White Paper on China International Optical Cable Interconnection （2018）

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Foreword

International optical cables are vital to global communications. With the vast majority of international data transmission occurring through submarine optical cables, a country's degree of international optical cable interconnectedness is critical to its economic competitiveness and standard of living. According to a TeleGeography report, over 95% international data is transmitted this way. Since China's first submarine optical cable, which connected with Japan, launched in 1993, submarine optical cables have become the most important way that China connects with the rest of the world. Submarine optical cables from China can directly connect to North America, coastal Asia, Europe, and Africa, and China has implemented direct network interconnection with key countries such as the US, Japan, Singapore, and the UK[1]. After years of research and development, China's submarine optical cable industry has independent capabilities in transmission equipment, optical cables manufacture, system integration, and construction and maintenance.

The continued promotion and implementation of the Belt and Road Initiative (BRI) is increasing China's international interactions, requirements on its networks' ability to provide global services, and both opportunities and challenges in the submarine optical cable industry. Chinese enterprises should actively participate in the global laying of submarine optical cables and actively promote the inception and development of related industries.

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[1]China submarine cables refer to the submarine cables whose operation involves China Telecom, China Unicom, and China Mobile and whose landing points are in China (including mainland China and Hong Kong).

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1.1 Submarine Optical Cables Vital for International Communications

The earth's geography necessitates submarine optical cables for effective international communications. The earth is a huge sphere, and the oceans cover about 71% of its surface. There is no land route between the Americas, the Eurasian landmass, and Australia, and Africa and Oceania are not conveniently accessed without submarine cables either. Out of the nearly 200 countries on earth, there are only 44 landlocked countries with no coastline, preventing their direct submarine cable access. However, landlocked countries generally have a small population. The largest landlocked country by landmass Kazakhstan, which has an area of nearly 3 million square kilometers but a population of less than 20 million. Even Ethiopia, the most populous landlocked country, has a population of only about 100 million. Currently, international communications mainly rely on submarine cables. Over 95% of international communications traffic is transmitted through them. The importance of submarine cables in international communications is self-evident.

The leading role of submarine cables in international communication will not change. In addition to submarine cables, international communications are made possible by terrestrial cables and satellites.

Landlocked countries cannot build submarine cable landing stations due to their lack of coastline. Therefore, they generally use land cables and satellites.

In recent years, satellite communications have developed rapidly, and new satellite Internet service providers such as O3b have emerged. However, the bandwidth they provide is significantly lower than that of submarine cables, and the market is limited to remote islands and landlocked countries.

Compared with submarine cables, terrestrial cables are cheaper to construct and maintain. However, due to the lack of joint operation mode, terrestrial cables are limited to communication between adjacent countries. Terrestrial cable networking across multiple countries is not mature and no success stories are yet available. It is likely that over a long period of time, submarine cables will still play a leading role in international communications.

1.2 Fierce Competition in Global Submarine Cable Market

Resources, policies, and geographical factors accelerate the formation of submarine cable centers. Currently, the US, UK, Japan, Singapore, and Hong Kong are becoming the starting points or key nodes of many international submarine cables because of their advantages such as geographical reachability and rich information technology resources.

Home to some of the world's top Internet companies, such as Google, Facebook, and Amazon, the US is rich in content resources and integrates global Internet traffic, building itself as a global submarine cable center.

The location advantages of Singapore and Hong Kong are obvious. Thanks to their open economies and well-developed service industries, they have attracted data centers of many Internet giants and promoted the access of submarine cables from many directions, stimulating their development as key international nodes.

Emerging markets are proactively challenging the submarine cable business landscape. With developing digital economies, countries such as Thailand, Indonesia, Oman, and Chile, along with countries such as Middle Eastern economic powerhouse the United Arab Emirates and northern Europe's tech-leader Finland, have realized that international submarine cables are of great significance to promote information resource convergence and seize the strategic ground in international competition.

