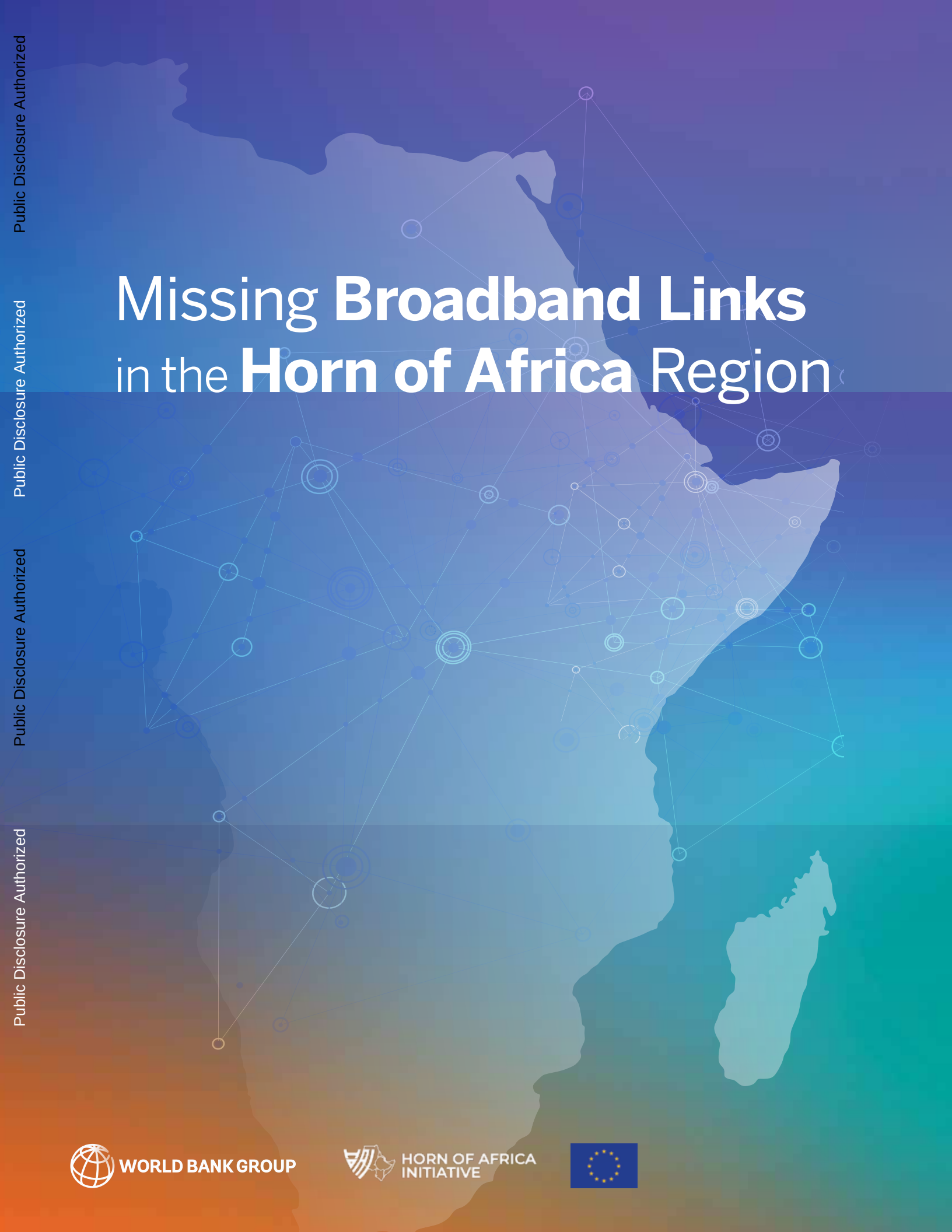
Missing **Broadband Links** in the **Horn of Africa** Region



WORLD BANK GROUP

HORN OF AFRICA INITIATIVE

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Acknowledgements

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Abbreviations

AAE-1	Asia Africa Europe 1
ADR	Djibouti Roads Agency
ADRT	Agency for the Regulation of Telecommunications (Djibouti)
AWS	Amazon Web Services
BCS	Bandwidth and Cloud Services Group
CDN	content delivery network
CISP	Communications Infrastructure and Services Provider (Somalia)
CLS	cable landing station
CSR	corporate social responsibility
DARE1	Djibouti Africa Regional Express 1
DBO	Design – Build - Operate
DFI	development finance institution
DjIX	Djibouti Internet Exchange
DT	Djibouti Telecom
EASSY	Eastern Africa Submarine System
ECA	Ethiopian Communications Authority
EIG	Europe India Gateway
ENDF	Ethiopian National Defense Force
ENPV	Expected Net Present Value
FNAs	Facebook Network Appliances
G2A	Gulf2Africa
GB	gigabytes
Gbps	gigabits per second
GDP	gross domestic product
GNI	gross national income
HoA	Horn of Africa
ICIP	International Communications Infrastructure Provider (Somalia)
ICT	information and communications technology
IDP	internally displaced person
IEX	Reliance Jio India-Europe Express
IP	Internet Protocol
ISIS/ISIL	Islamic State
ITU	International Telecommunication Union
IEX	internet exchange point
JV	joint venture
kbps	kilobits per second
km	kilometers
Liquid	Liquid Intelligent Technologies
MCPT	Ministry of Communication, Post, and Telecommunication (Djibouti)
MICT	Ministry of Information and Communication Technology (Somaliland)
MICTP	Ministry of ICT and Postal Services (South Sudan)
MNO	Mobile Network Operators
NCA	National Communications Authority (Somalia)
NCIP	National Communications Infrastructure Provider (Somalia)
NOFBI	Optic Fibre Backbone Infrastructure
OLA	Oromo Liberation Army
OPGW	optical ground wire
PoP	point-of-presence
PPP	public-private partnership
PPP	purchasing power parity
RFP	request for proposal
RFS	ready for service
SMW	Southeast Asia-Middle East-Western Europe
SOE	State-owned enterprise
SPV	special purpose vehicle
SSIGW	South Sudan International Gateway
STM	synchronous transport modules
Tbps	terabits per second
TDF	Tigray Defense Forces
TISD	Telecommunications Infrastructure Sharing and Collocation Directive (Ethiopia)
TPLF	Tigray People's Liberation Front
WIOCC	West Indian Ocean Cable Company.

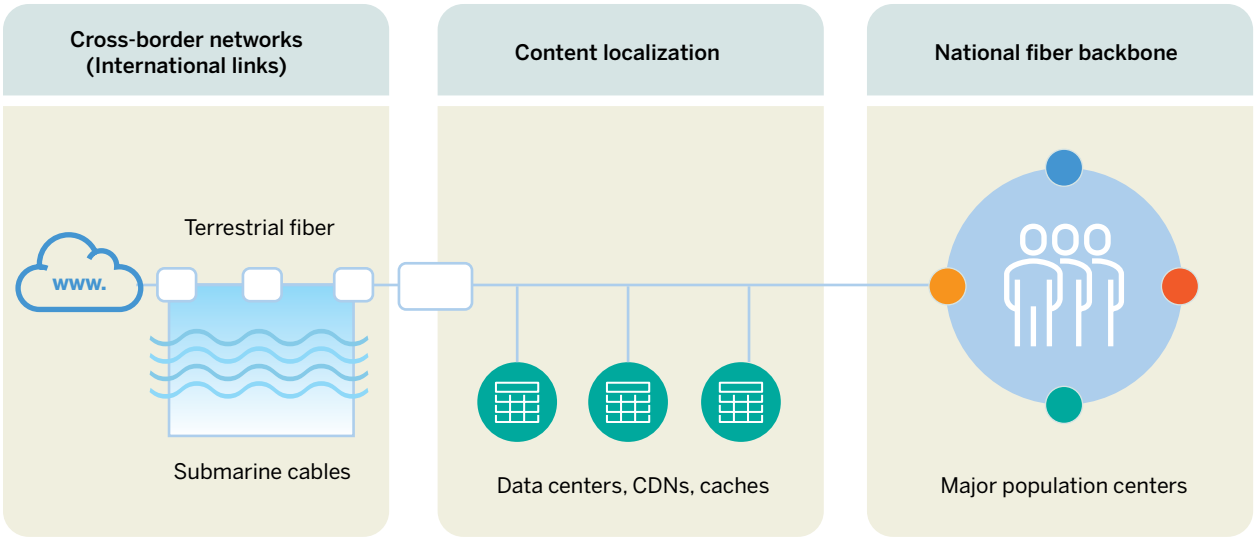
Executive Summary

This report focuses on four key countries in the Horn of Africa (HoA): Djibouti, Ethiopia, Somalia and South Sudan (collectively referred to as the "target countries"). The project's objectives are (i) to review current and planned deployments of cross-border networks (submarine and terrestrial fiber), content localization (data centers, internet exchanges, and content delivery networks (CDNs)), and national fiber backbones in the target countries, and (ii) to identify gaps that exist in those various infrastructure segments. The analysis accounts for all segments of the broadband value chain, as illustrated in figure 1. With the goal of crowding-in private investment in the target countries, and mobilizing private capital, the report identifies potential projects and proposes financing options and partnership opportunities to address the infrastructure gaps. Recognizing the key role of the regulatory environment of each target country in this analysis, the report also reviews potential regulatory barriers and proposes reforms to facilitate investment and operation in the target countries. The current report is about identifying existing missing links and less about identifying specific technical solutions.

Current Infrastructure Ecosystem Assessment

A key consideration for improving connectivity and internet performance in the HoA region is reducing the distance between users and the content or services they access, thereby improving load times and latency. Until recently, most internet traffic in Africa required connectivity to other regions, especially Europe. But two trends are gradually changing these traffic patterns: localization of content and new cross-Africa routes as supplementary to submarine cable routes. In Africa, there has been considerable expansion of networks and infrastructure operated by major content providers such as Amazon Web Services (AWS), Google, Meta

FIGURE 1. Links of the broadband value chain addressed in this report



Source: TMG/APTelecom.
Note: CDNs = content delivery networks.

(formerly Facebook), and Microsoft, as well as CDNs and data centers. Although it is less mature than in some neighboring countries, such as Kenya, this trend is also present in several of the target countries. Leveraging its geographic location, Djibouti has positioned itself as a regional connectivity hub and is home to a carrier-neutral data center, the Djibouti Data Center, with direct access to all major international and regional cable systems connecting Africa to Europe, the Middle East, and Asia. Similarly, Google (Djibouti, Ethiopia, Somalia) and Meta (Djibouti, Ethiopia, Somalia, and South Sudan) have deployed caches in the region to host content locally, although most of them require international connectivity for regular updates of content.

From an international connectivity landscape perspective, the review shows that existing and planned submarine cables provide adequate capacity for current and anticipated medium-term needs in the target countries. Nine submarine cables currently land in the HoA region—Djibouti (nine), and Somalia (at least two operational).[1] By 2024, four more systems are expected to land in the HoA region—PEACE, 2Africa, Africa-1, and India-Europe Express—which will provide the African market access to well over 500 terabytes per second of potential additional capacity.

However, the existing and planned terrestrial fiber networks, including national fiber backbones and cross-border links between the target countries and their neighbors, reveal many potential opportunities for improvement, as well as variability among the target countries.

- **Djibouti.** While a well-developed terrestrial backbone in the southern portion of the country provides connectivity to the cable landing stations (CLS) that serve the entire region, fiber infrastructure in the northern region is lacking. Numerous submarine cables land or will soon land in Djibouti City, making it the main regional connectivity hub in the HoA region. It will soon open an additional cable landing station, providing some degree of competition to Djibouti Telecom.
- **Ethiopia.** Despite its sizable population, Ethiopia is currently served by mainly one fiber optic transmission network for international connectivity, operated by the incumbent telecommunications provider, Ethio Telecom. International connectivity currently passes through cross-border links mainly to Djibouti, but with a lower level of traffic also to Kenya. Potential for further expansion of fiber optic infrastructure exists as a second operator, Safaricom Ethiopia, has been licensed, which has plans to roll out a new fiber optic network throughout the country. A large portion of Ethio Telecom's country-wide network consists of fibre leased from the Ethiopian Electricity Power Company which is not adequate for carry existing and future internet traffic. Therefore, reinforcement of national fibre backbone networks will need be made in parallel to reinforcement on cross-border connectivity.
- **Somalia.** Somalia lacks a national fiber optic backbone. The limited fiber networks deployed in the various parts of the country do not interconnect, effectively handling their international connectivity independently. The disparate fiber networks complicate international connectivity, which is provided by submarine cable landings in Mogadishu and Bosaso, as well as terrestrial links to Djibouti microwave links to Kenya. In the short-term, the connectivity provided by the international submarine cables will continue to substitute for backbone links, and there is scope to link to additional coastal cities, such as Kismayo.
- **South Sudan.** The key challenge is the lack of an operational domestic fiber backbone. South Sudan is served by a relatively recent route from Uganda to Juba, but this has been plagued by unreliability. The Government is also taking steps to restrict the use of microwave which is having a negative effect on domestic and regional connectivity.

Market Assessment

The target countries confront several challenges to deploying cross-border and fiber backbone infrastructure. This analysis considered three dimensions: (i) challenges in market structure, (ii) fragility and conflict dynamics, (iii) regulatory barriers, and (iv) topographical constraints. A combination of these barriers is present in each of the target countries.

- Several challenges pertaining to *market structure* affect investment in broadband connectivity infrastructure, service availability, and adoption in the target countries. These challenges include *market structure conditions that lead to limited competition* in specific market segments. This is the case in Ethiopia (currently in the process of liberalization, albeit progressing slower than had been hoped), Djibouti, and South Sudan. *Affordability of services and/or devices* is also a key challenge for broadband adoption in all the target countries, with prices for entry-level mobile and fixed broadband services well above the target affordability threshold recommended by the International Telecommunication Union's (ITU), the Alliance for Affordable Internet (A4AI) and other development partners.[2]

- *Fragility and conflict dynamics,* in particular, *stemming from past and ongoing internal armed conflicts, security concerns, and political instability, are a high barrier for mobilizing private investment in the region and addressing the missing links.* These factors would likely result in risk levels beyond the risk tolerance thresholds of many potential investors. Political stability and security are particularly relevant for deployment of national fiber backbone networks, which require control of the territory to lay, operate, and maintain terrestrial infrastructure. This is especially challenging in Somalia and South Sudan, where government-controlled territory and implementation capacity is limited. Somalia will likely continue to have only limited terrestrial fibre infrastructure due to ongoing tensions between the Government and al Shabaab. Also, in South Sudan, a process of demining would need to be carried out before new cables can be laid. Similarly, the ongoing internal armed conflict in the north of Ethiopia creates significant uncertainty and risks for the new entrant, as well as potential delays in deployment. It may also affect the ability to attract a potential third full service telecom license in the short term, possibly limiting the development of supporting infrastructure, which could, in turn, result in suboptimal pricing for middle- and last-mile connectivity for end-users.
- *Regulatory barriers* also present a challenge for the deployment of cross-border and fiber backbone infrastructure in the target countries. *License restrictions or lack of certainty in the licensing process* affects market entry or use of existing infrastructure in Ethiopia (for fiber backbone and international gateway deployment), and Djibouti (for deploying additional CLS, fiber backbones, and international gateways). Similarly, *lack of infrastructure sharing and wholesale access regulation* affects the ability to provide service in the target countries. Further development of the regulatory framework, as well as building the capacity of regulatory authorities, should be undertaken. *High regulatory fees* in the countries where these facilities are made publicly available may also create entry barriers. This appears to be the case in Somalia, where the recently adopted license fee structure may limit additional entry.
- *Topographical constraints* make some routes more difficult to lay fibre optic cables whether underground or aerial. For instance, one reason there is no direct link between Juba and Ethiopia is because there is a mountain range in the way.

Infrastructure Needs Assessment

The infrastructure needs assessment identifies potential projects that are required to complete or improve missing or inadequate components of domestic backbone and cross-border fiber optic connections, or to increase access to content, recognizing that the target countries may benefit from potential projects that would address more than one of these needs. This three-part analysis is based on the assumption that each country should have the following: (i) access to multiple high-capacity routes to first mile international connectivity (all the target countries have at least one route theoretically available) and multiple routing options to middle mile and regional nodes; (ii) a national fiber backbone connecting the entry point of international connectivity to major population centers (Djibouti and Ethiopia have this, while Somalia and South Sudan have only limited coverage), and, to ensure resilience, all the population centers ideally should be connected via at least two georedundant routes to eliminate single points of failure; and (iii) resilient cross-border routes to important traffic destinations (for example, major submarine cables and distant content, local or regional hubs, data centers, CDNs, and internet exchanges).

Table 1 highlights the findings from the needs assessment.

TABLE 1. Infrastructure needs assessment overview

COUNTRY	NATIONAL FIBER BACKBONE	CROSS-BORDER LINKS
Djibouti	Djibouti has a gap in the northern part of the country as it is less populated and there is limited trade on the border with Eritrea. If a fiber ring is deployed in the north, it could be closed by a new submarine cable landing station, potentially as part of a larger regional system.	Currently, two routes connect Djibouti and Ethiopia, and one route connects Djibouti to the Somaliland region. A third route to Ethiopia is suggested. This proposed route could also connect to a future route linking to Eritrea.
Ethiopia	Ethiopia would benefit from a more robust topology to cope with outages on the main routes. Many local fiber networks within Ethiopia also need to connect smaller towns and cell sites to the backbone, and to repair fiber that was damaged as a result of the conflict. There is also a need to provide fiber connections to communities that host refugee camps and internally displaced persons (IDPs).	Multiple options were identified for adding cross-border routes, including • A route to the coast through the Somaliland region • A third route to Djibouti • Routes to the coast through Eritrea • Routes to Somalia

continued

TABLE 1, *continued*

COUNTRY	NATIONAL FIBER BACKBONE	CROSS-BORDER LINKS
Somalia	Somalia needs an integrated national backbone throughout the entire country, linking, its two operational CLSs (Mogadishu and Bosaso). There is potential for a Berbera CLS awaiting the landing of a submarine cable, and cross-border connections to Kenya and Djibouti. Similarly, other coastal cities, such as Kismayo or Hoyo could usefully be served by submarine cables. This is proposed as a potential two-phase project.	Extension of fiber to the border with Kenya would allow direct links to Kenya's fiber routes, replacing the current use of microwave to connect Somalia's backbone to Kenyan fiber optic cables. The cross-border routes from Somalia into Ethiopia require development of the Ethiopian section. Additional fill-in routes are required to connect the smaller towns.
South Sudan	South Sudan lacks an operational domestic backbone; it depends on the fiber optic route from Juba to Uganda and satellite and microwave links for international connectivity.	Given Kenya's good connectivity and presence of content there, a route into Juba from the Kenyan border is a priority gap to be closed. Additional priority routes within South Sudan would connect the Central African Republic, the Democratic Republic of Congo, and Uganda. The Government has also expressed an interest in a route to Ethiopia.

Source: TMG/APTelecom.
Note: CLS = cable landing station.

Potential Commercial Options

Building on the infrastructure gap analysis, as well as the assessment of the market, political and security environment, and regulatory framework, the report identifies a preliminary list of 18 specific opportunities that potentially could be pursued in the target countries to expand or improve broadband connectivity.

Based on the assessment of the projects' relative priorities and the likelihood that private investment alone will not be able to undertake them, the 18 projects were pared down to four priority backbone links (table 2).

These projects are assessed based on a combination of factors: (i) relevant market factors, (ii) the potential enterprise structure, (iii) possible revenue or pricing strategies, (iv) the role of the public sector in mobilizing private investment, (v) open access considerations, and (vi) any necessary additional studies.[3] In addition, the assessment sets out information on the population centers that could benefit from the proposed projects, providing a concrete measure of project impact. This includes internally displaced persons (IDP) and refugee camps and its host communities in borderland areas. The consideration of the enterprise structure discusses high-level models as well as identifies potential stakeholders. The key role for governments in each project is in streamlining administrative processes, specifically in ensuring the availability of rights of way at a reasonable cost, which is especially important in countries where right-of-way guidelines are ambiguous.

TABLE 2. Potential commercial options considered

TARGET COUNTRY	DESCRIPTION
Somalia	*Central Somalia backbone.* Deployment of a 1100 km backbone to complete the Mogadishu-Galkayo-Garowe corridor, which would provide fiber connectivity—and thus higher capacity mobile broadband—to hundreds of unserved or underserved communities, including camps for internally displaced persons, and provide two additional cross-border links to Ethiopia.
	Northern Somalia backbone. Deployment of a 367 km backbone in Northern Somalia, from Burco to Laascaanood to Garowe, which would provide fiber connectivity/higher capacity mobile broadband to multiple unserved or underserved communities. The new fiber optic joint venture in Somaliland between Somtel, Telesom, and Somcable, established on February 8 2022, could be a partner for this project, as well as an example of collaborative infrastructure projects.[a]
	Southern Somalia backbone. Deployment of a 1,300 km backbone via the *Mogadishu-Kismayo-Liboi* corridor, providing fiber connectivity/higher capacity mobile broadband to hundreds of unserved or underserved communities and enabling two additional cross-border links with Kenya, where there are a number of significant, and longstanding, refugee camps.
South Sudan	*Juba connectivity.* Deployment of a 1,200 km backbone in South Sudan, providing fiber connectivity to hundreds of unserved or underserved communities as well as multiple additional cross-border links, and to refugee camps in borderland areas.

Source: TMG/APTelecom.
a. https://menafn.com/1103661390/Somaliland-Government-Telecom-Giants-Pen-a-New-Fiber-optic-Joint-Venture&source=30.

Public versus Private Financing Needs

Mindful of the goal of promoting private capital mobilization (PCM) and crowding-in private investment where viable and building on the identification of potential commercial options, for each potential project, the evaluation includes estimated system costs, partnership options, and financing options. This final component also includes information on the appropriate role of the state in each project. The results of this review are summarized in Table 2 and illustrated in map 1. In table 3, the distinction is made between "private" sources of financing, meaning private sector operators or financial entities, and "vendors," meaning equipment suppliers.

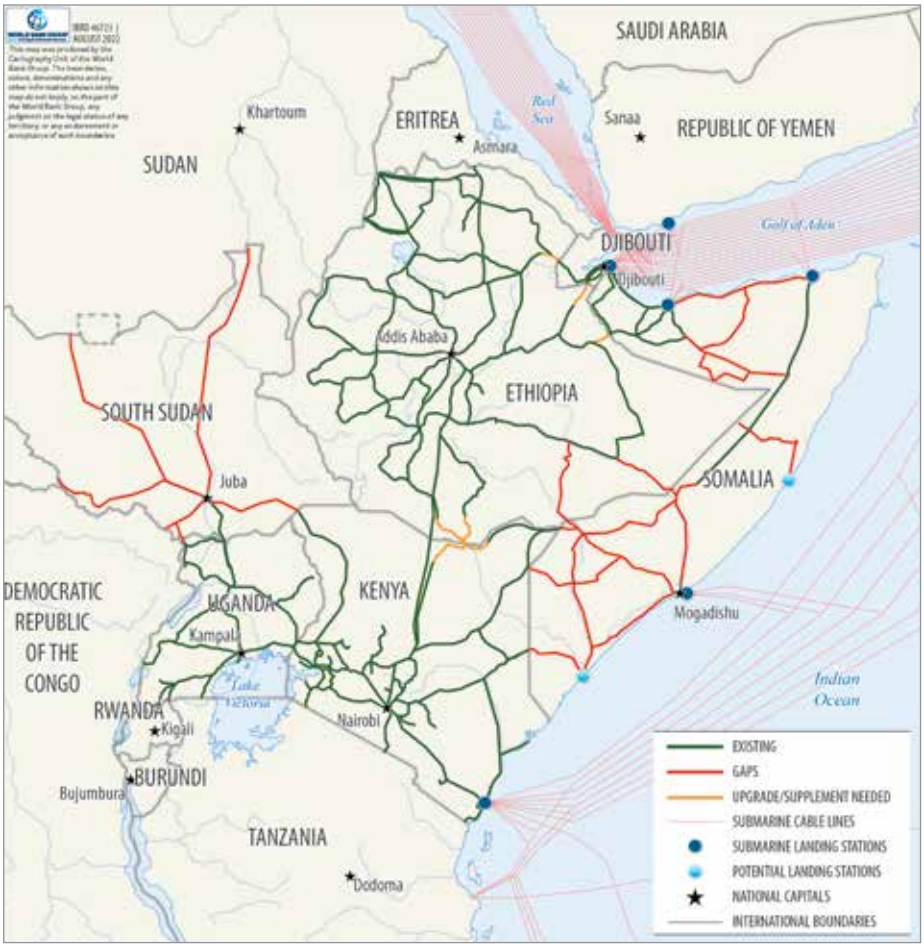
These potential opportunities are identified as key projects for improving cross-border and national backbone connectivity and redundancy across the HoA region. They would better enable the target countries to increase internet adoption, adapt to emerging regional traffic patterns, and access expanding international connectivity. As can be seen in table 3, each of the opportunities identified would likely benefit from the participation of development finance institutions in partnership with local entities. Collectively, the portfolio of projects provides options for significantly improving access to information, communications, and services across the HoA region, as well as better service refugee camps and host communities in borderland areas.

