highway 13 to Vientiane

Trans-border connectivity between Lao PDR and its neighbours Viet Nam and Thailand was constructed within the aegis of the China-Southeast Asia Cable (CSC) project. The network was activated in February 2001; it connects China, Viet Nam, Lao PDR, Thailand, Malaysia, and Singapore and has a length of 7,000 kilometres and a capacity of STM-16 (2.5 Gbps). It stretches 430 kilometres in Lao PDR and its Laotian point-of-presence is in the capital of Vientiane; to the north-east, the system connects to Hanoi, Viet Nam, and to the south-west it connects to Bangkok, Thailand. CSC was constructed by a consortium including the Enterprise of Telecommunications Lao (ETL), SingTel, China Telecom, Telekom Malaysia, the Communications Authority of Thailand, and the Viet Nam Posts and Telecommunications Corporation.

- Greater Mekong Subregion (GMS) Information Highway Project (Terrestrial Fibre Optic Network)

Greater Mekong Subregion (GMS) Information Highway Project	
Date	December 2007 to June 2009
Length	Integration of existing cables with some new construction
International Connectivity	Integrates: - Lao PDR-Cambodia - Lao PDR-Thailand - Lao PDR-Viet Nam
Main Nodes	Vientiane
Capacity	2.5 Gbps initial capacity
Network Technology	SDH / DWDM
Developers / Owners / Operators / Suppliers	- Developed by a consortium including Enterprise of Telecommunications Lao, or Enterprise Telecom Lao (ETL) - Supplied by Huawei
Continuity with Rail/Highway	- From Siem Reap via National Route 6 - To the Laotian border via National Route 7
Notes	Project partly financed by the Chinese Export-Import Bank

Connectivity between Lao PDR and Cambodia was constructed between December of 2007 and June of 2009 as part of the Greater Mekong Subregion Information Highway Project. The network was partly financed by the Export-Import Bank of China and supplied by Huawei. Its initial capacity was 2.5 Gbps. The GMS Information Highway Project includes trans-border links between Cambodia, China, Lao PDR, Myanmar, Thailand, and Viet Nam.

- Proposed International Connectivity

It was reported in June of 2012 that the Thai operator TOT had formed a partnership with China Telecom to construct terrestrial fibre optic connectivity between Thailand, Lao PDR, China, and Russia as part of a network that would also serve Cambodia and Viet Nam. Other potential partners in the project include AT&T (via its joint venture with China Telecom known as Shanghai Symphony Telecom) and NTT DoCoMo.

In addition, CAT Telecom of Thailand said in September of 2012 that it would spend 20 million Thai baht (USD$675,000) to install a link between Nakhon Phanom province in Thailand and Khammuan province in Lao PDR.

Domestic Network Connectivity in Lao PDR

The domestic Laotian fibre optic backbone runs along the country's primary highway, Route 13, and extends from Boten on the border with China, to Veun Kham on the border with Cambodia. A smaller east-west segment runs primarily along Route 9 between Dansavanh on the border with Viet Nam and Savannakhet on the border with Thailand. The Government Telecom Project Agency oversaw the network's deployment; it was initially launched in 2011 at a capacity of 10 Gbps.

The 1,834 kilometres of fibre along Route 13 comprise the project's "A1" segments; an additional 4,000 kilometres providing connectivity to other provinces are reportedly under development.

In addition to the country's long-haul fibre backbone, a 100-kilometre metropolitan fibre network comprising 24 fibre pairs is in operation in Vientiane, primarily designed to provide connectivity to key government locations.

Evaluation of Trans-Border Network Development and Identification of Missing Links

As the only landlocked country in South-East Asia, Lao PDR is fully reliant upon its trans-border terrestrial fibre optic networks for international connectivity. As of 2013 most international traffic is transited via Thailand and Viet Nam, which are well-served by competing fibre networks.

Terabit Consulting believes that Lao PDR's international connectivity could be greatly improved if additional international transit options could be arranged for Laotian operators and ISPs wishing to purchase international bandwidth; such transit options could comprise linkages via Myanmar, which hosts a SEA-ME-WE-3 cable landing station; via Yunnan Province, China, which could allow for onward connectivity via Chinese and Hong Kong submarine cables; and via Cambodia, where the development of the country's first submarine link is under consideration.

Figure 10: Evaluation of Trans-Border Networks in Lao PDR and Recommendations for Improvement

International Border (and border length)	Existing Fibre Infrastructure	Analysis	Recommendation	Linkage with Rail & Highway Networks	Stakeholders
Lao PDR to Cambodia (541 kilometres) *Medium Priority*	• Greater Mekong Subregion Information Highway Project (Cambodia-Lao PDR segment)	Existing fibre infrastructure is weak and capacity is controlled by Enterprise of Telecommunications of Lao (ETL). There are no submarine cables in Cambodia but future projects are under consideration.	Demand between the two countries is weak but transit traffic from Lao PDR via Cambodia could increase if a new Cambodian submarine cable is constructed.	Rail: No direct links (service via Thailand) Highway: Lao PDR Route 13 and Cambodia Nat'l Highway 7	Ezecom of Cambodia and Telecom Malaysia should be consulted to determine the seriousness of their plans for a Cambodian submarine cable, as well as transit options to serve Lao PDR.
Lao PDR to Myanmar (235 kilometres) *Medium Priority*	• Lao PDR-Myanmar link identified by Myanmar P&T but unconfirmed by Terabit Consulting	Demand between the two countries is weak but Myanmar hosts the SEA-ME-WE-3 cable.	Access to Myanmar's SEA-ME-WE-3 landing point could improve Lao PDR's options for connectivity.	Rail: None Highway: Military highway in Lao PDR	Smaller Laotian operators should be consulted regarding IP transit affordability via SEA-ME-WE-3 in Myanmar.
Lao PDR to Thailand (1,754 kilometres) *Low Priority*	• China-Southeast Asia Cable/Lao PDR-Thailand links	ETL's primary international connection is via Thailand, and ISPs Sky Telecom and Planet have fibre to Thailand.	The Lao PDR-Thailand route appears to be well-served by existing infrastructure.	Rail: Short 3.5-km link Highway: Friendship bridges (2)	ETL, Sky Telecom, and Planet should be consulted to ensure that their links are fully active.
Lao PDR to Viet Nam (2,130 kilometres) *Low Priority*	• China-Southeast Asia Cable/ Lao PDR-Viet Nam links	ETL and Lao Asia Telecom (LAT) each operate fibre links to Viet Nam.	Capacity between Lao PDR and Viet Nam appears to be sufficient.	Rail: None Highway: New Highway 2E	ETL and LAT should be consulted to ensure that their links are fully active.
Lao PDR to Yunnan	• Lao PDR-China link	ETL operates a fibre link to Yunnan Province,	The Lao PDR-China route would benefit	Rail: Vientiane-to-Kunming, China	Chinese operators should be consulted to

Province, China (423 kilometres) *High Priority*		China via Boten.	from greater competition.	rail link planned <u>Highway:</u> Kunming–Bangkok Expressway	determine the possibility of transit capacity via Yunnan.

VI. COUNTRY ANALYSIS: MALAYSIA

	YE 2012
Population	29,530,000
Population Growth Rate	*1.8%*
Gross Domestic Product (PPP)	USD$483 billion / $16,400 per capita
GDP Growth Rate	*5.1% in 2012, 5.3% forecasted in 2013*
Human Development Index	0.769
HDI Ranking	*64th out of 187 ("High")*
Literacy Rate	93%
Fixed-Line Subscribers	2,300,000
Fixed-Line Operators	1. Telekom Malaysia 2. Maxis Communications (subsidiary of Usaha Tegas Group Holdings)
Mobile Subscribers	40,600,000
Mobile Operators	1. Maxis Communications (including UMTS Malaysia) (subsidiary of Usaha Tegas Group Holdings) 2. Celcom (Axiata Group) 3. DiGi Telecommunications (Telenor 49% stake) 4. Umobile (U Television Sdn Bhd 63%; Singapore Technologies Telemedia (STT) 33%; Multipurpose Holding 4%)
Mobile Broadband	3G launched in 2005 but initially limited to Klang Valley (metropolitan Kuala Lumpur), Penang, Johor Bahru, and Kuantan; LTE launched in 2013 but initially limited to Klang Valley
Regulatory Agency	Malaysian Communications and Multimedia Commission (MCMC)
International Internet Bandwidth	460 Gbps
Int'l Internet Bandwidth per Capita	*15.6 Kbps*
Internet Service Providers	1. Telekom Malaysia 2. Time dotCom 3. Packet One Networks (P1) (subsidiary of Green Packet Bhd) 4. Celcom (Axiata Group) 5. Maxis Communications (including UMTS Malaysia) (subsidiary of Usaha Tegas Group Holdings) 6. DiGi Telecommunications (Telenor) 7. Umobile (U Television Sdn Bhd 63%; Singapore Technologies Telemedia (STT) 33%; Multipurpose Holding 4%)
Fixed Broadband Subscribers	2.3 million fixed broadband subscribers (>256 Kbps); 3 million mobile broadband subscribers (est.)
Fixed Broadband Technologies	ADSL, public wireless LANs, FTTH, fixed wireless
Typical Monthly Broadband Subscription	USD$33 per month for unlimited 1 Mbps ADSL, including modem + $54 for activation and installation (Telekom Malaysia)

Telecommunications Market Overview

The Malaysian telecommunications market is competitive in the mobile telephony and mobile data sectors, although the fixed-line telephony and fixed-line broadband sectors remain dominated by Telekom Malaysia. Telecommunications services and infrastructure are extremely well-developed on Peninsular Malaysia, while telecommunications infrastructure in the states of Sabah and Sarawak on the island of Borneo remain in need of greater investment.

The total annual value of the Malaysian telecommunications market is estimated at more than USD$10 billion.

Regulation and Government Intervention

The Malaysian telecommunications and Internet sectors are regulated by the Malaysian Communications and Multimedia Commission (MCMC).

In addition to the previously mentioned involvement of the Performance Management and Delivery Unit (Pemandu) in the promotion of international connectivity, the Malaysian government has actively promoted Internet adoption through its 1Malaysia initiative, which has budgeted several hundred million dollars for the distribution of subsidized netbooks. The programme, which provides Internet connectivity at a total cost of between USD$7 and $13 per month, has focused primarily on rural and less-economically developed areas such as Sabah, and approximately two-thirds of the 800,000 netbooks distributed as of late 2012 were given to students. The Malaysian government has indicated that it intends to distribute 1.5 million 1Malaysia netbooks and to expand the programme to include tablets and rebates for smartphones.

Fixed-Line Telephony Market

Telekom Malaysia holds a near-monopoly over the country's fixed-line market, but some other operators such as Maxis have limited metropolitan fixed-line deployment, primarily targeting business customers.

Mobile Telephony Market

The mobile telephony market, with more than 40 million subscriptions, is served by Maxis Communications (with a 35 per cent share), Celcom (33 per cent), DiGi Telecommunications (28 per cent), and UMobile (4 per cent).

3G service was launched in 2005 but it was initially limited to the Klang Valley in metropolitan Kuala Lumpur, as well as Penang, Johor Bahru, and Kuantan. Long-Term Evolution service is being launched by all of the major mobile operators in 2013, although availability will initially be limited to the Klang Valley.

Internet and Broadband Market

Malaysia's National Broadband Initiative has been led by Telekom Malaysia, with 20 per cent of the project's funding provided by the Malaysian government. Telekom Malaysia pledged to offer access

to the initiative's high-speed broadband network to competitors, and reportedly signed wholesale agreements with Celcom, Maxis, and Packet One Networks. Telekom Malaysia's chief technical officer said in 2012 that the government's limited contribution to the project meant that it was targeted primarily toward the country's most lucrative geographic areas. "If you want to cover the whole of the country you will need much higher investment from the government", he said.

Telekom Malaysia has an estimated 60 per cent share of the country's broadband market, with Time dotCom at 11 per cent, Packet One Networks at 10 per cent, Celcom at 8 per cent, Maxis Communications at 5 per cent, DiGi Telecommunications at 3 per cent, and Umobile at 3 per cent.

Although ADSL remains the country's leading broadband technology, Telekom Malaysia has reported tremendous growth in its fibre-to-the-home service, with 500,000 subscribers as of early 2013.

International Internet Bandwidth and Capacity Pricing in Malaysia

Figure 11: International Internet Bandwidth and Capacity Pricing in Malaysia, 2012

International Internet Bandwidth	International Internet Bandwidth per Capita	International Capacity Pricing
460 Gbps	15.6 Kbps	IP Transit: USD$30 per Mbps per month in 2012; $25 per Mbps per month in 2013

Source: Terabit Consulting research, Operator data and interviews

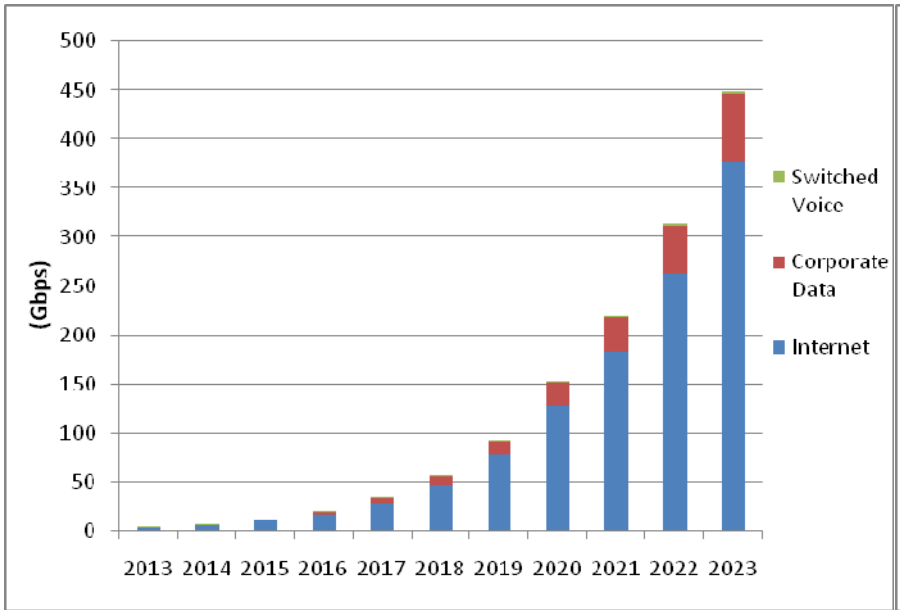
Malaysian international internet bandwidth is among the highest in the region, with 460 Gbps (15.6 Kbps per capita) as of year-end 2012.

IP transit in Kuala Lumpur was available for $30 per Mbps when purchased in volume as of year-end 2012 and reportedly for as little as $25 as of 2013. The Malaysian minister for information, communication, and culture said that as of 2011, international bandwidth accounted for 40 per cent of the cost of providing broadband service in Malaysia.

Figure 12: Historical and Forecasted International Bandwidth in Malaysia (Mbps), 2002-2023

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
International Internet	1,321	2,308	3,193	3,193	16,328	41,099	64,121	140,000	190,000	320,000	460,000
International Corporate Data	193	338	468	468	2,391	6,019	9,390	20,502	27,825	46,862	67,365
International Switched Voice	2,624	3,007	3,446	3,949	4,526	5,187	5,944	6,812	7,806	8,946	10,252
Total International Bandwidth	4,138	5,653	7,107	7,610	23,245	52,304	79,455	167,314	225,631	375,808	537,617
CAGR (2002-2012)	63%										

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
International Internet	670,220	976,511	1,412,034	2,041,802	2,952,445	4,269,235	6,173,314	8,926,613	12,907,882	17,219,115	22,970,299
International Corporate Data	98,150	143,005	206,785	299,012	432,371	625,208	904,051	1,307,258	1,890,295	2,521,653	3,363,885
International Switched Voice	11,749	13,464	15,430	17,683	20,264	23,223	26,614	30,499	34,952	40,055	45,903
Total International Bandwidth	780,119	1,132,980	1,634,250	2,358,496	3,405,080	4,917,667	7,103,979	10,264,370	14,833,129	19,780,823	26,380,087
CAGR (2012-2023)	42%										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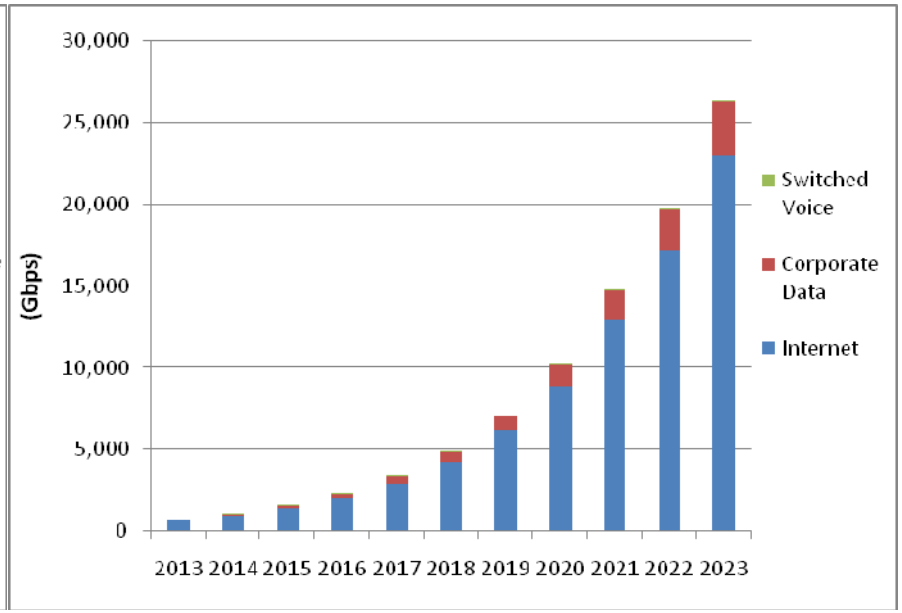
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(Gbps)
2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023
Switched Voice
Corporate Data
Internet

International Network Connectivity in Malaysia

Telekom Malaysia has invested in 10 submarine cable systems worldwide; most recently, it assumed a major role in the development of the 7,800-kilometre Asia Submarine-cable Express (ASE) submarine cable system, in which it retained control of two fibre pairs dubbed "Cahaya Malaysia". ASE and its Cahaya Malaysia subsystem initially entered service in August of 2012, connecting Japan, the Philippines, Malaysia, and Singapore; a branch to Hong Kong, China was completed in February of 2013. The project uses 40 Gbps technology allowing for 2.5 Tbps over each fibre pair; consequently, the Cahaya Malaysia subsystem offers 5 Tbps of capacity, while the combined ASE/Cahaya Malaysia system offers 15 Tbps. The ASE cable station serving Malaysia is in Mersing, which is also the site of the landing stations for the Asia-America Gateway (AAG) and SEA-ME-WE-3 cables.