These countries have formulated policies and strategies to attract submarine cables to their coastlines. In 2016, the Thai government allocated 5 billion Thai baht to Thailand's state-owned telecom CAT Telecom to develop new submarine cable paths, and has invested in new paths since 2017. The Finnish government supports enterprises to promote submarine cable construction in the Arctic, trying to create an

information channel from East Asia to Finland and Germany. Chile's government has proactively planned to reach China's transoceanic submarine cable and directly connection with Asia. After the acquisition of Tyco's global submarine optical cable network and the Canadian company Teleglobe in 2004 to 2005, Tata Communications in India now boasts some of the most abundant global network resources of any telecom by continuously expanding the global submarine cable laying and upgrading the submarine cable system capacity.

1.3 Internet Giants Become New Forces in the Submarine Cable Club

The submarine cable club is still the main mode of international submarine cable construction. The international submarine cable project involves numerous approval workflows, huge construction and O&M costs, and high risks in project operation. The submarine cable club was developed to resolve these issues. In the club, related enterprises invest in a submarine cable project based on their own business requirements. The investment party allocates the submarine cable resources according to its rights and interests, sharing both benefits and expenses. The operation and maintenance expenses are also allocated by each member. In addition, service sources are guaranteed. Each stakeholder enterprise proactively directs the service flow and fully uses its own submarine cable resources to ensure that the investment costs are recouped as quickly as possible. Moreover, enterprises in their own countries are responsible for handling domestic examination and approval, ensuring the successful acquisition of relevant construction permits.

The Internet giants have become an important part of the global transoceanic submarine cable market. Compared with entities of traditional submarine cable construction and operation, the submarine cable market mainly focuses on telecom operation enterprises. Private submarine cable owners include basic telecommunications enterprises and project companies formed by financial consortia. To meet the interconnection requirements for global data centers, Internet giants such as Google, Microsoft, and Facebook are becoming the leading force in constructing international submarine cables. These Internet giants have already invested in building more than 15 international submarine cables, covering key links such as North America-Europe, North America-Asia, and North America-South America.

1.4 Development Trends of Collaboration Between Submarine Cables and Data Centers Is Obvious

The traffic direction of Internet content source access takes the lead in the global submarine cable network architecture. In the traditional international telecommunication services, the bidirectional interactive voice service and the private line circuit service for branch networking are the main sources of the revenue for international telecom carriers. These two services determine the international network architecture.

However, with increasing Internet penetration and bandwidth requirements, content sources start to determine the service traffic

direction. Carriers in different countries need to connect to more content sources to provide global access to websites. In Europe and America, global traffic flows to countries that have rich content sources, promoting international optical cable integration to these countries. The Internet traffic direction determines the new global submarine cable network architecture. Submarine optical cables provide an important guarantee for the rapid development of the global Internet, with ultra-high transmission bandwidth and relatively low cost.

Global data center interconnection has begun to affect submarine cable construction. The development of cloud computing technologies promotes the optimization and deployment of data centers around the world.

Not only Google and other Internet giants have deployed data centers; telecom carriers are also building regional service data centers. Data flow between data centers requires a large amount of bandwidth, large granularity of circuits, and rapid bandwidth scaling. It is an important issue for Internet giants to flexibly configure and schedule circuit resources between data centers to meet long-term service development requirements. Data center interconnect (DCI) has become an important goal for Internet giants in their participation in international submarine cable construction. Google is the forerunner in submarine cable

construction. Its service applications are all over the world, with over 30 global service data centers. Because the bandwidth leased from operation enterprises cannot meet its development requirements, Google has started to build its own submarine cables to meet its huge Internet DCI requirements.

Tech enterprises such as Microsoft and Facebook have also participated in submarine cable construction, mainly using them for interconnection between data centers. The submarine cable provides information transmission channels, and data centers store and process information. To this end, the development path of the information hub is increasingly clear.