TABLE 3. Summary of potential investment opportunities

OPPORTUNITY	ESTIMATED COST (USD, millions)	POTENTIAL OPERATORS (Considering only existing operators. There is scope for additional market entry)	FINANCING OPTIONS
Central Somalia backbone	16.5–22	Local service providers	Vendor • DFIs
Northern Somalia backbone	5.5–7.3	Local service providers	Vendor • DFIs
Southern Somalia backbone	19–26	Local service providers	Vendor • DFIs
South Sudan backbone restoration	17.3	Liquid [a] MTN/Zain	Private • Vendor DFIs
Juba connectivity	17–23	Liquid • MTN/Zain	Private • Vendor DFIs

Source: TMG/APTelecom.
Note: Additional studies are required to assess the feasibility (political economy, cost, government capacity, private sector interest, and so forth) of each opportunity. DFIs = development finance institutions; SOE = state-owned enterprise.

MAP 1. Priority routes identified



Source: TMG/APTelecom.

Notes

1. The cables include Djibouti Africa Regional Express 1 (DARE1), Gulf2Africa (G2A), Asia Africa Europe 1 (AAE-1), SeaMeWe-5, Europe India Gateway (EIG), Saudi Arabia-Sudan-2 (SAS-2), Eastern Africa Submarine System (EASSy), SEACOM/Tata TGN-Eurasia, Saudi Arabia-Sudan-1 (SAS-1), and SeaMeWe-3. In Somalia, G2A and EASSY have been in service for several years, and Djibouti Africa Regional Express 1 (DARE1) was reportedly brought into service in 2021.
2. A Gb of data per month should cost less than 2 percent of monthly GNI Per capita ("one for two").
3. Market factors include current interest in the project or synergies with other infrastructure projects, communities potentially served, and other infrastructure gaps filled.

1

Introduction and Project Methodology

1.1 Introduction

The following are the main objectives of the report:

i. Review current and planned deployments of cross-border networks and terrestrial fiber backbone infrastructure in Djibouti, Ethiopia, Somalia, and South Sudan(collectively referred to in this report as the "target countries")

ii. Identify infrastructure gaps in the target countries in terms of terrestrial fiber and cross-border connectivity

iii. Consider whether those gaps can be addressed through commercial financing or whether public financing may be required

iv. Assess and identify potential regulatory reforms that should be implemented to facilitate investment and operation in the target countries.

The report's findings and recommendations are based on desk research and interviews with relevant stakeholders, as further described in the methodology section.

This report is structured in six substantive sections accompanied by an appendix.

1.2 Project Methodology

The methodology used for the project consisted of three broad categories of effort, as shown in figure 2.

1.2.1 Desk and background research

The project's kickoff incorporated a detailed review of all the relevant background materials. Additional desk research supplemented this review to develop a baseline understanding of the

FIGURE 2. High-level project methodology

1 Desk and Background Research	• Assessment of compnary filings, planned deployments, coverage maps, service offering • Review or prior WBG reports/work regarding HoA countries • Review of industry reports and dartabases • Analysis of ICT policies, laws, and regulations in target countries
2 Stakeholder outreach and industry consultation	• Interviews with service providers, government officials, and other industry experts with first-hand knowledge of cross border and fiber backbone infrastructure in the target countries
3 Evaluation, analysis, and recommendations	• Assessment of current infrastructure • Identification of infrastructure needs • Evaluated or potential commercial options to fill gaps identified • Consideration of financing requirements for deployment of the proposed commercial options

Source: TMG/APTelecom.
Note: HoA = Horn of Africa; ICT = information and communications technology; WBG = World Bank Group.

current situation in each of the target countries. The background research and consultation with key stakeholders to be approached for individual consultations.

The background research included the identification of all existing submarine cable landings in the target countries and the compilation of information related to total capacity and occupied capacity, among other factors, related to both existing and planned cables. This information is summarized in subsection 2.3, with further details provided in the appendix.

The research also identified existing and planned terrestrial fiber networks, including national fiber backbones and cross-border links between the target countries and their neighbors. This information is presented in subsection 2.4.

1.2.2 Stakeholder outreach and industry consultations

Building on the background research described above, this phase of the project involved outreach to stakeholders in the target countries. In total, 12 interviews were conducted via video conference with industry representatives, government officials, and other experts with first-hand knowledge of cross-border and fiber backbone infrastructure in the target countries. The objective was to gather information, experiences, and perspectives related to the expansion of connectivity infrastructure in each country. These one-to-one meetings were an important complement to the desk research and information gathering conducted in other parts of the project, serving as primary sources with up-to-date information on infrastructure status, business plans, challenges faced, and interest in future opportunities. While every effort was made to engage directly with stakeholders in each target country, several did not participate in the process. Accordingly, the information and analysis presented in this report are based on the best available information when stakeholder confirmation was unavailable.

1.2.3 Evaluation, analysis, and recommendations

The following analyses were conducted, building on the background research and stakeholder consultation processes:

- Assessment of the structure of the market for fiber network deployment (terrestrial and submarine) in each target country, as detailed in section 3, focused on three dimensions: market barriers, fragility and conflict dynamics, and regulatory barriers. This section also makes recommendations on how to address regulatory bottlenecks in the cross-border connectivity value chain (submarine wet cable deployment, cable landing station deployment, national fiber backbone, and international gateways).
- Assessment of infrastructure deployments or upgrades that are required to meet the target countries' needs. This work, which is presented in section 4, sought to ensure that sufficient regional and international capacity is available, offering satisfactory performance and resilience to meet projected demand. Crucially, this needs assessment was based on future demand expectations rather than current usage. The research drew on a combination of publicly available information, reports developed by the World Bank Group, and network providers. The gap assessment also considered the locations of large camps for internally displaced persons, with a focus on identifying fiber routes that would be necessary to provide connectivity to such areas.
- Evaluation of potential commercial options based on (i) the infrastructure gaps identified in section 4, and (ii) the projects with the highest benefit-to-cost ratios. The analysis then consolidated related high and medium-benefit projects into potentially financeable opportunities. These potential opportunities are presented in section 5, in a series of "deep dives" that identify relevant market trends, potential enterprise structures, revenue and pricing strategies, the role of the public sector, open access considerations, and any additional recommended studies.
- A projection of financing requirements for deployment of the proposed commercial options provides a rubric for considering the appropriate role for the public sector and possible financing options (section 6). Then each of the identified opportunities is considered, including estimates of system cost and partnership possibilities.

The maps of potential fiber routes and opportunities included in this report are intended for illustrative purposes only and do not reflect the real-world locations of fiber infrastructure deployments in the target countries. Follow-on country-specific studies would be required to identify the feasibility of designing, implementing, and managing each opportunity.

2

Traffic and Connectivity Ecosystem

2.1 Introduction

This section provides a comprehensive overview of the role of international traffic flows to and from the target countries and identifies all existing submarine and terrestrial fiber backbone infrastructure in the target countries.

Desk research and stakeholder outreach supplemented identification of the existing and planned cable landings in the region. Information was compiled related to total capacity and occupied capacity, among other factors, for both existing and planned submarine cables. An overview of each submarine cable, including a map, landing points, length, and other information, is provided in the appendix. Each target country, except landlocked Ethiopia and South Sudan, has at least one submarine cable landing. Overall, the current and planned submarine cables serving the region provide adequate capacity for current and anticipated future needs. A similar analysis identified existing and planned terrestrial fiber networks, including national fiber backbones and cross-border links between the target countries and their neighbors. The identification of existing and planned networks involved a combination of desk research and stakeholder interviews. The analysis in this section is a key input to the identification of infrastructure gaps in the target countries, which is further addressed in section 4.

2.2 Relevant International Traffic Flows

In reviewing the existing and planned submarine and terrestrial infrastructure serving the Horn of Africa (HoA) region, it is useful to consider how internet traffic flows in the region. Notably, internet traffic generated in the target countries continues to grow. But this traffic is constrained because it is served primarily by routes that reach content and services hosted in distant locations, including Marseille, London, Frankfurt, and likely the Middle East. Table 4 summarizes the Internet Protocol transit connections in each target country.

TABLE 4. Connection for Internet Protocol transit via Internet Protocol version 4 (IPv4) in the target countries, November 2021

COUNTRY	OPERATOR	PRIMARY ROUTES	ALTERNATIVE ROUTES
Djibouti	Djibouti Telecom	Cogent Level 3	STC CTGnet Telecom Italia Orange Sprint Hurricane Electric
Ethiopia	Ethio Telecom	Djibouti Telecom	Safaricom SomCable Sudatel
Somalia	Hormuud	Djibouti Telecom	Dalkom Somalia to WIOCC Golis to Oman Telecommunications (Omantel) Direct to WIOCC
	Somtel Golis	Djibouti Telecom Omantel	Dalkom Somalia to WIOCC
	Sahal	Somali Optical Networks to Dalkom to WIOCC	
	Dalkom	WIOCC	
	Telesom	Djibouti Telecom	Golis to Omantel Ethio Telecom to Canar and Sudatel
	SomCable	Djibouti Telecom	Ethio Telecom to Djibouti Telecom and Canar Telecom
South Sudan	MTN South Sudan	MTN South Africa	
	Zain	Zain Muya Fibre Construction	Mena Levant (Zain) BCS Seacom

Source: TMG/APTelecom based on Hurricane Electric.
Note: BCS = Bandwidth and Cloud Services Group ; WIOCC = West Indian Ocean Cable Company.

continued

A key consideration for improving connectivity in the HoA region will be to reduce the distance between users and content or services, thereby reducing load times and latency.

Until recently, most internet traffic in Africa required connectivity to other regions, especially to Europe. But two trends in the African backbone market are gradually changing these traffic patterns:

- Localization of content
- New cross-Africa routes as alternatives for submarine cable routes.

2.2.1 Content localization

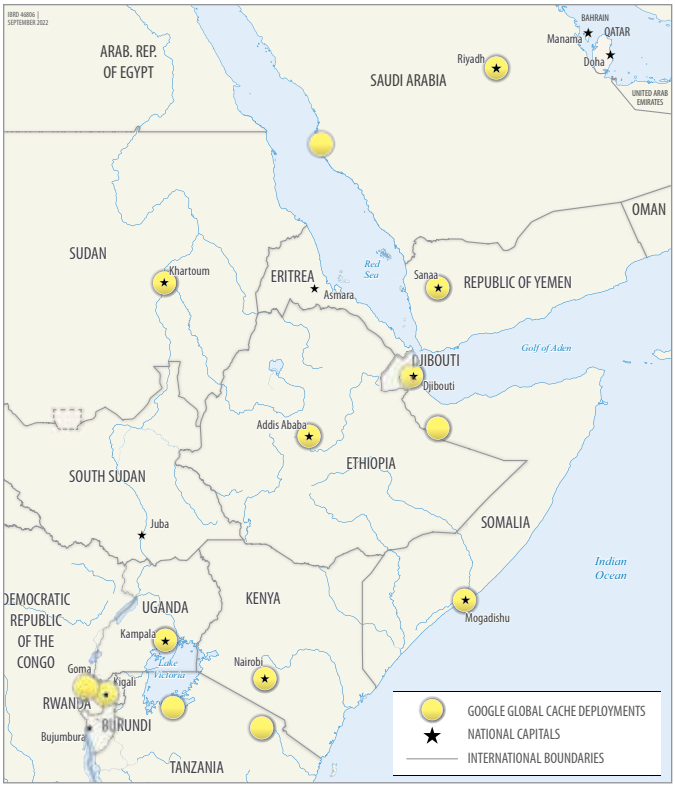
Global traffic patterns indicate that content is tending to become more localized. Key drivers of this behavior include the following:

- The deployment of caches by major players like Akamai, Google, Meta (formerly Facebook), and Netflix in operator networks or internet exchanges. It is not unusual to see approximately 50 percent of traffic become local when the top four or five content delivery networks (CDNs) are deployed in-country.[4]
- Major internet players and cloud providers, such as Alibaba, Amazon (AWS), Google, Meta, and Microsoft, are deploying data centers within a region to keep traffic within that region.
- Governments and companies are deploying and hosting services domestically instead of abroad.
- Internet exchanges are keeping traffic local and exchanging traffic between networks without the need to reach faraway nodes.

In Africa, this trend is evidenced in countries such as Kenya and Nigeria, where the share of local traffic jumped from 30 percent in 2012 to nearly 70 percent in 2020 due to local data centers, internet exchanges, and CDNs.[5]

Several major content hosts and providers have some level of deployment in Africa—including some in the HoA region—that should enable faster and more efficient access to content. With major cloud providers starting to deploy their services from data centers within Africa, more traffic will stay within the continent instead of being mostly routed to Europe, fundamentally altering traffic flows.

MAP 2. Google Global Cache deployments in and around the Horn of Africa region, 2021



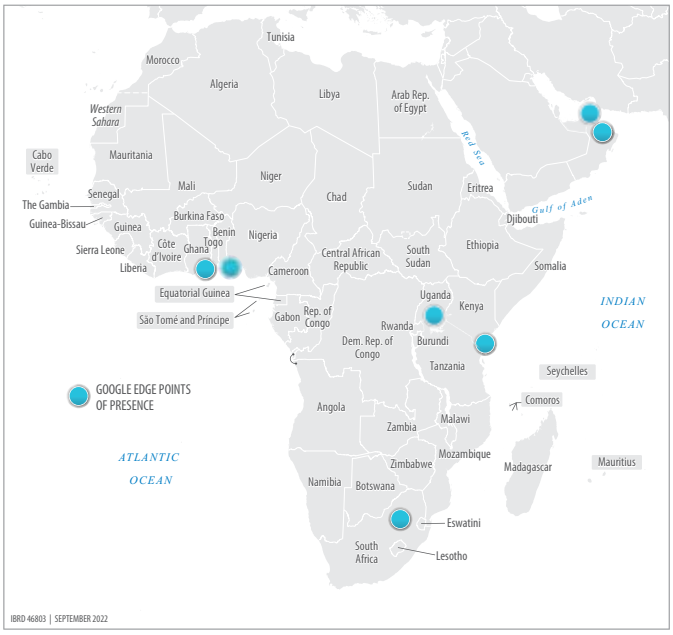
Source: Google, Our Infrastructure, https://peering.google.com/#/infrastructure.

Google. In the HoA region, the lowest-level Google Global Cache deployment shows that the caches with the highest amount of localized Google/YouTube traffic have been deployed in Djibouti, Ethiopia (Addis Ababa), and Somalia (Hargeisa and Mogadishu),, as illustrated in map 2.

The next level of nodes in the Google content distribution is the Edge Points of Presence. These are present around three centers: Nigeria (and one in Ghana), South Africa, and Kenya (and one in Uganda). Notably, immediately outside Africa, there are only two nodes of this class—one in the Middle East (United Arab Emirates and Oman, leveraging submarine cable connectivity), as shown in map 3, and the other in Europe.

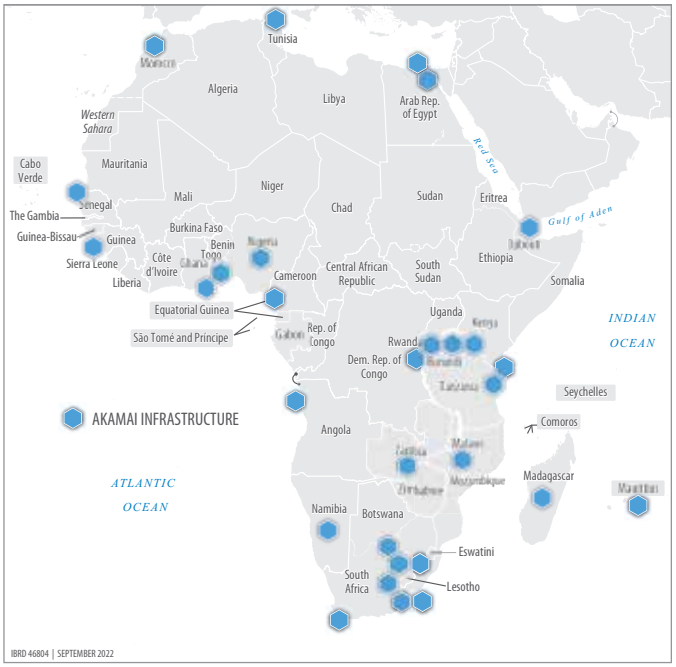
Akamai. Akamai is another major CDN used for global content distribution by numerous major content providers. Its presence in the HoA region is limited to Djibouti, but Akamai also has two nodes in Kenya and one in Uganda, as seen in map 4.

MAP 3. Google Edge Points of Presence in Africa and the Middle East, 2021



Source: Google, Our Infrastructure, https://peering.google.com/#/infrastructure.

MAP 4. Akamai infrastructure, Africa, 2021



Source: Akamai, Media Content Delivery Map, https://www.akamai.com/visualizations/media-delivery-network-map.

TABLE 5. Facebook Network Appliance locations in the Horn of Africa region, 2021

ORIGIN AS	ORIGIN AS NAME	IPV4	IPV6	AIRPORT CODE	AIRPORT NAME
37594	MTN, SS	197.231.238.146		JUB	Juba, South Sudan
327786	TELECOM-4G, SS	169.255.27.146		JUB	Juba, South Sudan
37376	ZAIN-South-Sudan, SS	41.79.121.18		JUB	Juba, South Sudan
37284	Aljeel-net, LY	41.74.65.18		MJI	Maji, Ethiopia
328200	w	156.38.38.20		MJI	Maji, Ethiopia
24757	EthioNet-AS, ET	196.188.31.17		ADD	Addis Ababa [Bole], Ethiopia
24757	EthioNet-AS, ET	196.188.31.81		BJR	Bahar Dar, Ethiopia
30990	ADJIB-AS, DJ	197.241.40.17	2001:4298:88:6000:face:b00c:0:a7	JIB	Djibouti [Ambouli], Djibouti
37371	HORMUUD, SO	41.78.74.145		MGQ	Mogadishu (Mogadiscio) [Petrella], Somalia
328469	Somtel-Somalia-AS, SO	102.68.18.18		MGQ	Mogadishu (Mogadiscio) [Petrella], Somalia
328250	Golis-Telecom-AS, SO	41.223.111.81		BSA	Bossaso, Somalia
37563	SOMTEL, SO	102.128.130.19		BSA	Bossaso, Somalia
37473	TELESOM, SO	154.115.242.145		HGA	Hargeisa, Somalia
37425	Somcable, SO	41.79.198.81		HGA	Hargeisa, Somalia
37563	SOMTEL, SO	197.231.200.210		HGA	Hargeisa, Somalia

Source: Anuragbhatia, Facebook FNA updates, April 2021, https://anuragbhatia.com/2021/04/networking/isp-column/facebook-fna-updates-april-2021/.

Meta. Meta has different cache levels. Facebook Network Appliances (FNAs), the lowest-level cache, are often provided to internet exchange locations and within operator networks. The locations of such FNAs in the HoA region are shown in map 5. Currently, an FNA is available in each target country, three across Somalia (Mogadishu, Bosaso, and Hargeisa).

The numerous FNAs in the HoA region imply that popular Meta data can be served locally. The next level of Meta cache is also available within Africa from three main points of presence (PoPs), as shown in map 5, with Kenya as the most logical nearby node for the target countries.

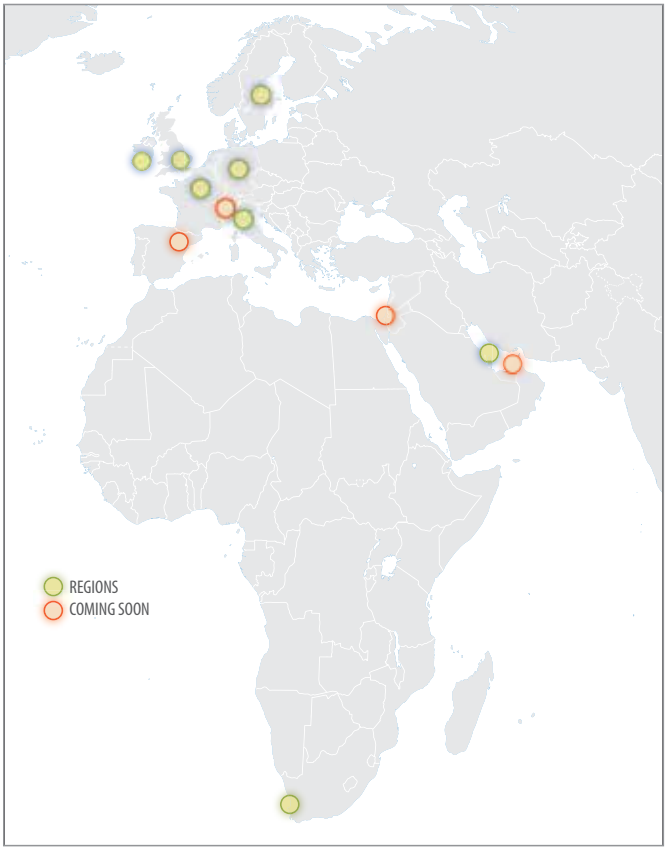
Amazon Web Services (AWS). AWS's services for the Africa region are provided from South Africa, Bahrain, or Europe, with no current or disclosed plans for presence in the HoA region, as seen in map 6.

However, AWS announced the rollout of a CloudFront Edge location in Nairobi, Kenya, in 2020.[6] This node, shown in map 7, should be serving the HoA region by now.

MAP 5. Meta PoP locations, 2020

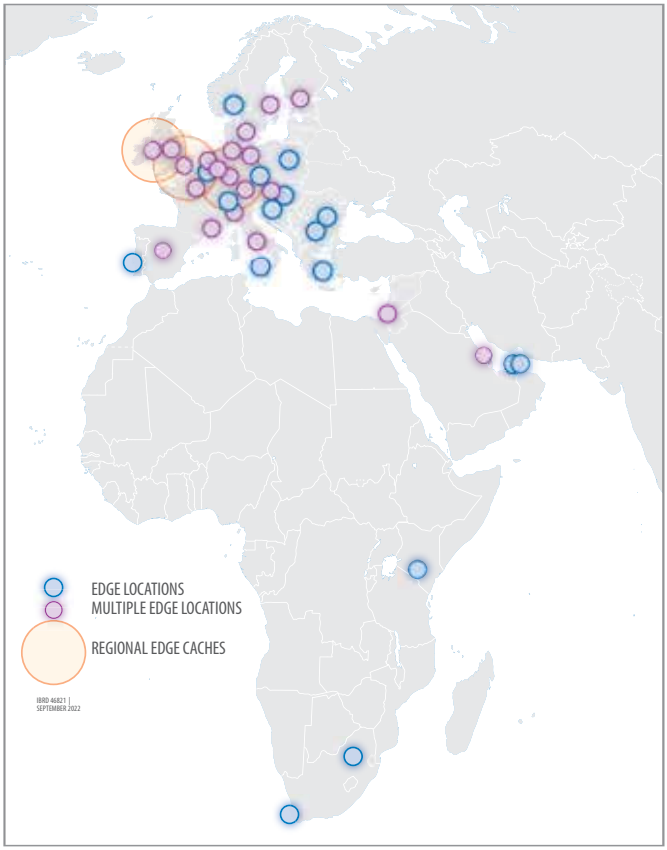
Source: Analysys Mason, The Impact of Facebook's Connectivity Initiatives in Sub-Saharan Africa, June 2020.
Note: PoP = point of presence.

MAP 6. AWS infrastructure in Africa, the Middle East, and Europe, 2021



Source: AWS, Global Infrastructure, https://aws.amazon.com/about-aws/global-infrastructure/.
Note: AWS = Amazon Web Services.

MAP 7. Amazon CloudFront Edge locations in Africa, the Middle East, and Europe, 2021



Source: Amazon Web Services, Amazon CloudFront Key Features, https://aws.amazon.com/cloudfront/features/?whats-new-cloudfront.sort-by=item.additionalFields.postDateTime&whats-new-cloudfront.sort-order=desc.

Microsoft Azure. Since 2019, Microsoft Azure has had PoPs in Angola, Kenya, Nigeria, and South Africa, to serve African markets, as illustrated in map 8.

Alibaba. Currently, none of Alibaba's main nodes are in Africa. The company's global node locations are mostly located in Asia, as shown in map 9.

MAP 8. Microsoft Azure infrastructure in Africa and the Middle East, 2021

Source: Microsoft, Global Infrastructure, https://infrastructuremap.microsoft.com/explore ?info=pop_NBO30.