Global Transit, which began operating as a Malaysian Internet protocol network operator and was subsequently acquired by Time dotCom for USD$34 million in 2011, owns a 10 per cent stake in the Unity trans-Pacific submarine cable linking Japan and the United States.

The Malaysian government's Performance Management and Delivery Unit (Pemandu), which was formed in 2009, identified the Cahaya Malaysia and Batam-Damai-Melaka (BDM) cable systems as two of 23 projects that it officially supported under its Economic Transformation Programme (ETP) as of March 2011. According to Pemandu, the ETP "will transform Malaysia into a high-income nation by 2020".

Pemandu also indicated that the government might provide a $200 million "soft loan" in order to reduce operators' costs for international bandwidth capacity. With Pemandu's support, a consortium for international capacity purchasing was reportedly formed in early 2011, consisting of 24 operators, including Telekom Malaysia, Time dotCom, Maxis, Celcom Axiata, DiGi Telecommunications, U Mobile, Green Packet, YTL Communications, RedTone International, Fiberail, Jaring, Sacofa, Sarawak Information Systems, Fibrecomm, and V Telecoms.

A memorandum of understanding between the carriers was signed in April of 2011 forming the Konsortium Rangkaian Serantau (Regional Network Consortium). The consortium's initial capital was only 10,000 Malaysian ringgits (USD$3,300) per operator, for a total of $80,000, but the intended investment per investor was to have subsequently risen to 10 million ringgits ($3.3 million). At first, the consortium was said to have focused on purchasing capacity via international networks serving Singapore, but it was later revealed that the consortium had investigated the possibility of constructing an 18,500-kilometre submarine cable connecting Malaysia and the United States, avoiding two major submarine cable "choke points" in the Luzon Strait and the waters off Singapore, which are vulnerable to earthquakes and anchor damage, respectively. As of 2013 the KRS submarine cable project seems unlikely; some sources indicated that the Malaysian government's financial support, which would likely have been a prerequisite in order to move forward, was never granted; other sources indicated that the logistics of ensuring cooperation among 24 competing companies had undermined the project's viability.

Figure 13 shows all active, under-construction, and retired interregional fibre optic submarine cable systems serving Malaysia.

Figure 13: Interregional Submarine Fibre Optic Systems Serving Malaysia

	Ready-for-Service Date	Status	Route (km)	Finance Type	Owner(s)	Cost ($Mil)	System Lit Capacity (Gbps)	System Design Capacity (Gbps)
Asia-Pacific Cable	1993	Retired	7,517	Consortium	International carrier consortium	$332	0	[1]
Asia-Pacific Cable Network (APCN)	1997	Retired	12,083	Consortium	International carrier consortium	$644	0	[10]
FLAG Europe-Asia (FEA) (formerly FLAG (Fiberoptic Link Around the Globe))	1997	Active	27,300	Investor-led / then carrier-owned	Reliance Globalcom (formerly FLAG Telecom)	$1,600	140	320
SEA-ME-WE-3 (SMW3)	1999	Active	39,000	Consortium	International consortium of carriers	$1,300	200	600
Asia-Pacific Cable Network-2 (APCN-2)	2002	Active	19,000	Consortium	International carrier consortium	$1,060	2,280	10,240
South Africa-Far East (SAFE) (integrated with SAT-3)	2002	Active	13,100	Consortium	International consortium of carriers	$267	440	960
SEA-ME-WE-4 (SMW4)	2005	Active	20,000	Consortium	International consortium of carriers	$500	2,000	4,800
Asia-America Gateway Cable System (AAG)	2010	Active	20,318	Consortium	AT&T, Bharti, BT Global Network Services, CAT Telecom, ETPI, PCP Co. Ltd, PLDT, PT Indosat, Saigon Postel Corp., StarHub, Telekom Malaysia, Telkom Indonesia, Telstra, the Government of Brunei Darussalam, TNZL, Viettel, and VNPT	$554	1,540	5,096
Asia Submarine-cable Express (ASE) (includes	2012	Active	7,800	Consortium	NTT / Telekom Malaysia / PLDT /	$430.0	2,986	15,360

Cahaya Malaysia)					StarHub			

A number of competing projects are vying to provide connectivity between Europe and Asia in the near future, including **Bay of Bengal Gateway (BBG),** which awarded a supply contract to Alcatel-Lucent in May of 2013 and would land in Penang, Malaysia in 2014; **Africa-Asia-Europe-1 (AAE-1),** which had also reportedly gained the support of Telekom Malaysia and would land in both Malaysia and nearby Myanmar; and **SEA-ME-WE-5.**

Additionally, the planned **Asia-Pacific Gateway (APG)** submarine cable project, which features Time dotCom's Global Transit subsidiary and Facebook as investors, would land in Malaysia in 2014 and connect to China, Japan, the Republic of Korea, Singapore, Thailand, and Viet Nam, as well as Hong Kong, China and Taiwan Province of China.

Regional submarine cable systems serving Malaysia include the following:

- **Brunei-Malaysia-Philippines (BMP),** which entered service in 1992 but was removed from service in 2004;
- **Malaysia-Thailand,** which entered service in 1994 as part of the ASEAN submarine cable network;
- Time dotCom's **Malaysia-Thailand East and West** systems, which entered service in 1996 in correspondence with the Communications Authority of Thailand (CAT);
- Sacofa Sdn Bhd's **East-West Submarine Cable System**, which entered service in 2004 between Peninsular and Sarawak Malaysia with intermediate landing points in Indonesia;
- Telekom Malaysia's and PT Telekomunicasi Indonesia's **Dumai-Melaka Cable System (DMCS),** which entered service in 2004;
- The **Batam-Rengit Cable System (BRCS**), which entered service in 2007 and was constructed by Telekom Malaysia and Indonesian mobile operator PT XL Axiata;
- The **Batam-Dumai-Malacca Cable System (BDM),**which entered service at the end of 2011 and was constructed by Telekom Malaysia and the Indonesian operators PT XL Axiata and Moratelindo (PT Mora Telematika);
- The proposed **BIMP-EAGA** submarine cable system, which would connect Malaysia, Indonesia, Brunei, and the Philippines and which has been proposed by the Brunei Darussalam-Indonesia-Malaysia-Philippines-East ASEAN (Association of Southeast Asian Nations) Growth Area (BIMP-EAGA) initiative, with initial support from 10 organizations, including Telekom Malaysia; the Malaysian Communications and Multimedia Commission (also known as SKMM for the Malaysian Suruhanjaya Komunikasi dan Multimedia Malaysia); the State Information Technology Advancement Unit of the Ministry of Resource Development and Information Technology in the eastern Malaysian state of Sabah (also known as KIT, for the Malaysian "Kemajuan IT Negeri"); Celcom Timur Sabah Sdn Bhd, a fibre optic network operator in Sabah; and Sacofa Sdn Bhd, which was founded in 2001 with the mandate of developing telecommunications infrastructure in the Malaysian state of Sarawak.

Terrestrial fibre optic links to Malaysia's neighbours include the following:

- **Malaysia-Thailand terrestrial links** operated by Telekom Malaysia via Padang Besar;
- **Malaysia-Singapore terrestrial links** via Johor Baharu (and the Singaporean Causeway), also operated by Telekom Malaysia;

- The **Time dotCom Cross-Peninsular Cable System (CPCS),** which runs along Malaysia's North-South Expressway from Singapore to Thailand.

Time dotCom Cross-Peninsular Cable System (CPCS)	
Date	2009 (est.)
Length	6,000 kilometres
International Connectivity	- Malaysia-Singapore via Causeway and Tuas Second Link - Malaysia-Thailand access points via Bukit Kayu Hitam and Padang Besar
Main Nodes	Kuala Lumpur, Singapore
Capacity	10 Gbps and 40 Gbps wavelengths
Network Technology	DWDM
Developers / Owners / Operators / Suppliers	- Developed, owned, and operated by Time dotCom
Continuity with Rail/Highway	- Installed alongside the North-South Expressway

Domestic Network Connectivity in Malaysia

Telekom Malaysia and Time dotCom both operate extensive domestic fibre optic networks. In addition, Fibrecomm, in which Telekom Malaysia has a 54 per cent stake, operates a 10,000-kilometre fibre network along the transmission network of Malaysian electricity company Tenaga Nasional Berhad, and Fiberail, in which Telekom Malaysia holds 51 per cent of shares, operates a 5,000-kilometre network along the rights-of-way of the country's rail and gas infrastructure. Most fibre optic network connectivity is deployed on Peninsular Malaysia, which is also the location of most broadband deployment, with fibre deployment concentrated along the western, southern, and eastern coasts of Peninsular Malaysia, and little deployment in the peninsula's central and northern areas such as Kelantan and Pahang. East Malaysia, consisting of the states of Sabah and Sarawak, has the least fibre network deployment, as well as two of the lowest broadband penetration rates, with Sarawak household penetration at 47.8 households per 100 and Sabah at only 34.2 households per 100, compared with the national average of 63.8 households per 100. However, some entities, including the Sabah Economic Development Corporation's SComm venture, have recently sought to improve fibre connectivity on the island of Borneo through the construction of new networks.

Malaysia's domestic undersea connectivity includes the following:

- **Kuantan-Kota Kinabalu** (1991);
- **Juru-Pulau Pinang** (1996);
- **Malaysian Coastal Links (Langkawi-Tanjong Belungkor)** (1996);
- **Malaysian Domestic Northern and Southern Links** (1996);
- **Pinang-Kampong Serberang Paya** (1996).

Evaluation of Trans-Border Network Development and Identification of Missing Links

Malaysia shares terrestrial borders with Indonesia (1,782 kilometres on the island of Borneo) and Thailand (506 kilometres), as well as Brunei Darussalam (which is not included within the scope of this study). Malaysia is also linked to Singapore via a causeway and a bridge.

Malaysia and Thailand are linked by Telekom Malaysia's fibre infrastructure, and Time dotCom's Cross-Peninsular Cable System offers access at the Thai border. The causeway and bridge between Singapore and Malaysia are served by multiple fibre links. Consequently, Terabit Consulting does not believe that Malaysia's connectivity with Thailand or Singapore is in need of immediate improvement.

On the other hand, Terabit Consulting was not able to identify any existing terrestrial fibre optic connectivity between Indonesia and Malaysia and believes that a new fibre link between West Kalimantan, Indonesia and Sarawak, Malaysia would be a boon to the region's connectivity, given the strong linguistic, economic, and cultural links between the two countries. Terabit Consulting recommends that the link be pursued within the context of the proposed Trans Borneo Power Grid's West Kalimantan-Sarawak segment, given the poor state of highway and rail infrastructure between the two countries.

Figure 14: Evaluation of Trans-Border Networks in Malaysia and Recommendations for Improvement

International Border (and border length)	Existing Fibre Infrastructure	Analysis	Recommendation	Linkage with Rail & Highway Networks	Stakeholders
Malaysia to Indonesia (1,782 kilometres) *High Priority*	• No fibre connectivity identified	Although undersea connectivity exists between Indonesia and Malaysia, no direct connectivity is present between the countries' states on the island of Borneo.	A new terrestrial fibre link between Indonesia and Malaysia would greatly improve the region's connectivity and is warranted by the countries' linguistic, economic, and cultural ties. Such a link would also improve connectivity to the Malaysian states of Sabah and Sarawak, which have traditionally relied upon transit capacity through Peninsular Malaysia.	Rail: No direct links Highway: Secondary highway crossing between Tebedu, Malaysia and Entikong, Indonesia	The Asian Development Bank is reportedly exploring the feasibility of constructing a West Kalimantan-Sarawak segment on the proposed Trans Borneo Power Grid and should be consulted, as should the region's operators.
Malaysia to Singapore (Causeway & Bridge) *Low Priority*	• Malaysia-Singapore Causeway links; Time dotCom Cross-Peninsular Cable System	There is sufficient fibre capacity between Malaysia and Singapore.	There is no need for additional fibre capacity between Malaysia and Singapore.	Rail: KTM Berhad Highway: Causeway & Second Link	The Causeway and Second Link are operated and maintained by PLUS Expressway Bhd, Linkedua Malaysia Bhd, and the Singaporean Land Transport Authority (LTA).
Malaysia to Thailand (506 kilometres) *Low Priority*	• Malaysia-Thailand links; border access to Time dotCom Cross-Peninsular Cable System	Although there is limited competition among operators, there is sufficient trans-border bandwidth between Malaysia and	From Malaysia's perspective, there is no need for additional fibre capacity between Malaysia and Thailand, but the crossing is of increasing importance to Thai operators who use it to access cheaper bandwidth and	Rail: Two crossings: Padang Besar and Rantau Panjang-Sungai Golok Highway: Seven crossings	Smaller operators and ISPs in Thailand and Malaysia should be consulted to determine if additional competition is needed on the route.

		Thailand.	IP transit in Malaysia and Singapore.		

VII. COUNTRY ANALYSIS: MYANMAR

	YE 2012
Population	48,914,000
Population Growth Rate	*0.8%*
Gross Domestic Product (PPP)	USD$93 billion / $1,900 per capita
GDP Growth Rate	*5.5% in 2012, 6.3% forecasted in 2013*
Human Development Index	0.543
HDI Ranking	*149th out of 187 ("Low")*
Literacy Rate	93%
Fixed-Line Subscribers	604,500
Fixed-Line Operators	Myanmar Posts and Telecommunications (MPT) (Government of Myanmar)
Mobile Subscribers	5,440,000
Mobile Operators	Myanmar Posts and Telecommunications (MPT) (Government of Myanmar)
Mobile Broadband	3G being launched in 2013
Regulatory Agency	Ministry of Communications and Information Technology (MCIT) – Posts and Telecommunications Department (PTD)
International Internet Bandwidth	14 Gbps
Int'l Internet Bandwidth per Capita	*0.286 Kbps*
Internet Service Providers	1. MPT (Government of Myanmar) 2. Yatanarpon Teleport (Government of Myanmar 51%) 3. Red Link Communications 4. Elite Tech 5. Fortune International Ltd.
Fixed Broadband Subscribers	50,000 fixed broadband subscribers (>256 Kbps); 25,000 mobile broadband subscribers (est.)
Fixed Broadband Technologies	ADSL, broadband wireless, WiMax, FTTH, broadband satellite, Metro Ethernet
Typical Monthly Broadband Subscription	1. USD$55 per month + $536 installation/equipment fee for 1 Mbps WiMax, 6 GB download limit (Red Link Communications) 2. USD$100 per month + $172 installation/ equipment fee for 1 Mbps (Yatanarpon Teleport) 3. USD$91 per month + $880 installation for 1 Mbps FTTH+VoIP (Fortune International)

Telecommunications Market Overview

The Government of Myanmar has committed to opening its telecommunications markets to competition, with passage of a new telecommunications law expected to occur in 2013. Myanmar Posts and Telecommunications (MPT) is in the process of corporatization, and 12 bidders for new telecommunications licenses were shortlisted in April of 2013, including consortia led by China Mobile, Vodafone Group, Singtel, Bharti, Axiata Group, Telenor, Millicom International, Viettel, Qatar Telecom, Digicel, KDDI, MTN Dubai, and Sumitomo Corporation. Each of the two new licenses would be valid for 15 years. The widespread international interest stems from Myanmar's status as one of the last telecommunications markets to be liberalized, combined with what is currently one of the lowest mobile penetration rates of any country in the world.

The Myanmar telecommunications market is estimated to be worth USD$200 million annually.

Regulation and Government Intervention

The telecommunications industry is regulated by the Ministry of Communications and Information Technology (MCIT) – Posts and Telecommunications Department (PTD).

Fixed-Line Telephony Market

Myanmar Posts and Telecommunications reportedly serves more than 600,000 fixed-line subscribers.

Mobile Telephony Market

The Ministry of Posts and Telecommunications operates the country's mobile network, which serves 5.4 million subscribers via only 1,500 mobile transmission towers (in comparison with approximately 50,000 in Thailand or Viet Nam). Most of the towers are concentrated in Yangon, Mandalay, and Nay Pyi Taw.