1.5 International Submarine Cable Interconnection Will Usher in an Important Development Phase

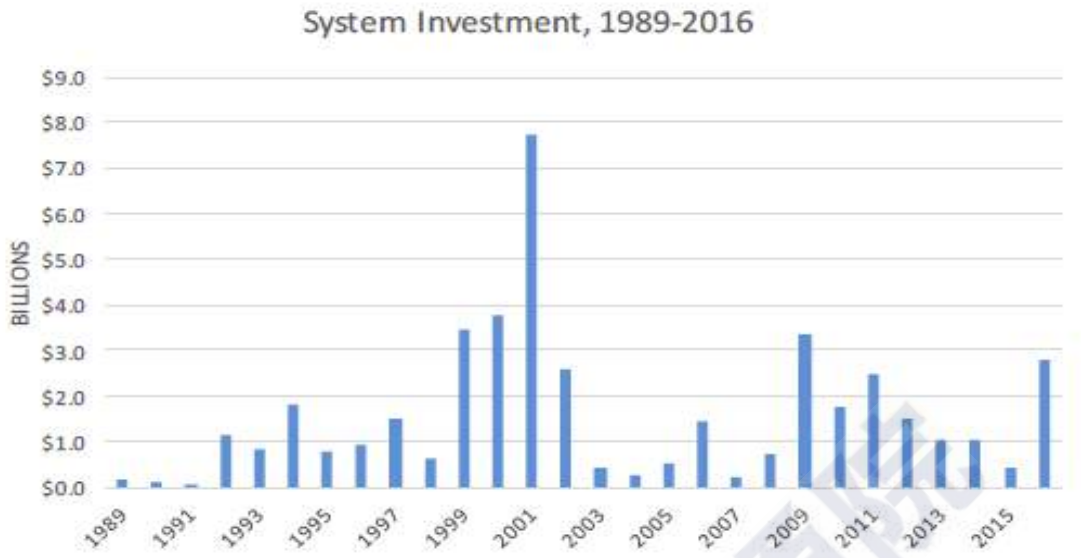
Over the years, global Internet bandwidth has maintained steady growth. According to TeleGeography's statistics, the annual growth rate of global Internet bandwidth is around 30%, and the global bandwidth has grown from 196 Tbps in 2013 to 295 Tbps in 2017. With the development of the global digital economy and the increasing use of big data, international Internet traffic growth will continue to increase.

The continuous and rapid growth of international Internet traffic will stimulate another international submarine cable construction peak. In the development history of submarine optical cables over the past 30 years,

two construction climaxes are evident: First, **from 1999-2002**, from the Internet bubble formation to bursting. During this period, the combination of control, demand, technology progress, and a large amount of capital investment greatly promoted the development of the submarine cable industry, and a large number of cables were put into use. Second, **from 2009-2012**, the data center became the biggest driving force in the construction of the international submarine cables.

At present, global submarine cable construction is entering the third construction burst. 40% of existing the submarine cables were built before 2000, and have gradually entered the end of their lifespan. In the next few years, DCI and Internet bandwidth requirements will continue to grow, and global submarine cables will enter a transition period, forming a time window for submarine cable layout. Since 2016, the submarine cable systems across the Pacific, Atlantic, and Asia-Europe have been upgraded.

Figure 1-1 Submarine cable system investment (1989-2016)



Source: STF Analytics

2 Development of China International Optical Cables

2.1 Surrounding Countries Connected by Cross-border Terrestrial Cables

Bordering 14 countries, China has unique geopolitical advantages in the global laying of international submarine and terrestrial cables. Through cross-border terrestrial cables, China has built a terrestrial optical cable network architecture that connects neighboring countries and reaches Europe. At present, China has 17 international terrestrial cable border stations, including Khorgast, Alashakou, Manzhouli, Pingxiang, and Ruili, and has established cross-border terrestrial optical cable systems with 12 neighbors, with the system bandwidth exceeding 70 Tbps[2]. China's only neighbors with whom it has no terrestrial connection are Bhutan and Afghanistan. Through cooperation with countries such as Russia, China's basic operation enterprises have created information channels between China, Russia, and Europe, between China, Mongolia, Russia, and Europe, and between China, Kazakhstan, Russia, and Europe.

Table 2-1 China's cross-border terrestrial cables

No.	Direction	Cross-border Terrestrial Cable	Border Station	Operator
1	Russia and Mongolia	China-Russia	Fuyuan，Manzhouli，Heihe，Suifenhe	China Telecom, China Unicom, China Mobile
2		China-Mongolia	Erenhot	China Telecom, China Unicom, China Mobile
3	ASEAN	China-Vietnam	Pingxiang,Dongxing	China Telecom, China

[2]The data is up to the end of 2017.