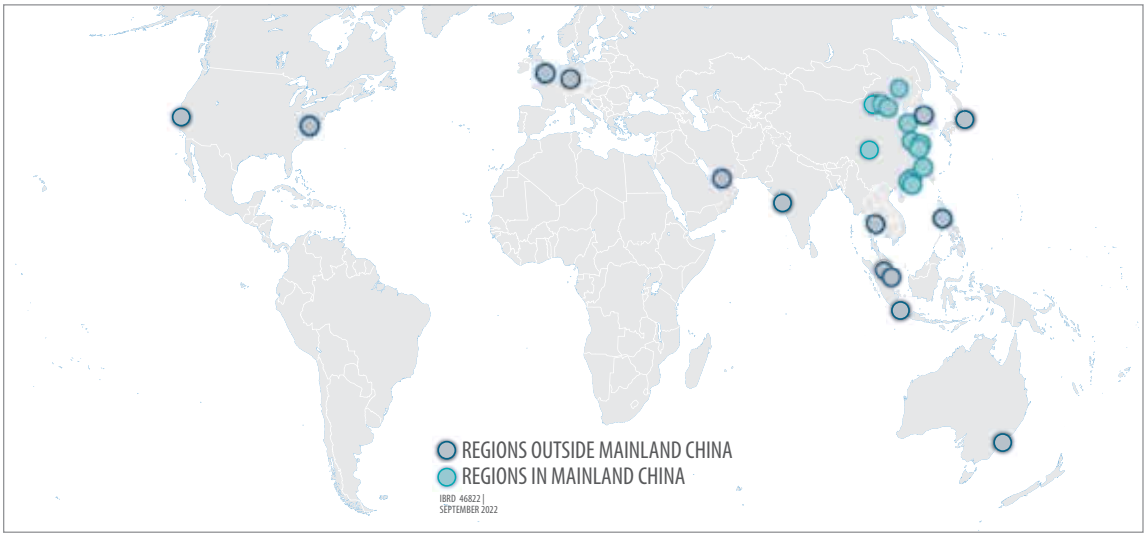
Internet exchanges. Djibouti is the only target country that has an active internet exchange to facilitate local traffic exchanges. But Kenya and other neighbors south and west of Kenya have started internet exchange points (IXPs). The internet exchanges in and near the HoA region are shown in map 10.

Data centers. Data centers are needed to host CDNs, cloud providers, and internet exchanges. Typically, every major operator has data centers to host its network equipment. These operator data centers sometimes also host caches from major content providers or CDNs, such as Akamai, Google, Meta, and Netflix, and offer some colocation space to third parties. The largest internet players (for example, AWS, Google, Meta, and Microsoft) deploy very large data centers (hyperscale) at key hub locations, while carrier-neutral data centers cater to a broad range of colocation customers, including edge nodes of the hyperscalers, to bring content and services closer to customers.

Within the target countries, the Djibouti Data Center positioned itself as the first Tier 3 carrier-neutral data center in East Africa with direct access to all major international and regional cable systems connecting Africa to Europe, the Middle East, and Asia.[7]

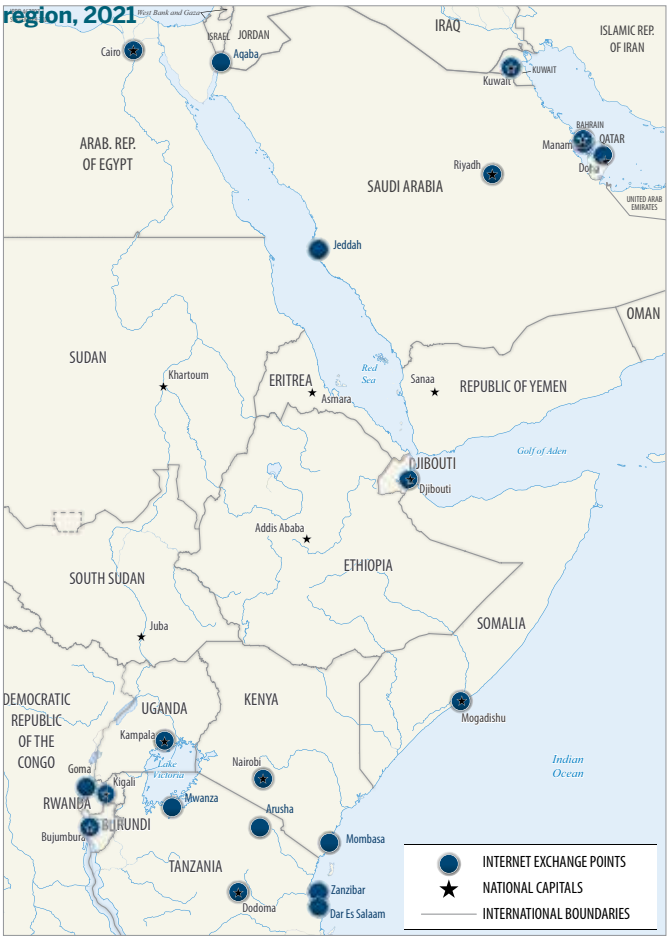
It is expected that market players will aim to establish data centers within Ethiopia, thereby reducing the dependency on high-latency routes to faraway data centers, as is the case today. To that end, data center activities are underway, such as the Ethio ICT Park.[8] However, certain challenges exist within Ethiopia, related to the process, costs, and requirements that must be met to establish such data centers.

MAP 9. Alibaba nodes, 2021



Source: Alibaba, Alibaba Cloud's Global Infrastructure, https://www.alibabacloud.com/global-locations.

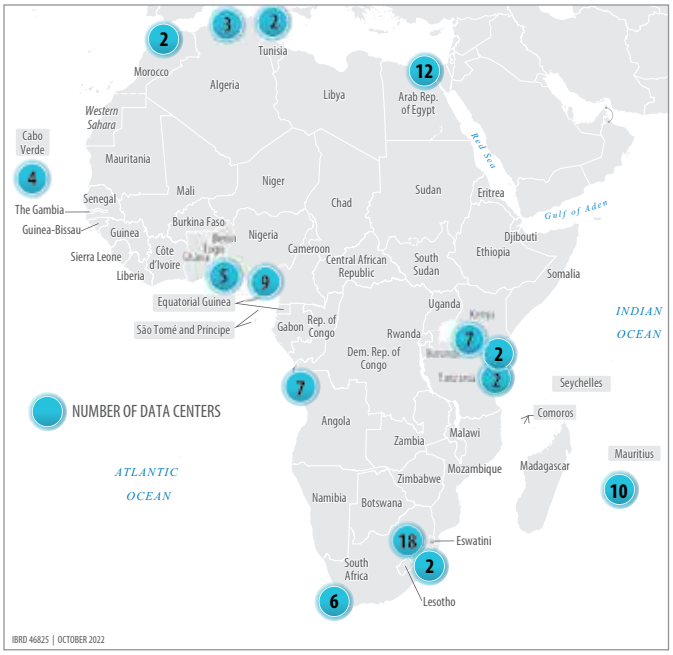
MAP 10. Internet exchanges in and around the Horn of Africa region, 2021



Sources: TeleGeography Internet Exchange Map, https://www.internetexchangemap.com/#/;

Note: The internet exchange point in Somalia has been inactive for an extended period of time.

MAP 11. Data centers in Africa



Source: Data Center Research, https://www.datacentermap.com/.

Looking slightly beyond the target countries, as illustrated in map 11, the hub closest to the region is in Kenya, with other African hubs in Nigeria and South Africa, with some specific developments in Angola as well.

2.2.2 New cross-Africa fiber optic routes

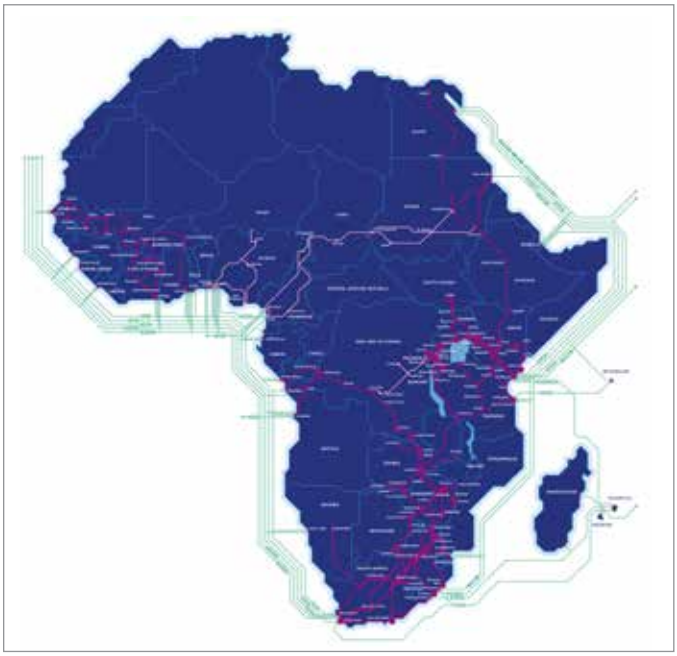
The growth of data centers, cloud providers, and CDNs, particularly in Kenya, South Africa, and Nigeria, implies that a significant portion of content can be delivered to users in the HoA region from those locations instead of retrieving it from Europe. In a related development, Africa-wide fiber optic backbones are also addressing and preparing for these changing traffic patterns, including the development of coast-to-coast connections.

For example, Liquid Intelligent Technologies (Liquid) and its partners have recently announced the first coast-to-coast route from the Democratic Republic of Congo to Mombasa, Kenya, and that a second route from Port Sudan to Chad to Cameroon is close to being integrated.[9] This route is seen on Liquid's network in map 12. The route will likely be further connected to the cloud providers in Nigeria, especially given Liquid's plans to build a data center in Lagos.[10] Liquid has also deployed a cable to the border with Somalia, although laying fibre along this route is complicated due to the insurgency situation in Somalia.[11]

Notably, cross-Africa routes can connect many countries to data centers, cloud providers, and CDNs within Africa, reducing emphasis and reliance on submarine connectivity to Europe, focusing instead on the main (emerging) African internet hubs. For the target countries, the closest emerging hub is Kenya. While Djibouti is an important hub for submarine connectivity (as discussed in subsection 2.3), it has not yet attracted as many of the data centers, CDNs, and cloud providers as have the other emerging internet hubs.

Based on these trends, future traffic flows from the target countries are expected to shift away from a very European-centric pattern to a more diverse topology, with Kenya quickly positioning itself as an upcoming hub. In addition, Nigeria may become a notable area of

MAP 12. Liquid network map



Source: Liquid Intelligent Technologies.

focus when terrestrial routes and connectivity further improve. In the Middle East, a similar shift will likely take place, with more traffic remaining within that region as emerging nodes in Oman, Saudi Arabia (such as the ambitious Neom project to build the first cognitive and smart city in the world), and the United Arab Emirates grow in importance.[12] These nodes may also try to serve the African market, especially East Africa. This is particularly relevant for Somalia, given its close commercial ties to the broader Arab world.

2.3 Submarine Cables Serving the Target Countries

Currently, 10 submarine cables land in the target countries, as outlined in table 6. Four new cables serving the HoA region are expected to be ready for service between early 2022 and 2024. Based on the existing and planned capacity available in the target countries, the HoA region has sufficient access to submarine international connectivity to meet current and projected demand.

TABLE 6. Submarine cable systems reviewed

	SUBMARINE CABLE SYSTEM	REGIONAL VERSUS INTERNATIONAL	TARGET COUNTRY LANDINGS	READY-FOR-SERVICE DATE	CAPACITY (TBPS)
Existing systems					
1	Djibouti Africa Regional Express 1 (DARE1)	Regional	Djibouti (YAC A), Somalia (Bosaso, Mogadishu, and potentially also Berbera[a])	2021	36
2	Gulf2Africa (G2A)	International	Somalia (Bosaso)	2017	30
3	Asia Africa Europe 1 (AAE-1)	International	Djibouti (YAC A)	2017	50
4	SeaMeWe-5	International	Djibouti (Haramous)	2016	26.6
5	Europe India Gateway (EIG)	International	Djibouti (Haramous)	2011	36.6
7	Eastern Africa Submarine System (EASSy)	Regional	Djibouti (Haramous), Somalia (Mogadishu)	2010	11.8
8	SEACOM/Tata TGN-Eurasia	International	Djibouti (YAC A)	2009	6
10	SeaMeWe-3	International	Djibouti (YAC A)	1999	0.755
Planned systems					
1	PEACE Cable	International	Djibouti (YAC A), Somalia (Bosaso, Mogadishu)	2022 Q1	96
2	2Africa	International	Djibouti (New CLS), Somalia (Mogadishu), Sudan (Port Sudan)	2023	180
3	Africa-1	International	Djibouti (YAC A), Somalia (Berbera), Sudan (Port Sudan), Yemen, Rep. (Mocha)	2023 Q4	192
4	Reliance Jio India-Europe Express (IEX)	International	Djibouti (New CLS)	2024	210

Source: TMG/APTelecom based on TeleGeography.

Note: All the CLSs in Djibouti are located in Djibouti City. Currently, there are two CLSs (YAC C and Haramous), with a third expected to be completed in 2022). CLS = cable landing station; Tbps = terabytes per second.

a. The cable ship to land the DARE1 cable in Berbera was sent away in 2020. See https://menafn.com/1099606463/Somaliland-and-Djibouti-in-Dare1-Submarine-Cable-System-Standoff%20but%20the%20Feb%208. But the February 8, 2022, establishment of a Somaliland fiber optic joint venture hints at one or two cable landings in Berbera in the near future, which would imply Africa-1 and DARE1. It remains unclear whether the previously scheduled G2A landing in Berbera will be resumed as well.

Multiple submarine cables land in Djibouti, and Somalia; landlocked Ethiopia and South Sudan naturally have no such landings. The first submarine cable to land in the region was the SeaMeWe-3 system, which landed in Djibouti in 1999. Several cables have since landed in Djibouti, with four more expected in the coming years. By 2024, the 11 total cables landing in Djibouti will further cement it as a key hub for submarine connectivity in the HoA region and Africa more broadly. International connectivity via submarine cables in Djibouti, supplemented by landings in Somalia, provide the target countries sufficient access, capacity, and resilience. However, the high concentration of cables creates concerns that Djibouti will constitute a chokepoint for international connectivity in the HoA region.

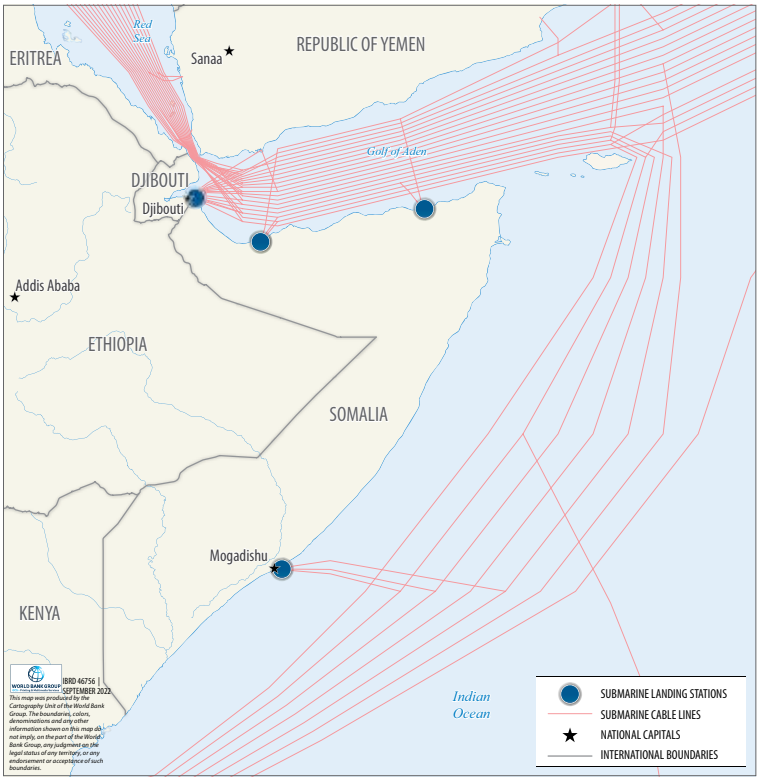
Several additional cables are scheduled to land in the target countries in the coming years. These include the PEACE and 2Africa cables, which were reported to have landed in Djibouti and Somalia in May 2022; the Africa-1 cables, both of which will land in Djibouti, and Somalia in 2023; and the Reliance Jio India-Europe Express, which will land in Djibouti in 2024. The current cable landing station (CLS) locations in the region are identified in map 13.

Submarine cable technology is constantly advancing, and the cables being developed and deployed today have far greater capacity than older cables. For example, existing cables have an average capacity of 23.4 terabytes per second (Tbps), while the planned cables will deliver 169.5 Tbps on average.[13] The latest submarine cables planned for the Africa region—2Africa, Africa-1, and PEACE—will provide the African market access to well over 500 Tbps of potential additional capacity.

As noted in subsection 3.1.6, the demand for international capacity in the target countries is projected to increase to over 7.4 Tbps by 2030.[14] This is well below both existing and planned capacity. Accordingly, expected international capacity needs in the HoA region are well-served by the current and planned submarine network infrastructure.

Maps and additional details on existing and planned submarine cables are provided in the appendix.

MAP 13. Submarine cable landing stations in the target countries



Source: TMG/APTelecom.
Note: CLS = cable landing station.

2.4 Terrestrial Fiber Backbone Networks in the Target Countries

2.4.1 Djibouti

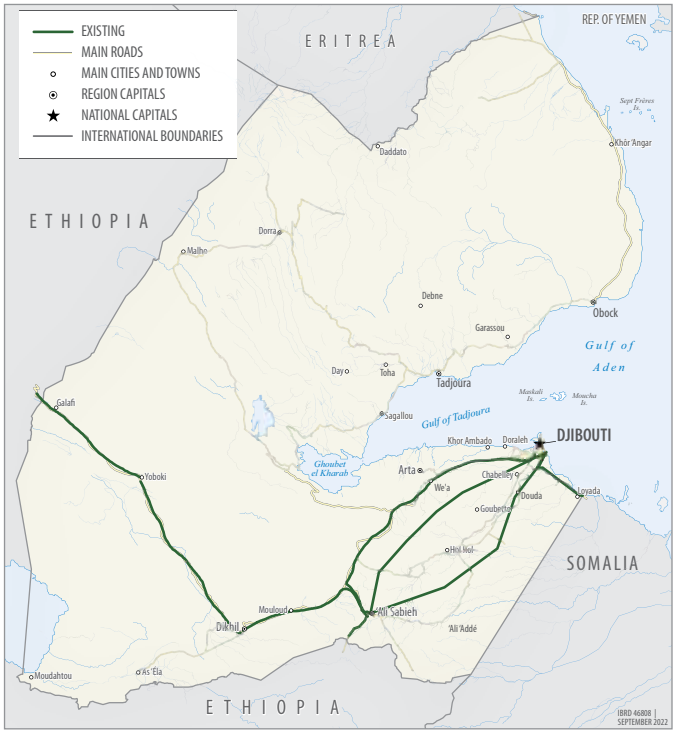
National backbone. Given Djibouti's status as a primary point of submarine cable connectivity in the HoA region, it has a well-developed terrestrial backbone network in the southern portion of the country, which is linked to the CLSs there.

Djibouti Telecom has a local fiber optic ring from Djibouti City to Ali Sabieh. This ring is a mix of an optical ground wire (OPGW) ring on the power lines, an underground cable route, and a route along the railway.

Map 14 provides an overview of the key terrestrial fiber routes in Djibouti. As can be seen, however, fiber infrastructure follows the international road corridors and planned projects with Ethiopia and Somaliland.

Relationship to cross-border connectivity. Djibouti is very well connected to global traffic via various large submarine cables that currently land at the two existing CLSs. Djibouti's position as a key hub for the region and the need for onward connectivity are key drivers of the development of fiber infrastructure in the southern part of the country.

MAP 14. Djibouti: Terrestrial fiber map



Source: TMG/APTelecom based on operator data.
Note: CLS = cable landing station.

Djibouti Telecom currently operates two CLSs, the YAC A CLS and the Haramous CLS. Eight submarine cables connect Djibouti to the world, and terrestrial cables connect Djibouti to its neighbors, including two to Ethiopia and one to the Somaliland region.

The following submarine cables land at the YAC A CLS:

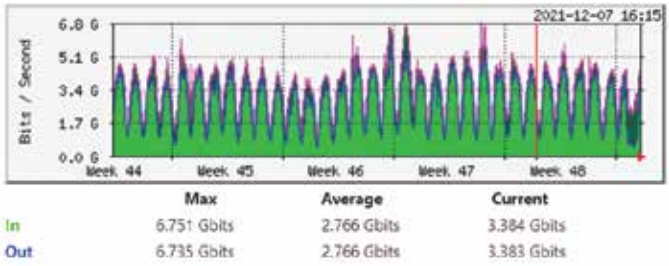
- AAE-1
- SEACOM
- SMW3
- DARE1.

The following cables land at the Haramous CLS:

- EIG
- EASSy
- SMW5
- Djibouti-Ethiopia (terrestrial cable)
- Djibouti-Somalia (terrestrial cable).

Four additional submarine cables are currently planned to land in Djibouti, including PEACE, 2Africa, Africa-1, and IEX. In addition to the YAC A and Haramous CLSs, Djibouti Telecom is building a new CLS in Djibouti City, adjacent to YAC A, which was due to be completed by April 2022.[15]

FIGURE 3. Djibouti Internet Exchange monthly traffic, December 2021



Source: Djibouti Data Center, https://portal.djix.dj/statistics/ixp.

The following are the relevant terrestrial cross-border connections in Djibouti:

- Onward fiber optic cable to Galafi for connectivity to Ethiopia
- From Ali Sabieh, another route that goes south directly into Ethiopia
- Two routes from the Somaliland region that converge in Djibouti.

Localization of content. There are a Google cache, a Meta cache, and an Akamai cache in Djibouti. As the first Tier 3 carrier-neutral data center in East Africa, the Djibouti Data Center offers colocation services and hosts the Djibouti Internet Exchange (DjIX).[16] The DjIX has 16 members, mostly operators and one CDN (Cloudflare) and runs about 5 to 6 gigabytes per second (Gbps) of traffic, as shown in figure 3.[17]

Key gap to be addressed. As further discussed in subsection 4.2.1, the most notable gap in Djibouti's fiber infrastructure is the development of a terrestrial fiber backbone in the northern region. The Djibouti network mostly targets the CLS and currently lacks the capability to meet the national needs. The entry of a private wholesale fibre network, AfriFiber, in July 2019 has been a first step towards sector liberalization although Djibouti Telecom still maintains its monopoly on access to all active landing stations and gateways to international connectivity. AfriFiber is currently deploying its own fiber backbone in Djibouti City. AfriFiber is currently deploying its own fiber backbone in Djibouti City.

2.4.2 Ethiopia

National backbone. Ethiopia has a single fiber optic transmission network for telecommunications, deployed by incumbent operator Ethio Telecom. The domestic backbone network currently consists of 21,178 kilometers (km) of fiber optic route, of which 7,302 km is OPGW (along power lines) using Huawei and ZTE equipment. The OPGW appears to be on routes deployed by Ethiopian Electric

Power, which has installed OPGW (24 core, 48 core) on many of its power lines for internal use.[18]

Maps 15 and 16 present Ethiopia's existing fiber routes, with the latter providing additional network details.

Ethio Telecom has deployed its national fiber optic backbone along roads, power lines (OPGW), and railway routes to establish a resilient national network topology.[19]

In May 2021, Ethiopia awarded a second telecommunications license to Safaricom Ethiopia, a consortium led by Safaricom Kenya (Vodafone/Vodacom). While the new entrant is entitled under the regulatory framework to access Ethio Telecom's fiber optic backbone, in practice this has not yet been practicable.[20] Accordingly, Safaricom Ethiopia is likely to construct an independent fiber optic backbone (or parts thereof) in the country.[21]

The new Safaricom Ethiopia backbone notwithstanding, Ethiopia is a large market that would benefit from a more robust fiber network topology to cope with outages on the main routes and provide additional resilience, given that many cross-border routes pass through or are near conflict areas (see subsection 3.2.2).

Relationship to cross-border connectivity. Ethiopia's current fiber backbone connects to three cross-border routes: via Djibouti (main route)and Kenya.

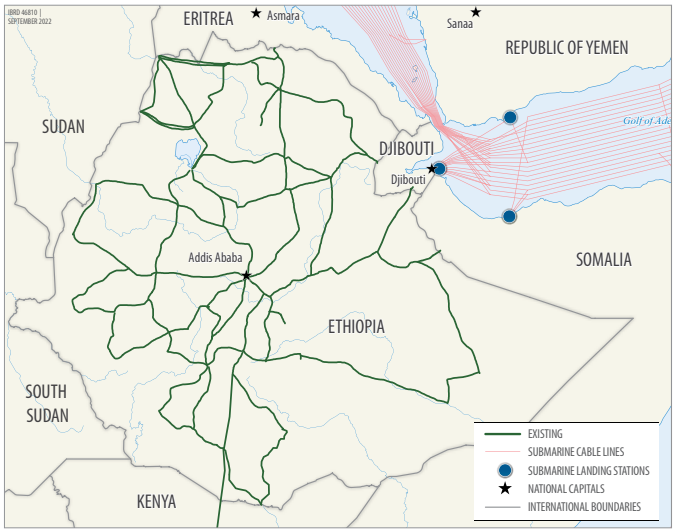
- *Via Djibouti.* The primary international route is via two border crossings (Galafi and Ali Sabieh) into Djibouti. Given the recent internal conflicts within Ethiopia, the fiber optic route from Addis Ababa to Djibouti along highways A1 and A2 may be vulnerable.[22]
- *Via Kenya.* The route to Kenya connects to a terrestrial cable in Northern Kenya that is reportedly prone to outages. However, a second route using OPGW along the Sodo-Moyale-Suswa High Voltage Power Line has been deployed and is expected to be less prone to outages than the existing cable.

There is also a cross-border route to Somalia (Hargeisa/Berbera Somaliland region) and the SomCable network with potential onward submarine cable connectivity forthcoming once the planned Berbera landing becomes operational. Despite the presence of multiple cross-border routes, Ethiopia would benefit from additional options to connect to Eritrea, and Somaliato guarantee resilience and reduce latency in accessing content hosted outside the country.