Internet and Broadband Market

ADSL has been available since 2005 and several sources estimated the number of ADSL subscribers to be between 30,000 and 40,000. Fibre-to-the-home (FTTH) service was launched in Yangon and Mandalay in December of 2010, and some sources claimed that there were as many as 10,000 FTTH subscribers as of 2013. Internet is available in a total of 42 cities across the country, but Yangon and Mandalay account for an estimated 97 per cent of all users. There are three registered Internet service providers: MPT, Yatanarpon Teleport (in which the Government of Myanmar owns a 51 per cent stake), and Red Link Communications (reportedly led by investors with ties to the government). Two other companies, Elite Tech and Fortune International Limited, have reportedly been given limited fibre-to-the-home concessions in two zones in Yangon.

International Internet Bandwidth and Capacity Pricing in Myanmar

Figure 15: International Internet Bandwidth and Capacity Pricing in Myanmar, 2012

International Internet Bandwidth	International Internet Bandwidth per Capita	International Capacity Pricing
14 Gbps	0.286 Kbps	IP Transit: more than $100 per Mbps per month in in 2012

Source: Terabit Consulting research, Operator data and interviews

As of mid-2011, the country's Hantharwaddy National Gateway handled a total of 3.1 Gbps, including 1.6 Gbps on SEA-ME-WE-3, 622 Mbps to Thailand, 311 Mbps terrestrially to China, 311 Mbps terrestrially to India, and 311 Mbps earmarked for the Greater Mekong Subregion (GMS) Information Highway.

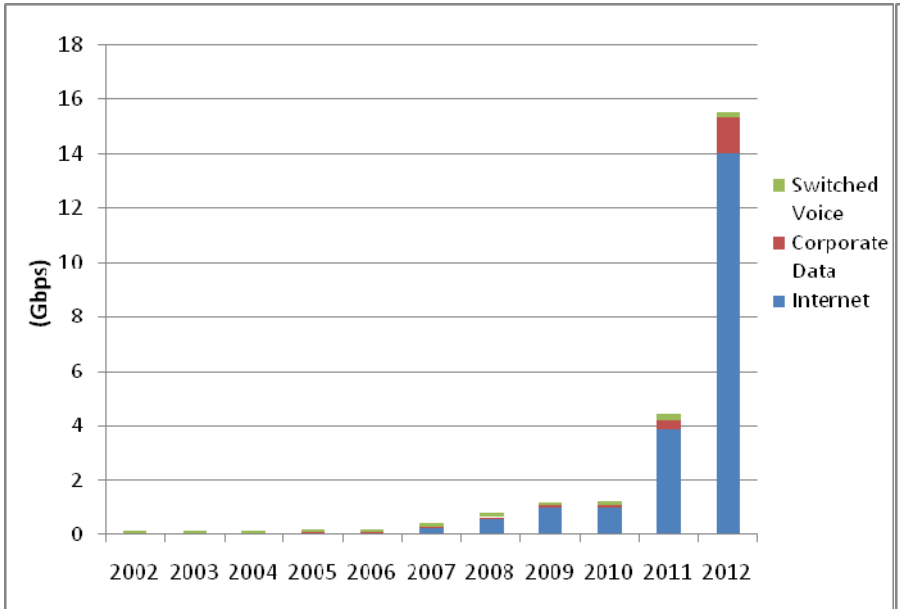
Myanmar Posts and Telecommunications reported that in late 2012 capacity was increased to 14 Gbps. The figure of 14 Gbps was reconfirmed by Myanmar Posts and Telecommunications in July of 2013, following the repair of the damaged SEA-ME-WE-3 cable. Between 22nd July and 30th July, while the SEA-ME-WE-3 connection was out of service, Myanmar's international bandwidth temporarily fell to 7 Gbps, or 50 per cent of normal levels.

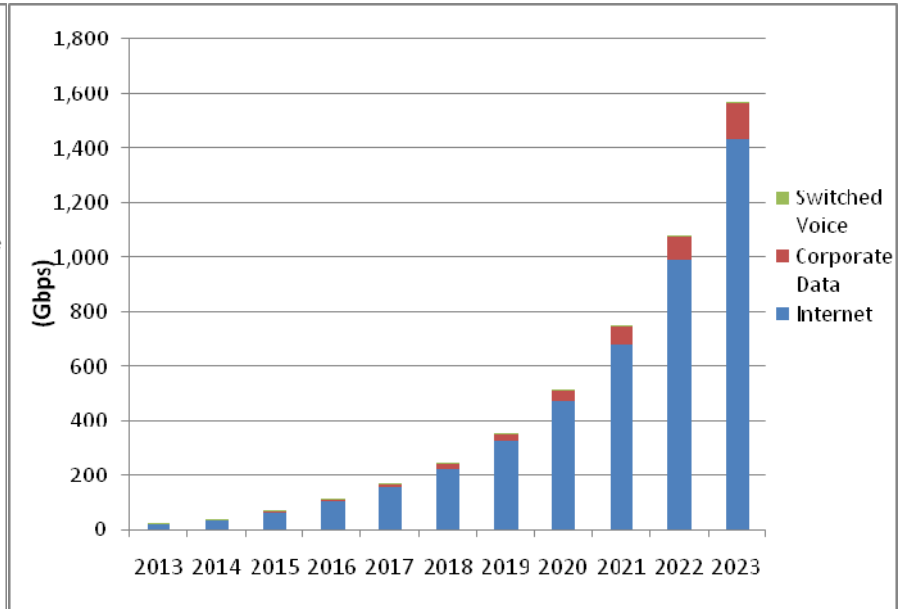
The market for IP transit capacity in Myanmar is extremely limited and transparent pricing is not available, but 1 Mbps is estimated to cost well in excess of $100 per month.

Figure 16: Historical and Forecasted International Bandwidth in Myanmar (Mbps), 2002-2023

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
International Internet	5	9	61	94	94	293	600	975	1,000	3,875	14,000
International Corporate Data	0	1	6	9	9	27	55	90	92	358	1,294
International Switched Voice	113	106	108	103	113	119	136	156	178	204	234
Total International Bandwidth	119	115	175	206	216	439	791	1,221	1,271	4,437	15,528
CAGR (2002-2012)	63%										

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
International Internet	23,282	38,718	64,388	107,077	155,155	224,819	325,763	472,031	683,973	991,077	1,436,070
International Corporate Data	2,152	3,579	5,952	9,899	14,343	20,783	30,115	43,637	63,230	91,620	132,758
International Switched Voice	268	307	352	403	462	529	607	695	797	913	1,046
Total International Bandwidth	25,702	42,604	70,692	117,379	169,960	246,132	356,485	516,363	747,999	1,083,610	1,569,874
CAGR (2012-2023)	52%										


18
16
14
12
10
8
6
4
2
0
(Gbps)
2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012
Switched Voice
Corporate Data
Internet


1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
(Gbps)
2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023
Switched Voice
Corporate Data
Internet

International Network Connectivity in Myanmar

The SEA-ME-WE-3 submarine cable, which lands in Pyapon, serves as Myanmar's primary international connection. There are also terrestrial cables linking Myanmar to China, India, and Thailand.

➢ Satellite and Microwave Connectivity

Satellite and microwave connectivity now accounts for only a small portion of Myanmar's international bandwidth. A satellite earth station was first commissioned in Yangon in 1979, but the first Intelsat Standard-A earth station, known as the Tanyin MPT Earth Station, was commissioned on 4th March 1994 and provides a link to the Intelsat-6 60E IS-604 satellite. The station features an 18.3-meter Gregory antenna, constructed by Siemens. It is equipped with seven 512-Kbps circuits, nine 1-Mbps circuits, and nine 2-Mbps circuits. An EWSD-type switch (manufactured by Siemens) provides a capacity of 2,940 international channels; transmission to most countries uses digital circuit multiplication equipment (DCME) compression technology. The Ministry of Posts and Telecommunications also operates an international transmission maintenance centre at the same site.

➢ International Terrestrial Fibre Optic Connections

Myanmar's terrestrial fibre optic connections consist of the following:

- **China–Myanmar** (2007) – Connects Kunming, China and Muse, Myanmar with an onward domestic extension to Yangon, Myanmar. Owned by MPT and China Telecom subsidiary Yunnan Telecom.

- **India–Myanmar** (2010) – 640-kilometre project initiated in December of 2006 at a cost of $7 million, offering a capacity of STM-4 (622 Mbps). Connects Mandalay, Myanmar and Moreh, India via Tamu, Kampatwa, Kyi Gone, Shwebo, Monywa, and Sagaing. Owned by MPT and BSNL, with the installation contract awarded to Telecommunications Consultants India Ltd. (TCIL).

- **Myanmar–Thailand** (2010) – Crosses the border between Myawaddy, Myanmar and Mae Sot, Thailand, capacity of 10 Gbps. Operated by MPT in partnership with a "Thai counterpart". Onward connectivity is provided through Thailand to Lao PDR.

- **Bangladesh-Myanmar** (under development) – Expected completion in 2013 linking the landing stations of SEA-ME-WE-3 in Myanmar and SEA-ME-WE-4 in Bangladesh, thereby providing redundancy for both countries' intercontinental connectivity.

- **China-Myanmar** (proposed) – In July of 2013, MPT signed an agreement with China Unicom for the development of a new terrestrial fibre cable between Myanmar and China.

The links to China and Thailand are integrated into the Greater Mekong Subregion (GMS) Information Highway Project.

Greater Mekong Subregion (GMS) Information Highway Project	
Date	2007 to 2010
Length	Intra-Myanmar loop estimated at 2,000 kilometres
International Connectivity	- Lao PDR-China - Lao PDR-Thailand
Main Nodes	Yangon, Mandalay
Capacity	2.5 Gbps initial capacity
Network Technology	SDH / DWDM
Developers / Owners / Operators / Suppliers	- Operated by Myanmar Posts and Telecommunications - Developed in partnership with the Communications Authority of Thailand and China Telecom - Supplied by Huawei
Continuity with Rail/Highway	- To the Thai border via National Highway 85 - To the Chinese border via National Highway 3
Notes	$17.5 million project partly financed by the Chinese Export-Import Bank

Hong Kong operator Hutchison Global Communications (HGC) reported that it had established its first point-of-presence in Myanmar in May of 2013; the POP was established in partnership with MPT and utilizes bandwidth on the Greater Mekong Subregion Information Highway Project.

Myanmar Posts and Telecommunications has also identified a **Lao PDR-Myanmar** link but its existence was not verified by any Laotian operators.

SEA-ME-WE-3 Submarine Cable

SEA-ME-WE-3, a 39,000-kilometre system serving 34 countries, is the only undersea system serving Myanmar. Myanmar's Ministry of Posts and Telecommunications invested $30 million in the system, which entered service in 1999, and there is a fibre optic link between the Pyapon cable station and the country's international gateway switch in Yangon. The total design capacity of the SEA-ME-WE-3 cable is more than 1.6 Tbps; as of 2013 the lit capacity to Myanmar on the cable reportedly consisted of two 10 Gbps (STM-64) wavelengths.

SEA-ME-WE-4 Submarine Cable via Bangladesh

The Bangladesh Submarine Cable Company Limited (BSCCL) and MPT are implementing a terrestrial link between Myanmar and Bangladesh in order to provide Myanmar with connectivity to SEA-ME-WE-4 and Bangladesh with connectivity to SEA-ME-WE-3. The Bangladesh Submarine Cable Company Ltd. (BSSCL) has reportedly budgeted $2.75 million for their share of the project, which would include a 50-kilometre link between its Cox's Bazar landing station and the Myanmar border, and completion is expected in 2013.

SEA-ME-WE-5 and Africa-Asia-Europe (AAE) Proposed Submarine Cable Projects

Two proposed submarine cable projects between Europe and Asia would land in Myanmar: SEA-ME-WE-5 and Africa-Asia-Europe (AAE). Some sources indicated that China Unicom would partly fund the capital and operational expenditures associated with building a branch of SEA-ME-WE-5 to Myanmar, at a cost of $40 million. Some of the sources indicated that the arrangement would provide land-based redundancy for China's own westward international demand, while others

theorized that the investment was a prelude to China's entry into Myanmar's newly liberalized telecommunications market, as well as an attempt by Chinese operators to capture transit demand bound for the United States from South Asian countries, including India and Bangladesh.

Myanmar-Thailand Proposed Submarine Cable Project

CAT Telecom of Thailand is reportedly exploring the construction of a new $41 million, 800-kilometre undersea fibre optic link from Satun, Thailand to Dawei in south-eastern Myanmar. Dawei is the planned site of a deepwater port and the country's first special economic zone. A contract for development of the area was awarded to a Thai-Italian consortium in 2010.

Domestic Network Connectivity in Myanmar

Myanmar's domestic fibre optic telecommunications network, operated by MPT, spans 2,812 kilometres and has 242 points-of-presence. It has three primary trunk segments:

- Muse, on the Chinese border, to Mandalay, which operates at 20 Gbps;
- Mandalay to Yangon via Nay Pyi Taw, which operates at 10 Gbps;
- Yangon to Myawadi, near the Thai border, which also operates at 10 Gbps.

There is also reported to be a fibre link from Mandalay to the Indian border at Tamu, as well as connectivity from Yangon to the SEA-ME-WE-3 cable landing station in Pyapon. Elsewhere, connectivity is provided by a microwave network with 342 stations and 184 links.

In addition to MPT's telecommunications network, some sources indicated that the Myanmar Ministry of Defence operates a fibre optic network for its own exclusive use. At 11,446 kilometres in length, the network is reported to be more than four times as large as the MPT network, providing connectivity to almost all of the country's 21 administrative subdivisions.

Evaluation of Trans-Border Network Development and Identification of Missing Links

As the Myanmar telecommunications market becomes more liberalized, there is expected to be increased demand for international connectivity, particularly through Thailand and China as those two countries offer competitive international submarine cable facilities. Consequently, Terabit Consulting believes that the development of additional fibre connectivity from Myanmar to Thailand and China should be seriously considered; furthermore, development of the route from Myanmar to Lao PDR, while likely to be of little utility to operators and ISPs in Myanmar, could prove to be extremely useful for operators and ISPs in Lao PDR.

Figure 17: Evaluation of Trans-Border Networks in Myanmar and Recommendations for Improvement

International Border (and border length)	Existing Fibre Infrastructure	Analysis	Recommendation	Linkage with Rail & Highway Networks	Stakeholders
Myanmar to Lao PDR (235 kilometres) *Low Priority (Medium Priority in Lao PDR-Myanmar direction)*	• Lao PDR-Myanmar fibre link identified by Myanmar P&T but unconfirmed by Terabit Consulting	Demand between the two countries is weak, but Myanmar hosts the SEA-ME-WE-3 cable and could provide a useful path to international connectivity for landlocked Lao PDR.	Access to Myanmar's SEA-ME-WE-3 landing point could improve Lao PDR's options for connectivity, but from the perspective of Myanmar there is little requirement for improved connectivity.	Rail: None Highway: Military highway in Lao PDR	Smaller Laotian operators should be consulted regarding IP transit affordability via SEA-ME-WE-3 in Myanmar, and Myanmar operators should be consulted regarding willingness to supply to the Laotian market.
Myanmar to Thailand (1,800 kilometres) *Medium Priority*	• 10-Gbps fibre link installed in 2010	As the Myanmar telecommunications market opens to competition, there will be increased demand for additional international paths.	Additional Myanmar-Thailand capacity should be considered, especially in light of high consumer broadband costs in Myanmar (132.8% of per-capita GDP per Mbps).	Rail: 420-km link currently out of use and blocked by hydroelectric dam Highway: Asian Highway 123 on Thai side, but road on Myanmar side less developed; new India-Myanmar-Thailand trilateral highway planned for 2016	Construction of India-Myanmar-Thailand Highway could offer a good opportunity for the installation of new fibre connectivity along the route. Italian-Thai Development is responsible for construction and should be consulted.
Myanmar to Yunnan Province, China (1,997 kilometres) *Medium Priority*	• Link constructed in 2007 by MPT and Yunnan	As the Myanmar telecommunications market opens to competition, there will be increased	Additional Myanmar-China capacity should be seriously considered, but	Rail: Development of a new rail link between Myanmar west coast and Kunming, China has been delayed.	Chinese operators should be consulted to determine the possibility of transit capacity via Yunnan.

	Telecom (China Telecom subsidiary)	demand for additional international paths.	relations between the two nations have weakened since 2011.	Highway: Road linking Kunming and Yunnan, China to Lashio, Myanmar through mountains (constructed in 1930s and 1940s)	Myanmar-China gas and oil pipelines may offer opportunity for fibre network construction.