No.	Direction	Cross-border Terrestrial Cable	Border Station	Operator
				Unicom, China Mobile
4		China-Myanmar	Ruili	China Telecom, China Unicom
5		China-Laos	Mengla	China Telecom, China Unicom
6	Central Asia	China-Kazakhstan	Khorgas,Alashankou	China Telecom, China Unicom, China Mobile
7		China-Kyrgyzstan	Artux	China Telecom, China Unicom
8		China-Tajikistan	Tashikuergantajike	China Telecom
9	Southern-East Asia	China-Pakistan	Tashikuergantajike	China Telecom
10		China-India	Yadong	China Telecom, China Unicom, China Mobile
11		China-Nepal	Zhangmu	China Telecom, China Unicom
12	Northeast Asia	China-DPRK	Dandong	China Unicom

Source: MIIT

2.2 Key Countries Connected by International Submarine Cables

Since the deployment of China's first submarine optical cable, the China-Japan link, in 1993, submarine optical cables have become the most important way to connect China to the rest of the world. The submarine optical cables from China can be directly connected to North America, Central Asia, Europe, and Africa, and connected via transits to South America, Africa, and Oceania. China has implemented direct network interconnection with key countries such as the US, Japan, Singapore, and UK.

By the end of 2017, four international submarine cable landing stations – all in the coastal cities of Qingdao, Shanghai Nanhui, Shanghai

Chongming, and Shantou – had been established in mainland China. Towards Taiwan, the cities of Fuzhou and Xiamen host two submarine cable landing stations. In addition, Chinese operating enterprises have established international submarine cable landing stations in Hong Kong, such as Tseung Kwan O and Chung HomKok.

After years of construction of international submarine cables, China has amassed 10 of them. Chinese operating enterprises have more than 43.4 Tbps[3] of bandwidth on the landing submarine cables, and a batch of projects are being planned and built. Towards the US, the main submarine cable is the Trans-Pacific Express (TPE) submarine cable. The New Cross Pacific (NCP) is being constructed and expected to be put into operation in the second half of this year. The China-US Cable Network (CUCN) came to the end of its service life at the end of 2016. Major submarine cables towards Southeast Asia include new direct Asia Pacific Gate (APG), South-East Asia Japan Cable (SJC), Asia Pacific Cable Network 2 (APCN2), East Asia Crossing (EAC), and City-to-City (C2C). The main submarine cables towards Europe include South-East Asia - Middle East - Western Europe 3 (SEA-ME-WE 3, or SMW3), Fiber-Optic Link Around the Globe (FLAG), and Asia-Africa-Europe 1 (AAE-1).

In addition to direct participation in submarine cable landing construction,

[3]The data is up to the end of 2017.

Chinese enterprises have obtained some non-landing submarine cable system capacity by initiating construction and purchase. For example, in the direction of the US, Chinese operating enterprises have purchased significant capacity in the submarine cables between Japan and America, such as Pacific Crossing (PC-1) and Japan-US (JUS). These enterprises have also invested in the construction of submarine cables such as FASTER, a trans-Pacific submarine communications cable. In Europe, Chinese enterprises participated in construction of the SMW5 submarine cable to build capacity from Singapore to Europe. Moreover, Chinese enterprises have initiated or participated in the construction of some key routing submarine cables. For example, China Unicom and Cameroon Telecommunications jointly initiated the construction of the Cameroon-Brazil Cable System (CBCS) connecting Africa and Latin America.

Table 2-2 China's landing submarine cables

No.	Region/ Direction	Landing Submarine Cable	Submarine Landing Station	Operator
1	US	TPE	Qingdao;Chongming, Shanghai	China Telecom，China Unicom
2		NCP	Chongming, Shanghai;Nanhui, Shanghai	China Telecom，China Mobile，China Unicom
3	Southeast Asia	EAC	Qingdao	China Unicom
4		APG	Chongming, Shanghai;Nanhui, Shanghai;HK	China Telecom，China Mobile，China Unicom
5		APCN2	Chongming, Shanghai;Shantou	China Telecom，China Unicom
6		C2C	Nanhui, Shanghai	China Unicom
7		SJC	Shantou;HK	China Telecom，China Mobile，China Unicom

8	Europe	FLAG	Nanhui, Shanghai	China Telecom，China Unicom
9		SWM3	Chongming, Shanghai;Shantou	China Telecom，China Unicom
10		AAE-1	HK	China Unicom

Source: MIIT

2.3 Booming Optical Cable Industry

In recent years, the optical cable industry in China has flourished, and the sales volume accounts for more than 50% of the world's market share. Five Chinese enterprises – YOFC, HENGTONG, FiberHome, ZTT, and Futong – lead the manufacturing field. HENGTONG, ZTT, and TG have made breakthroughs in deep ocean submarine cable manufacturing, and HENGTONG has passed a 5000 meter deep sea test.