Localization of content. There are a Google cache and two Meta caches in Ethiopia. Several data centers are slated for construction in the information and communications technology (ICT) park. One, Sun Data World, reports that it has available colocation space.[23] Various companies, such as Raxio Data, Wingu.africa, RedFox Web Solutions, and ScutiX, are reportedly preparing data centers as well.[24]

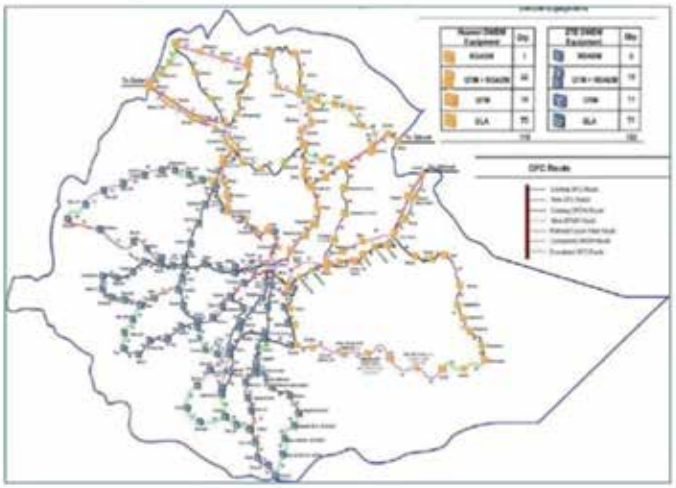
Key gaps to be addressed. As further discussed in subsection 4.2.2, multiple priority gaps in fiber connectivity need to be addressed in Ethiopia, including further development of middle-mile and access fiber infrastructure and pursuit of additional

MAP 15. Ethiopia: Terrestrial fiber map



Source: TMG/APTelecom based on operator data.
Note: CLS = cable landing station.

MAP 16. Ethiopia: Fiber routes



Source: Digital Ethiopia presentation, 2018, https://www.slideshare.net/Myles-Freedman/digital-ethiopia-iad-2018-addis-ababa-ethiopia.

cross-border routes to improve resilience and obtain better routes to regionally hosted content.

2.4.3 Somalia

National backbone. The most important observation when considering Somalia's terrestrial infrastructure is the lack of a single national fiber optic backbone. Accordingly, Somalia's telecom sector can best be considered as three separate regional markets, each obtaining international connectivity via submarine and terrestrial cables, complemented with some cross-border microwave connections, such as to Kenya.

The existing fiber optic cable infrastructure in Somalia is limited. There are three main fiber optic backbone deployments, as described in table 7, but these do not seem to be interconnected. As shown in table 4, there is a low level of domestic interconnectivity between providers. The lack of a unified domestic backbone network in Somalia contributes to that situation.

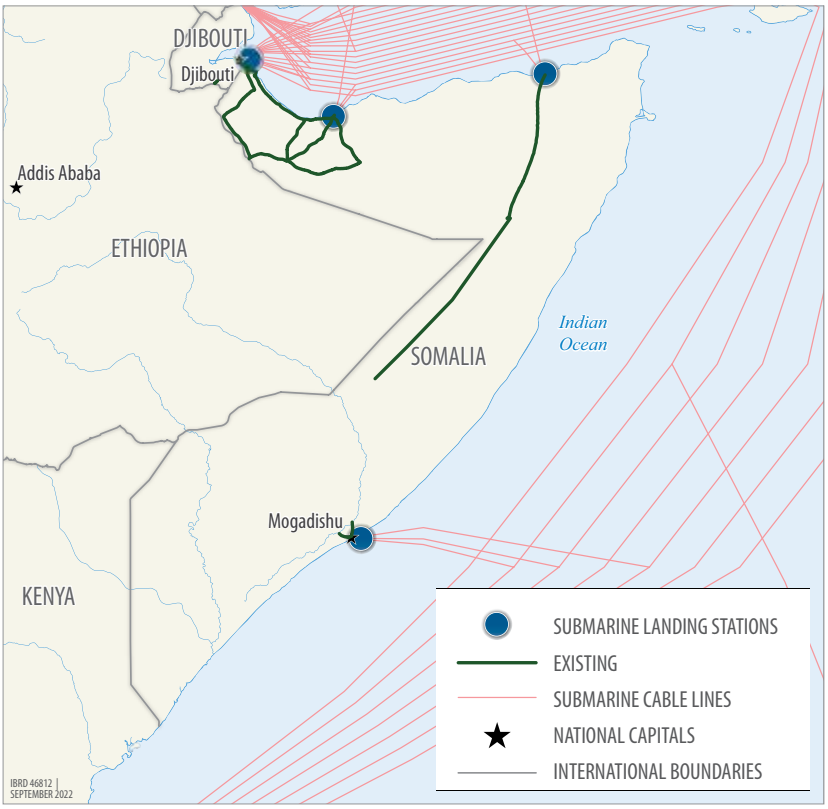
Three metro rings have been deployed in Hargeisa as well as smaller metro networks in Berbera, Boramo, and Burca. In 2020, SomCable's monopoly to deploy fiber optic networks in the Somaliland region was lifted (see the discussion in subsection 3.3.3). Other operators have begun to deploy fiber in the Somaliland region, but the extent or details of such deployments are unavailable.

Although plans exist for more fiber optic routes, they have been difficult to implement given the security issues in many parts of Somalia (see the discussion in subsection 3.2.3). Therefore, most of the country's terrestrial connectivity presently depends on microwave connectivity.

Map 17 provides an overview of the key terrestrial fiber routes in Somalia.

Relationship to cross-border connectivity. Somalia's disparate fiber networks complicate international connectivity. The country's main international connectivity arrives via various routes:

MAP 17. Somalia: Terrestrial fiber map



Source: TMG/APTelecom based on operator and International Telecommunication Union data.
Note: CLS = cable landing station.

TABLE 7. Somalia: Fiber optic cable infrastructure

REGION	PROVIDER	DESCRIPTION
Somaliland region	SomCable	A ring topology connecting the main city, Hargeisa, and Berbera (CLS) to Djibouti. Extension to Burco for onward connectivity.
Puntland region	Golis Telecom	From Bosaso (CLS), a route toward the south with Galkayo and Goldogob as destinations. Prior studies have confirmed that it is operational to Qardho and there are indications that it is operational at least to Garowe.[a]
Rest of Somalia	Hormuud and Dalkom	Small sections around Mogadishu to Balcad and Afgoye. CLS landing party for submarine cables landing in Mogadishu.

Source: TMG/APTelecom.

Note: CLS = cable landing station.

a. *World Bank Group, Strategy and PPP Options for Supporting the ICT Sector and Broadband Connectivity in Somalia, January 2017,* https://ppiaf.org/documents/5419; Kalba International and Heritage Institute for Policy Studies, Broadband Backbones in Somalia: Needs, Resources, Plans and Options, December 11, 2019.

- Mogadishu cable landings (EASSy, DARE1, and Dalkom CLS)
- Bosaso cable landings (G2A, DARE1)
- Berbera cable landings (upcoming Africa-1 landing but possibly also the DARE1 landing that was halted in 2020 or the previously planned G2A landing)

- Terrestrial cables from the Somaliland region into Djibouti
- Microwave links to Kenyan fiber optic cables at Liboi to Kismayo.

Further, SomCable claims that it connects not only to Djibouti, but also to the Puntland region and Ethiopia.[25] However, SomCable's connection to Puntland was not verified at the time of writing, and it is understood that the political tension in the border region has prevented the connection thus far.

The border gateway protocol data presented in table 4 confirm that SomCable and Ethio Telecom exchange traffic on their respective routes, and industry sources confirmed that there is also a cross-border fiber optic cable at the 100 Gbps level.[26] Although the CLS in Berbera is not yet operational, once the planned cables that are intended to land in Berbera are completed and operating, Berbera could become a major alternative route for Ethiopia to increase the resilience of its international connectivity.

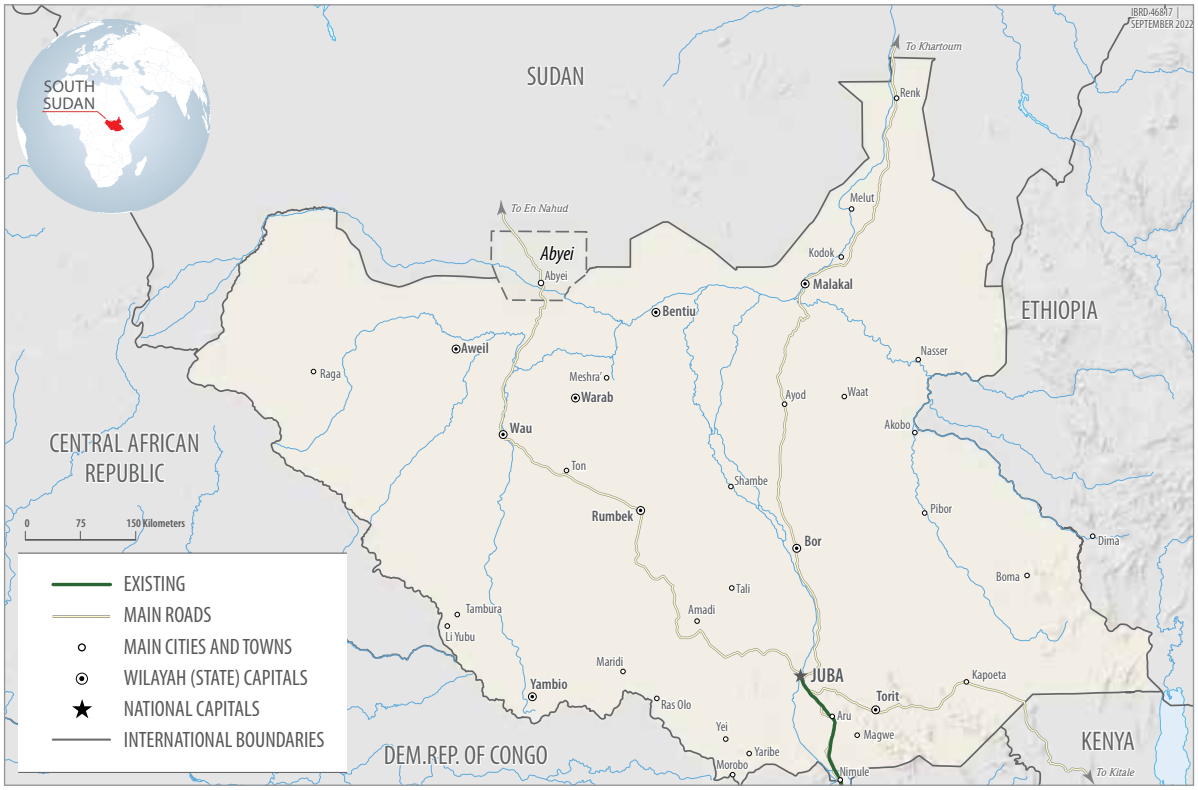
Localization of content. There are Google caches in Mogadishu and Hargeisa and seven Meta caches in various operator locations in Hargeisa, Bosaso, and Mogadishu.

Key gap to be addressed. As further discussed in subsection 4.2.3, the key gap to be addressed in Somalia is the completion of a national backbone, which would also enable improved cross-border connectivity and expand local access.

2.4.4 South Sudan

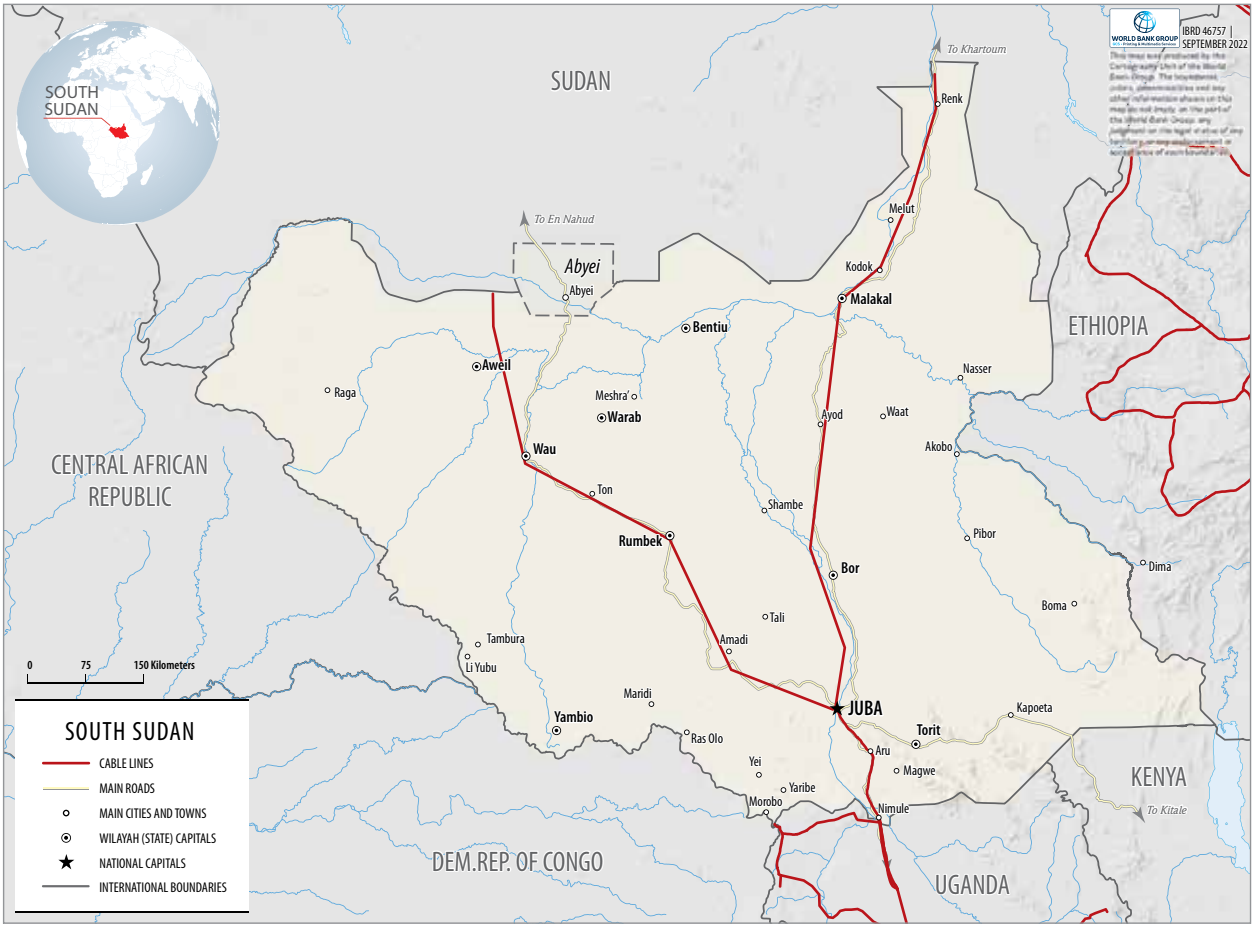
National backbone. The most important infrastructure gap to be addressed in South Sudan is the lack of an operational domestic backbone. Before the establishment of the independent South Sudan, the region was served by the mobile network operators that were active in Sudan. In approximately 2010, the networks in Sudan and South Sudan were separated, enabled by the addition of a mobile core network in South Sudan. Sudatel played an important role in connecting current Sudan to Juba along two routes, but these routes were not completed and the remaining infrastructure cannot be recovered for future use. Map 18 presents the known active fiber routes in South Sudan, and map 19 [should there be more text?]

MAP 18. Active fiber routes in South Sudan



Source: TMG/APTelecom based on Liquid Telecom data.
Note: CLS = cable landing station.

MAP 19. Illustration of Sudatel's Sudan/South Sudan network prior to the separation



Map 19 presents an illustration of Sudatel's Sudan/South Sudan network prior to the separation.

The two fiber optic routes to Sudan—the Sudatel East-Central and West-Central backbone routes— were previously operational, but these routes are not currently operational for cross-border traffic. Some sections may remain in use for domestic connectivity, but this could not be confirmed.

Relationship to cross-border connectivity. In 2019, South Sudan introduced a centralized international gateway for voice and subsequently for data traffic controlled by the government (see further discussion in subsection 3.3.4). Located in Juba, this requires all international traffic to be routed to the capital city before exiting the country.

In 2020, Liquid established a fiber optic route into Juba along the road from Uganda, which added a significant amount of terrestrial capacity as an alternative to the previously limited satellite connectivity. A second cable follows the same route as Liquid's.

Deployment of previously announced terrestrial fiber projects, such as Juba-Bangui (2013) and Juba-Nairobi (2013), could not be confirmed.[27]

Localization of content. The only known caches are three Meta caches in the networks of three main operators (Zain, MTN, and Telecom 4G).

MAP 20. Sudatel Sudan/South Sudan: Terrestrial fiber routes

Source: Sudatel, Annual Contents 2008, https://www.sudatel.sd/wp-content/uploads/2016/01/anrep2008.pdf.

Key gaps to be addressed. The most urgent fiber infrastructure priority in South Sudan is reestablishment of the prior Sudatel East-Central and West-Central backbone routes and a second international route, with Kenya being the most likely candidate given the availability of fiber at the Kenyan side of the border and the large ICT/content ecosystem present in Kenya. South Sudan would also benefit from the establishment of fiber to the Central African Republic and the Democratic Republic of Congo. These projects are discussed in greater detail in subsection 4.2.4.

Muya Fibre Construction has reportedly been working on the construction of a new fiber optic route along the northwestern corridor from Juba to Rumbek. However, the work was stopped in March 2021 because the Director General of the National Communication Authority decided that the quality of an aerial cable route was not acceptable and an underground route should be built.[28]

BOX 1

Optical ground wire in the Horn of Africa

Cross-sector sharing has become a component of many national and multinational broadband development policies to facilitate broadband development. The rollout of fiber networks is a very capital-intensive activity, but the electricity power network infrastructure provides an opportunity to deploy fiber networks more cost effectively than a new build, and overhead poles (more common in rural and suburban areas) are more suited to rollout that underground ducts.

Access to existing power infrastructure for fiber rollout provides a way for telcos to reduce the costs involved. A telco having access to power infrastructure through a wholesale model, joint venture, or a combination of both provides the best chance of success overall. Further analysis should be implemented to understand how the target countries in the Horn of Africa (HoA) could leverage existing power infrastructure, but some countries in Africa, such as Ethiopia, Angola, and the Democratic Republic of Congo, are already using telco companies to reduce the costs involved. In Ethiopia, for example, optical ground wire (OPGW) bandwidth is much in excess of the internal needs of the power sector, and therefore excess bandwidth is being made available for commercial use by Ethio Telecom and other internet/telecom operators.

However, not all power infrastructure is suitable for rolling out fiber networks, with overhead power networks likely to be better suited than those underground, due to availability of space. The use of power infrastructure makes more business case sense in suburban and rural areas, where overhead deployment is more widespread. According to Mason Analysis, the use of power infrastructure in rural areas can reduce rollout costs by up to 45 percent.[a]

OPGW cables, including cables on the transmission lines, are currently being implemented and designed in the HoA region (Map B1.1). The World Bank and other development partners

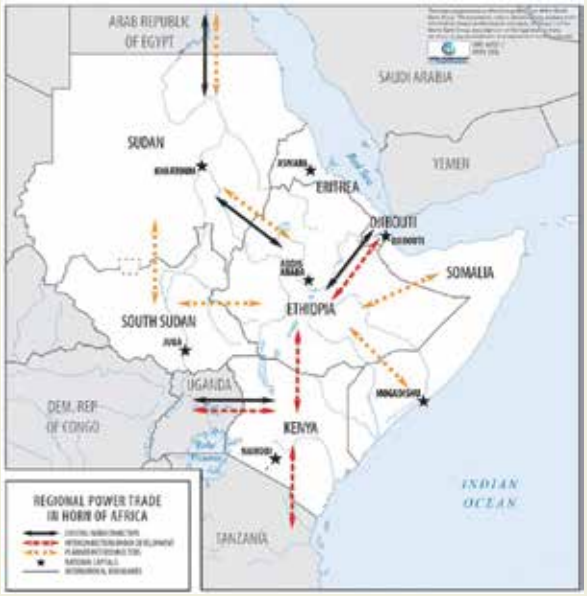
continued

BOX 1 *continued*

have a large electricity transmission investment program in the HoA countries comprising several projects. Under these projects, upcoming transmission lines would be equipped with OPGW cables and some of these additional bandwidths will be available for commercial broadband purposes:

- *The Horn of Africa Regional Integration for Sustainable Energy Supply Project* is a USD 400 million World Bank regional intervention that will provide support for (i) the construction of two 230 kilovolt (kV) transmission lines between Ethiopia and Somalia (Northern and Southern), (ii) the reinforcement of the existing Ethiopia-Sudan 230 kV double circuit transmission line, and (iii) the construction of the second Ethiopia-Sudan 500 kV transmission line. In addition, the project targets energy access interventions in borderland areas, mostly for the agri-pastoralist population. Finally, the third component will provide technical assistance and capacity building to the Eastern Africa Power Pool, its member countries, and the regional Independent Regulatory Board.
- *The Electricity Network Reinforcement and Expansion Project's* development objective is to improve reliability of the electricity network and increase access to electricity services in Ethiopia. There are four components to the project, the first component being reinforcement and expansion of the electricity network. This component consists of two subcomponents: (i) grid upgrade, and (ii) grid extension to improve the overall service delivery of the Ethiopian electricity network. The second component is access scale-up. Access scale-up includes intensification of connections to the households and villages in the areas already connected by the grid. The third component is market development for renewable energy and energy efficient products. Finally, the fourth component is modernization support.
- *The Second interconnection line Djibouti Ethiopia Transmission Project, Eastern Electricity Highway Project* is a project funded by the African Development Bank and the World Bank. The development objective is to increase power trade between Ethiopia and Djibouti and enhance regional integration in the HoA. It involves the following. (i) Construction of a 230 kV double circuit transmission line from Semera (Ethiopia) to Nagad (Djibouti). The line length is 292 kilometers (km) (102 km in Ethiopia and 190 km in Djibouti). Each circuit will have a rated power transfer capacity of 160 megawatts. (ii) Extension of the existing Semera 230 kV substation (Ethiopia) and extension of the 230/63/20 kV substation at Nagad (Djibouti). (iii) Strengthening of the existing 230 kV transmission line between Kombolcha-Mile to Semera, 170 km long, and construction of a 230 kV new substation at Mile and extension of Kombolocha and Semera's existing 230 kV substations (Ethiopia). (iv) Last-mile connection in Djibouti. (v) Technical Assistance and Capacity Building on Master Plan study and Power Trade Agreements and creating strong trading units in Ethiopian Electric Power and Electricite de Djibouti.
- *The new Regional Electricity Access and Battery-Energy Storage Technologies* project is a USD 465 million World Bank intervention to expand energy access and renewable energy integration in West Africa. The project will increase grid connections in fragile areas of the Sahel, build the capacity of the Economic Community of West African States Regional Electricity Regulatory Authority, and strengthen the West African Power Pool's network operation with battery-energy storage technology infrastructure.

MAP B1.1. Regional power trade in the Horn of Africa



Source: Horn of Africa Regional Integration for Sustainable Energy Supply Project

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Notes

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3

Market Structure Analysis

This section reviews the barriers to deployment of cross-border and fiber backbone infrastructure in the target countries. The assessment focuses on three dimensions: (i) market barriers, (ii) fragility and conflict dynamics, and (iii) regulatory barriers. It finds that a combination of these barriers is present in the target countries.

Several *market barriers* affect broadband service availability and adoption in the target countries. These include market structure conditions, such as the presence of a monopoly, that limit competition in specific market segments. The market barrier analysis also considers the relationship between income levels and service and device costs. Certain countries in the region also face *fragility and conflict dynamics,* stemming from ongoing internal armed conflicts, security concerns, and political instability. *Regulatory barriers* also present a challenge to cross-border and fiber backbone infrastructure deployment in the target countries, including licensing restrictions, regulatory fees, and institutional structure limitations.

3.1 Assessment of Market Structure

3.1.1 Income level and market structure

The target countries vary widely in terms of income level and size, which have a direct impact on investment and performance in the telecommunications sector. For example, while Djibouti is one of the smallest nations in Africa (with a population of about 988,000), Ethiopia is the second largest country in the continent (115 million) after Nigeria.[29] South Sudan and Somalia are mid-sized African countries (with populations of about 11 million and approximately 16 million, respectively).[30]

Djibouti has the highest gross domestic product (GDP) per capita among the target countries.[31] With a GDP per capita of USD 3,576,[32] Djibouti falls within the group of lower-middle-income countries.[33] All the other target countries fall within the low-income country group.[34] Despite achieving considerable economic growth over the past decade, with GDP growth of about 10 percent per year, Ethiopia is still one of the world's poorest countries.[35] The COVID-19 pandemic and ongoing internal armed conflict have slowed GDP growth significantly, to 2 percent, leading to a GDP per capita of approximately USD 940 in 2021.[36] With a GDP per capita of USD 789 in 2021,. Lastly, Somalia and South Sudan have the lowest income levels within the target countries (table 8).

The following subsections present an overview of the market structure in each of the target countries, discussing current active players and recent developments in each market.