VIII. COUNTRY ANALYSIS: PHILIPPINES

	YE 2012
Population	97,259,000
Population Growth Rate	*1.7%*
Gross Domestic Product (PPP)	USD$420 billion / $4,300 per capita
GDP Growth Rate	*6.6% in 2012, 6.0% forecasted in 2013*
Human Development Index	0.654
HDI Ranking	*114th out of 187 ("Medium")*
Literacy Rate	94%
Fixed-Line Subscribers	4,200,000
Fixed-Line Operators	1. Philippines Long Distance Telephone Co. (PLDT) 2. Globe Telecom (Singtel 47%, Ayala Corp. 32%) 3. Bayan Telecommunications (BayanTel) (Lopez Group) (Globe Telecom takeover in process through debt-to-equity conversion)
Mobile Subscribers	102,000,000
Mobile Operators	1. PLDT Subsidiaries: Smart Telecommunications, Talk 'N Text, Sun Cellular 2. Globe Telecom (Singtel 47%, Ayala Corp. 32%)
Mobile Broadband	3G launched in 2006, WiMax launched in 2009, LTE introduced in 2012
Regulatory Agency	National Telecommunications Commission (NTC)
International Internet Bandwidth	530 Gbps
Int'l Internet Bandwidth per Capita	*5.450 Kbps*
Internet Service Providers	1. Philippines Long Distance Telephone Co. (PLDT) 2. Globe Telecom (Singtel 47%, Ayala Corp. 32%)
Fixed Broadband Subscribers	1.470 million fixed broadband subscribers (>256 Kbps); 4 million mobile broadband subscribers (est.)
Fixed Broadband Technologies	ADSL, broadband wireless, WiMax, FTTH
Typical Monthly Broadband Subscription	1. USD$24 per month for 1 Mbps ADSL, unlimited download (PLDT, Tattoo (Globe)) 2. USD$73 per month for 3 Mbps ADSL, unlimited download (PLDT)

Telecommunications Market Overview

The Filipino telecommunications market was valued at approximately USD$6 billion in 2012. The market is dominated by only two operators: Philippines Long Distance Telephone Company (PLDT) and Globe Telecom, in which Singtel holds a 47 per cent stake and Ayala Corporation holds a 32 per cent stake. In 2011 PLDT assumed a majority stake in a third major operator, Digital Telecommunications Philippines (Digitel), and that company's landline subscribers were officially migrated to PLDT in early 2013.

The San Miguel Corporation, which is the Philippines' largest food and beverage conglomerate, has become increasingly aggressive in the country's telecommunications sector through its subsidiaries and partnerships, which include Bell Telecommunications, Eastern Communications (Extelcom), and Liberty Telecom Holdings (an investor in Wi-tribe).

Both PLDT and Globe Telecom announced significant network upgrade investments totalling more than USD$2 billion over the course of the last two years, focused on increasing investment in Long-Term Evolution (LTE) service, domestic fibre optic networks, and international submarine cable connectivity.

The Philippines' telecommunications and Internet sectors are heavily influenced by the country's position as a leader in business process outsourcing (BPO), particularly in the call-centre sector; some sources indicated that the Philippines overtook India as the world's largest call-centre industry in 2010, with a total of $5.7 billion in revenue. The Business Processing Association of the Philippines estimates that 600,000 Filipinos are employed in the sector.

The Filipino diaspora also influences the country's international telecommunications sector, with an estimated 12.5 million Filipinos abroad, particularly in the United States, Saudi Arabia, Malaysia, the United Arab Emirates, Canada, Japan, Australia, and Qatar.

The Philippines had historically been known as the "text-messaging capital of the world", although some sources assert that recent declines (from historical highs of as many as 2 billion daily messages to the current average of approximately 500 million messages) have positioned the country behind the United States. Nevertheless, text messages remain an important source of revenue for Filipino operators, with PLDT reporting text message revenue of more than $1.1 billion in 2012.

Regulation and Government Intervention

The National Telecommunications Commission, an agency of the Department of Transportation and Communications, serves as the overseeing body for the country's telecommunications sector.

In March of 2013 the Philippines Securities and Exchange Commission released new guidelines concerning foreign investment in key sectors, including telecommunications. Although the rules were considered to be less strict than those that had previously been in place, they nevertheless maintained a 40 per cent limit on foreign ownership of telecommunications companies.

Fixed-Line Telephony Market

Despite the global downturn in fixed-line penetration rates due to mobile substitution, there has been little attrition among fixed-line subscribers in the Philippines as fixed-line services have been bundled within telecommunications, Internet, and cable television packages. PLDT reported 2.1 million fixed subscribers as of year-end 2012.

Mobile Telephony Market

Following PLDT's assumption of control in Digitel in 2011, the share of PLDT-controlled entities in the mobile market is 69 per cent. Globe Telecom retains the remaining 31 per cent of subscribers.

Although Smart Communications started trials of LTE service in mid-2011, commercial service was not formally launched until mid-2012, when both Smart and Globe began offering LTE in metropolitan Manila. In 2013 the LTE offering has been expanded to other areas including Baguio, Borocay, Cebu, Davao, and Tagaytay.

PLDT reported that as of mid-2013, it had 1,000 operational LTE sites, while its 3G coverage reached 71 per cent of the population. PLDT subsidiary Smart offered LTE coverage in metropolitan Manila, Davao City in Mindanao, nine cities in Luzon (Baguio, Laoag, San Fernando, Cabanatuan, Antipolo, Urdaneta, Olongapo, Tagaytay, and Dagupan), and four cities in Visayas (Cebu, Iloilo, Mandaue, and Bacolod).

At the same time, Globe Telecom's LTE was available on its network in metropolitan Manila, Cebu City, and Boracay Island.

The average revenue per user (ARPU) is estimated at approximately USD$3.70 per month.

Internet and Broadband Market

As of year-end 2012 the PLDT group was the Philippines' largest broadband provider, with 2.36 million wireless broadband subscribers and 1 million fixed broadband subscribers. Overall PLDT broadband and Internet revenue was more than USD$500 million in 2012.

PLDT reported approximately 900,000 DSL subscriptions, with the group's revenue from DSL services accounting for $260 million in 2012, up 12 per cent from 2011. PLDT's total FTTH deployment totalled 14,000 kilometres, serving 20,000 subscribers. Following a $57 million, 5,000-km expansion of PLDT's fibre network completed in August of 2013, the operator said that FTTH service would be available in metropolitan Manila, Central Luzon, Southern Tagalog, Panay, Negros Occidental, Cebu, and Davao, with its network expected to pass 2.1 million homes by the end of 2013.

Globe Telecom reported 1.7 million fixed and mobile broadband subscriptions as of year-end 2012.

Globe Telecom and Smart Communications had both launched WiMax services as of 2009. San Miguel Corporation formed a partnership with Qatar Telecom (now Ooredoo) in 2008, which ultimately resulted in the launch of the 4G data service Wi-tribe; in 2010 the venture launched its 4G service.

International Internet Bandwidth and Capacity Pricing in the Philippines

Figure 18: International Internet Bandwidth and Capacity Pricing in the Philippines, 2012

International Internet Bandwidth	International Internet Bandwidth per Capita	International Capacity Pricing
530 Gbps	5.450 Kbps	IP Transit: USD$100 per Mbps per month in in 2012; $80 per Mbps per month in 2013

Source: Terabit Consulting research, Operator data and interviews

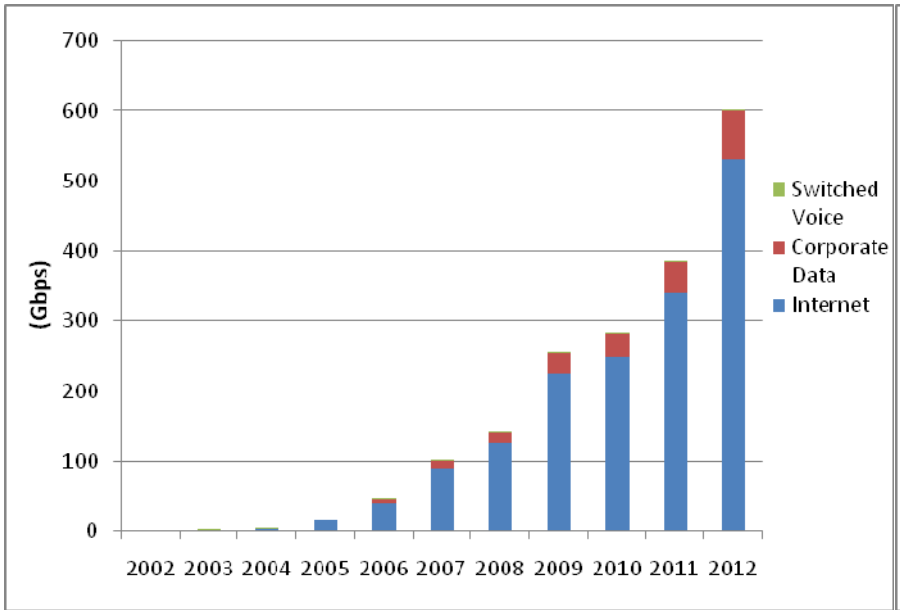
PLDT's reported international bandwidth, which accounts for the majority of Filipino international traffic, grew to 270 Gbps as of year-end 2011, and sources indicated that it exceeded 400 Gbps as of year-end 2012. Approximately 60 per cent of PLDT's demand is directed toward North America, while demand to East Asia accounts for more than 30 per cent.

Pricing of international bandwidth and IP transit capacity in the Philippines has remained high, with reported prices well in excess of $100 per Mbps as recently as 2011. As of 2013, prices were estimated to have fallen to $80 per Mbps.

Figure 19: Historical and Forecasted International Bandwidth in the Philippines (Mbps), 2002-2023

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
International Internet	891	2,323	3,215	15,000	40,000	90,000	125,000	225,000	250,000	340,000	530,000
International Corporate Data	118	308	426	1,987	5,298	11,920	16,556	29,800	33,111	45,031	70,196
International Switched Voice	578	641	712	790	877	974	1,081	1,200	1,332	1,478	1,641
Total International Bandwidth	1,586	3,272	4,352	17,777	46,175	102,894	142,636	256,000	284,443	386,509	601,836
CAGR (2002-2012)	81%										

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
International Internet	762,140	1,095,957	1,563,931	2,231,730	3,184,678	4,544,536	6,485,053	9,254,170	13,205,701	17,365,497	22,835,628
International Corporate Data	100,942	145,154	207,135	295,581	421,795	601,901	858,913	1,225,669	1,749,029	2,299,973	3,024,465
International Switched Voice	1,837	2,058	2,305	2,582	2,891	3,238	3,627	4,062	4,550	5,095	5,707
Total International Bandwidth	864,919	1,243,169	1,773,371	2,529,893	3,609,364	5,149,675	7,347,592	10,483,901	14,959,279	19,670,565	25,865,800
CAGR (2012-2023)	41%										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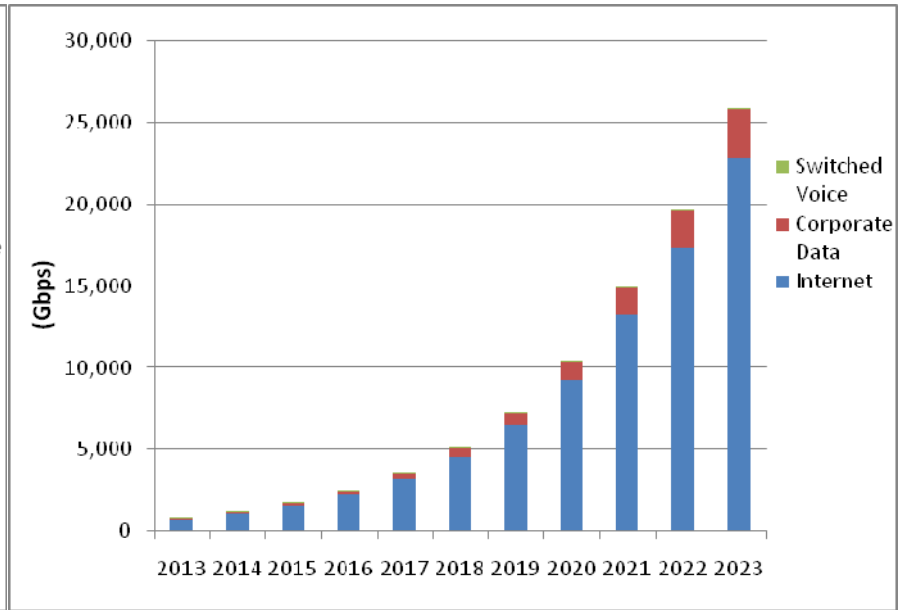
(Gbps)
2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012
Switched Voice
Corporate Data
Internet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(Gbps)
2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023
Switched Voice
Corporate Data
Internet

International Network Connectivity in the Philippines

PLDT operates three international submarine cable landing stations. The first, in Batangas City, is the site of the APCN-2 and SEA-ME-WE-3 landings. PLDT constructed a second cable station in 2009 in Bauang, La Union to serve the trans-Pacific Asia-America Gateway (AAG) cable, and in November of 2011 PLDT began constructing its third cable station in Daet, Camarines Norte to serve the Asia Submarine-cable Express (ASE) system, in which the company invested USD$55 million. PLDT had reported in 2009 that its investments in international submarine cables had at that time totalled $238 million.

Globe Telecom operates international submarine cable landing stations in Ballesteros, Cagayan and Nasugbu, Batangas for the TGN-Intra Asia and Southeast Asia-Japan Cable systems, respectively.

In addition, the Pacnet-owned EAC-C2C pan-Asian submarine cable network has dual landings in the Philippines, in Capepisa, Cavite and in Nasugbu, Batangas.

Figure 20 shows all active, under-construction, and retired interregional fibre optic submarine cable systems serving the Philippines.

Figure 20: Interregional Submarine Fibre Optic Systems Serving the Philippines

	Ready-for-Service Date	Status	Route (km)	Finance Type	Owner(s)	Cost ($Mil)	System Lit Capacity (Gbps)	System Design Capacity (Gbps)
Asia-Pacific Cable Network (APCN)	1997	Retired	12,083	Consortium	International carrier consortium	$644	0	[10]
SEA-ME-WE-3 (SMW3)	1999	Active	39,000	Consortium	International consortium of carriers	$1,300	200	600
East Asia Crossing-C2C (EAC-C2C)	2001/ 2002	Active	36,800	Investor-led	Pacnet	$2,500	3,800	17,920
Asia-Pacific Cable Network-2 (APCN-2)	2002	Active	19,000	Consortium	International carrier consortium	$1,060	2,600	10,240
TGN Intra-Asia (TGN-IA)	2009	Active	6,700	Carrier-sponsored	EVN Telecom (Viet Nam), Globe Telecom (Philippines), PCCW (Hong Kong, China), & Tata Communications (formerly VSNL of India)	$250	1,380	3,840
Asia-America Gateway Cable System (AAG)	2010	Active	20,318	Consortium	AT&T, Bharti, BT Global Network Services, CAT Telecom, ETPI, PCP Co. Ltd, PLDT, PT Indosat, Saigon Postel Corp., StarHub, Telekom Malaysia, Telkom Indonesia, Telstra, the Government of Brunei Darussalam, TNZL, Viettel, and VNPT	$554	1,540	5,096
Asia Submarine-cable Express (ASE) (includes Cahaya Malaysia)	2012/ 2013	Active	7,800	Consortium	NTT / PLDT / StarHub / Telekom Malaysia	$430	2,986	15,360
Southeast Asia-Japan Cable (SJC)	2013	Under construction	8,900	Consortium	Globe Telecom & 11 others	$400	0	15,360

Past and future regional submarine cable systems serving Philippines include the following:

- **Guam-Philippines-Taiwan Province of China (GPT),** which was activated in 1990 but was removed from service in 2003;
- **Brunei-Malaysia-Philippines (BMP),** which entered service in 1992 and was removed from service in 2004;
- **Guam-Philippines,** which was completed in 1999 and retired in 2011;
- The proposed **BIMP-EAGA** submarine cable system, which would connect Malaysia, Indonesia, Brunei, and the Philippines, and which has been proposed by the Brunei Darussalam-Indonesia-Malaysia-Philippines-East ASEAN (Association of Southeast Asian Nations) Growth Area (BIMP-EAGA) initiative, with initial support from 10 organizations, including Telekom Malaysia; the Malaysian Communications and Multimedia Commission (also known as SKMM for the Malaysian Suruhanjaya Komunikasi dan Multimedia Malaysia); the State Information Technology Advancement Unit of the Ministry of Resource Development and Information Technology in the eastern Malaysian state of Sabah (also known as KIT, for the Malaysian "Kemajuan IT Negeri"); Celcom Timur Sabah Sdn Bhd, a fibre optic network operator in Sabah; and Sacofa Sdn Bhd, which was founded in 2001 with the mandate of developing telecommunications infrastructure in the Malaysian state of Sarawak. In the Philippines, BIMP-EAGA would target the southern region of Mindanao.

Domestic Network Connectivity in the Philippines

PLDT said that as of year-end 2012, its submarine and terrestrial Domestic Fibre Optic Network (DFON) comprised 10 self-healing loops throughout the country and that its entire nationwide fibre deployment totalled 54,000 kilometres, with an expected addition of 5,000 kilometres in 2013 at a cost of USD$60 million. PLDT's domestic network capacity was upgraded to 1 Tbps in 2009.

Globe Telecom's domestic submarine and terrestrial network was reported to be 12,000 kilometres as of 2013. This included its own Fibre Optic Backbone Networks (the 1,250-kilometre FOBN, constructed in 2003, and the 1,900-kilometre FOBN-2, which was activated in 2009), as well as an 83 per cent stake in the 1,300-kilometre National Digital Transmission Network (NDTN), constructed by the Telic Phil consortium in 1999 but subsequently assumed by Globe Telecom through its acquisition of Bayan Telecommunications (BayanTel) from the Lopez Group and Benpres.