In addition, Huawei has world-class technical talent in the optical communications field and the submarine cable transmission field. In terms of project experience, the optical cables of HENGTONG and ZTT have penetrated into the European and American markets. Huawei Marine has become one of the most important submarine cable system integrators in the world, and has strong capabilities and experience in turnkey of transoceanic submarine cables.

In general, after years of unremitting efforts, China's optical cable industry has become an important new force in the international market and begun to compete with enterprises in developed countries such as America, Japan, and European countries. The construction of China's international submarine cable resources also meets the rapid development

of international interconnection requirements. Chinese enterprises have begun to become the main initiator and facilitator. In addition, to achieve direct submarine cable connection with more countries, Chinese enterprises are actively applying for submarine cable landing permits and service licenses around the world.

2.4 Insufficient Development in Comparison with International Submarine Cables

China's international submarine cable development still lags the world's other major economies. The number of submarine cables in the US, Japan, the UK, and Singapore is eight, two, five, and two times that of China, respectively, and the per capita bandwidth is 20, 10, 73, and 265 times that of China, respectively.

Table 2-3 Comparison of submarine cables between China and major countries in the world

	China	US	Japan	UK	Singapore
Number of submarine cables[4]	10	80	23	53	24
Total International bandwidth in 2017 (Gbps)	43445	201527	38799	151066	46544
Per capita international bandwidth (Mbps)	0.031	0.618	0.306	2.289	8.297

Source: TeleGeography and MIIT

[4]Submarine cable data includes landing submarine cables, non-landing submarine cables, and planned submarine cables.

China's current international submarine cable quantity and per capita international bandwidth does not match the status of China's booming communications and interconnection industry, restricting the development of Chinese enterprises. In addition, China's carriers of the submarine cable systems usually cooperate with carriers in other countries, lacking the international submarine cable system led by China and weakly influencing the submarine cable operation.

3 Prospects of China International Optical Cables

3.1 Information and Communication Infrastructure Interconnection is an Important Cooperative Content of " The Belt and Road "

Infrastructure interconnection is an important part of BRI. The participating countries will jointly promote the construction of cross-border optical cable networks, plan and build intercontinental submarine cable projects, and gradually form an information communication network connecting Asian countries, as well as the Americas, Europe, and Africa, to improve the level of international communication interconnection and smooth the information Silk Road.

The level of countries involved in BRI is relatively low. Southeast Asia and some landlocked countries in Center Asia have no submarine cable resources and cannot benefit from international Internet development. With the in-depth implementation of BRI, the China-ASEAN Expo, China-Arab Expo, and China-Asia-Europe Expo have been established. Economic, trade, and cultural exchanges among these countries are increasingly deep, Internet traffic is booming, and the requirements for information communication infrastructure such as international submarine cables and cross-border land cables are increasing.

In addition, compared with the information communication development in Europe and the US, most countries in the region are still at the initial stage. They can learn from the experience of developed countries and

play a leading role in the development of a new era of information applications. With the development of information technology to improve information infrastructure, the cooperation between China and the countries participating in BRI has great potential.

3.2 International Exchanges and Flow of Production Factors to Promote the Development of International Submarine Cables

Currently, there are signs of slowing globalization, but the trend of increasing globalization will not change. China is proactively promoting a new round of globalization and accelerating interaction and integration with other countries. In 2017, the number of outbound Chinese and travelers the amount of outbound foreign direct investment (FDI) hit a record high. The number of mainland Chinese residents going abroad, to other countries or special administrative regions, reached 131 million, with a year-on-year (YoY) growth rate of 6.9%. The top 10 destinations were: Hong Kong, Macau, Thailand, Japan, Vietnam, South Korea, the US, Taiwan, Malaysia, and Singapore. The number of inbound travelers was 139 million, an increase of 0.8% compared with that of the previous year. The top 10 source countries or special administrative regions were Hong Kong, China, Macao, Taiwan, Myanmar, Vietnam, South Korea,