TABLE 8. Target country population, GDP per capita, and income classification

COUNTRY	POPULATION (World Bank, 2020)	GPD PER CAPITA PPP (USD) (World Bank, 2020)	WORLD BANK INCOME CLASSIFICATION
Djibouti	998,000	5,782	Lower-middle income
Ethiopia	115 million	2,423	Low-income
Somalia	16 million	1,246	Low-income
South Sudan	11 million	1,235[a]	Low-income

Sources: TMG/APTelecom based on World Bank; International Monetary Fund.
Note: GDP = gross domestic product; PPP = purchasing power parity.
a. Based on the latest available data, 2015.

Djibouti

The Djibouti telecommunications market is still served under a monopolistic structure. This has resulted in limited availability and take-up of broadband services in the country. Djibouti Telecom, a state-owned enterprise, is currently the only fixed and mobile services provider in the country. Over the years, Djibouti Telecom has placed significant focus on leveraging Djibouti's strategic geographic location to develop as a regional hub for international connectivity and offer cross-border connectivity mainly to Ethiopia.

Starting in July 2019, the Ministry of Communications, in charge of Posts and Telecommunications initiated a liberalization process and assigned a service license to AfriFibre (a subsidiary of IIB Group Holdings) to provide internet and data services in Djibouti.[37] AfriFibre is currently deploying a fiber access network in Djibouti City. In addition, in July 2021, the Djibouti government announced plans for partially privatizing Djibouti Telecom by selling a minority stake of 40 percent of the company.[38] Despite this, a clear liberalization policy has not yet been articulated and it is unknown if additional service licenses will be assigned, particularly for the provision of mobile and cross-border services.

Ethiopia

Currently, state-owned Ethio Telecom is the sole operator of retail mobile and fixed broadband services, but this market structure is expected to shift in the short run. Starting in 2019, policy decisions to liberalize the market have resulted in the following, although the full liberalization agenda is yet to be realized:

- Adoption of a new legal and regulatory framework
- Creation of a national regulatory authority, the Ethiopian Communications Authority (ECA)
- Actions toward partial privatization of Ethio Telecom (40 percent stake)
- Opening of the sector to competition via the assignment of two new full-service licenses.

To date, one of these licenses has been awarded to Safaricom Ethiopia,[39] and the ECA relaunched the process to assign the other license in September 2021.[40] However, in December 2021, the ECA suspended the request for proposal (RFP) process for a second new full-service nationwide telecommunications license.[41] The ECA noted that several bidders requested that the procedure be postponed, and stated that it would restart the RFP process in the near future.[42] Further, in June 2021, the Ethiopian Ministry of Finance opened a public invitation to submit expressions of interest for the partial privatization of Ethio Telecomm, followed in September 2021 by an RFP for the sale of 40 percent of the company's equity share capital.[43] However, a deadline for proposals was not set, and the government has not published additional updates on the privatization process at the time of this writing.

Somalia

Despite low-income levels and persistent security challenges affecting Somalia over recent decades (see subsection 3.2.3), several operators have launched services in the market, taking advantage of the absence of a regulatory framework or licensing requirements. Over the past few years, Somalia has promulgated a National Communications Law, established a regulatory authority, and begun implementing a new regulatory framework for the telecommunications sector (see subsection 3.3.3).

The mobile market is dominated by three companies with different sub-regional footprints: Hormuud, Golis , and Telesom. Jointly, these providers serve about 62 percent of the country's mobile subscribers. From an operational standpoint, the providers interconnect their networks and services and share infrastructure, but they do not compete with each other.[44] The remaining mobile providers are smaller in scale (table 9).

This market structure has limited competition at the regional level and created potential dominant providers within their operating regions. For example, although regional data are not available, Telesom is projected to serve around 75 percent of the mobile market in the Somaliland region, and Hormuud is estimated to serve about 60 percent of the mobile market in Its own regional market segment.

TABLE 9. Somalia: Mobile connections and market share, by provider, third quarter of 2021

PROVIDER	TOTAL MOBILE CONNECTIONS	MARKET SHARE (%)	MAIN COVERAGE AREA
Hormuud	2,201,112	29.05	South-Central region
Telesom	1,918,552	25.32	Somaliland region
Somnet	768,400	10.14	South-Central region
NationLink	705,084	9.31	National
Somafone	686,574	9.06	South-Central region
Golis	606,427	8.00	Puntland region
Somtel	580,295	7.66	Somaliland region
Sahal	60,353	0.80	National
SomCable	49,848	0.66	Somaliland region

Source: TMG/APTelecom based on GSMA Intelligence.
Note: The connections and market shares presented are national aggregates. While market shares appear to be well distributed, this should be interpreted with caution as the market is regionally segmented, with little interconnection and competition.

On the fixed services side, there is limited network development in Somalia, with penetration at less than 1 percent of households. This market is also regionally segmented. In the Puntland region, Golis Somtel and Telesom provide services, while SomCable offers services in the Somaliland region. In the rest of Somalia, Hormuud and SomLink offer fixed broadband connections to residential and corporate customers. Lastly, in Mogadishu, Dalkom has deployed a cable landing station (CLS), serves as a landing party for submarine cables landing there, and has deployed a metro fiber network in and around the city.

Others have also deployed metropolitan fiber:[45]

- Hormuud has deployed fiber cables in Mogadishu (20–30 kilometers (km)) and reportedly also in Kismayo and some other cities.
- Somali Optical Network operates two fiber rings with a combined length of 115 km and is planning a third (35 km) for redundancy in Mogadishu.
- Somcast has deployed fiber within the Mogadishu International Airport compound, from the Dalkom landing station to its Network Operations Centre and on to the KM4 junction. Somcast plans to extend the fiber route from KM4 to the Bakara and Hamarweyne areas.
- Somalia Wireless and Airsom have also deployed fiber optic networks in Mogadishu.

South Sudan

In South Sudan, mobile service is currently offered by two international providers: MTN and Zain. This market structure resulted following the exit of Gemtel in 2016 (which had been operated by Green Lab of Libya) and Vivacell in 2018 (after the government shut down the former market leader for failure to pay taxes and license fees).[46] MTN is currently the market leader, with 62 percent market share (table 10). In December 2020, Digitel, a new wireless operator, entered the market; it launched commercial 2G, 3G, and 4G services in July 2021. Currently, Digitel only provides services in Juba.

South Sudan's fixed-line infrastructure was largely destroyed during the country's civil war.[47] Several small-scale players, including RCS, fastNet, Bilpam Telecommunications, IPTEC, and 4G Telecom, primarily provide fixed broadband services to nongovernmental organizations, government ministries, businesses, and banks.[48] Further, in 2019, Muya, then Liquid began building a fiber optic backbone network in South Sudan. The operating environment in South Sudan creates significant challenges for expansion of fiber infrastructure given the political instability and security concerns.

TABLE 10. South Sudan: Market share overview, third quarter of 2021

PROVIDER	TOTAL MOBILE CONNECTIONS	MARKET SHARE (%)
MTN	2,018,000	62.25
Zain	1,223,607	37.75

Source: GSMA Intelligence.

3.1.2 Availability of mobile broadband services in the target countries

Broadband service availability continues to be limited in the target countries, leading to significant coverage gaps. Although most broadband connections are mobile, 3G is still the dominant mobile technology in these countries. As shown in table 11, coverage levels vary widely between the target countries, but in all the countries, less than 50 percent of the population has access to 4G services.

Notably, Ethiopia and Djibouti, the countries with the highest income levels among the target group, have the lowest 4G coverage by population (6 and 22 percent, respectively). Lack of competition in the mobile market is likely at the root of this result, considering that Somalia, and South Sudan have already liberalized their mobile markets. In Ethiopia, the target country with lowest 4G coverage rate, low urbanization rates may also impact deployment costs. Safaricom Ethiopia plans to invest more than USD 8 billion in

TABLE 11. Mobile broadband coverage, income level, and urbanization rate, third quarter of 2021

COUNTRY	3G NETWORK COVERAGE (% of population)	4G COVERAGE (% of population)	GDP PER CAPITA PPP, 2020 (USD)	URBANIZATION RATE, 2020 (% of population)
Djibouti	77	22	5,782	78
Ethiopia	97	6	2,423	20
Somalia	77	45	1,246	46
South Sudan	66	43	1,235[a]	20

Sources: Based on GSMA Intelligence; International Monetary Fund; World Bank.
Note: GDP = gross domestic product; PPP = purchasing power parity.
a. Per the latest available year, 2015.

4G coverage over five years. Similarly, Ethio Telecom has ramped up investment in 4G coverage to position itself ahead of market entry.[49] Conversely, Djibouti's high urbanization rate would suggest lower costs to extend coverage, but Djibouti Telecom's traditional focus on cross-border connectivity rather than domestic connectivity may explain the low 4G network coverage.

Although Somalia, and South Sudan have significantly higher 4G coverage than their other peers in the Horn of Africa (HoA) region, this rate is lower than in countries such as Zambia (63 percent), Nigeria (66 percent), Kenya (97 percent), and Rwanda (99 percent).[50] These three target countries have largely rural and partially nomadic populations (ranging from about 54 to 80 percent), which impacts terrestrial network deployment costs and would benefit from consideration of different technologies to achieve expanded availability of 4G service.[51]

3.1.3 Adoption of mobile broadband services in the target countries

Mobile broadband adoption remains low in the target countries, resulting in significant usage gaps—the difference between the population that is covered by mobile broadband networks and that which accesses the internet. Although notable progress has been made over the past five years, with mobile broadband–capable connections increasing between twofold and sevenfold, the target countries still trail the regional country sample average of 52 percent penetration, as shown in figure 4.

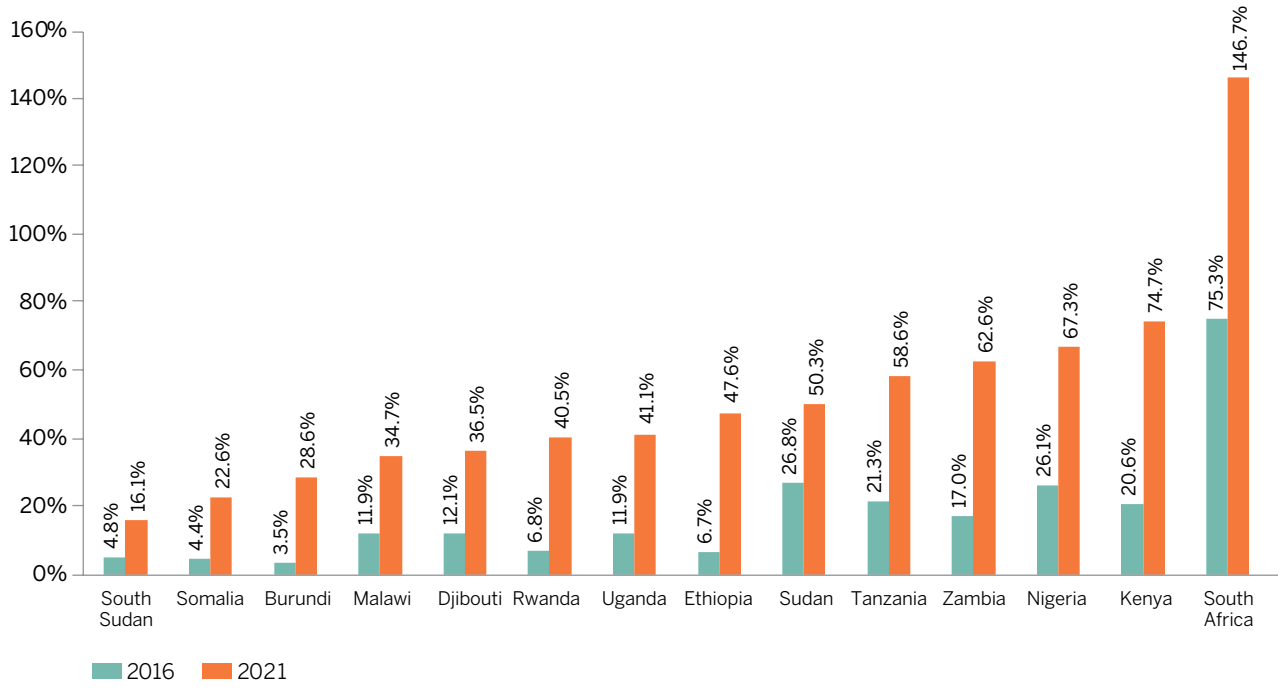
In addition, in several of the target countries, only a limited number of subscribers of broadband-capable connections own smartphones with internet capability, further reducing internet adoption rates. For instance, as shown in table 12, in Ethiopia (40 percent), South Sudan (53 percent), and Djibouti (70 percent), a limited number of subscribers of broadband-capable connections own smartphones with internet capability. Conversely, a high number of subscribers of broadband-capable connections in Somalia (89 percent)

TABLE 12. Smartphone penetration rate and unique broadband subscriptions in the target countries, third quarter of 2021

COUNTRY	SMARTPHONE OWNERSHIP (% of subscribers to broadband-capable connections)	UNIQUE MOBILE INTERNET SUBSCRIBERS (% of the population)
Djibouti	70	19
Ethiopia	40	23
Somalia	89	14
South Sudan	53	8

Source: GSMA Intelligence.

FIGURE 4. Penetration of mobile broadband–capable connections (%)



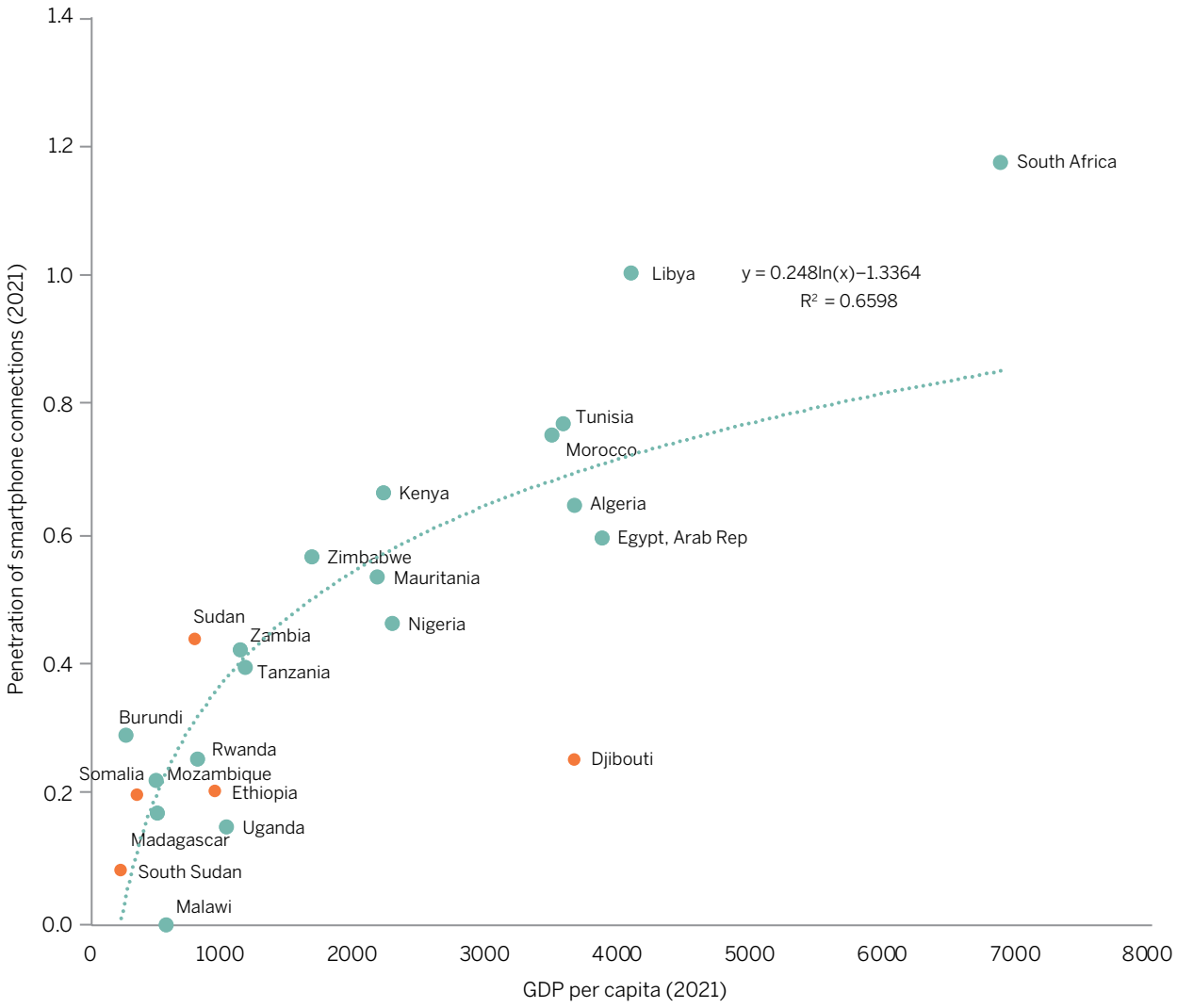
Source: TMG/APTelecom based on GSMA Intelligence.

own internet-enabled smartphones, a rate comparable to that in Kenya (90 percent). The high use of mobile money in Somalia partly accounts for the relatively high mobile phone ownership, as World Bank estimates suggest that at least 73 percent of the population over age 16 uses mobile money services. Similarly, the country's remittance-fueled economy may have also propelled mobile ownership, as phones may have been sourced by family overseas.[52]

The unique mobile internet penetration rate is even more constrained in the target countries, ranging from about 8 to 30 percent, as shown in table 12. This, in turn, leads to a significant mobile broadband usage gap, considering that 3G networks are available for 66 to 97 percent of the population in the target countries (table 11).

Low income represents a barrier to mobile broadband adoption in several of the target countries. Although the target countries have varying levels of income, with Somalia (USD 350) and South Sudan (USD 230) having among the lowest GDPs per capita in the region, they all fall within the low-income or lower-middle-income groups. As shown in figure 5, a correlation appears to exist between the rate of smartphone connections and GDP per capita within the African countries reviewed. Penetration of smartphone connections in Djibouti and Ethiopia, the two target countries with the highest

FIGURE 5. GDP per capita versus the penetration rate of smartphone connections, 2021



Source: TMG/APTelecom based on International Monetary Fund data and GSMA Intelligence.
Note: GDP = gross domestic product.

incomes, appears to be underdeveloped relative to GDP per capita, as it lies well below the correlation curve. This suggests that factors different from income, such as lack of competition and affordability, are likely driving barriers to adoption in these two countries. In Somalia, and South Sudan, part of the lag in mobile broadband and smartphone connection penetration can be explained by relative income levels. Performance in these countries sits just slightly above the correlation curve. This suggests that policies to stimulate demand, such as demand subsidies, should be considered in these two markets.

3.1.4 Adoption of fixed broadband service

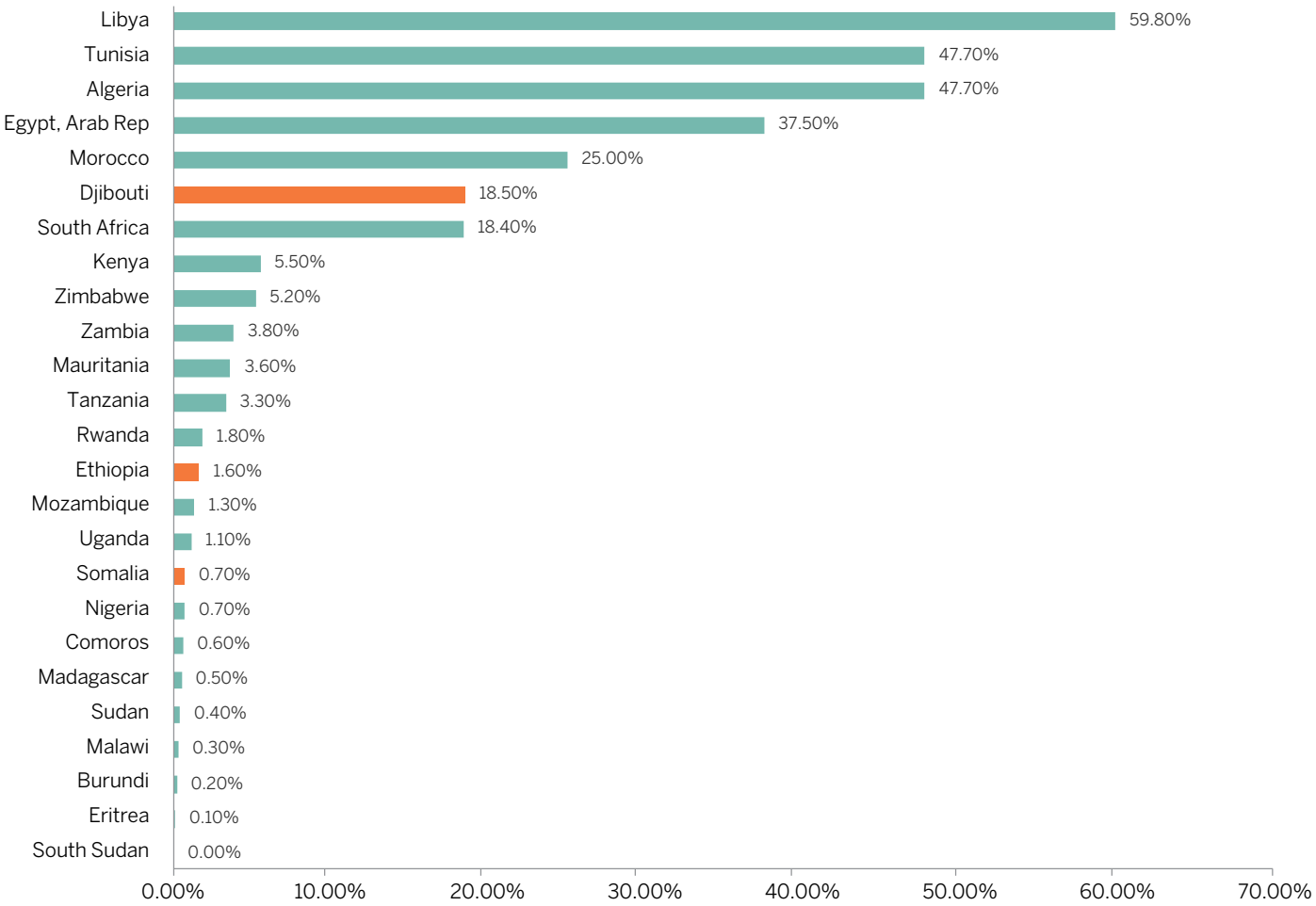
Fixed broadband connections are very limited in the target countries (figure 6). With the exception of Djibouti, where the penetration rate is relatively high, at about 19 percent, the other target countries have fixed broadband penetration well below 2 percent of households.[53] Penetration in Djibouti is comparable to that of South Africa (18.4 percent), but lower than its North African peers. In South Sudan, for example, fixed line networks are almost non-existent as legacy fixed networks were destroyed in recent armed conflicts.[54] Similarly, fixed broadband penetration is very low in Ethiopia (1.6 percent), and Somalia (0.7 percent).

3.1.5 Affordability of broadband services and devices

Service affordability

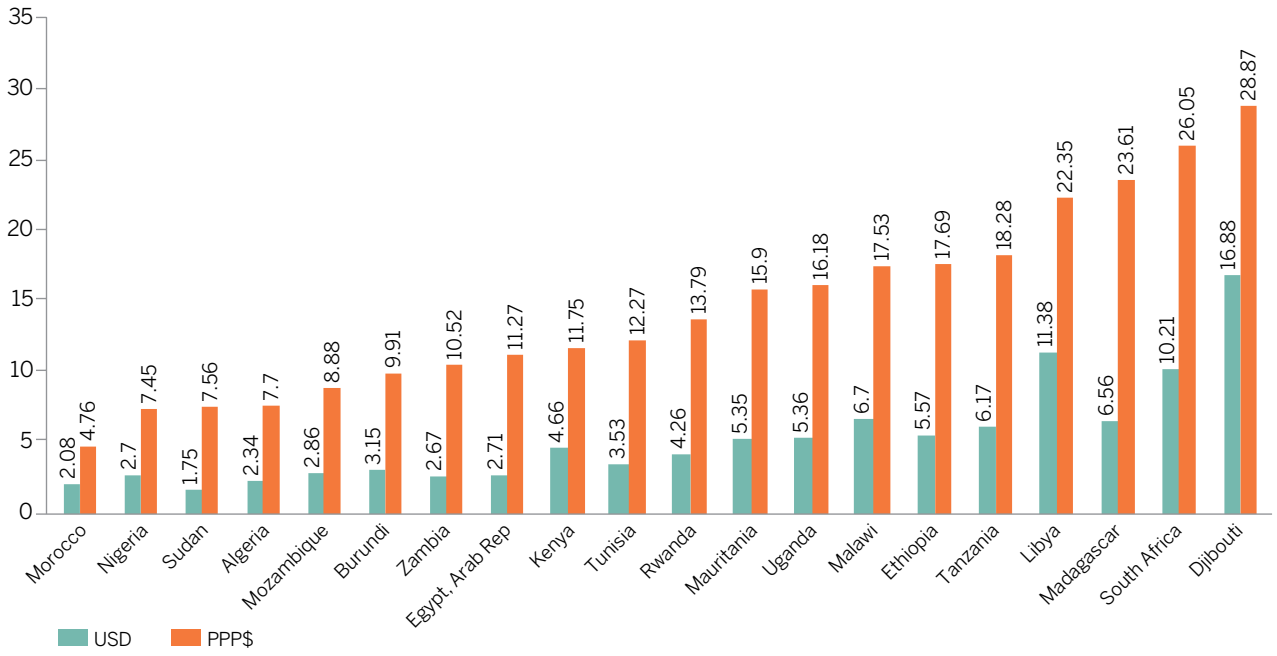
Mobile and fixed broadband services in the target countries are typically expensive and priced well above the affordability targets recommended by the International Telecommunication Union (ITU). In absolute terms, the prices of a data-only mobile broadband basket (1.5 gigabytes (GB)) in Ethiopia and Djibouti are among the highest (in USD purchasing power parity (PPP)) of the regional sample for which data are available (figure 7). This is consistent with the adoption rates observed above (figure 6), where both Djibouti and Ethiopia are underperforming considering their

FIGURE 6. Fixed broadband penetration, 2021 (% of households)



Source: TMG/APTelecom based on TeleGeography Global Comms Database: Household Penetration (2021).