The Mindanao region in the southern Philippines has exhibited the country's lowest levels of development, both economically as well as in the telecommunications sector; fixed-line teledensity is only 44 per cent of the national average, and in the Autonomous Region of Muslim Mindanao (ARMM), there are fewer than 3,000 fixed lines serving a population of 3.3 million. However, there has recently been increased interest in the region, as PLDT and its mobile subsidiary Smart Communications announced the construction of a $21 million, 210-Gbps fibre optic cable linking Cebu, Bohol, and Misamis Oriental (northern Mindanao), with an expected ready-for-service date in September of 2013. The Brunei-Indonesia-Malaysia-Philippines East ASEAN Growth Area (BIMP-EAGA) has proposed an international link between southern Mindanao and Malaysia.

The western island province of Palawan has also been the focus of increased investment in 2013, with Globe Telecom installing a 400-kilometre cable between Palawan and Coron, offering a design capacity of 19.2 Tbps. In late 2012 PLDT also said that it would construct a 300-kilometre submarine cable from Ioilo to northern Palwawan, as well as 364 kilometres of terrestrial cable to the island's largest city, Puerto Princesa.

Evaluation of Trans-Border Network Development and Identification of Missing Links

As an archipelago of more than 7,000 islands, the Philippines is well-served by both domestic and international fibre optic cables. Increased telecommunications investment is needed in the south of the country (Mindanao) as well as in Palawan, but both areas are the focus of increased investment as of 2013.

The Philippines has no international terrestrial borders; consequently, Terabit Consulting did not perform an evaluation of trans-border network development.

IX. COUNTRY ANALYSIS: SINGAPORE

	YE 2012
Population	5,379,000
Population Growth Rate	*2.5%*
Gross Domestic Product (PPP)	USD$320 billion / $59,500 per capita
GDP Growth Rate	*1.3% in 2012, 1.5% forecasted in 2013*
Human Development Index	0.895
HDI Ranking	*18th out of 187 ("Very High")*
Literacy Rate	96%
Fixed-Line Subscribers	1,988,400
Fixed-Line Operators	1. Singtel (Temasek/Government of Singapore) 2. StarHub (Singapore Technologies Telemedia/Gov't)
Mobile Subscribers	8,063,000
Mobile Operators	1. Singtel (Temasek/Government of Singapore) 2. StarHub (Sing. Technologies Telemedia/Gov't) 3. M1
Mobile Broadband	3G launched in 2005; 4G LTE services first launched in 2011 and nationwide service available as of mid-2012
Regulatory Agency	Infocomm Development Authority of Singapore (IDA)
International Internet Bandwidth	1.389 Tbps
Int'l Internet Bandwidth per Capita	*258 Kbps*
Internet Service Providers	1. StarHub (Sing. Technologies Telemedia/Gov't) 2. Singtel (Temasek/Government of Singapore) 3. M1 4. SuperInternet 5. LGA Telecom 6. Others
Fixed Broadband Subscribers	1,370,900 fixed broadband subscribers (>256 Kbps); 8,823,900 mobile broadband subscribers
Fixed Broadband Technologies	Cable modem, ADSL, FTTH
Typical Monthly Broadband Subscription	1. USD$24 per month for 6 Mbps cable modem plus free 7.2 Mbps mobile broadband (Singtel) 2. USD$41 per month for 150 Mbps FTTH plus free fixed telephone (Singtel)

Telecommunications Market Overview

Singapore is one of the world's wealthiest countries, with per-capita GDP among the four highest globally in purchasing power parity terms, well in excess of all G8 nations. More than half of the Singaporean economy is state-controlled via investment vehicles, including the sovereign wealth fund Temasek, which is the majority shareholder in the country's largest telecommunications operator, Singtel. The Singaporean government is also a majority shareholder in the country's second-largest operator, StarHub (via Singapore Technologies Telemedia), and a minority investor in its third, M1 (via Singapore Press Holdings).

The Singaporean telecommunications market is valued at approximately USD$8 billion annually, or more than $125 per capita per month. Such robust revenue has funded the development of first-class telecommunications infrastructure, both domestically and with respect to international connections.

Singtel held a monopoly over the Singaporean telecommunications market until 1997, when mobile services were launched by MobileOne (now M1). A third operator, StarHub, began offering service in 2000 and eventually climbed to second place in mobile telephony and first in fixed broadband. Some smaller operators, such as SuperInternet and LGA Telecom, offer services via the country's Next Generation Nationwide Broadband Network.

Singapore's linguistic and ethnic demographics, coupled with its small size and disproportionately large economic strength, have fostered strong demand for Chinese-language and English-language Internet content stored abroad, as well as content in Malaysia, India, and Indonesia.

Regulation and Government Intervention

Singapore's telecommunications regulator is the Info-communications Development Authority; because of the influence of the IDA, as well as government investment in each of the three telecommunications operators, the industry's level of competition is considered to be tightly controlled by the public sector.

Fixed-Line Telephony Market

The Singaporean fixed-line market, with two million lines in service, is dominated by the incumbent operator Singtel, although StarHub maintains a small market share of approximately 2 per cent.

Mobile Telephony Market

The Singaporean mobile market is served by three operators: Singtel, StarHub, and M1, with market shares of 46 per cent, 28 per cent, and 26 per cent, respectively. Average revenue per user (ARPU) is approximately USD$13 per month for prepaid users and $60 per month for postpaid subscribers.

3G connections represent 73 per cent of all subscriptions. Singtel launched the country's first Long-Term Evolution (LTE) service in December of 2011, although the initial rollout was limited to USB modems and not available for mobile handsets.

"Wireless broadband subscriptions", as reported by industry regulator IDA, exceeded the number of mobile subscriptions by 30,000, after taking into account USB modem and WiFi subscriptions.

Internet and Broadband Market

The country's primary telecommunications development initiative is the Next Generation Nationwide Broadband Network (NextGen NBN), a fibre network developed under IDA's Intelligent Nation 2015 (iN2015) Master Plan. The 1-Gbps-capable NextGen NBN fibre network was deployed to 75 per cent of households as of August 2011 and had achieved coverage of 95 per cent as of 2013. In 2009 StarHub was selected as the operator of the network's active components and the wholesaler of capacity, via its subsidiary Nucleus Connect; construction of the fibre network was awarded to the OpenNet consortium, which includes Singtel. Each of the country's retail service providers (RSPs), including Singtel, StarHub, M1, SuperInternet, and LGA Telecom, are free to price their NextGen NBN retail services at whatever level they choose.

Initial NextGen NBN products offered by the RSPs were priced at approximately USD$40 per month for nominal 100 Mbps download speeds. The cost of equivalent NextGen NBN bandwidth at the wholesale level was reported to be $24 per month.

As of year-end 2012, Singapore counted a total of 638,500 cable modem subscribers, 443,300 DSL subscribers, and 284,800 FTTH subscribers. In 2012, FTTH subscriptions grew at a rate of 189 per cent, and as of year-end, Singtel's share of fibre broadband subscribers was 60.2 per cent, StarHub's was 21.6 per cent, and M1's was 18.6 per cent, although previous estimates of the overall broadband market placed StarHub as the leader with 55 per cent of subscribers, largely due to its cable modem service.

International Internet Bandwidth and Capacity Pricing in Singapore

Figure 21: International Internet Bandwidth and Capacity Pricing in Singapore, 2012

International Internet Bandwidth	International Internet Bandwidth per Capita	International Capacity Pricing
1.389 Tbps	258 Kbps	IP Transit: USD$10 per Mbps per month for large-volume purchases (>1 Gbps)

Source: Terabit Consulting research, Operator data and interviews

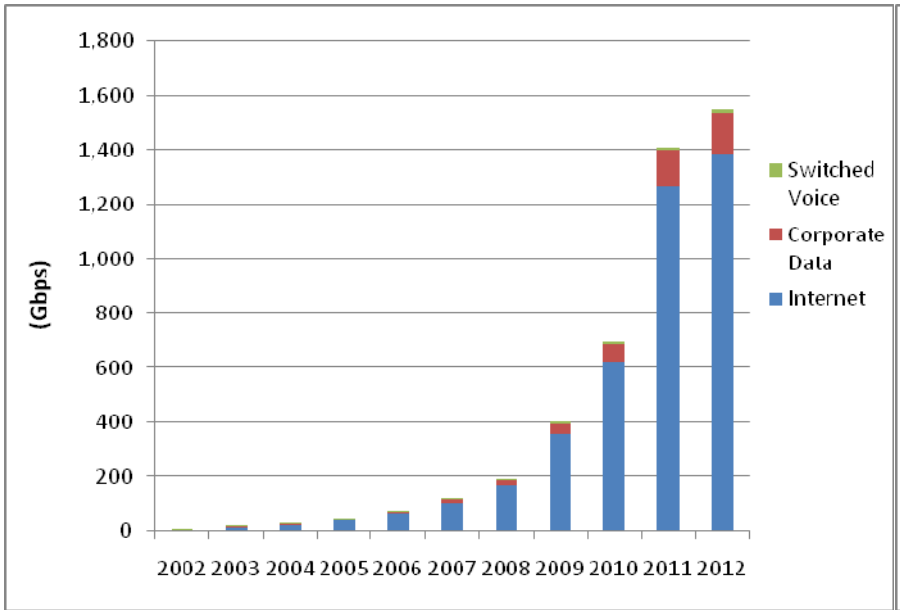
As of year-end 2012, Singapore's international Internet bandwidth was 1.389 Tbps, or 258 kbps per capita.

The price of IP transit capacity in Singapore is among the least expensive in the region, and in recent years has been closely aligned to the price of IP transit in rival market Hong Kong, China. As of year-end 2012, large-volume purchases of IP transit capacity (greater than 1 Gbps) were typically priced at USD$10 per Mbps or below.

Figure 22: Historical and Forecasted International Bandwidth in Singapore (Mbps), 2002-2023

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
International Internet	5,898	15,564	24,704	40,000	66,039	104,544	170,100	358,100	621,700	1,266,100	1,388,524
International Corporate Data	279	1,657	2,630	4,258	7,030	11,128	18,106	38,118	66,177	134,770	147,801
International Switched Voice	2,886	3,308	3,791	4,344	4,978	5,705	6,538	7,493	8,587	9,841	11,277
Total International Bandwidth	9,064	20,529	31,124	48,602	78,047	121,378	194,745	403,711	696,464	1,410,711	1,547,603
CAGR (2002-2012)	67%										

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
International Internet	1,948,100	2,733,184	3,834,657	5,380,024	7,548,174	10,590,088	13,671,803	17,650,298	22,786,535	29,417,416	37,977,885
International Corporate Data	207,365	290,934	408,180	572,677	803,465	1,127,262	1,455,295	1,878,786	2,425,513	3,131,337	4,042,556
International Switched Voice	12,924	14,811	16,973	19,451	22,291	25,545	29,275	33,549	38,447	44,060	50,493
Total International Bandwidth	2,168,389	3,038,928	4,259,810	5,972,152	8,373,930	11,742,895	15,156,373	19,562,633	25,250,495	32,592,814	42,070,934
CAGR (2012-2023)	35%										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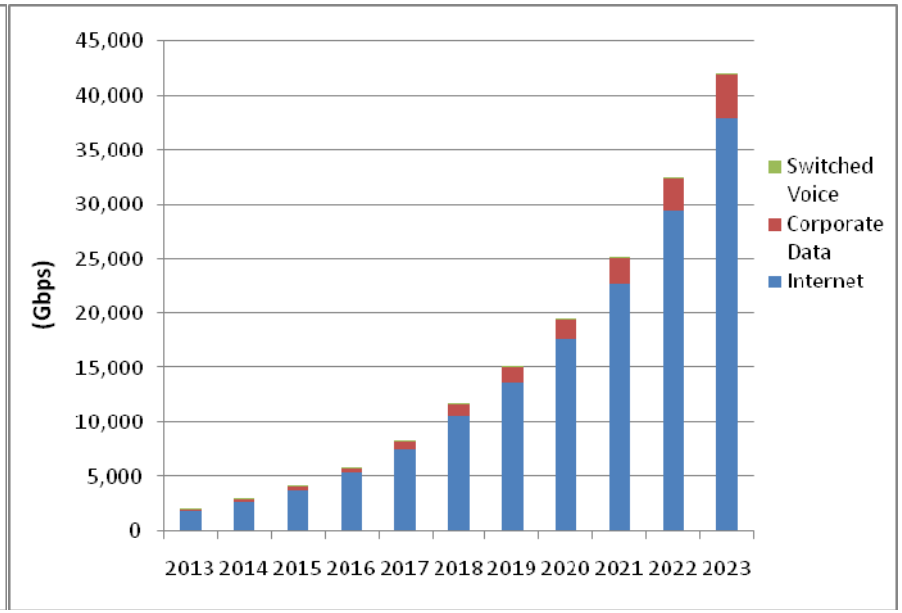
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(Gbps)
2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023
Switched Voice
Corporate Data
Internet

International Network Connectivity in Singapore

As of mid-2012, the "total international transmission capacity owned" by Singaporean operators on submarine cables landing in the country was 6.994 Tbps.

Figure 23 shows all active, under-construction, and retired interregional fibre optic submarine cable systems serving Singapore.

Figure 23: Interregional Submarine Fibre Optic Systems Serving Singapore

	Ready-for-Service Date	Status	Route (km)	Finance Type	Owner(s)	Cost ($Mil)	System Lit Capacity (Gbps)	System Design Capacity (Gbps)
Asia-Pacific Cable	1993	Retired	7,517	Consortium	International carrier consortium	$332	0	[1]
Asia-Pacific Cable Network (APCN)	1997	Retired	12,083	Consortium	International carrier consortium	$644	0	[10]
SEA-ME-WE-2 (SMW2)	1994	Retired	18,337	Consortium	International consortium of carriers	$780	0	[1]
SEA-ME-WE-3 (SMW3)	1999	Active	39,000	Consortium	International consortium of carriers	$1,300	200	600
East Asia Crossing-C2C (EAC-C2C)	2001/ 2002	Active	36,800	Investor-led	Pacnet	$2,500	3,800	17,920
Asia-Pacific Cable Network-2 (APCN-2)	2002	Active	19,000	Consortium	International carrier consortium	$1,060	2,280	10,240
i2i (ISCN)	2002	Active	3,200	Carrier-owned	Bharti Airtel (originally Bharti Group-Singtel JV)	$259	640	8,400
TGN-TIC (formerly Tata Indicom Cable)	2004	Active	3,175	Carrier-owned	Tata Communica-tions (formerly VSNL)	$120	960	5,120
SEA-ME-WE-4 (SMW4)	2005	Active	20,000	Consortium	International consortium of carriers	$500	2,000	4,800
TGN Intra-Asia (TGN-IA)	2009	Active	6,700	Carrier-sponsored	EVN Telecom (Viet Nam), Globe Telecom (Philippines), PCCW (Hong Kong, China), and Tata Communica-tions (formerly VSNL of India)	$250	1,380	3,840

Asia-America Gateway Cable System (AAG)	2010	Active	20,318	Consortium	AT&T, Bharti, BT Global Network Services, CAT Telecom, ETPI, PCP Co. Ltd, PLDT, PT Indosat, Saigon Postel Corp., StarHub, Telekom Malaysia, Telkom Indonesia, Telstra, the Government of Brunei Darussalam, TNZL, Viettel, and VNPT	$554	1,540	5,096
Asia Submarine-cable Express (ASE) (includes Cahaya Malaysia)	2012	Active	7,800	Consortium	NTT / Telekom Malaysia / PLDT / StarHub	$430	2,986	15,360
Southeast Asia-Japan Cable (SJC)	2013	Under construc-tion	8,900	Consortium	Singtel & 11 others	$400	0	15,360

Singapore will likely be served by one or more of the proposed Asia-Europe submarine cable projects currently under consideration, including the **Bay of Bengal Gateway (BBG),** which awarded a supply contract to Alcatel-Lucent in May of 2013 and would land in Singapore in 2014; **Africa-Asia-Europe-1 (AAE-1),** in which StarHub would reportedly be an investor; and **SEA-ME-WE-5,** led by Singtel. The country would also be served by the proposed **BRICS Cable,** connecting Russia, China, Singapore, India, South Africa, Brazil, and the United States.

Additionally, the planned **Asia-Pacific Gateway (APG)** submarine cable project, in which StarHub and Facebook are consortium members, would land in Singapore in 2014 and connect to China, Japan, Malaysia, the Republic of Korea, Thailand, and Viet Nam, as well as Hong Kong, China and Taiwan Province of China.

Several investors, including **ASSC-1** (JPC International)**, Leighton Contractors Telecommunications**, **Matrix Networks, PT NAP Info Lintas Nusa,** and subpartners, have proposed cables that would connect Singapore, Indonesia, and Australia.

Existing and retired regional undersea fibre optic systems serving Singapore include the following:

- **Brunei-Singapore,** which was activated in 1992 as part of a network development initiative led by the Association of Southeast Asian Nations (ASEAN) but was removed from service in 2003;
- **Thailand-Indonesia-Singapore,** which entered service in 2003 and was constructed by CAT, PT Telekomunikasi Indonesia, and Singtel;
- The **Matrix Cable System (MCS),** which connected Jakarta and Singapore in 2008 and was constructed by PT NAP Info Lintas Nusa of Indonesia and its affiliate Matrix Networks of Singapore;

- The **Moratelindo International Cable System-1 (MIC-1),** which entered service in 2008 connecting Batam, Indonesia to Singapore, constructed by PT Mora Telematika Indonesia and ViewQwest (a Singaporean operator that began operations in 2001 as a subsidiary of the Comcraft Group, an East African mining company);
- PT Telekomunikasi Indonesia's **Batam-Singapore Cable System (BSCS),** which entered service in 2009;
- PT Indosat's **Jakabare (Java-Kalimantan-Batam-Singapore**) system, which entered service in 2009;
- The **PGASCOM Java-Sumatra-Batam-Singapore** system, which entered service in 2010 and is operated by Indonesia's largest natural gas company, PT PGAS Telekomikasi Nusantara, also known as PGASCOM.