Japan, Russia, the US, and Mongolia.[5]

In terms of external investment, the *2016 Statistical Bulletin of China's outward foreign direct investment* shows that China's annual FDI has been growing rapidly for 15 consecutive years, hitting a record high of 196.15 billion USD, accounting for 13.5% of the global share of FDI. This represents a YoY growth rate of 34.7%, the second highest in the world, achieving net capital outflows. By the end of 2016, a total of 24,400 domestic investors had set up 37,200 FDI enterprises outside China, which are distributed in 190 countries and regions. China's outward FDI has concentrated in Hong Kong, the US, the Cayman Islands, the British Virgin Islands, Australia, Singapore, Canada, Germany, and other countries and regions.[6]

In terms of international trade, the total value of China's imports and exports reached 27.79 trillion RMB in 2017, ranking first in the world for many consecutive years. Exports reached 15.33 trillion RMB with an increase of 10.8%, and imports reached 12.46 trillion RMB with an increase of 18.7%. The top 10 countries and regions in terms of Chinese bilateral trade volume are the US, Japan, Hong Kong, South Korea,

[5]*2018 China Outbound Tourism Travel Report* and *2018 China Inbound Tourism Travel Report*, China Tourism Academy

[6] Ministry of Commerce

Taiwan, Germany, Australia, Vietnam, Malaysia, and Brazil.[7]

From the perspectives of people, funds, and goods, China has increasingly frequent international exchanges and has close contacts with Hong Kong, Macao, Taiwan, the US, Europe, Japan, South Korea, and Southeast Asia. With frequent international exchanges that promote the flow of information, the average growth rate of Internet traffic in China has reached 38%, about 10 percentage points higher than the world average. The rapid development of information traffic will surely promote the requirements of international submarine and terrestrial cable construction and interconnection.

Table 3-1 YoY growth rate of China's Internet traffic

Region	2012	2013	2014	2015	2016	2017
North America	46%	45%	35%	26%	25%	25%
Asia-Pacific	47%	39%	47%	34%	44%	38%
Europe and Africa	50%	33%	45%	28%	41%	33%

Source: TeleGeography

3.3 Overseas Business Development of the Internet Enterprises Promotes Strong Demand for International Bandwidth

China's development in information applications, such as the mobile Internet, is in a leading global position. Chinese enterprises have accelerated the pace of globalization, and e-commerce, video, mobile

[7] General Administration of Customs

payment, and online gaming services have developed well in overseas markets. These Internet enterprises have high requirements on data centers and CDNs, and high dependency on globalized networks, requiring fast interconnection and interworking. In terms of Internet application promotion, Chinese Internet enterprises have advantages in technology, capital, and innovation, and are accelerating the pace of global operations.

Alibaba's international wing has developed into the world's largest B2B e-commerce platform. Alibaba's Alipay and Tencent's WeChat have expanded into nearly 40 countries and regions in Asia, North America, and Europe. By the end of the first quarter of 2018, WeChat had 1.04 billion monthly active users. Alipay had 870 million annual active users worldwide, among which Chinese users accounted for 552 million and overseas users the remaining 320 million. In terms of the deployment of Internet application facilities, overseas development has become the main strategic direction of many Internet enterprises.

Through proprietary construction, cooperation, and acquisition, Huawei provides cloud servers, cloud databases, cloud storage, CDN, and big data services for Chinese and international enterprises. Alibaba Cloud has 15 global data centers, and strengthening Alibaba Cloud's global position in the cloud computing field. Wangsu has more than 300 overseas acceleration nodes, covering over 40 countries and regions in Europe,

America, Southeast Asia, and Africa. It recently acquired mainstream CDN enterprises such as CDNetworks and CDNvideo. The global expansion of China's Internet enterprises is bound to increase the Internet traffic between China and other countries.