FIGURE 7. Data-only mobile broadband basket (1.5 GB) prices, 2020



Source: TMG/APTelecom based on International Telecommunication Union data.
Note: GB = gigabytes; PPP = purchasing power parity.

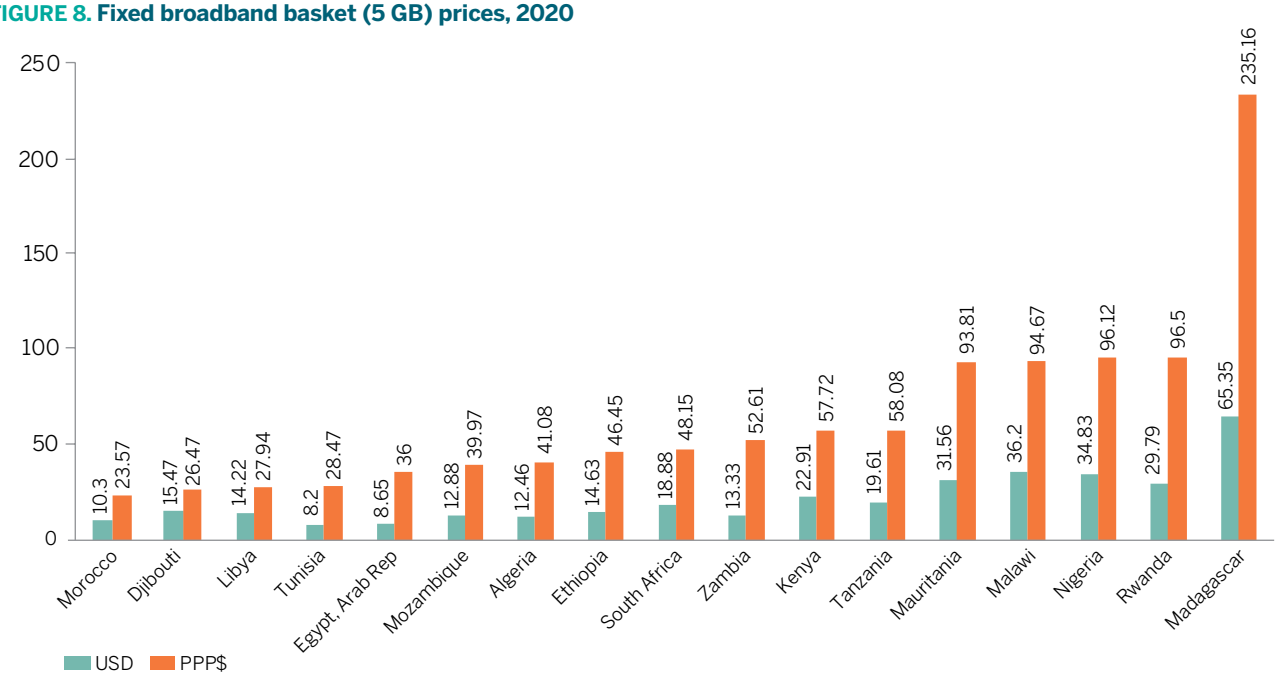
relative income levels, likely due to limited competition and high prices in the market.[55]

In the case of the entry-level fixed broadband basket (5 GB), prices in Djibouti are among the lowest in the African country sample reviewed (in USD PPP). Such low prices are consistent with the relatively high penetration of fixed broadband service in Djibouti, as shown in figure 6. Prices in Ethiopia are higher than in Djibouti, but still below most other Sub-Saharan African countries in the sample, including the largest markets: South Africa, Kenya, and Nigeria (figure 8). Penetration of fixed broadband service in Somalia, and South Sudan is almost nonexistent.

As shown in figure 9, Djibouti has the most affordable data-only mobile broadband basket (1.5 GB) prices, but these still cost more than two times the 2 percent of gross national income (GNI) per capita affordability target recommended by the ITU. In the case of Djibouti, despite having the highest absolute prices in the sample, the country's higher per capita income leads to a lower average affordability gap. In Ethiopia, data-only mobile connections are even more unaffordable, representing on average about 9.5 percent of GNI per capita. While comparable International Telecommunication Union (ITU) affordability data for Somalia and South Sudan are unavailable, the British research firm Cable ranked Somalia among the top seven countries with the world's cheapest (mobile) internet costs.[56]

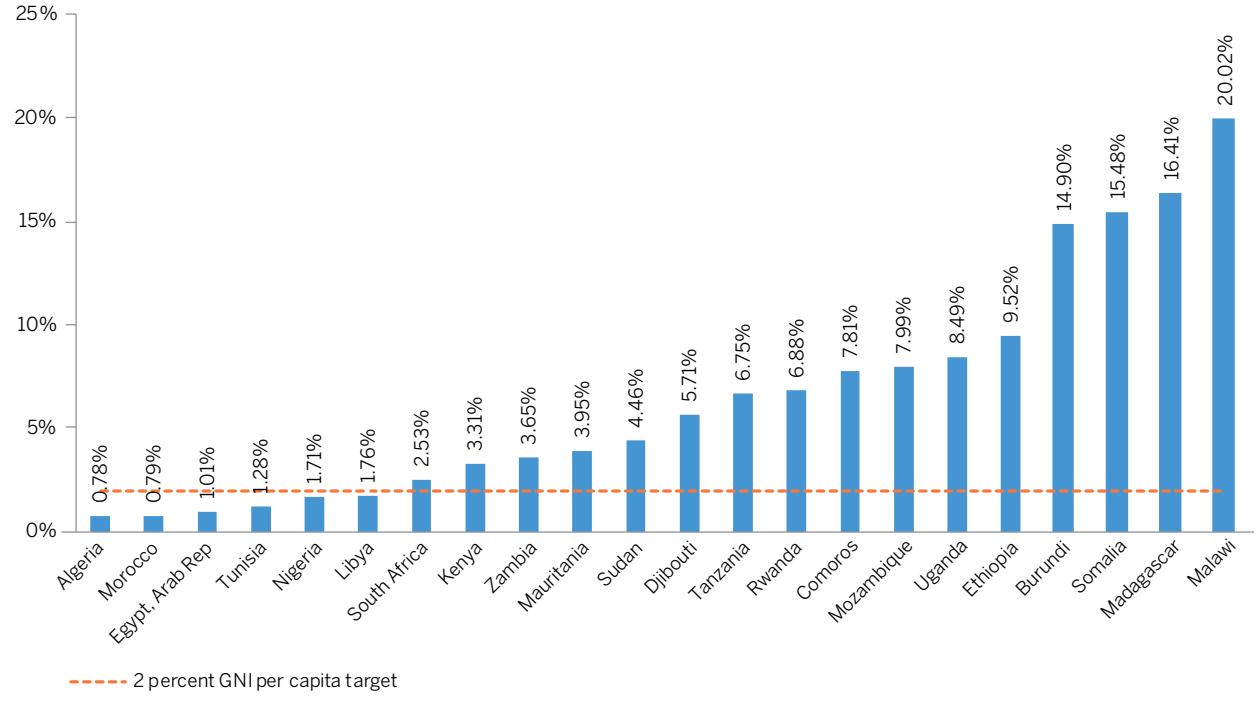
When the affordability data are further disaggregated based on household income, inequalities become even more apparent. In Djibouti, for example, for consumers in the 40 percent highest income bracket, the entry-level mobile broadband basket costs only 3.3 percent of income, compared with 14.4 percent of income for those in the bottom 40 percent income bracket.[57] According to the ITU, only 10 percent of the population in Djibouti can pay 2 percent or less of their monthly income for mobile broadband services. Similarly, the entry-level mobile broadband basket costs 5.9 percent of monthly income for Ethiopians in the 40 percent highest income bracket but 19.6 percent of monthly income for the bottom 40 percent of the population in terms of income. Not even the most affluent 10 percent of the Ethiopian population (those with the highest household consumption) pay 2 percent or less of their monthly income for mobile broadband services.[58] This indicates that high price and limited affordability also impact mobile broadband service take-up in the target countries reviewed.

FIGURE 8. Fixed broadband basket (5 GB) prices, 2020



Source: TMG/APTelecom based on International Telecommunication Union data.
Note: GB = gigabytes; PPP = purchasing power parity.

FIGURE 9. Data-only mobile broadband basket (1.5 GB) as a percent of GNI per capita, 2020



Source: TMG/APTelecom based on International Telecommunication Union and World Bank data.
Note: GB = gigabytes; GNI = gross national income.

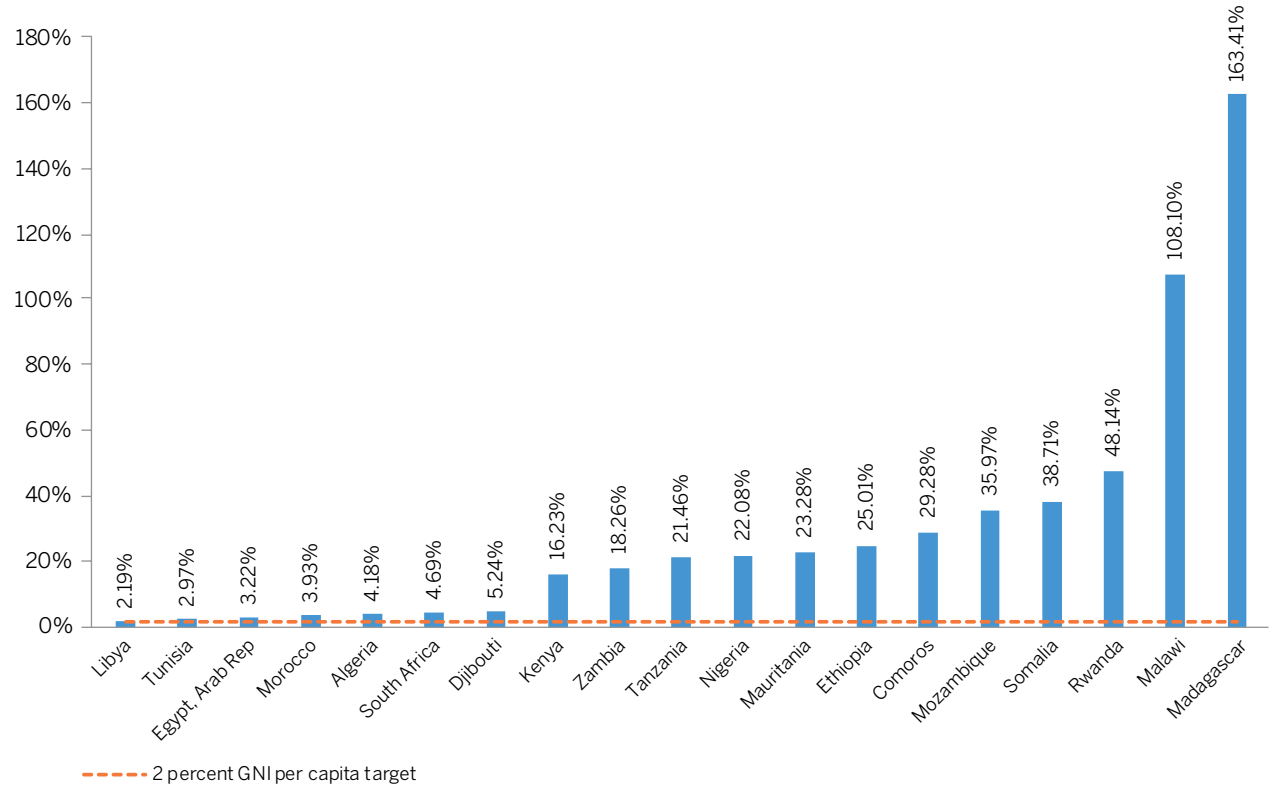
Affordability is also a key issue for fixed broadband service in the target countries. For example, as shown in figure 10, while Djibouti has the lowest fixed broadband basket (5 GB) prices among the target countries (for which data are available), at about 5 percent of per capita GNI, it is still more than double the ITU affordability target. Fixed broadband basket (5 GB) prices in Ethiopia and Somalia are much higher, at about 25 and 39 percent of GNI per capita, respectively. This affordability gap directly impacts low adoption rates of fixed broadband service. The ITU does not report fixed broadband package pricing for South Sudan, likely due to the country's extremely low fixed broadband penetration rates. For Somalia, another source states, "Sub-Saharan Africa fares worst overall with most of its 37 included countries in the most expensive half of the table. Somalia is the cheapest in the region, coming in 30th in the world, and with an average package price of USD 19.15."[59] However, being the cheapest in the region still results in the average cost equating to a very high percentage of GNI per capita.

Device affordability

Device prices also limit service adoption rates in several of the target countries. As shown in table 12, in 2021 only about 40 percent of mobile broadband subscribers in Ethiopia owned a smartphone. Although this share increases to 53 and 70 percent in South Sudan and Djibouti, respectively, it is still low compared with regional peers. This suggests a relevant gap in device affordability in these markets. To reduce this gap, for example, Djibouti Telecom has recently offered subsidies to subscribers to encourage demand, offering smartphone packages with a 24-month contract.[60] Similarly, starting in 2020, financing solutions for low-income users were launched by Ethio Telecom to facilitate smartphone adoption.[61]

By contrast, about 9 in 10 subscribers of broadband-capable connections in Somalia (89 percent) own smartphones that would allow them to connect to the internet.[62] The comparatively high

FIGURE 10. Fixed broadband basket (5 GB) as percent on GNI per capita, 2020



Source: TMG/APTelecom based International Telecommunication Union and World Bank data.
Note: GB = gigabytes; GNI = gross national income.

rate of smartphone adoption in these two countries suggests that the affordability of mobile devices is not necessarily a significant barrier to internet service adoption in these countries. Rather, the high cost of mobile broadband services seems to be the likely primary issue. Various other factors, including income level, taxation, and regulations, can also drive the high cost of broadband services in these markets.

3.1.6 Demand projections for internet bandwidth

Demand for international capacity in the target countries is expected to rise over the next 10 years, consistent with international trends. Demand is modeled through consideration of the fixed and mobile retail broadband market for the mass market, businesses, and institutions (for example, government, education, and health). However, only the high-end segment of the fixed market is considered due to the low penetration of fixed services in the target countries.

As shown in table 13, demand for total international internet traffic in the target countries will be driven by Ethiopia, followed by Somalia, mainly due to the scale of the markets.

Further, internet bandwidth consumption per user in the target countries is projected to increase by 2030 (table 14).

TABLE 13. Total international internet traffic projections (Gbps)

COUNTRY	2020	2025	2030
Djibouti	8	23	45
Ethiopia	169	1,513	3,169
Somalia	186	635	1,314
South Sudan	0	154	445

Source: World Bank data.
Note: Gbps = gigabytes per second.

TABLE 14. Demand projections for internet bandwidth per user, kbps

Country	2025	2030
Djibouti	69	99
Ethiopia	48	67
Somalia	73	103
South Sudan	38	72

Source: World Bank data.
Note: kbps = kilobits per second.

3.2 Assessment of Fragility and Conflict Dynamics: Political Security and Stability

Significant political and security challenges threaten the broader regional agenda in the HoA region and pose crucial obstacles to the expansion of broadband linkages and the digital development sector. For example, intercommunal violence and competition over shared resources threaten progress. The past few years have highlighted the confluence of these opposing dynamics. Until quite recently, the HoA appeared to be on a positive trajectory in the context of the warming of relations between Ethiopia and Eritrea in 2018, transitions in S Somalia, and encouraging economic growth and poverty reduction trends. However, events over the past year have posed a serious challenge to this progress, particularly in light of the outbreak of a major conflict and humanitarian crisis in Ethiopia, continued cross-border political tensions and security challenges, and compounding crises—including climate change and COVID-19—that have intensified underlying fragility, conflict, and violence dynamics across the HoA. Box 2 describes the Risk and Resilience Assessment for the target countries (Box 2)

3.2.1 Djibouti

Relative to its regional peers, Djibouti has remained stable despite security challenges in neighboring countries. Its neutrality toward the internal politics of belligerent faction in other countries spared the country from the exportation of armed conflict in its territory. However, the government needs to advance on transparency.[63]

The presence of a strong and consistent centralized government in Djibouti has prevented many of the stability- and security-related issues present in the other target countries. Fragility, stability, and security do not currently present significant challenges to further development of cross-border and national fiber infrastructure in Djibouti.

3.2.2 Ethiopia

Despite a series of advancements early in the administration of Prime Minister Abiy Ahmed, Ethiopia continues to face challenging times.

The primary concerns stem from conflict between the Ethiopian central government and the regional authorities in the Tigray region. This conflict arose in 2019 when the Ethiopian People's Revolutionary Democratic Front coalition and several opposition parties merged into the new Prosperity Party. The Tigray People's Liberation Front (TPLF), however, refused to join the new party.

BOX 2

Risk and Resilience Assessment in the Horn Of Africa[a]

Although the root causes of fragility across the HoA are diverse and multifaceted, the Risk and Resilience Assessment developed by the World Bank in 2021 identifies five regional drivers of fragility, grouped under three thematic areas:

1. *Intercommunal contestation over resources*

- *Driver 1.* Interethnic and religious tensions, intensified by a legacy of arbitrary borders and external interference, resulting in exclusive identity politics that limit political will for cooperation at the local, national, and regional levels and spur ethno-nationalist and secessionist movements, as well as localized, cross-border, and regional conflicts.
- *Driver 2.* Localized and cross-border competition for scarce natural resources—including access to water, pasture, and land—contributing to intercommunal tensions and violence, and exacerbated by the impacts of rapid population growth, environmental degradation, and climate change.

2. *Spillover impacts of weak state legitimacy and fractured social contracts*

- *Driver 3.* The failure of the state to establish legitimacy and effective territorial control—particularly in borderlands—resulting in the creation of expansive ungoverned spaces, the flourishing of illicit activities, and insurgent groups operating both within and across state boundaries.
- *Driver 4.* Systemic political and social marginalization of certain groups, coupled with the state's incapacity to provide sufficient economic opportunities, contributing to high levels of spatial inequality, lagging border regions, displacement, and cross-border population movements that can further reinforce intercommunal tensions.

3. *Interstate competition over control and access to regional resources*

- *Driver 5.* Geopolitical contestation among states in the region over the control of strategic resources—including fresh water, seaports, and mineral reserves—exacerbated by the continued legacies of mutual interference and mistrust, and external interference.

Although the challenges affecting the HoA are significant, the Risk and Resilience Assessment also identifies five main sources of resilience, grouped under three thematic areas, which can help mitigate shocks and offer potential entry points to promote peace, stability, and inclusive development.

1. *Social capital*

- *Source 1.* Social ties, traditional institutions, and civic engagement that help to sustain livelihoods in the absence of formal institutions, mitigate the impacts of diverse shocks, support the management and resolution of local conflicts, build social cohesion, and promote governance reforms and accountability.
- *Source 2.* Diaspora groups providing crucial economic lifelines to communities across the region through remittances, and contributing toward the strengthening of state and nonstate institutions.

2. *Evolving economic opportunities*

- -*Source 3.* Expansion and facilitation of cross-border and regional trade networks—both formal and informal—with the potential to reduce incentives for conflict, strengthen economic linkages, promote local private sector growth, and support livelihoods.
- -*Source 4.* Prospects for improving economic opportunities and service delivery, particularly in borderlands, through the expansion of infrastructure, technological innovation, digitalization, well-managed urbanization, and the growth of secondary cities.

3. *Regional integration initiatives*

- *Source 5.* Strengthening regional institutions and forums promoting policy dialogue and economic integration, addressing shared challenges and shocks, strengthening cooperation over transboundary resources, and providing platforms for conflict management and the peaceful resolution of disputes.

a. World Bank Group, 2021, "Horn of Africa Risk and Resilience Assessment."

Subsequently, the TPLF declared the central government's elections invalid due to delays caused by COVID-19, and later proceeded to conduct its own regional election processes in September 2020, which the central government declared illegal.[64]

Armed fighting between the Ethiopian National Defense Force (ENDF) and the Tigray Defense Forces (TDF) broke out in November 2020 in the northern Tigray Region, with the ENDF taking control of Tigray's capital city, Mekelle, and Prime Minister Abiy declaring the Tigray War and operation complete.[65] However, Tigray forces later recaptured Mekelle in June 2021 and advanced into other regions of Ethiopia.

The ongoing conflict has also led to an increase in sanctions and restrictions on aid financing and funding, which may affect the liberalization process in the telecommunications market. For instance, the U.S. International Development Finance Corporation delayed its USD 500 million loan to finance Safaricom Ethiopia's market entry.[66] The United States also imposed a new sanctions regime on several Ethiopian parties, resulting from the conflict, and U.S. President Biden announced plans in November 2021 to remove Ethiopia from the African Growth and Opportunity Act, an important trade program.[67]

At the time of this writing, the conflict in Ethiopia appears to have de-escalatedHowever, Ethiopia still faces ongoing military operations and numerous challenges as a result of the conflict, including a humanitarian crisis in the northern part of the country.[68]

Safaricom Ethiopia's plans for significant investment in the country over the next five years may be influenced by the government's ability to stabilize the territory and provide confidence for such long-term investments. The situation is fluid, with Safaricom's chief executive officer confirming in early November 2021 that the company maintains its plans to invest and conduct operations in Ethiopia, despite evacuating its staff from the country around that same time.[69] Safaricom has indicated that while it aims to carry out its plans as projected, it will adapt and reassess as the situation evolves.[70]

The ensuing instability in Ethiopia pose a major threat to investment and development in the country. Further, the spillover effects from the conflict threaten regional stability, creating the potential for significant disruption to investment and development in the broader HoA and East Africa regions. An inability to address these concerns promptly will likely push Ethiopia, and the region, beyond the risk tolerance of potential investors and may present new obstacles in the form of increased sanctions and restrictions on aid and/or funding.

3.2.3 Somalia

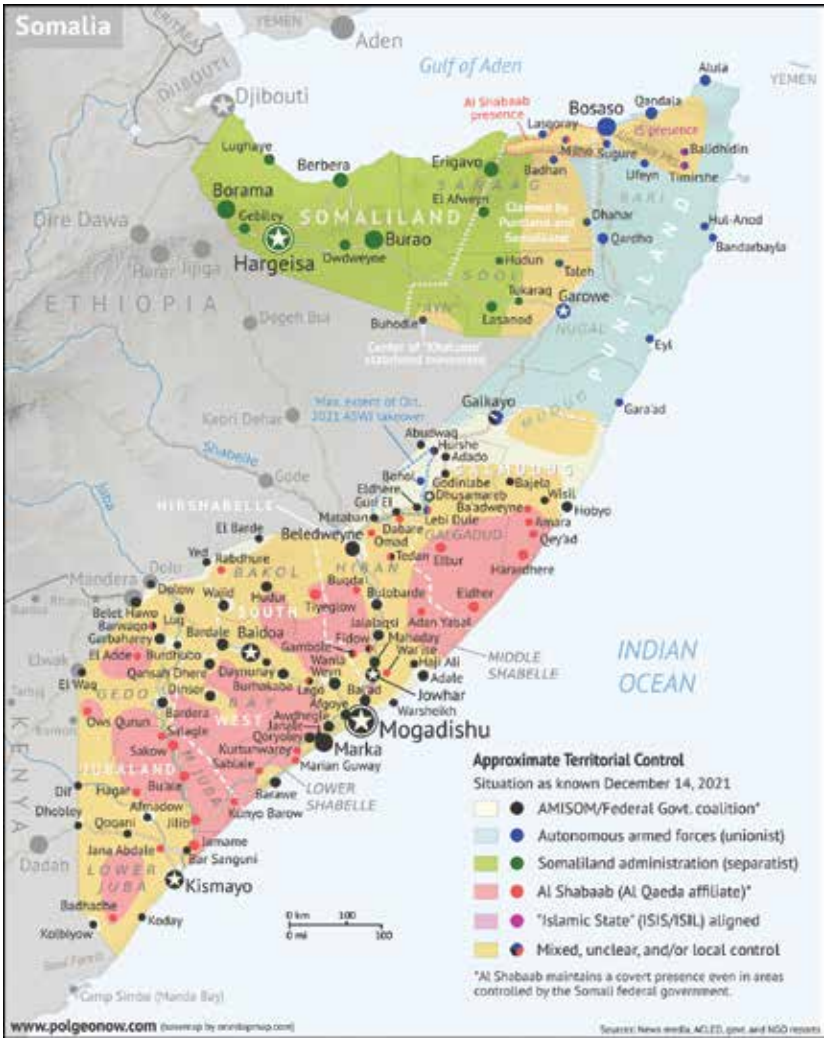
The political stability and security situation has been a significant and long-standing concern in Somalia, which has resulted in limited capacity and territorial control by the Federal Government of Somalia.