Singapore is also served by fibre optic connectivity to Malaysia via the causeway and bridge in the north of the island:

- **Malaysia-Singapore terrestrial links** via the Singaporean Causeway to the Telekom Malaysia network in Johor Baharu;
- The **Time dotCom Cross-Peninsular Cable System (CPCS),** which runs from Singapore along Malaysia's North-South Expressway to Thailand.

Time dotCom Cross-Peninsular Cable System (CPCS)	
Date	2009 (est.)
Length	6,000 kilometres
International Connectivity	- Singapore-Malaysia via Causeway and Tuas Second Link
Main Nodes	Singapore
Capacity	10 Gbps and 40 Gbps wavelengths
Network Technology	DWDM
Developers / Owners / Operators / Suppliers	- Developed, owned, and operated by Time dotCom
Continuity with Rail/Highway	- Installed alongside the North-South Expressway in Malaysia

Domestic Network Connectivity in Singapore

With a total area of 700 square kilometres, Singapore's city-state geography has enabled near-ubiquitous next-generation network deployment, with fibre and 4G mobile coverage available to 95 per cent of homes and businesses.

Evaluation of Trans-Border Network Development and Identification of Missing Links

As an island nation, Singapore has no terrestrial boundaries although it is linked to Malaysia via a causeway and a bridge, which carry multiple fibre pairs between the two countries. Given this connectivity, as well as Singapore's role as a submarine cable and Internet transit hub for the region, Terabit Consulting does not believe that Singapore's trans-border connectivity is in need of improvement.

Figure 24: Evaluation of Trans-Border Networks in Singapore and Recommendations for Improvement

International Border	Existing Fibre Infrastructure	Analysis	Recommendation	Linkage with Rail & Highway Networks	Stakeholders
Singapore to Malaysia (Causeway & Bridge) *Low Priority*	• Causeway links; Time dotCom Cross-Peninsular Cable System (via Second Link)	There is sufficient fibre capacity between Malaysia and Singapore.	There is no need for additional fibre capacity between Malaysia and Singapore.	Rail: KTM Berhad Highway: Causeway & Second Link	The Causeway and Second Link are operated and maintained by the Singaporean Land Transport Authority (LTA), PLUS Expressway Bhd, and Linkedua Malaysia Bhd.

X. COUNTRY ANALYSIS: THAILAND

	YE 2012
Population	69,915,000
Population Growth Rate	*0.6%*
Gross Domestic Product (PPP)	USD$646 billion / $9,240 per capita
GDP Growth Rate	*6.6% in 2012, 5.1% forecasted in 2013*
Human Development Index	0.690
HDI Ranking	*103rd out of 187 ("Medium")*
Literacy Rate	94%
Fixed-Line Subscribers	6,314,000
Fixed-Line Operators	1. TOT (Government of Thailand) 2. True (Charoen Pokphand Group 63%) 3. TT&T (Restructured with equity to creditors)
Mobile Subscribers	80,000,000
Mobile Operators	1. Advanced Info Service (AIS) (Shin Corporation/Intouch PLC 40%, Singtel 23%) 2. DTAC (Total Access Communications) (Telenor 62%) 3. TrueMove/TrueMove-H (True Corporation) (Charoen Pokphand Group 63%)
Mobile Broadband	3G launch in 2.1-GHz spectrum delayed until 2013 due to political crisis; LTE launch also expected in 2013
Regulatory Agency	National Broadcasting and Telecommunications Commission (NBTC)
International Internet Bandwidth	463 Gbps
Int'l Internet Bandwidth per Capita	*6.622 Kbps*
Internet Service Providers	1. TrueOnline (True Corporation) (Charoen Pokphand Group 63%) 2. TOT (Government of Thailand) 3. 3BB / Triple T Broadband (Jasmine International Group)
Fixed Broadband Subscribers	4,307,000 fixed broadband subscribers (>256 Kbps); 4 million mobile broadband subscribers (estimated; 11 million total 3G mobile subscribers)
Fixed Broadband Technologies	ADSL, FTTx, cable modem, Wi-Fi
Typical Monthly Broadband Subscription	1. USD$20 per month for 10 Mbps ADSL or cable modem (TrueOnline/3BB) 2. USD$41 per month for 30 Mbps FTTx (3BB)

Telecommunications Market Overview

The Thai telecommunications market's key sectors, i.e. fixed-line, mobile, and broadband, are each served by three operators. The total value of the market is estimated to be $10 billion annually.

Regulation and Government Intervention

The Thai telecommunications sector is overseen by the National Broadcasting and Telecommunications Commission (NBTC).

Fixed-Line Telephony Market

TOT, a state-owned enterprise, is the incumbent fixed-line operator and maintains a majority share of the market, although it faces competition from True in the Bangkok metropolitan area and TT&T in areas outside Bangkok. TOT's market share is estimated to be 60 per cent, while True and TT&T have 27 per cent and 13 per cent, respectively.

Mobile Telephony Market

Advanced Info Service (AIS), in which Shin Corporation holds a 40 per cent stake via Intouch PLC and Singtel holds a 23 per cent stake, is the country's largest mobile operator, with a 41 per cent market share. Total Access Communications, operating under the DTAC brand, is 62 per cent owned by the Norwegian operator Telenor; its market share is 30 per cent. Charoen Pokphand Group's TrueMove has a market share of approximately 27 per cent.

3G services in the 2.1 GHz spectrum were not officially launched until 2013, following years of delay exacerbated by the country's political crisis; the launch of 4G services was expected in mid-2013. Prior to the launch of 2.1-GHz 3G services, AIS, DTAC, and TrueMove had been using 850 and 900 MHz spectrum and were obligated to pay concession fees of approximately 30 per cent of revenues to incumbent operators under a build-transfer-operate agreement.

Average revenue per user (ARPU) is approximately USD$7.50 per month.

Internet and Broadband Market

True and TOT each have an estimated 35 per cent share of the broadband market, with 3BB at an estimated 25 per cent. The majority of broadband subscriptions are via ADSL although FTTH is available in Bangkok and is being expanded to some secondary cities. In July of 2013, TOT announced plans for increased investment in its FTTH infrastructure as well as submarine cable connectivity in Satun and Songkhla provinces.

International Internet Bandwidth and Capacity Pricing in Thailand

Figure 25: International Internet Bandwidth and Capacity Pricing in Thailand, 2012

International Internet Bandwidth	International Internet Bandwidth per Capita	International Capacity Pricing
463 Gbps	6.622 Kbps	IP Transit: USD$80 per Mbps per month

Source: Terabit Consulting research, Operator data and interviews

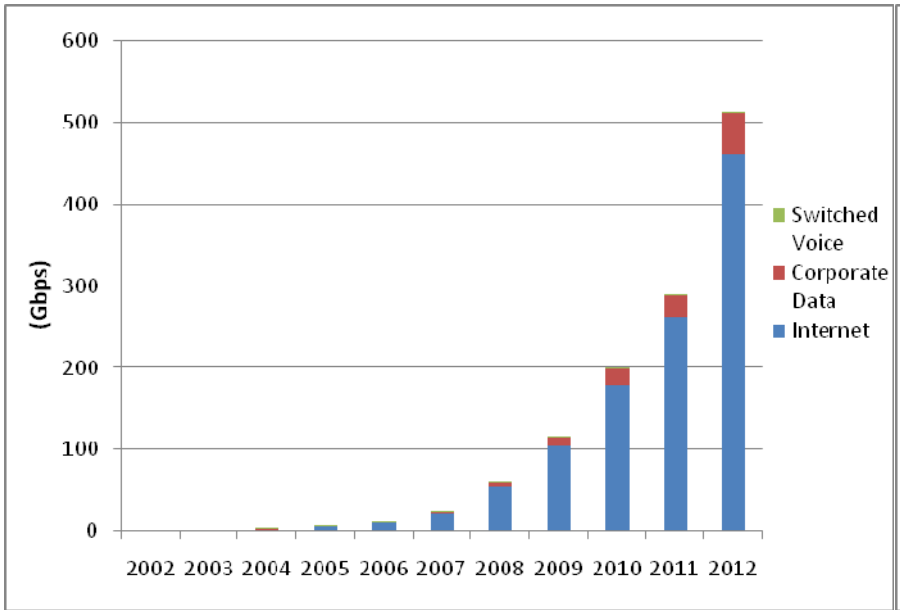
Thailand's international Internet bandwidth was 463 Gbps or 6.622 Kbps per capita as of year-end 2012. True International Gateway said that its own international bandwidth had increased to 10 Gbps as of August 2013.

IP transit bandwidth in Bangkok cost approximately USD$80 per Mbps per month as of year-end 2012, when purchased in volume.

Figure 26: Historical and Forecasted International Bandwidth in Thailand (Mbps), 2002-2023

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
International Internet	1,011	1,438	3,006	6,808	9,909	22,073	55,095	104,595	180,000	261,530	462,997
International Corporate Data	108	153	320	725	1,055	2,350	5,865	11,134	19,160	27,839	49,284
International Switched Voice	371	399	449	505	568	639	719	809	910	1,024	1,152
Total International Bandwidth	1,489	1,990	3,775	8,038	11,532	25,062	61,679	116,538	200,070	290,393	513,433
CAGR (2002-2012)	79%										

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
International Internet	658,845	937,536	1,334,114	1,883,769	2,659,881	3,755,753	5,303,123	7,488,009	10,573,069	13,744,989	17,868,486
International Corporate Data	70,131	99,796	142,010	200,518	283,131	399,781	564,491	797,061	1,125,450	1,463,085	1,902,011
International Switched Voice	1,296	1,458	1,640	1,845	2,076	2,335	2,627	2,956	3,325	3,741	4,209
Total International Bandwidth	730,271	1,038,790	1,477,764	2,086,132	2,945,088	4,157,869	5,870,241	8,288,026	11,701,844	15,211,816	19,774,706
CAGR (2012-2023)	39%										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Switched Voice
Corporate Data
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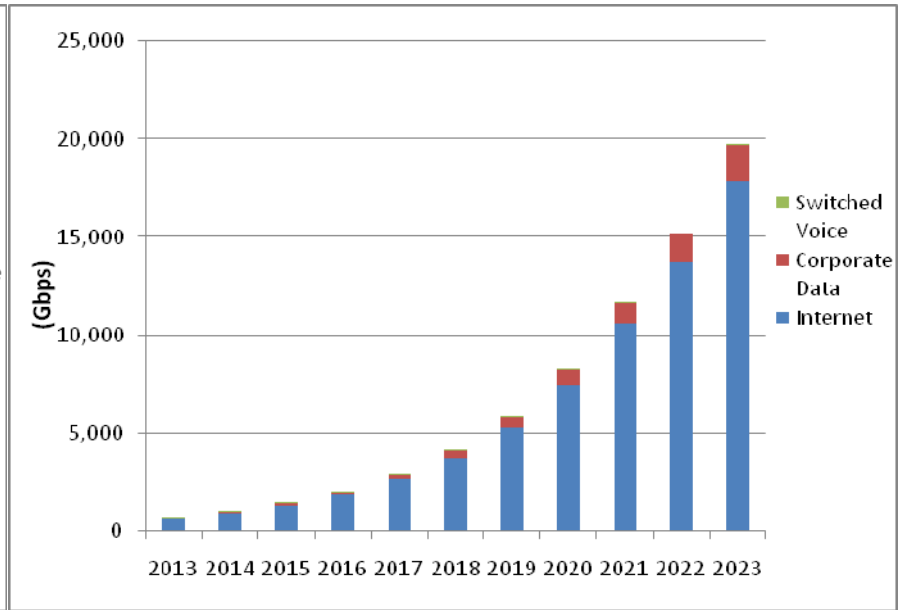
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(Gbps)
2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023
Switched Voice
Corporate Data
Internet

International Network Connectivity in Thailand

The Communications Authority of Thailand (CAT)'s monopoly over international Internet gateway services was ended in 2006, leading to the creation of five additional international gateway licensees and a major increase in international traffic from 2007 onward. As of 2012, CAT had a one-third share of the country's international gateway traffic and, according to sources interviewed by Terabit Consulting, effective control of the country's international submarine infrastructure. The country's other international gateway operators, namely TOT (formerly Telephone Organization of Thailand), True International Gateway, JasTel, CS LoxInfo, and Super Broadband Network (SBN), each access their international capacity primarily via terrestrial links from Padang Besar through Malaysia to Singapore, where IP transit capacity is priced significantly lower than in Thailand. Among the competing international gateway operators, True International Gateway reported that its total international fibre bandwidth had risen to 100.6 Gbps as of May 2012.

Figure 27 shows all interregional fibre optic submarine cable systems serving Thailand.

Figure 27: Interregional Submarine Fibre Optic Systems Serving Thailand

	Ready-for-Service Date	Status	Route (km)	Finance Type	Owner(s)	Cost ($Mil)	System Lit Capacity (Gbps)	System Design Capa-city (Gbps)
Asia-Pacific Cable Network (APCN)	1997	Retired	12,083	Consortium	International carrier consortium	$644	10	10
FLAG Europe-Asia (FEA) (formerly FLAG (Fiberoptic Link Around the Globe))	1997	Active	27,300	Investor-led, then carrier-owned	Reliance Globalcom (formerly FLAG Telecom)	$1,600	110	320
SEA-ME-WE-3 (SMW3)	1999	Active	39,000	Consortium	International consortium of carriers	$1,300	200	600
SEA-ME-WE-4 (SMW4)	2005	Active	20,000	Consortium	International consortium of carriers	$500	640	4,800
Asia-America Gateway Cable System (AAG)	2010	Active	20,318	Consortium	AT&T, Bharti, BT Global Network Services, CAT Telecom, ETPI, PCP Co. Ltd., PLDT, PT Indosat, Saigon Postel Corp., StarHub, Telekom Malaysia, Telkom Indonesia, Telstra, the Government of Brunei Darussalam, TNZL, Viettel, and VNPT	$554	500	1,920

The planned **Asia-Pacific Gateway (APG)** submarine cable project, proposed by a consortium that includes CAT and Facebook, would be completed in 2014 and link Thailand to China, Japan, Malaysia, the Republic of Korea, Singapore, and Viet Nam, as well as Hong Kong, China and Taiwan Province of China.

CAT Telecom of Thailand is reportedly exploring the construction of a new $41 million, 800-kilometre **Satun-Dawei** undersea fibre optic link from Satun, Thailand to Dawei in south-east Myanmar. Dawei is the planned site of a deepwater port and the country's first special economic zone. A contract for development of the area was awarded to a Thai-Italian consortium in 2010.

Regional submarine cable systems serving Thailand include the following:

- **Malaysia-Thailand,** a joint project between CAT and Telekom Malaysia that entered service in 1994 as part of the ASEAN submarine cable network;
- CAT's **Malaysia-Thailand East and West** systems, which entered service in 1996 in correspondence with Malaysian operator Time dotCom;
- **Thailand-Viet Nam-Hong Kong (TVH),** which entered service in 1996 but which was reportedly decommissioned in 2012;
- **Thailand-Indonesia-Singapore**, which entered service in 2003 and was constructed by CAT, PT Telekomunikasi Indonesia, and Singtel.