3.4 China's Geopolitical Advantage Breeds Broad Space for Synergetic Development of Terrestrial and Submarine Cable

China has unique geographical advantages in the global laying of terrestrial and submarine cables. Located in the east of Eurasia along the Pacific coast, China has the most neighbors in the word, that is, 23 sea and land neighbors. Cross-border terrestrial optical cables have already been established in 12 land-bordering countries to the south, west, and north. The transmission and IP backbone networks have been built, and the transmission in China and IP backbone networks from the Eurasian continent to the Pacific west coast have been built. There are six submarine cable landing stations along China's coast, providing multiple large-capacity submarine cables to the Asia Pacific, North America, Europe, and Africa. China can make full use of the geopolitical resources that have been built and will be further expanded in the future. This will facilitate synergy between the submarine and terrestrial cables, allowing them to work together to build a Eurasian information hub that connects east to west. It is estimated that the transit latency of Central Asia and the

Middle East countries traversing China to Asia Pacific is 10 times shorter than that traversing the US. In the future, China will vigorously develop international Internet transfer services, mainly providing Internet transfer services connecting the east of Eurasia (Europe, Russia, Central Asia, Middle East, and South Asia) to Japan, South Korea, Hong Kong, Macao, Taiwan, and Southeast Asia.

4 Recommendations on China International Optical Cables

4.1 Serving BRI and Accelerating the Global Submarine Cable Layout

China's submarine cable construction policy environment should be optimized to support the construction of information communication facilities such as submarine cables. This will support the goal of building China into one of the world's most important international submarine cable communication centers within a decade or two. International submarine cables can well serve B&R countries, supporting China's globalization development goals.

Considerations when laying future submarine cables in key directions include:

- North America is the most important connection direction for Internet services. China should accelerate the implementation of the NCP submarine cable and new harbor submarine cable projects to ensure the bearing, security, and reliability requirements of the circuits from China to the US. Submarine cable construction towards the US is still a major focus.
- Inside Asia, China and ASEAN countries have great potential in cooperation and development in the Internet field. They focus on increasing direct submarine cable construction, directly connecting China and these countries, and also constructing submarine cables in the rest of Asia, Africa, Europe, Oceania, and South America.
- Europe is one of the important destinations for China's international communications services. Currently, there are terrestrial optical cable channels spanning China-Russia-Europe, China-Kazakhstan/Mongolia-Russia-Europe, and submarine cable channels such as SWM3 and AAE-1. In the medium and long term, the service development demands of China and

Europe need to be arranged in advance, and more route selection needs to be offered.

- In Africa, only AAE-1 is available. The circuits to Africa mainly rely on Hong Kong, Singapore, the UK, Spain, and the US. As an increasingly important region for China's international economic diplomacy, Chinese enterprises should consider deploying more submarine cable resources in African countries such as Kenya and South Africa.

4.2 Optimizing Landing Station Laying and Cooperating to Build Supporting Points of Submarine Cable Network

Optimizing the Laying of Submarine Cable Landing Stations in China. China currently has four international submarine cable landing stations: Qingdao, Shanghai Chongming, Shanghai Nanhui, and Shantou. These submarine cable landing stations belong to China Telecom and China Unicom. The Shanghai harbor landing station that belongs to China Mobile is still under construction. To further optimize the laying of submarine cable landing stations in China, it is recommended that following tasks be implemented in the future:

- **Plan new submarine cable landing stations in China.** In the long run, China's existing submarine cable landing stations cannot meet the development requirements of its international Internet services market. It is recommended that the availability of site resources of submarine cable landing stations be verified in advance for reserving resources for landing stations and international submarine cable routing channels.
- **Strengthen the sharing of existing submarine cable landing stations.** Competition among operation enterprises restricts sharing. This problem also exists in the use of submarine cable landing stations. Industry guidance should be strengthened to encourage enterprises to share submarine cable landing station resources and facilitate the introduction of other enterprise

submarine cable circuits. Enterprises can contract the rights and interests of the submarine cable landing stations.

- **Continue to play the advantage of Hongkong.** Hongkong is an important link between China's Internet and the global Internet. Hong Kong's openness advantages can be further leveraged to proactively participate in landing submarine cable construction.

Co-constructing Submarine Network with Other Countries. Because of its advantageous geographical location, China can use international submarine cables to link many key countries and regions. However, it is still far from many countries and regions, and coordinating submarine cable construction is difficult. To facilitate submarine cable network organizations, some key countries should be selected to strengthen cooperation by building an international submarine cable transfer point (STP) as a branch of the global submarine cable network.