Among the most significant issues is the lack of a political compact with authority over the entire Somali territory. Although Somalia is comprised of a federal government, Federal Member States and Somaliland, several governments operate somewhat in parallel for sectoral engagement.In particular, Somaliland operates as a de facto sovereign state, having declared independence from Somalia in 1991. As such, Somaliland has agovernment and legislature, adheres to its own legislation, and operates under the jurisdiction of separate regulatory authorities. Unlike Somaliland, Puntland does not seek international recognition as an independent state, despite having declared autonomy in 1998 and maintaining a regional government. Instead, Puntland has sought to remain a part of Federal Somalia, along with the states of , Galmudug, Hirshabelle, Jubaland, and South West.[71]

Further, Somalia has long been plagued by violence involving radical and terrorist groups, conflict between such groups and government troops, and clan-related violence. The terrorist group Al Shabaab has retreated from most of the major Somali cities since 2015, but remains active and carries out attacks, claiming responsibility for significant attacks in Mogadishu as recently as November 25, 2021.[72] Although Al-Shabaab has been largely prevented from expanding territorial control in recent years, it continues to pose a significant threat). This points to the strong influence that Al-Shabaab maintains in large swaths of the country and the challenge to government institutions to establish territorial control and foster a strong and sustainable state-citizen social contract.

The electoral impasse over the past year has further intensified the fragility dynamics, which have at times escalated into outbreaks of conflict and violence, threatening to reverse some of the hard-won political and development progress made over the past few years. These dynamics have deterred private sector investment in Somalia due to the fragile political context and ongoing conflict.

MAP 21. Somalia: Approximate territorial control as of April 30, 2021



Source: Political Geography Now (December 2021), https://www.polgeonow.com/2021/12/who-controls-somalia-crisis-timeline.html.

3.2.4 South Sudan

South Sudan gained independence via referendum in July 2011, marking the fulfillment of a 2005 peace agreement between Sudan and South Sudan, which was reached after a decades-long civil war. However, South Sudan has remained unstable and volatile since gaining independence, with significant internal ethnic violence and clan-based conflict.[73] Further, shortly following their split, Sudan and South Sudan engaged in armed conflict in 2012 over disputes related to the oil-rich Abyei region, although a peace deal was reached, and a demilitarized zone was established in 2012.

A civil war erupted in 2013 when President Salva Kiir removed the cabinet and accused Vice President Riek Machar of planning a failed coup. This resulted in thousands of deaths, the displacement of more than 2 million South Sudanese people, as well as economic collapse, further poverty, and famine.[74] Ultimately, in 2018, a power-sharing agreement between President Kiir and Vice President Machar ended the civil war.[75] The new government assumed power in February 2020. South Sudan's political stability will face a significant test during its next election cycle. Although the elections are scheduled for 2022, they are expected to face possible delays.

Although the peace deal remains in effect, it and the new coalition government are viewed as very fragile. Further, significant issues remain, related to community-based violence, and political and military leaders have exacerbated conflicts by supplying weapons and equipment to community militias.[76] The government has also attempted to restrict free speech and access to information, aggravating existing tensions.[77]

As a consequence, South Sudan remains highly unstable and the country is currently beyond the risk appetite of many potential foreign investors. In addition, security concerns due to sporadic community militia-based violence, government corruption, and a lack of confidence in the security of investments due to the history of government instability may limit investment in the South Sudanese telecommunications market. Increased investment needs to be underpinned by internal stability, ensuring transparency of government actions and minimizing the prevalence and frequency of violent conflict.

3.3 Assessment of Regulatory Barriers to the Deployment of Cross-Border Digital Infrastructure

This subsection reviews the regulatory barriers in the target countries, focusing on the key links in the cross-border digital infrastructure value chain: (i) submarine cable wet plant deployment, (ii) CLS deployment and cable landings, (iii) national fiber backbone deployment, and (iv) international gateway deployment. As a preliminary issue, the creation of sector regulatory frameworks and national regulatory authorities in the target countries is very recent. Ensuring an independent, efficient, accountable, and technically capable regulatory authority will be a critical factor for successful implementation of reforms or regulations to address the barriers identified in the following subsections. Continued proj-

ects to establish and support national regulators' technical and enforcement capabilities are critical to ensure the credibility and success of these processes and avoid industry capture. This will be especially relevant if mandated or regulated wholesale access solutions are favored in some of the target countries (for example, Djibouti and Ethiopia). However, the process of building capacity is a long-term endeavor and should be supplemented by continued external support from development finance institutions. As institutional capabilities are developed, incentive-based regulations to foster voluntary sharing and access agreements should be seen as an effective lever to address the identified regulatory barriers and promote policies to expand cross-border and national fiber optic backbones in these countries.[78]

3.3.1 Djibouti

Each of the key links in the cross-border digital infrastructure value chain in Djibouti presents several potential regulatory barriers to private investment. The assessment below finds barriers that mainly affect CLSs, national fiber backbones, and international gateway deployments, mostly related to restrictions on licenses. In addition, the absence of policies to promote infrastructure sharing and lack of coordination and certainty of processes to secure rights of way have caused delays in deploying competing fiber networks in Djibouti. A summary of the regulatory barriers in Djibouti is presented in table 15.

TABLE 15. Regulatory barriers assessment: Djibouti

	BACKGROUND	REGULATORY BARRIERS ASSESSMENT	
Submarine Cable deployment (wet plant)	Landing cables in Djibouti is a streamlined process.	Permitting	No specific barriers identified. Landing party agreements with Djibouti Telecom required for deployment. Specific licensing and other permitting requirements (if any) were not clearly identified.
Cable landing station deployment	Djibouti Telecom has deployed two CLSs in Djibouti City: (i) YAC CLS and (ii) Haramous CLS.	Licensing	Djibouti Telecom is the only company licensed to deploy CLSs in Djibouti. However, Djibouti Telecom's exclusivity may be lifted by a decree issued by the Council of Ministers should the government adopt a policy to allow competing CLS providers in the market.[a]
		Open access	Open access framework not adopted.
		Regulatory fees	No information on regulatory fees is available.
National fiber backbone deployment	Djibouti Telecom has deployed national fiber backbone in the southern part of the country, but gaps persist in the north. A second service provider, AfriFibre, was licensed and plans to deploy fiber infrastructure connecting Djibouti City with the Ethiopian border.	Licensing	Further clarity on license rights and liberalization policy is required. In July 2019, MCPT assigned AfriFibre a license to offer internet and data services and construct fiber infrastructure.[b] But the government has not issued a liberalization policy or indicated whether additional licenses will be assigned. In addition, while the actual text of AfriFibre's license is not publicly available, a lack of clarity exists between the provider and certain government entities as to the scope of the licensed services and networks, creating challenges and delaying rollout.[c] The creation of the Djiboutian Agency for the Regulation of Telecommunications (*Agence Djiboutienne de Régulation des Telecommunications,* ADRT) in 2020 and the recent appointment of its General Director in July 2021 are steps that may address some of these issues and provide more clarity as to the scope of the liberalization policy.[d]
		Infrastructure sharing and wholesale access obligations	No network infrastructure sharing and access policy or regulation was identified. Djibouti Telecom continues to operate as the monopoly provider of fixed and mobile services, while AfriFibre is currently rolling out fiber in Djibouti City and expected to launch service in the fourth quarter of 2021. AfriFibre has yet to deploy a fiber link to the Ethiopian border. ***Recommendation:*** *To ensure that competing fiber infrastructure and services are deployed, competitors should be able to share and have access to active and passive infrastructure held by Djibouti Telecom at reasonable terms and cost-oriented rates.*
		Rights of way	Rights of way to deploy fiber need to be defined. Uncertainty in relation to the process and building standards as well as a lack of coordination between government entities (Road Authority (ADR), municipal government, and the electricity company) have delayed AfriFibre's network rollout. ***Recommendation:*** *The MCPT and the newly established ADRT should consider actions to raise awareness of competing providers' rights to deploy fiber networks and mechanisms to coordinate rights of way with other relevant government agencies (for example, instituting a single window policy for permitting).*
		Regulatory fees	No information on regulatory fees is available.

TABLE 15, *continued*

	BACKGROUND	REGULATORY BARRIERS ASSESSMENT	
International gateway service	Djibouti Telecom has deployed international gateways and cross-border links connecting Djibouti with Ethiopia and Somalia.	Licensing	Djibouti Telecom is the only company licensed to deploy an international gateway in Djibouti. All international traffic must be routed to Djibouti Telecom. However, the government may lift Djibouti Telecom's exclusivity via a decree adopted by the Council of Ministers.
		Regulatory fees	No information on regulatory fees is available.

Source: TMG/APTelecom.
Note: ADR = Djibouti Roads Agency; ADRT = Agency for the Regulation of Telecommunications; CLS = cable landing station; MCPT = Ministry of Communication, Post, and Telecommunication.
a. Loi n°80/AN/04/5ème L Portant Réforme du Secteur des Technologies de l'Information et de la Communication, art. 68, https://www.presidence.dj/PresidenceOld/LES%20TEXTES/loi80an04.htm.
b. Décret N° 2019-172/PR/MCPT portant approbation de l'attribution d'une licence pour la fourniture de service internet data, https://www.presidence.dj/texte.php?ID=2019-172&ID2=2019-07-17&ID3=D%E9cret&ID4=14&ID5=2019-07-31&ID6=n.
c. Efforts to obtain a copy of AfriFibre's license were unsuccessful.
d. Loi n°80/AN/04/5ème L Portant Réforme du Secteur des Technologies de l'Information et de la Communication, https://www.presidence.dj/texte.php?ID=74&ID2=2020-02-13&ID3=Loi&ID4=3&ID5=2020-02-13&ID6=n; Decree No. 162 / PRE appointing a Director General of the Multisectoral Regulatory Authority of Djibouti (ARMD), https://www.presidence.dj/texte.php?ID=162&ID2=2021-07-13&ID3=D%E9cret&ID4=13&ID5=2021-07-15&ID6=n.

3.2.2 Ethiopia

Several regulatory barriers to private investment affect the cross-border digital infrastructure value chain in Ethiopia.[79] As Ethiopia is a landlocked country, the assessment focuses on barriers affecting national fiber backbone deployment and international gateways. These barriers include, for example, licensing restrictions that may limit entry. Similarly, policies to promote infrastructure sharing and effective processes to access rights of way will be necessary to facilitate fiber deployments going forward. A summary of the regulatory barriers in Ethiopia is presented in table 16.

3.2.3 Somalia

This subsection reviews regulatory barriers to private investment in each of the links of the cross-border digital infrastructure value chain separately in Somalia and the Somaliland region. This takes account of the existing separate legal, regulatory, and institutional framework governing Somaliland.

In Somalia, the 2017 creation of the National Communications Authority (NCA), the adoption of regulations beginning in 2020, and the 2020–21 assignment of licenses to preexisting providers can help lower regulatory barriers. This will depend on effective implementation of the new framework and the institutional capacity of the NCA to oversee the market. However, certain regulatory fees set by the NCA seem excessive compared with neighboring countries with deeper and more competitive markets, such as Kenya. This may limit entry of new service providers (foreign or domestic) into the Somali market. A summary of the regulatory barriers in Somalia is presented in table 17.

In the Somaliland region, the termination of SomCable's monopoly in 2020 lifted the key preexisting regulatory barrier to deployment of backbone fiber networks as well as CLSs and international gateways. However, policies to promote infrastructure sharing and effective processes to access rights of way may facilitate fiber deployment going forward. A summary of the regulatory barriers in Somaliland is presented in table 18.

3.3.4. South Sudan

Regulatory barriers to private investment affect the cross-border digital infrastructure value chain in South Sudan. As a landlocked country, the assessment focuses on barriers affecting national fiber backbone deployment and international gateways. Licensing limits do not allow infrastructure deployment. Similarly, policies to promote infrastructure sharing and effective processes may facilitate fiber deployment going forward. A summary of the regulatory barriers in South Sudan is presented in table 19.

TABLE 16. Regulatory barriers assessment: Ethiopia

	BACKGROUND	REGULATORY BARRIERS ASSESSMENT	
Submarine cable deployment (wet plant)	Not applicable as Ethiopia is a landlocked country.		
Cable landing station deployment	Not applicable as Ethiopia is a landlocked country.		
National fiber backbone deployment	Ethio Telecom has deployed an extensive national fiber backbone in Ethiopia. No effective commercially negotiated (voluntary) infrastructure sharing between Ethio Telecom and Safaricom Ethiopia has been achieved to date.	Licensing	Limits on the number of licenses to be awarded for deployment of national fiber backbone networks. Under the Telecommunications Licensing Directive, rollout of fiber backbone networks (in addition to other networks) is subject to also obtaining a unified telecommunications service license.[a] The two-license requirement limits potential investment in, and deployment of, competing national or subnational fiber backbone infrastructure (targeting specific underserved or unserved geographic areas, including borderland areas) or the provision of wholesale services by other potential entrants (such as regional fiber backbone specialists). ***Recommendation:*** *The ECA should consider implementing a new license category to allow deployment of competing fiber infrastructure and the provision of wholesale infrastructure services.*
		Infrastructure sharing and wholesale access regulation	ECA adopted the Telecommunications Infrastructure Sharing and Collocation Directive (TISD).[b] It regulates access to passive infrastructure such as ducts, poles, masts, trenches, and dark fiber[c] and active infrastructure, including wholesale leased circuits and IP transit services.[d] ***Recommendation:*** *Implementation of an effective infrastructure-sharing and access regulatory framework is required. Considering the lack of voluntary sharing, ECA should begin implementing the TISD by assessing competition in key wholesale markets, identifying providers with significant market power, and imposing wholesale obligations, including adoption of a Reference Infrastructure Sharing Offer.[e] This will require significant capacity and credibility in the institutional framework in Ethiopia.* *In parallel, the ECA and the national government should consider fostering conditions conducive to operators reaching voluntary sharing agreements where viable as these may be more efficient than mandated wholesale access requirements.*
		Rights of way	The current law recognizes service providers' right to access land and buildings and the TISD identifies rights of way as a type of passive infrastructure that is susceptible to sharing, but further clarity is still needed in terms of process, coordination with different government agencies, and pricing.[f] In addition, key challenges identified for fiber backbone infrastructure deployment are concerns from ongoing internal conflict in the country. ***Recommendation:*** *A clear framework for access to rights of way is needed for fiber infrastructure deployment.*
		Regulatory fees	No information on regulatory fees is available.
		Licensing	A stand-alone international gateway license has been created, but it is not classified as a class or an individual license.[g] This omission creates uncertainty about the process and requirements to obtain such licenses. Notably, international gateways may be deployed under the unified telecommunications service license. Accordingly, Safaricom Ethiopia and the second entrant (once and if selected) will be licensed to deploy this service. ***Recommendation:*** *Further clarification of the licensing is framework required. To promote cross-border services, the ECA should increase regulatory certainty by defining international gateway licenses as a class license to make such licenses available in the market.*
		Regulatory fees	No information on regulatory fees is available.

Source: TMG/APTelecom.
Note: ECA = Ethiopian Communications Authority; IP = Internet Protocol; TISD = Telecommunications Infrastructure Sharing and Collocation Directive.
a. Telecommunications Licensing Directive N 792/2021 (July 9, 2021), https://eca-ethiopia.com/wp-content/uploads/2021/07/Telecommunications-Licencing-Directive-No.-792-2021-English.pdf.
b. Telecommunications Infrastructure Sharing and Collocation Directive No. 793/2021 (July 9, 2021), https://eca-ethiopia.com/wp-content/uploads/2021/07/Telecommunications-Infrastructure-Sharing-and-Collocation-Directive-No.-793-2021English-1.pdf.
c. TISD, Annex A, art. 2 (a), (b) and (c) and Annex B, art. 1 (c), (d), and (f).

TABLE 16, *continued*

d. TISD, Annex A, art. 3(a).
e. TISD, art. 14.
f. Communications Service Proclamation No. 1148/2019 (August 12, 2019), art. 32, https://eca-ethiopia.com/wp-content/uploads/2019/10/Communications-Service-Proclamation-No.-1148-2019.pdf; TISD, Annex B, (1)(a).
g. An international gateway license allows "the provision of international voice, internet and data services or international transmission capacity through microwave, submarine cables/fiber, terrestrial cables/fiber or satellites, and for voice services using IP connectivity to deliver Voice over Internet Protocol (VoIP) services." (Telecommunications Licensing Directive, art. 2(14)) International gateway licenses are not included in appendix A or B of the TDL, which cover individual and class licenses, respectively.

TABLE 17. Regulatory barriers assessment: Somalia

	BACKGROUND	REGULATORY BARRIERS ASSESSMENT	
Submarine cable deployment (wet plant)	Obtaining permitting for deploying wet plant and landing cables is relatively straightforward in Somalia, provided a local partner is identified.	Permitting	No specific regulatory barriers identified. Specific licensing and other permitting requirements (if any) were not clearly identified.
Cable landing station deployment	Two CLSs operational: Dalkom in Mogadishu and Golis in Bosaso.	Licensing	Licensing framework in place. Two different licenses allow deployment of CLS: (i) the International Communications Infrastructure Provider (ICIP) license and (ii) the Communications Infrastructure and Services Provider (CISP) license, which is a unified license covering multiple networks/services, including CLSs. NCA has assigned Golis a CISP license and Dalkom an ICIP license.[a] No explicit or formal restrictions exist on the number of licenses to be assigned.
		Open access	Open access framework adopted. Standard ICIP license template provides for open access to CLS facilities for purpose of colocation.[b]
		Regulatory fees	High licensing fees for a market the size of Somalia. NCA has set licensing fees that likely may result in entry barriers to new providers.[c] For the ICIP license, these include i. Application fee of USD 5,000 ii. Initial operating fee of USD 100,000 iii. Annual fee of USD 50,000. For the CISP license, these include iv. Application fee of USD 10,000 v. Initial operating fee of USD 2,500,000 vi. Annual fee of USD 50,000. Notably, existing providers (Dalkom and Golis) were not subject to the same application and initial fees that apply to new licensees, thereby creating regulatory asymmetries. ***Recommendation:*** *Further review of the fee framework should be undertaken to ensure that it does not become a barrier to entry into the market.*
National fiber backbone deployment	There is no national fiber backbone in Somalia, although there is limited fiber in the Mogadishu area and in the Somaliland region. Golis has deployed certain routes in Puntland, Considerable gaps remain in the rest of the country. Key challenges identified are mainly associated with security concerns.	Licensing	Licensing framework in place. Two different licenses allow deployment of national fiber backbone infrastructure: (i) NCIP license (which covers network deployment and wholesale services) and (ii) CISP license (which supports network deployment and retail/wholesale services). NCA has assigned CISP licenses to legacy providers Hormuud, Golis, Telesom, NationLink, Somtel, Amtel, and Somlink.[d] No NCIP licenses have been assigned to date. No explicit or formal restrictions on the number of licenses to be assigned.

TABLE 17, *continued*

	BACKGROUND	REGULATORY BARRIERS ASSESSMENT	
		Interconnection and access	Network interconnection has historically been a challenge in Somalia. As the market developed organically, in an unregulated environment, interconnection among networks was not uniform. To address this, the National Communications Law set forth the obligation to interconnect networks and grants the NCA power to set interconnection terms and conditions if the parties are unable to reach an agreement.[e] NCA held a public consultation on implementing regulations, procedures, and a reference interconnection offer from June to August 2021. This proposed framework provides NCA further tools to implement interconnection between networks. Currently, only Golis, Hormuud, and Telesom (all part of the same conglomerate) are interconnected. Interconnection with Somtel is pending. Considering existing backbone fiber in Somalia (Puntland) and Somaliland and the additional deployments identified in subsection 4.2.3, interconnection and interoperability will be critical to ensure a national backbone and avoid unnecessary duplication of infrastructure. This will require significant institutional capacity and convening/coordination powers by NCA and the federal government.
		Rights of way	Access to rights of way was not identified as a key barrier to fiber backbone deployment. While current law recognizes licensed providers' rights to access public and private property/land, implementing regulations and potential coordination between government entities (for example, NCA, Road Authority, and Security Agencies) may be required in the future.[f] The key challenges identified for deployment of fiber backbone infrastructure are security concerns, coordination/negotiation with tribal groups, and multiple local regulatory fees.
		Regulatory fees	High licensing fees for a market the size of Somalia. NCA has set licensing fees that likely may result in entry barriers to new providers.[g] Existing providers (Hormuud, Golis, Telesom, NationLink, Somtel, Amtel, and Somlink) were not subject to the same application and initial fees as new entrants, creating regulatory asymmetries. ***Recommendation:*** *Further review of the fee framework should be undertaken to ensure that it does not become a barrier to entry into the market.*
International gateway service	Several providers have deployed international gateways and cross-border links connecting Somalia with neighboring countries and to connect to existing submarine cables.	Licensing	Licensing framework in place. Two different licenses allow deployment of international gateways: (i) the ICIP license and (ii) the CISP license. NCA has assigned an ICIP license to Dalkom and CISP licenses to legacy providers Hormuud, Golis, Telesom, NationLink, Somtel, Amtel, and Somlink.[h] No explicit or formal restrictions on the number of licenses to be assigned.
		Regulatory fees	High licensing fees for a market the size of Somalia. NCA has set licensing fees that likely may result in entry barriers to new providers.[i] Existing providers (Hormuud, Golis, Telesom, NationLink, Somtel, Amtel, and Somlink) were not subject to the same application and initial fees as new entrants. ***Recommendation:*** *Further review of the fee framework should be undertaken to ensure that it does not become a barrier to entry into the market.*

Source: TMG/APTelecom.
Note: CISP = Communications Infrastructure and Services Provider; CLS = cable landing station; ICIP = International Communications Infrastructure Provider; NCA = National Communications Authority; NCIP = National Communications Infrastructure Provider.
a. See https://nca.gov.so/licensed-operators/. The texts of the licenses assigned to service providers are not publicly available.
b. NCA, ICIP license template, sections 13 and 15, https://nca.gov.so/wp-content/uploads/2021/07/International-Communications-Infrastructure-Provider-License-Template.pdf.
c. NCA, Unified Licensing Framework – Categories, Fees, Duration (August 2021), https://nca.gov.so/wp-content/uploads/2021/06/FEE-STRUCTURE-ULF-BV-Final-2021.pdf.
d. See https://nca.gov.so/licensed-operators/. The texts of the licenses assigned to service providers are not publicly available.
e. National Communications Law, art. 50.
f. National Communications Law, art. 60.
g. NCA, Unified Licensing Framework – Categories, Fees, Duration (August 2021), https://nca.gov.so/wp-content/uploads/2021/06/FEE-STRUCTURE-ULF-BV-Final-2021.pdf.
For refence, in Kenya license application fees are set at around USD 44 for all services licenses, while initial fees for Tier 1 licenses (comparable to national communications infrastructure and service licenses in Somalia) are set at around USD 132,500. See Communications Authority, Telecommunications Market Structure Under the Unified Licensing Framework (January 2016), https://www.ca.go.ke/wp-content/uploads/2018/03/New-Market-Structure-Under-The-Unified-Licensing-Framework-January-2016.pdf. Initial fees for the deployment of a national fiber backbone network in Somalia are thus between two and 19 times higher than in Kenya (depending on whether retail services will be provided) despite the fact that the addressable market is much smaller.
h. See https://nca.gov.so/licensed-operators/. The texts of the licenses assigned to service providers are not publicly available.
i. NCA, Unified Licensing Framework—Categories, Fees, Duration (August 2021), https://nca.gov.so/wp-content/uploads/2021/06/FEE-STRUCTURE-ULF-BV-Final-2021.pdf.