Thailand's international terrestrial links include the following:

- **Malaysia-Thailand** links, which cross the border between Sadao, Thailand and Padang Besar, Malaysia, and offer interconnection to Malaysian operators with transit to Singapore (and which carry the path of the **China-Southeast Asia Cable**);
- The **Time dotCom Cross-Peninsular Cable System (CPCS),** which runs along Malaysia's North-South Expressway from the Thai border to Singapore;

Time dotCom Cross-Peninsular Cable System (CPCS)	
Date	2009 (est.)
Length	6,000 kilometres
International Connectivity	- Thailand-Malaysia access points via Bukit Kayu Hitam and Padang Besar, Malaysia
Main Nodes	Bukit Kayu Hitam and Padang Besar, Malaysia
Capacity	10 Gbps and 40 Gbps wavelengths
Network Technology	DWDM
Developers / Owners / Operators / Suppliers	- Developed, owned, and operated by Time dotCom
Continuity with Rail/Highway	- Installed alongside the North-South Expressway in Malaysia

- **Myanmar–Thailand,** crossing the border between Mae Sot, Thailand and Myawaddy, Myanmar, constructed in 2010 and operating at a capacity of 10 Gbps;
- **Lao PDR-Thailand,** via Friendship Bridge I between Vientiane, Lao PDR and Udon Thani, Thailand (linking to Lao Telecommunications Company at 5 Gbps), forming part of the **China-Southeast Asia Cable**;

China-Southeast Asia Cable (CSC)	
Date	2001
Length	7,000 kilometres total international network length
International Connectivity	- Thailand-Lao PDR at Nong Khai
Main Nodes	Bangkok
Capacity	2.5 Gbps initial capacity
Network Technology	SDH / DWDM
Developers / Owners / Operators / Suppliers	- Developed by a consortium including Communications Authority of Thailand
Continuity with Rail/Highway	- Continuity with Thailand Route 2 (Mittraphap Road) (Asian Highway 12)

- **Lao PDR-Thailand,** via Friendship Bridge II between Mukdahan, Thailand and Savannakhet, Lao PDR (linking to Lao Telecommunications Company at 2 Gbps);

- **Thailand-Cambodia-Viet Nam (TCV),** commissioned in the late 1990s as a "Friendship Project" funded in part by a USD$9 million grant from the German government through its financing agency KfW. TCV crosses the Thai-Cambodian border at Aranyaprathet District, Sa Kaeo, Thailand and Poipet, Cambodia. The contract for the network's construction was awarded to ALCO Deutschland and fibre was supplied by Alcatel; the network was completed in 1999. TCV initially operated at STM-1 capacity and comprises either four or six fibre pairs, depending on the segment. The TCV system was subsequently expanded to Lao PDR and integrated into a larger, regional network known as the **Greater Mekong Subregion (GMS) Information Highway Project,** connecting Cambodia, Lao PDR, Myanmar, Thailand, Viet Nam, and Yunnan Province, China;

Thailand-Cambodia-Viet Nam (TCV)	
Date	Late 1990s
Length	290 kilometres within Thailand (est.)
International Connectivity	- Thailand-Cambodia (Aranyaprathet District, Sa Kaeo, Thailand to Poipet, Cambodia via Thailand Route 33 and Thai National Highway 5)
Main Nodes	Bangkok
Capacity	Initial capacity of STM-1 (155.52 Mbps); 4 to 6 fibre pairs per segment
Network Technology	SDH / DWDM
Developers / Owners / Operators / Suppliers	- Operated by the Communications Authority of Thailand (CAT) - Constructed by ALCO Deutschland - Fibre supplied by Alcatel
Continuity with Rail/Highway	- Continuity with Thailand Route 33 (Suwannason Road) (Asian Highway 1)
Notes	- Funded in part by a $9 million grant from the German government (KfW) - Subsequently integrated into Greater Mekong Subregion (GMS) Information Highway Project

- **Telcotech (Ezecom) Connectivity to the Asia-America Gateway Submarine Cable (Terrestrial Fibre Optic Network):** In November of 2007 the Cambodian investor Telcotech became a party to the Asia-America Gateway (AAG) trans-Pacific submarine cable system; the project did not land in Cambodia, and Telcotech was left to negotiate for AAG bandwidth through "reasonably-priced backhaul agreements" with the cable's landing parties in neighbouring Thailand and Viet Nam. In order to access those countries' landing points, Telcotech operates an international fibre connection to each; its link to Thailand crosses the border at Poipet, Cambodia and continues to the AAG cable station in Si Racha, Thailand, operated by CAT Telecom. In May of 2011 Telcotech was purchased by the Cambodian Internet service provider Ezecom (a subsidiary of Royal Group); Ezecom's chief executive officer Paul Blanche-Horgan said that "the main reason for buying the company was the AAG cable, which is really important for Cambodia". In 2012 the transborder capacity of Ezecom's network was reported to be 10 Gbps, but Mr. Blanche-Horgan indicated that an upgrade to 100 Gbps was expected;

Telcotech (Ezecom) Connectivity to the Asia-America Gateway Submarine Cable	
Date	2009-2010 (est.)
Length	570 kilometres within Cambodia (est.)
International Connectivity	- Thailand-Cambodia (Poipet, Cambodia)
Main Nodes	Si Racha (CAT submarine cable landing station)
Capacity	Initial capacity of 10 Gbps, upgrade to 100 Gbps announced
Network Technology	SDH / DWDM
Developers / Owners / Operators / Suppliers	- Developed and operated by Telcotech (now Ezecom); Thai segments believed to be operated by CAT
Continuity with Rail/Highway	- Continuity on eastern segments with Thailand Route 33 (Suwannason Road) (Asian Highway 1)
Notes	- Provides access to Cambodian access to AAG submarine cable; Telcotech purchased by Ezecom in 2011

- Additionally, CAT has reported that two additional fibre links to Lao PDR are in place between Chiang Khong, Thailand and Buokaew, Lao PDR, as well as between Ubon Ratchathani, Thailand and Paksae, Lao PDR, but neither link was confirmed by Lao Telecommunications Company as being active. A terrestrial link was also identified by CAT as connecting Trat, Thailand and Koh Kong Cambodia, but it was not confirmed as active by Telecom Cambodia. Furthermore, CAT has reported that fibre is in place between Mae Sai, Thailand and

Tachilek, Myanmar, but the latter link was not confirmed as operational by Myanmar Posts and Telecommunications (MPT).

Proposed terrestrial connectivity serving Thailand includes the **Thailand-Cambodia-Viet Nam-Hong Kong Fibre Highway** initiative, which was announced in March of 2012 as a partnership between NeocomISP of Cambodia (a subsidiary of NTC), Donghwa Telecom of Hong Kong (a subsidiary of Chunghwa Telecom of Taiwan Province of China), Vietnam Telecom International (VTI, a subsidiary of VNPT), and TCC Technology of Thailand. The initiative integrates the existing fibre networks of each investor under a single network management system, providing a ring architecture operating at multiple STM-64 (10 Gbps) wavelengths. The network would allow access to international submarine cables in Hong Kong.

Local media reported in June of 2012 that the Thai operator TOT had formed a partnership with China Telecom to construct terrestrial fibre optic connectivity between **Thailand, Cambodia, and Viet Nam as part of a network that would also serve Lao PDR, China, and Russia.** Other potential partners in the project include AT&T (via its joint venture with China Telecom known as Shanghai Symphony Telecom) and NTT DoCoMo.

Domestic Network Connectivity in Thailand

The Thai domestic fibre backbone infrastructure provides connectivity to most provinces of the country. CAT reports that its domestic fibre optic network totals 30,000 kilometres. Additionally, in 2009 the Thai government's Stimulus Package 2 financed the construction of an additional 8,000 kilometres of dark fibre nationwide targeting the research and education communities.

In addition to its terrestrial backbone, Thailand has a strong domestic submarine cable infrastructure. In 1993 CAT and Jasmine Submarine Cable Company constructed a $165 million, 1,300-kilometre festoon submarine cable system along the east coast of Thailand between Chon Buri and Tak Bai, serving a total of ten landing points. The following year CAT constructed a submarine cable connection between Phetchaburi and Si Racha. Then in 1997 CAT and Jasmine constructed a $60 million, 720-kilometre festoon system serving five landing points on Thailand's west coast, between Satun and Ranong and including Phuket. In 2011 the Italian-Thai Development Public Company Ltd. signed a supply contract with CAT to construct the 1,300-kilometre CAT Submarine Network (CSN) cable in the Gulf of Thailand, connecting Si Racha and Songkhla.

Evaluation of Trans-Border Network Development and Identification of Missing Links

Thailand is well-served by regional and intercontinental undersea cables; consequently, its terrestrial networks are not normally considered to be of critical importance, as bilateral traffic to Thailand's neighbours is minimal. However, given the relatively high price of international bandwidth and IP transit in Thailand in comparison with prices in Malaysia, the Malaysia-Thailand links are increasingly utilized as a means to bypass Thailand's submarine gateways and access cheaper submarine bandwidth and IP transit in Malaysia and Singapore. Consequently, fibre across the Malaysia-Thailand border will be of critical importance in order to ensure that Thai operators and Internet service providers have access to competitively priced international connectivity options in neighbouring markets. For the time being, however, fibre connectivity between the two countries appears to be adequate.

Figure 28: Evaluation of Trans-Border Networks in Thailand and Recommendations for Improvement

International Border (and border length)	Existing Fibre Infrastructure	Analysis	Recommendation	Linkage with Rail & Highway Networks	Stakeholders
Thailand to Cambodia (803 kilometres) *Low Priority (Medium Priority in opposite direction)*	• Thailand-Cambodia-Viet Nam / GMS Info. Highway Project • Telcotech AAG backhaul	Although of little importance to Thailand, the route provides one of Cambodia's primary paths to international submarine connectivity and is competitive, with Telecom Cambodia and Telcotech operating fibre.	From Thailand's perspective, the Thailand-Cambodia route has sufficient capacity.	Rail: Direct link, no longer active Highway: Thailand Route 33 (Suwannason Road) (Asian Highway 1)	The route's role as Cambodia's primary outlet for international bandwidth means that competitive Cambodian operators should be consulted to ensure that capacity remains accessible and affordable.
Thailand to Lao PDR (1,754 kilometres) *Low Priority*	• China-Southeast Asia Cable/Lao PDR-Thailand links	Laotian operator ETL and ISPs Sky Telecom and Planet have fibre across the border.	The Lao-PDR Thailand route appears to be well-served by existing infrastructure.	Rail: Short 3.5-km link Highway: Friendship bridges (2)	Laotian operators ETL, Sky Telecom, and Planet should be consulted to ensure that their links are fully active.
Thailand to Malaysia (506 kilometres) *Low Priority*	• Malaysia-Thailand links; border access to Time dotCom CPCS	Although there is limited competition among operators, there is sufficient trans-border bandwidth between Malaysia and Thailand.	There is currently sufficient capacity, but the route is critical as an outlet to cheaper international bandwidth.	Rail: Two crossings: Padang Besar and Rantau Panjang-Sungai Golok Highway: Seven crossings	Smaller operators and ISPs in Thailand and Malaysia should be consulted to determine if additional competition is needed on the route.
Thailand to Myanmar (1,800 kilometres)	• 10-Gbps fibre link installed in	Carries little traffic from Thailand, but as the Myanmar telecom	Thai operators and ISPs are unlikely to require additional	Rail: 420-km link currently out of use and blocked by hydroelectric	Construction of India-Myanmar-Thailand Highway could offer

Low Priority (Medium Priority in opposite direction)	2010	market opens to competition, there will be increased demand for additional international paths.	bandwidth to Myanmar, but the route will be of great importance to Myanmar operators.	dam Highway: Asian Highway 123 on Thai side, but road on Myanmar side less developed; new India-Myanmar-Thailand highway planned for 2016	opportunity for new fibre connectivity along the route. Italian-Thai Development is respon-sible for construction and should be consulted.

XI. COUNTRY ANALYSIS: VIET NAM

	YE 2012
Population	88,780,000
Population Growth Rate	*1.1%*
Gross Domestic Product (PPP)	USD$315 billion / $3,550 per capita
GDP Growth Rate	*5.1% in 2012, 5.2% forecasted in 2013*
Human Development Index	0.617
HDI Ranking	*127th out of 187 ("Medium")*
Literacy Rate	93%
Fixed-Line Subscribers	7,500,000
Fixed-Line Operators	1. Vietnam Posts and Telecommunications Group (VNPT) (Government of Viet Nam) 2. Viettel / EVN Telecom (Vietnam Military Telecommunications Company) 3. Saigon Post and Telecommunications Services Corporation (SPT)
Mobile Subscribers	135,000,000
Mobile Operators	1. Viettel (Vietnam Military Telecommunications Company) 2. Vinaphone (VNPT) (Government of Viet Nam) 3. Mobifone (VNPT) (Government of Viet Nam) 4. Vietnamobile 5. GMobile (formerly Beeline) (GTel Mobile) 6. Sphone
Mobile Broadband	3G launched in 2009; LTE not expected to be licensed until 2015 or later
Regulatory Agency	Viet Nam Telecommunications Authority (VNTA)
International Internet Bandwidth	360 Gbps
Int'l Internet Bandwidth per Capita	*5.150 Kbps*
Internet Service Providers	1. Vietnam Posts and Telecommunications Group (VNPT) (Government of Viet Nam) 2. FPT Telecom 3. Viettel / EVN Telecom (Vietnam Military Telecommunications Company)
Fixed Broadband Subscribers	4.330 million fixed broadband subscribers (>256 Kbps); 17 million mobile broadband subscribers (est.)
Fixed Broadband Technologies	ADSL, FTTx, cable modem, leased line
Typical Monthly Broadband Subscription	1. USD$10 per month for 1 Mbps ADSL with unlimited download (VNPT) 2. USD$19 per month for 12 Mbps FTTx with unlimited download (Viettel)

Telecommunications Market Overview

State-owned Vietnam Posts and Telecommunications (VNPT) dominates the Vietnamese telecommunications market, with almost three-quarters of fixed-line subscribers, more than half of mobile subscribers, and more than two-thirds of the broadband market. Its primary competitor, Viettel, is controlled by the Vietnamese Ministry of Defence.

The Vietnamese telecommunications market is estimated to be worth USD$10 million annually.

Regulation and Government Intervention

The industry regulator, the Viet Nam Telecommunications Authority (VNTA), was established in mid-2011.

Fixed-Line Telephony Market

The Vietnamese fixed-line market is primarily served by three operators: VNPT, Viettel, and Saigon Post and Telecommunications Services Corporation (SPT). VNPT's fixed-line market share is 73 per cent, although Viettel's merger with EVN Telecom has strengthened Viettel's market share to 26 per cent.

Mobile Telephony Market

The country's three largest mobile operators account for 95 per cent of the market. Viettel's share is 37 per cent, while VNPT's subsidiaries Vinaphone and Mobifone each have 29 per cent (for a combined VNPT group market share of 58 per cent).

Russian investor Vimpelcom withdrew from the market in 2012.

Average revenue per user (ARPU) is between USD$4 and $5 per month.

Internet and Broadband Market

ADSL service was first introduced in 2003 and fibre-to-the-home is reportedly under implementation in "63 provinces and cities", according to VNPT. VNPT's broadband market share is 68 per cent, while FPT has 21 per cent and Viettel has 10 per cent.

International Internet Bandwidth and Capacity Pricing in Viet Nam

Figure 29: International Internet Bandwidth and Capacity Pricing in Viet Nam, 2012

International Internet Bandwidth	International Internet Bandwidth per Capita	International Capacity Pricing

360 Gbps	5.150 Kbps	IP Transit: USD$70 per Mbps per month

Source: Terabit Consulting research, Operator data and interviews

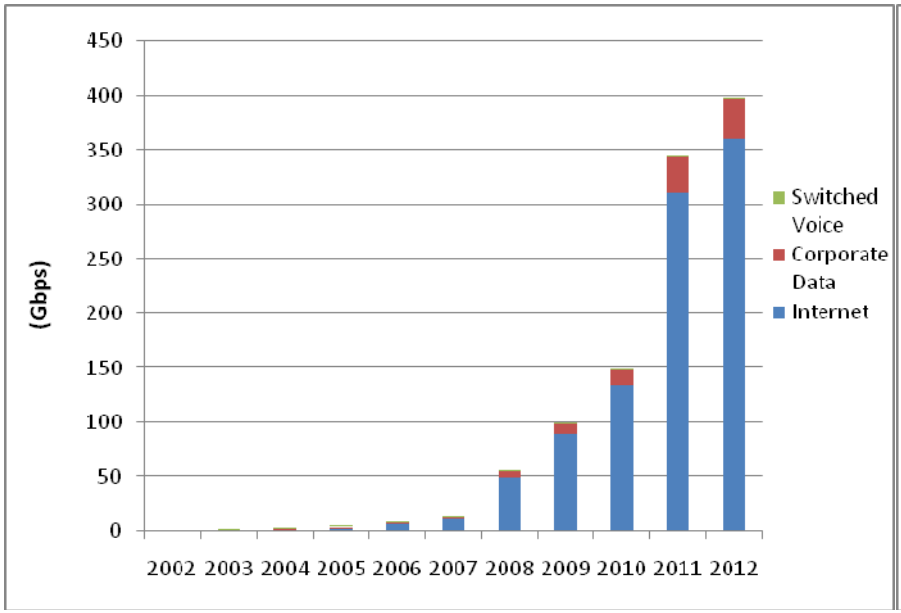
Recent figures indicated that state-owned VNPT controlled 49 per cent of international bandwidth, followed by Viettel, the operator run by the Vietnamese military, with 27 per cent. FPT Telecom, a division of Viet Nam's largest publicly traded telecommunications and software conglomerate FPT Corporation, ranked third with 18 per cent of international Internet bandwidth.

IP transit bandwidth in Viet Nam was estimated to cost approximately USD$70 per Mbps per month, as of year-end 2012.