In Europe, whilst cooperation with Singapore can be deepened, cooperation with countries such as Thailand, Myanmar, Pakistan, and the UAE can also be strengthened to create more submarine cable transfer points in Southeast Asia and the Middle East. In Africa, cooperation with countries such as Djibouti, Kenya, Tanzania, and South Africa should be strengthened to expand interconnection between China and the continent. In South America, transfer through the US is still dominant. In the future, if direct submarine cables are built between China and Latin America, cooperation with countries such as Chile and Brazil can be deepened. In Europe, strengthening cooperation with countries such as the UK,

Germany, and Russia is still a focus, and such cooperation will help further extend links to other European countries.

4.3 Optimizing Policies and Regulations for Better International Submarine Cable Development Environment

Improving the submarine cable construction environment. First, plan dedicated submarine cable routes, improve the geographical position of international submarine cables, strengthen overall planning, explore laying dedicated international submarine cable routing corridors, and reduce the impact of other industries such as fisheries and shipping on routine submarine cable operation and maintenance. In addition, learn from practices of developed countries such as Singapore to lay out centralized offshore routing pipes, facilitating the use of new submarine cable systems.

Second, streamline the approval workflows for submarine cable construction; shorten the approval time for route survey application, environment assessment, construction application, and sea review; and enable green channels for major submarine cable projects. Unlike oil and gas pipelines, submarine cables have slight impact on the submarine environment during the construction phase. After construction is complete, the operation period does not affect the environment. It is recommended that the submarine cable environmental assessment requirements be reduced and the investigation be simplified. Third,

further strengthen submarine cable protection, develop relevant laws and regulations, intensify the publicity of protection for submarine cables, and reduce human-caused damage to submarine cables.

Optimizing industry regulatory policies. First, establish a security review process for foreign enterprises, referencing the practices of developed countries such as the US, Japan, and Singapore. With the goal of ensuring national security, expand open telecom services to allow foreign capital, explore new business models, study specific measures and methods to proactively attract Internet traffic, and increase the business volume of foreign enterprises or ISPs in or traversing China.Second, strengthen communications between governments to eliminate obstacles facing China's telecom and Internet enterprises overseas. This will help increase the service traffic of Chinese enterprises and increase demand for submarine cable construction in both import and export directions.

4.4 Encouraging overseas business and network to develop together

The development of Internet enterprises based on globalization is an important foundation for promoting information flow and building submarine cable.At present, China is applying cloud computing, big data, mobile Internet, Internet of Things and other information technologies to

all fields of economic society, promoting cross-border integration and innovation of Internet and urban management, transportation and logistics, production and manufacturing, agricultural and rural areas, and has formed a number of new products, new business and new models.Encourage Internet enterprises to go out and develop cross-border e-commerce, Internet finance, intelligent manufacturing, smart cities, smart agriculture and other businesses, and create a number of influential multinational Internet enterprises.At the same time, network operators work closely with Internet enterprises, strengthen the construction of international land and submarine cables, actively carry out overseas POP construction and local network operations, and upstream and downstream enterprises have formed a joint overseas development.

4.5 Strengthening International Cooperation and Exploring the Submarine Cable Connection Mode

Submarine cables play an important role to access the international Internet. Landlocked countries can participate in submarine cable construction, through the backbone network of neighboring countries and submarine cable landing stations, to achieve efficient connectivity between the domestic network and the international Internet. At the ITU-T SG3 plenary meeting in April 2017, under the initiative of the China's MIIT, the standards and guidance topics for the tariff and charging issues of cross-country terrestrial optical cable circuit settlement

agreements were set up. These studies will effectively promote the development of the combined transportation mode of submarine and terrestrial cables, enriching international Internet connections to landlocked countries.

China has a good geographic advantage. China, in cooperation with Myanmar, Pakistan and other countries, can open a westward information channel through the joint operation of terrestrial and submarine cables; Nepal, Laos, Kazakhstan, Uzbekistan and other countries can connect the international submarine cable through China. In addition, the ITU and MIIT are working with East African countries to promote the construction of an information superhighway in that region, strengthen the network interworking between its countries, and plan to combine sea and land transportation modes. This greatly reduces the costs of connecting landlocked countries, such as Rwanda and Uganda, to the global submarine cable network and international Internet.

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