Figure 30: Historical and Forecasted International Bandwidth in Viet Nam (Mbps), 2002-2023

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
International Internet	143	1,038	1,892	3,615	7,076	12,580	50,064	89,619	134,415	311,331	360,000
International Corporate Data	15	106	194	370	724	1,287	5,122	9,168	13,751	31,849	36,828
International Switched Voice	316	339	382	429	483	543	611	688	774	870	979
Total International Bandwidth	473	1,483	2,467	4,414	8,283	14,410	55,797	99,475	148,939	344,051	397,807
CAGR (2002-2012)	96%										

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
International Internet	512,280	728,974	1,037,331	1,464,711	2,068,172	2,920,258	4,123,405	5,822,248	8,221,014	11,608,072	15,090,493
International Corporate Data	52,406	74,574	106,119	149,840	211,574	298,742	421,824	595,616	841,010	1,187,506	1,543,757
International Switched Voice	1,102	1,239	1,394	1,569	1,765	1,985	2,233	2,512	2,827	3,180	3,577
Total International Bandwidth	565,788	804,788	1,144,844	1,616,119	2,281,510	3,220,986	4,547,463	6,420,376	9,064,850	12,798,757	16,637,828
CAGR (2012-2023)	40%										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Switched Voice
Corporate Data
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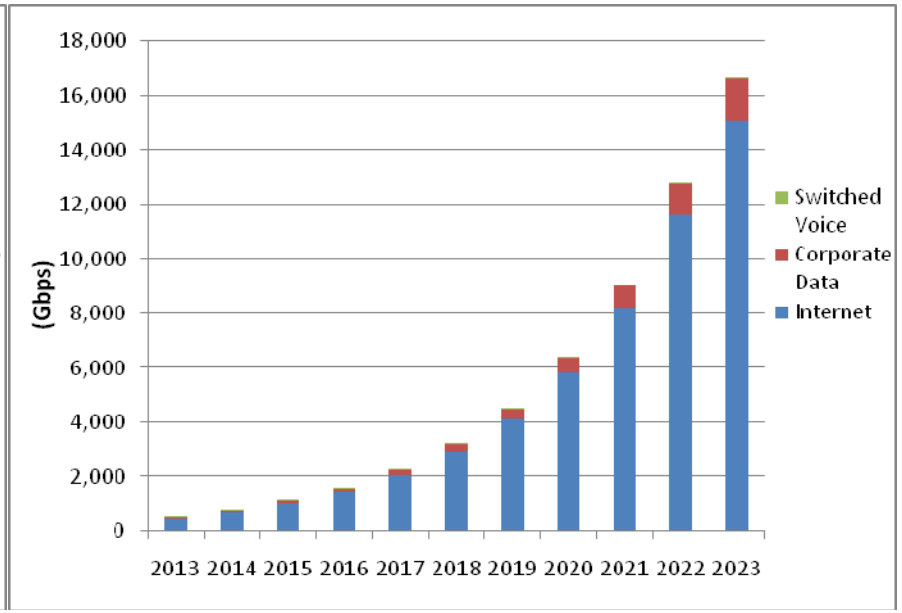
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(Gbps)
2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023
Switched Voice
Corporate Data
Internet

International Network Connectivity in Viet Nam

Figure 31 shows all interregional fibre optic submarine cable systems serving Viet Nam.

Figure 31: Interregional Submarine Fibre Optic Systems Serving Viet Nam

	Ready-for-Service Date	Status	Route (Km)	Finance Type	Owner(s)	Cost ($Mil)	System Lit Capacity (Gbps)	System Design Capacity (Gbps)
SEA-ME-WE-3 (SMW3)	1999	Active	39,000	Consortium	International consortium of carriers, including VNPT	$1,300	200	600
TGN Intra-Asia (TGN-IA)	2009	Active	6,700	Carrier-sponsored	Tata Communications (formerly VSNL of India), PCCW (Hong Kong, China), Globe Telecom (Philippines), and EVN Telecom (Viet Nam)	$250	1,380	3,840
Asia-America Gateway Cable System (AAG)	2010	Active	20,318	Consortium	AT&T, Bharti, BT Global Network Services, CAT Telecom, ETPI, PCP Co. Ltd, PLDT, PT Indosat, Saigon Postel Corp., StarHub, Telekom Malaysia, Telkom Indonesia, Telstra, the Government of Brunei Darussalam, TNZL, Viettel, and VNPT	$554	500	1,920

Viet Nam was also served by one regional submarine cable system:

- **Thailand-Viet Nam-Hong Kong (TVH),** which entered service in 1996 but which was reportedly decommissioned in 2012.

In addition, Viet Nam would be served by another submarine cable which is currently under development:

- **Asia-Pacific Gateway (APG)** submarine cable project, proposed by a consortium that includes VNPT, Viettel, CMC Telecom, and Facebook, is scheduled to be completed in 2014 and will link Viet Nam to China, Japan,

Malaysia, the Republic of Korea, Singapore, and Thailand, as well as Hong Kong, China and Taiwan Province of China.

- Thailand-Cambodia-Viet Nam (TCV) (Terrestrial Fibre Optic Network) / Greater Mekong Subregion (GMS) Information Highway Project (Terrestrial Fibre Optic Network)

Thailand-Cambodia-Viet Nam (TCV)	
Date	Late 1990s
Length	110 kilometres within Viet Nam (est.)
International Connectivity	- Viet Nam-Cambodia (Moc Bay border crossing)
Main Nodes	Ho Chi Minh City
Capacity	Initial capacity of STM-1 (155.52 Mbps), subsequently upgraded to STM-16 (2.488 Gbps) when integrated into the Greater Mekong Subregion Information Highway; four to six fibre pairs per segment
Network Technology	SDH / DWDM
Developers / Owners / Operators / Suppliers	- Commissioned and operated by VNPT - Constructed by ALCO Deutschland - Fibre supplied by Alcatel
Continuity with Rail/Highway	- To Cambodian border via Route QL 22 / Asian Highway 1
Notes	- Funded in part by a $9 million grant from the German government (KfW) - Subsequently integrated into the Greater Mekong Subregion (GMS) Information Highway Project

In the late 1990s, the Thailand-Cambodia-Viet Nam terrestrial fibre optic network was commissioned as a "Friendship Project" funded in part by a USD$9 million grant from the German government through its financing agency KfW. Constructed in partnership with the Communications Authority of Thailand, TCV crosses the Cambodian border at between Moc Bay, Viet Nam and Bavet, Svay Rieng, Cambodia. The contract for the network's construction was awarded to ALCO Deutschland, and fibre was supplied by Alcatel; the network was completed in 1999. TCV initially operated at STM-1 capacity and it comprises either four or six fibre pairs, depending on the segment. The system was subsequently expanded to Lao PDR and integrated into a larger, regional network known as the Greater Mekong Subregion (GMS) Information Highway Project, connecting Cambodia, Lao PDR, Myanmar, Thailand, Viet Nam, and Yunnan Province, China.

The $17.5 million GMS Information Highway Project includes trans-border links between Cambodia, China, Lao PDR, Myanmar, Thailand, and Viet Nam and was constructed between December of 2007 and June of 2009.

➢ China-Southeast Asia Cable (Terrestrial Fibre Optic Network)

China-Southeast Asia Cable (CSC)	
Date	February 2001
Length	430 kilometres in Cambodia (7,000 kilometres total)
International Connectivity	- Viet Nam-Lao PDR via Cau Treo - Viet Nam-China via Youyiguan Pass (unconfirmed)
Main Nodes	Hanoi
Capacity	2.5 Gbps initial capacity
Network Technology	SDH / DWDM
Developers / Owners / Operators / Suppliers	- Developed by a consortium, including VNPT
Continuity with Rail/Highway	- To Cambodian border via Route QL 8A / Asian Highway 15 - To Chinese border via Route QL 1A / Asian Highway 1 (unconfirmed)

Trans-border connectivity between Viet Nam and its neighbours China and Lao PDR was constructed under the aegis of the China-Southeast Asia Cable (CSC) project. The network was activated in February 2001; it connects China, Viet Nam, Lao PDR, Thailand, Malaysia, and Singapore and has a length of 7,000 kilometres and a capacity of STM-16 (2.5 Gbps). Its integrated network, which included pre-existing links, connects Shanghai, Guangzhou, Hanoi, Vientiane, Bangkok, Kuala Lumpur, and Singapore. CSC was constructed by a consortium including the Enterprise of Telecommunications Lao (ETL), SingTel, China Telecom, Telekom Malaysia, the Communications Authority of Thailand, and the Vietnam Posts and Telecommunications Corporation. Viet Nam's terrestrial capacity to China was reported to be 65 Gbps as of early 2012.

➢ Lao PDR-Viet Nam Links (Terrestrial Fibre Optic Network)

VNPT subsidiary Viet Nam Data Communication operates a 5-Gbps link between Dansavanh, Lao PDR and Lao Bao, Viet Nam, as well as a 5-Gbps link between Namphao, Lao PDR and Cau Treo, Viet Nam.

➢ Telcotech (Ezecom) Connectivity to the Asia-America Gateway Submarine Cable (Terrestrial Fibre Optic Network)

Telcotech (Ezecom) Connectivity to the Asia-America Gateway Submarine Cable	
Date	2009-2010 (est.)
Length	275 kilometres
International Connectivity	- Cambodia-Viet Nam (via Tan Bien district)
Main Nodes	Vung Tau (AAG submarine cable landing station)
Capacity	Initial capacity of 10 Gbps, upgrade to 100 Gbps announced
Network Technology	SDH / DWDM
Developers / Owners / Operators / Suppliers	- Developed and operated by Telcotech (now Ezecom)
Continuity with Rail/Highway	- QL 228 (unconfirmed)
Notes	- Provides Cambodia access to AAG subsea cable via Thailand and Viet

Nam

In November of 2007, Cambodian investor Telcotech (then controlled by Cambodian businessman Huot Vanthan and subsequently purchased by Ezecom), replaced Pacific Communications as the Cambodian member of the Asia-America Gateway trans-Pacific cable consortium. At the time of Telcotech's membership, the final configuration of AAG had been decided and did not include a Cambodian landing point; consequently, Telcotech was left to negotiate for AAG bandwidth through "reasonably-priced backhaul agreements" with the cable's landing parties in neighbouring Thailand and Viet Nam. In order to access those countries' landing points, Telcotech operates an international fibre connection to Viet Nam which crosses the border in the Ponhea Kraek District and connects to the AAG cable station in Vung Tau, Viet Nam. The capacity of the link was reported to be 10 Gbps as of 2012 but an upgrade to 100 Gbps was expected.

- Viettel Cambodia-Viet Nam (Terrestrial Fibre Optic Network)

Viettel Cambodia operates an international fibre connection to Viet Nam that consists of dual paths to Phnom Penh, with one segment along National Highway 2 and another along National Road 21.

- Cambodia-Viet Nam High-Speed Transmission Line (Terrestrial Fibre Optic Network)

VNPT subsidiary Vietnam Telecom International (VTI) and Telecom Cambodia announced the launch of the Cambodia-Viet Nam High-Speed Transmission Line (also known as the Cambodia-Viet Nam Super Highway) in April of 2012, comprising a 260-kilometre fibre optic link between Phnom Penh, Cambodia and Ho Chi Minh City, Viet Nam. The initial capacity of the link was 10 Gbps.

- Proposed International Connectivity

The Thailand-Cambodia-Viet Nam-Hong Kong Fibre Highway initiative was announced in March of 2012 as a partnership between NeocomISP of Cambodia (a subsidiary of NTC), Donghwa Telecom of Hong Kong, China (a subsidiary of Chunghwa Telecom of Taiwan Province of China), Vietnam Telecom International (VTI, a subsidiary of VNPT), and TCC Technology of Thailand. The initiative integrates the existing fibre networks of each investor under a single network management system, providing a ring architecture operating at multiple STM-64 (10 Gbps) wavelengths. The network would allow access to international submarine cables in Hong Kong.

Local media reported in June of 2012 that the Thai operator TOT had formed a partnership with China Telecom to construct terrestrial fibre optic connectivity between Thailand, Cambodia, and Viet Nam as part of a network that would also serve Lao PDR, China, and Russia. Other potential partners in the project include AT&T (via its joint venture with China Telecom known as Shanghai Symphony Telecom) and NTT DoCoMo.

Domestic Network Connectivity in Viet Nam

VNPT operates a domestic North-South Fibre Optic Cable Network as its domestic backbone, following the path of National Route 1A and Ho Chi Minh Road. There are also metropolitan fibre networks in Hanoi, Ho Chi Minh City, Da Nang, and Can Tho. As of year-end 2012, domestic bandwidth was 33 per cent higher than international bandwidth, at approximately 475 Gbps.

Evaluation of Trans-Border Network Development and Identification of Missing Links

There are existing international fibre optic links across each of Viet Nam's three terrestrial borders. In particular, the border with Cambodia is well-served, since Viet Nam acts as a vital outlet for international bandwidth to Cambodia. Viettel and VNPT both operate fibre links across the Cambodian border, and Ezecom operates a fibre backhaul network through Viet Nam to the landing point of the Asia-America Gateway (AAG) trans-Pacific undersea cable. VNPT and its subsidiary VDC operate links across the border with Lao PDR.

Neither the Cambodian nor the Laotian border is considered to be in need of additional fibre, given the existing infrastructure and relatively low bilateral demand between Viet Nam and its contiguous western neighbours. Currently, most of the traffic across the borders is due to Cambodian and Laotian outward demand for international bandwidth via Viet Nam's submarine cable landing points. Nevertheless, the construction of a new railway link between Viet Nam and Cambodia that would be funded by the Chinese government might offer an efficient opportunity for the simultaneous installation of further fibre capacity or ducts in the near future. On the other hand, construction of the new 2E Highway between Cambodia and Lao PDR has already been recently completed.

Although the China-Southeast Asia Cable (CSC) connects Viet Nam and China, its exact routing was not able to be confirmed. Even if CSC directly connects Viet Nam and Yunnan Province, Terabit Consulting believes that additional capacity across the border would greatly improve regional connectivity and encourage more efficient access to affordable international bandwidth. Trade between Yunnan Province and Viet Nam has increased 20 per cent annually in recent years, to approximately USD$1.5 billion, positioning Viet Nam as Yunnan Province's second-largest trading partner. In 2012 the governor of Yunnan Province called for improved trans-border transport links via highway and rail, which could provide an opportunity for the installation of new fibre links.

Figure 32: Evaluation of Trans-Border Networks in Viet Nam and Recommendations for Improvement

International Border (and border length)	Existing Fibre Infrastructure	Analysis	Recommendation	Linkage with Rail & Highway Networks	Stakeholders
Viet Nam to Cambodia (1,228 kilometres) *Low Priority*	• Thailand-Cambodia-Viet Nam / Greater Mekong Subregion Information Highway Project • Telcotech (Ezecom) AAG backhaul network • Viettel Cambodia-Viet Nam • Cambodia-Viet Nam High-Speed Transmission Line	One of Cambodia's primary paths to international submarine connectivity; multiple operators and networks are present.	Existing infrastructure is sufficient to support Vietnamese demand toward Cambodia	Rail: None; direct link may be funded by Chinese gov't Highway: QL 22 (Asian Highway 1) & QL 228	New rail project funded by Chinese government may offer diverse path for new fibre construction
Viet Nam to Lao PDR (2,130 kilometres) *Low Priority*	• China-Southeast Asia Cable/ Lao PDR-Viet Nam links	VNPT operates links in correspondence with both ETL and LAT of Lao PDR.	Capacity between Lao PDR and Viet Nam appears to be sufficient.	Rail: None Highway: New Highway 2E (Viet Nam-Lao PDR Highway Project)	VNPT, ETL, and LAT should be consulted to ensure that their links are fully active and traffic is flowing over them.
Viet Nam to China (Yunnan Province border 1,281 kilometres) *Medium Priority*	• China-Southeast Asia Cable	VNPT and China Telecom operate the link between Viet Nam and China.	The link is believed to follow the Youyiguan Pass; additional connectivity via Yunnan Province should be considered in order to improve regional connectivity.	Rail: Kunming–Hai Phong Railway Highway: AH-1	VNPT and China Telecom should be consulted to determine the exact routing of the existing network.

XII. ANALYSIS OF YUNNAN PROVINCE, CHINA

	YE 2012
Population	1,354,000,000 (China) / 46,600,000 (Yunnan Province)
Population Growth Rate	*0.5% (China) / 0.7% (Yunnan Province)*
Gross Domestic Product (PPP)	USD$12.4 trillion / $9,150 per capita (China) / USD$223.8 billion / $4,800 per capita (Yunnan)
GDP Growth Rate	*7.8% in 2012, 8.0% forecasted in 2013 (China) / 13.0% in 2012, 12.0% forecasted in 2013 (Yunnan)*
Human Development Index	0.699 (China) / equivalent of 0.630 (Yunnan)
HDI Ranking	*101st out of 187 ("Medium") (China) / Equivalent of 121st out of 187 ("Medium") (Yunnan)*
Literacy Rate	96% (China) / 94% (Yunnan)
Fixed-Line Subscribers	278,153,000 (China) / 5,243,000 (Yunnan)
Fixed-Line Operators	1. China Telecom (Government of China) 2. China Unicom (Government of China)
Mobile Subscribers	1,112,155,000 (China) / 28,958,000 (Yunnan)
Mobile Operators	1. China Mobile (Government of China) 2. China Unicom (Government of China) 3. China Telecom (Government of China)
Mobile Broadband	3G launched in 2009; possibility of commercial 4G/LTE launch by August 2013
Regulatory Agency	Ministry of Industry and Information Technology (MIIT)
International Internet Bandwidth	1.900 Tbps (China)
Int'l Internet Bandwidth per Capita	*1.403 Kbps (China)*
Internet Service Providers	1. China Telecom (Government of China) 2. China Unicom (Government of China) 3. China Mobile (Government of China)
Fixed Broadband Subscribers	175,183,000 (China) / 3,755,000 (Yunnan)
Fixed Broadband Technologies	ADSL, FTTx
Typical Monthly Broadband Subscription	1. USD$24 per month for 10 Mbps ADSL with unlimited download (China Telecom Shanghai) 2. USD$31 per month for 10 Mbps FTTH with IP telephony and unlimited download (China Telecom Shanghai)

There were 14,805,707 kilometres of fibre optic cable deployed throughout China as of year-end 2012, according to the Ministry of Industry and Information Technology, while Yunnan Province had 486,971 kilometres, or 3.2 per cent of the country's total (in line with the province's 3.4 per cent share of the country's population).

Yunnan Province is tied with Jiangxi for last place in the country with respect to Internet usage, with a penetration rate of only 28.5 per cent. However, Yunnan's growth rate of 15.9 per cent positions it sixth in the country (out of 31).