TABLE 18. Regulatory barriers assessment: Somaliland

	BACKGROUND	REGULATORY BARRIERS ASSESSMENT	
Submarine cable deployment (wet plant)	Prior challenges for deploying wet plant and landing cables in the Somaliland region are no longer in place and permitting is available provided a local partner is identified.	Permitting	Permitting requirements to land a submarine cable in Berbera are not clearly defined and, in the past, have been tied to reaching agreements with SomCable as a landing party. This blocked the landing of the Gulf2Africa (G2A) and DARE1 cables in Berbera in the past. SomCable's monopoly for fiber deployment in Somaliland was lifted in 2020 and this may facilitate the process of landing cables in the future. The Ministry of Information and Communication Technology (MICT) announced it would adopt Submarine Cable Regulations by August 2021, but these have not been released as of this writing.[a] Implementing an effective regulatory framework may facilitate additional submarine cable systems landing in Berbera as an alternative to Djibouti in the future. ***Recommendation:*** *A clear framework to secure permits to land submarine cables in Berbera should be implemented. This may be achieved via the announced Submarine Cable Regulations.*
Cable landing station (CLS) deployment	One CLS awaiting cable landings deployed by SomCable in Berbera.	Licensing	Limitations on CLS licensing have been formally lifted. SomCable's prior legal monopoly was withdrawn in early 2020.[b] Deployment of CLS is subject to a general license, but no specific licensing framework or regulations have been adopted to date.[c] MICT announced it would adopt Submarine Cable Regulations, but these are still pending. Information on the specific licenses assigned to deploy CLSs is not available. ***Recommendation:*** *A clear framework to secure permits to deploy CLSs in Berbera should be implemented. This may be achieved via the announced Submarine Cable Regulations.*
		Open access	Open access framework not adopted.
		Regulatory fees	No information on regulatory fees is available.
National fiber backbone deployment	There is significant fiber backbone infrastructure in the Somaliland region deployed by SomCable. Since 2020, Somtel and Telesom have reportedly also begun laying or are planning to lay fiber infrastructure.	Licensing	Licensing restrictions on fiber deployment lifted. SomCable no longer holds a monopoly for fiber deployments in Somaliland. Somtel and Telesom have presently secured relevant licenses and are currently deploying or planning to deploy fiber infrastructure in Somaliland.
		Interconnection and access	Network interconnection between the main service providers has not been achieved in Somaliland. Several efforts to promote interconnection have been advanced by the government over the years, but these have not been effective. Unusually, a review of the Post and Telecommunications Act of 2020 found that this legislation does not include specific provisions governing network interconnection. Despite this, the MICT has set a target of 2022–23 to adopt and implement Interconnection Regulations and ensure that all service providers have entered into interconnection agreements in Somaliland.[d] An effective network interconnection/access framework will facilitate the rollout of a national fiber backbone, particularly if the objective is to leverage existing fiber between Somalia and the Somalilandregion. This will require significant institutional capacity and convening/coordination power on the part of the MCIT and the federal government.
		Rights of way	Access to rights of way was not identified as a key barrier to fiber backbone deployment in Somaliland. Current law recognizes licensed providers' rights to access public and private property/land.e The key challenges identified for deployment of fiber backbone infrastructure are security concerns and coordination/negotiation with tribal groups to raise awareness of the benefits of fiber deployment and assuage concerns and distrust of government.
		Regulatory fees	No information on regulatory fees is available.
International gateway service	SomCable has deployed international gateways and cross-border links connecting Somaliland to Ethiopia and Djibouti.	Licensing	Licensing restrictions on international gateways lifted in 2020.
		Regulatory fees	No information on regulatory fees is available.

Source: TMG/APTelecom.

Note: CLS = cable landing station; MICT = Ministry of Information and Communication Technology.

a. MICT Yearly Work-plan Book, 2021, p. 30.
b. Post and Telecommunications Act, Law No. 50/2020 (April 4, 2020), art. 3(17), https://mict.govsomaliland.org/article/somaliland-post-and-telecommunication-act?category=legislations.
c. Post and Telecommunications Act, art. 25.
d. MCIT, Five Year's Strategic Plan 2021–2025.
e. Post and Telecommunications Act, art. 64 and 66.

TABLE 19. Regulatory barriers assessment: South Sudan

	BACKGROUND	REGULATORY BARRIERS ASSESSMENT	
Submarine cable deployment (wet plant)	Not applicable as South Sudan is a landlocked country.		
Cable landing station deployment	Not applicable as South Sudan is a landlocked country.		
National fiber backbone deployment	Limited operational fiber backbone exists in South Sudan. Muya and Liquid deployed a fiber link connecting Juba to the Ugandan border and is considering expanding the network to additional cities.	Licensing	Currently the licensing framework for fibre deployment is unclear if it is awarded on a nationwide basis (international best practice) or by segments. The government proposed to deploy the National Broadband Network (NBN) with an initial total length of over 1,600 km. However, due to financial challenges this was not realized. The National Communication Authority subsequently entered into an agreement with Liquid to deploy a national fiber backbone in the country. In January 2020, Muya and Liquid initially deployed a 200-kilometer fiber network from the Ugandan border through Nimule to Juba. The government reportedly appears to have an informal policy to limit the number of licenses/authorizations it will grant to deploy national fiber backbone infrastructure in South Sudan as well as to use existing fiber for cross-border connectivity. Reportedly, four licenses were assigned over the past four years to deploy national fiber networks, some of which may have been revoked for noncompliance. ***Recommendation:*** *The Government of South Sudan should adopt a more transparent and formal licensing process to grant rights to build and operate national backbone infrastructure. This framework would benefit from assessing the current status and potential use of fiber deployed prior to independence to maximize the benefits of the limited infrastructure in the country.*
		Infrastructure sharing and wholesale access regulation	Infrastructure sharing circular is in place and all operators have been directed to share infrastructure. The MNOs are sharing their towers. While the National Communications Act sets forth high-level provisions related to common use of infrastructure, specific implementing regulations have not been issued to date.[a]
		Rights of way	Access to rights of way was not identified as a key barrier to fiber backbone deployment. Instead, key challenges for building out fiber networks are linked to security concerns and political stability in the country.
		Regulatory fees	No information on regulatory fees is available. Regulatory fees are included in the texts of the licenses, which are not made publicly available.[b]
International gateway service	A single, government-owned international gateway facility exists in South Sudan.	Licensing	Limits have been imposed on the deployment of international gateway facilities. Around 2017, the MICTP adopted a policy to nationalize the international gateway service. In 2019, the government-owned South Sudan International Gateway (SSIGW) deployed this facility in association with MGI (a Swiss company focused on deployment of international gateways). Existing licensees (MTN and Zain) were required to forego their rights to provide international service to renew their operating licenses, so they are now prohibited from directly exchanging cross-border traffic and instead must route it through SSIGW. ***Recommendation:*** *The limit on international gateway licenses, which was reportedly grounded on security concerns and revenue generation objectives, should be revised to facilitate entry and competition in the market.*
		Regulatory fees	No information on regulatory fees is available. This information is included in the texts of the licenses, which are not made publicly available.

Source: TMG/APTelecom.

Note: ICT = information and communications technology; MICTP = Ministry of ICT and Postal Services; SSIGW = South Sudan International Gateway.
a. National Communications Act, 2012, Act. No 24, art. 53.
b. National Communications Act, 2012, Act. No 24, art. 66.

3.4 Summary of the Market Assessment

In sum, several *market barriers* affect broadband service availability and adoption in the target countries. These include market structure conditions that lead to limited competition in specific market segments. This is the case in Ethiopia (currently in the process of liberalization), Djibouti, and South Sudan. Affordability of services and/or devices is also a key challenge for broadband adoption in all the target countries, with prices for entry-level mobile and fixed broadband service well above the target affordability threshold recommended by the ITU. Income levels, among other factors, also likely result in low mobile broadband service adoption in these markets. The factors that were considered in assessing market barriers included network coverage, adoption and affordability, and the level of competition in each target market.

Fragility and conflict dynamics, stemming from ongoing internal armed conflicts, security concerns, and political instability, are identified as a high barrier for private investment in Ethiopia, Somalia, and South Sudan. Security conditions in these markets result in risk levels beyond the risk tolerance thresholds of many potential investors. Political stability and security are particularly relevant for deployment of national fiber backbone networks, which require control of the territory to lay, operate, and maintain terrestrial networks. This is particularly challenging in Somalia and South Sudan. Similarly, the ongoing internal armed conflict in Ethiopia creates significant uncertainty and risks for the new entrant, Safaricom Ethiopia, and may affect the market's ability to attract a potential second entrant in the short term. These conditions may delay investments by Safaricom Ethiopia, which had initially committed to launching services during the second half of 2022.

Regulatory barriers also present a challenge for cross-border and fiber backbone infrastructure deployment in the target countries. License restrictions or lack of certainty in the licensing process affect market entry or use of existing infrastructure in Ethiopia (for fiber backbone and international gateway deployment), and Djibouti (to deploy CLS, fiber backbones, and international gateways). Similarly, a lack of infrastructure sharing and wholesale access regulation affects the ability to provide service in the target countries. Regulatory frameworks should be further developed and regulatory authorities' capacity should be strengthened. High regulatory fees in the countries where they are made publicly available may also create entry barriers. This appears to be the case in Somalia, where the recently adopted fee structure may limit additional entry.

Table 20 summarizes the barriers to infrastructure investments identified for each of the target countries. A rating of "high" implies the existence of significant regulatory barriers to enter the specific segment of the value chain. These include legal or de facto monopolies; limitations on the number, availability, or processes to obtain licenses; and the imposition of high regulatory fees that deter entry, among other factors. A rating of "low" implies that entry into the segment of the value chain is not impeded by existing regulations based on the review conducted and information available.

TABLE 20. Summary of barriers to the deployment of cross-border infrastructure in the target areas

COUNTRY	FRAGILITY AND CONFLICT DYNAMICS	MARKET BARRIERS	REGULATORY BARRIERS			
			SUBMARINE CABLE WET PLANT	CABLE LANDING STATION	FIBER BACKBONE	INTERNATIONAL GATEWAY
Djibouti	Low	High	Low	High	High	High
Ethiopia	High	High	N/A	N/A	High	High
Somalia	High	High	Low	High	High	High
Somaliland region	Low	Low	Low	Low	Low	Low
South Sudan	High	High	N/A	N/A	High	High

Source: TMG/APTelecom.
Note: N/A = not available.

Notes

29. World Bank, Population, Total-Djibouti (2020), https://data.worldbank.org/indicator/SP.POP.TOTL?locations=DJ; World Bank, Population, Total-Ethiopia (2020), https://data.worldbank.org/indicator/SP.POP.TOTL?locations=ET.
30. ; World Bank, Population, Total-South Sudan (2020), https://data.worldbank.org/indicator/SP.POP.TOTL?locations=SS; World Bank, Population, Total-Somalia (2020), https://data.worldbank.org/indicator/SP.POP.TOTL?locations=SO.
31. GDP in Djibouti is more comparable to that of the Arab Republic of Egypt (USD 3,850) and Algeria (USD 3,640).
32. https://thedocs.worldbank.org/en/doc/225296a4c6f52827dab7b7ca8a27edea-0280012022/original/mpo-sm22-djibouti-dji-kcm.pdf
33. International Monetary Fund, GDP per capita, current prices-Djibouti (2021), https://www.imf.org/external/datamapper/NGDPDPC@WEO/OEMDC/DJI; World Bank, World Bank Country and Lending Groups, https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups.
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35. World Bank, Report No. PAD3617, Project Appraisal Document for Ethiopia Digital Foundation Project, pp. 7-8 (March 24, 2021).
36. International Monetary Fund, GDP per capita, current prices-Ethiopia (2021), https://www.imf.org/external/datamapper/NGDPDPC@WEO/ETH.
37. Décret N° 2019-172/PR/MCPT portant approbation de l'attribution d'une licence pour la fourniture de service internet data, https://www.presidence.dj/texte.php?ID=2019-172&ID2=2019-07-17&ID3=D%E9cret&ID4=14&ID5=2019-07-31&ID6=n.
38. République de Djibouti, Le gouvernement de la République de Djibouti annonce l'ouverture du capital de Djibouti Telecom (July 11, 2021), https://www.presidence.dj/article.php?ID=999.
39. Effective from July 9, 2021, a nationwide full-service Unified Telecommunications Service License was assigned to a consortium comprised of Safaricom, Vodafone, Vodacom, Sumitomo, and the CDC Group, which later incorporated Safaricom Telecommunications Ethiopia (Safaricom Ethiopia). See TeleGeography, ECA confirms issuance of licence to Safaricom Telecommunications Ethiopia (July 15, 2021), https://www.commsupdate.com/articles/2021/07/15/eca-confirms-issuance-of-licence-to-safaricom-telecommunications-ethiopia/.
40. See ECA, Tender Notice, The request for proposals for a second telecommunications license (license B) in the Federal Democratic Republic of Ethiopia (September 28, 2021), https://eca-ethiopia.com/wp-content/uploads/2021/09/RFP-Public-Notice-for-License-B.pdf.
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54. TeleGeography Global Comms Database: South Sudan-Household Penetration (2021).
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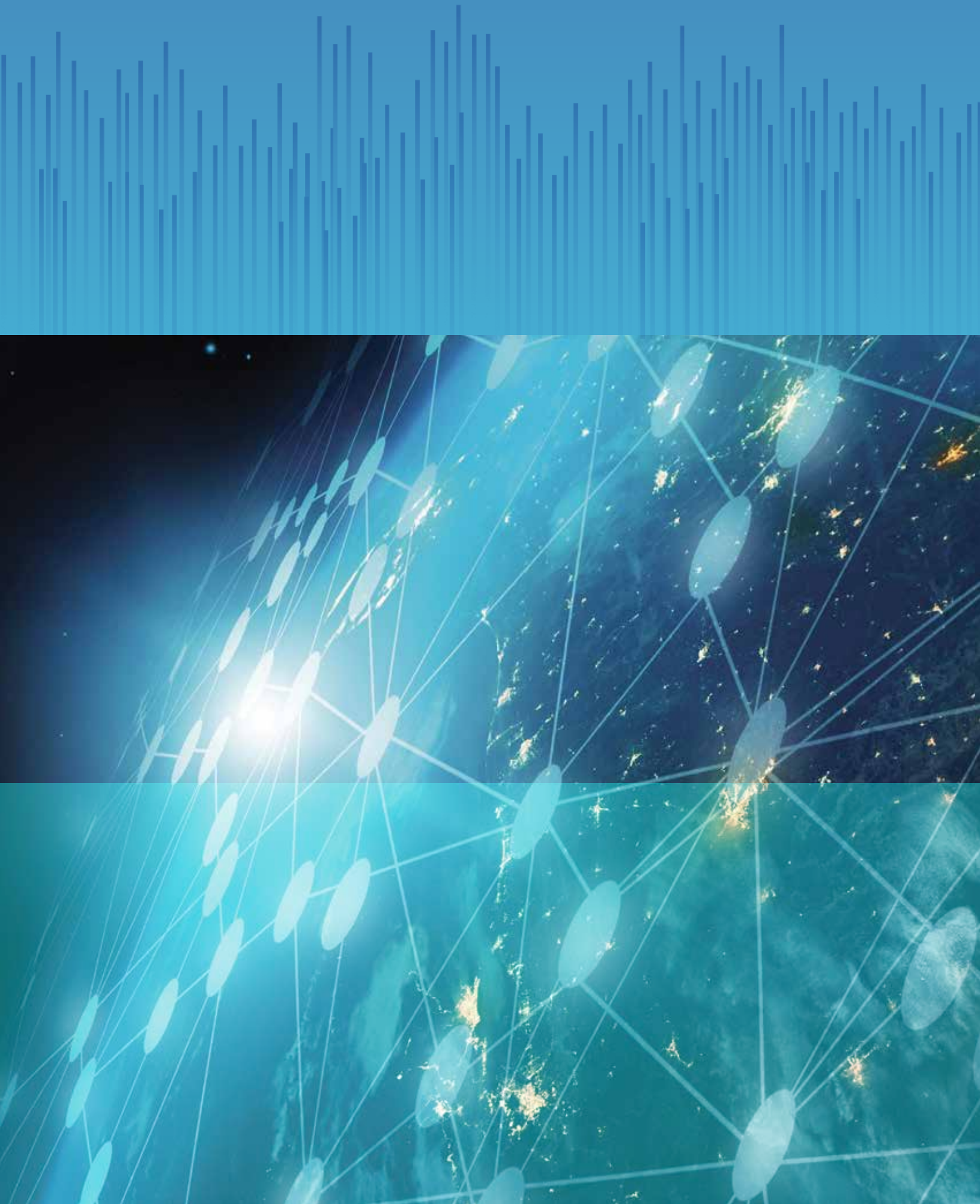
78. Along these lines, for example, the European Union's new Electronic Communications Code offers co-investors in new fiber network regulatory forbearance from asymmetric access regulation as an incentive to form such sharing arrangements.
79. As a landlocked country, the assessment focuses on barriers affecting national fiber backbone deployment and international gateways.



4

Infrastructure Needs Assessment

4.1. Introduction and Approach

This section presents the infrastructure needs assessment conducted for Djibouti, Ethiopia, Somalia, and South Sudan. It seeks to identify potential projects that would be required to complete or improve missing or inadequate components of the domestic backbone and cross-border fiber optic connections or to improve access to content, recognizing that the target countries may benefit from potential projects addressing more than one of these needs.

To this end, the review considered three key requirements, as illustrated in figure 11.

1. *International connectivity.* Each country should have at least one high-capacity international route to ensure initial connectivity and multiple routing options to distant and regional content nodes. Currently, at least one such route is present in each of the five target countries, as described in section 2. Accordingly, this issue is not further addressed in this section.
2. *National fiber backbone.* Each country should have a fiber route connecting the entry point of international connectivity to the major population centers. Djibouti, and Ethiopia each have an operational national backbone, while Somalia and South Sudan do not. In addition, beyond an initial backbone route, and to ensure resilience, all population centers should ideally be connected via at least two georedundant routes to eliminate single points of failure.
3. *Cross-border links.* Each country should have resilient cross-border routes to important traffic destinations (for example, major submarine cables and distant content, local or regional hubs, content delivery networks (CDNs), and internet exchanges). As in the case of national fiber backbones, geo-redundancy is crucial to eliminate single points of failure that could cause major nationwide outages of international traffic. Another key benefit of additional cross-border connections is lower latency routes to important content and hub locations. Prioritization is highly dependent on the readiness of onward connectivity on the other side of the border. Ultimately, coast-to-coast routes will become more important for landlocked countries to reach major hubs and onward submarine cable systems at both coasts, to reduce dependency on a single route.

The analysis also considers existing fiber routes and, as appropriate, the potential for cross-border transmission opportunities with neighboring countries beyond the target countries, such as the Arab Republic of Egypt, Kenya, and Uganda.

Applying the three-factor assessment approach mentioned above, the following subsections present country-by-country assessments of key infrastructure gaps. These are supplemented in some cases with deeper dives, such as content localization considerations in Ethiopia, given the emergence of Kenya as a regional hub, and a more in-depth consideration of Somalia's national backbone needs.

FIGURE 11. Approach to identify infrastructure needs in the target countries

Source: TMG/APTelecom.

4.2 Target Country Infrastructure Needs Assessments

4.2.1 Djibouti

4.2.1.1 National fiber backbone

Based on the discussion in subsection 2.4.1, the primary gap in Djibouti's domestic fiber backbone is in the northern part of the country. To bridge this gap, there could be a route to Tadjourah and Obock. If implemented, the fiber ring should be closed by a new cable landing station (CLS) in Obock, with a submarine cable connecting back to Djibouti City (An initiative to connect Eritrea with DARE project, with a bifurcation to Obock, is yet to materialize considering the political standstill between the two countries).

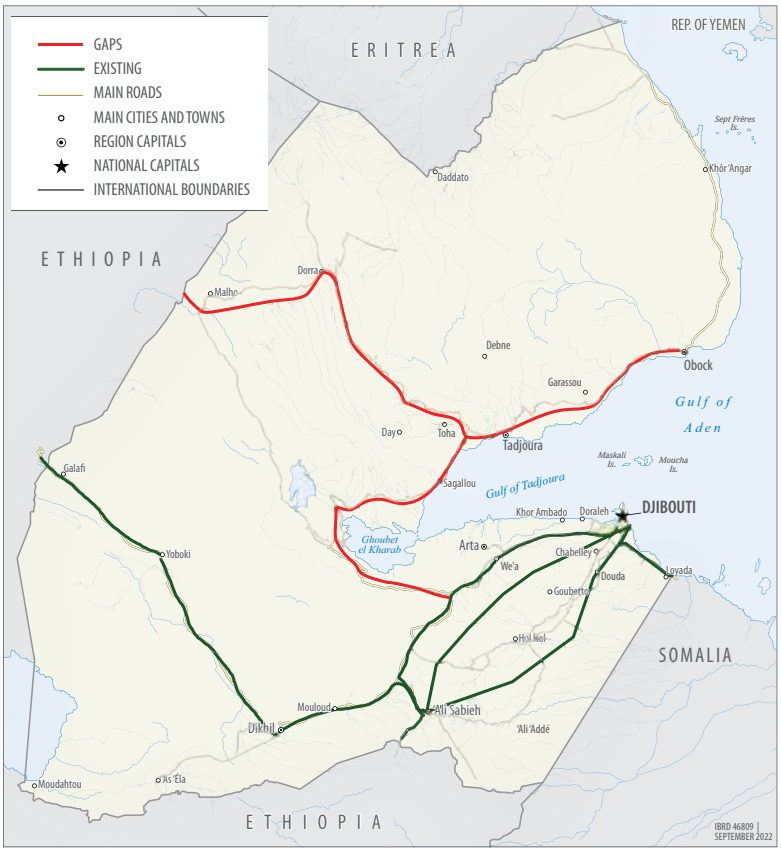
4.2.1.2 Cross-border connections to Ethiopia and beyond

Currently, two routes connect Djibouti and Ethiopia (Ali Sabieh and Galafi) and one route connects Djibouti and the Somaliland region (Lawyacado). To increase resilience, the possibility of establishing a third route to Ethiopia via Balho could be assessed. This proposed third route then could be connected to a future route from Assab, Eritrea, to Ethiopia. This would also fit into a broader regional subsea project (see project #3 in table 28, in section 5).

4.2.1.3 Summary of the national fiber backbone and cross-border gap assessment

Map 22 and table 21 summarize the identified fiber infrastructure gaps in Djibouti.

MAP 22. Djibouti's fiber infrastructure gaps (in red)



Source: TMG/APTelecom.
Note: CLS = cable landing station.

4.2.2 Ethiopia

4.2.2.1 National fiber backbone

As described in subsection 2.4.2, the main domestic Ethiopian fiber optic backbone is in place and connects to existing international routes. However, as Ethiopia has the second largest population in Africa, it would benefit from a more robust topology to cope with outages on the main routes. For example, many cross-border routes pass through or border conflict areas, exposing them to increased risk of damage and outages.

Many local fiber networks (middle mile, access) within Ethiopia will also be required to connect the smaller towns and cell sites to the main domestic fiber backbone, and the Ethiopian Communications Authority is considering using universal service funding to bridge these gaps.[80]

Ethio Telecom reportedly has a series of projects under development, as well as several planned projects to bridge fiber access gaps. However, it was not possible to speak with an Ethio Telecom representative to obtain information on these projects.

TABLE 21. Proposed fiber links: Djibouti

START	END	DESCRIPTION	DISTANCE (km)
RN9/RN1 intersection	Tadjourah– Obock	Route in Djibouti connecting the existing fiber optic backbone to Tadjourah and Obock.	151
Obock	Djibouti	Submarine cable connecting Obock back to Djibouti to close the domestic ring.	50
Tadjourah	Balho	Route connecting Tadjourah to the Ethiopian border via Balho.	125

Source: TMG/APTelecom.

4.2.2.2 Cross-border connections to Somalia, Djibouti, and Eritrea

Based on the analysis included in subsection 2.4.2, multiple options for adding cross-border routes were identified and are detailed in table 22.

4.2.2.3 Summary of the national fiber backbone and cross-border gap assessment

Map 23 and table 23 summarize the identified fiber infrastructure gaps in Ethiopia.

4.2.2.4 Traffic localization and CDNs

The issue of localization of content and CDNs is critical for a large country like Ethiopia. As shown in subsection 2.2.1, Google reports a Google Global Cache in Addis Ababa, which is a positive development and implies that Google content (including YouTube content) is available locally and does not require retrieval from Marseille or other distant Google data centers. Similarly, Meta has two caches in Ethiopia to serve the market locally.

As noted in subsection 2.2.1, market players intend to establish data centers within Ethiopia to serve that market locally, reducing the dependency on high-latency routes to faraway data centers. To that end, there are data center activities underway, such as the Ethio ICT Park.[81] However, press reports point to challenges related to such data center development. For example, in October 2021, press reports indicated that the Ethiopian entity charged with managing the information and communications technology (ICT) park set new lease prices at 21 to 30 times the price per square meter compared with the price initially agreed with the tenants (depending on whether the lessee is domestic or foreign). These significantly increased prices were applied to four new ICT park tenants that had already begun construction and can be expected to disrupt deployments.[82]

Kenya is also developing as an internet hub in East Africa with several of the main internet players having presence in the country (see the discussion in subsection 2.2.1). As such, until more content is hosted locally in Ethiopia, it can be expected that a significant

TABLE 22. Ethiopia: Additional cross-border route options

ROUTE	DESCRIPTION AND BENEFITS
Route to and through Somaliland/ Puntland regions	A route from Ethiopia to Hargeisa (Somaliland region) and on to the cable landing station in Berbera or to Djibouti already exists. This route would provide an additional path to international connectivity when a submarine cable becomes operational in Berbera and/or an onward connection toward submarine cables in Bosaso can be deployed.
Third route to Djibouti	The resilience of cross-border routes to Djibouti would be improved by the deployment of a new route via Balho. Further information on this route is provided in subsection 4.2.1.
Eritrea routes	Possible routes through Eritrea (Asmara-Mitsiwa and Assab) would potentially serve multiple purposes, although onward submarine connectivity from Eritrea would also be required. This would be a regional project combining a new land route from Ethiopia via Eritrea and a festoon cable via two landing stations in Eritrea to Djibouti (see projects #3 and #4 in table 28, in section 5). This would be highly beneficial for Eritrea, which is currently mainly dependent on satellite links for internet connectivity (and some microwave links for telephony), as well as for Ethiopia and and Djibouti.
Routes to Somalia Southern	There are two possible new routes to Mogadishu, Somalia, via Dolo and Beledweyne.

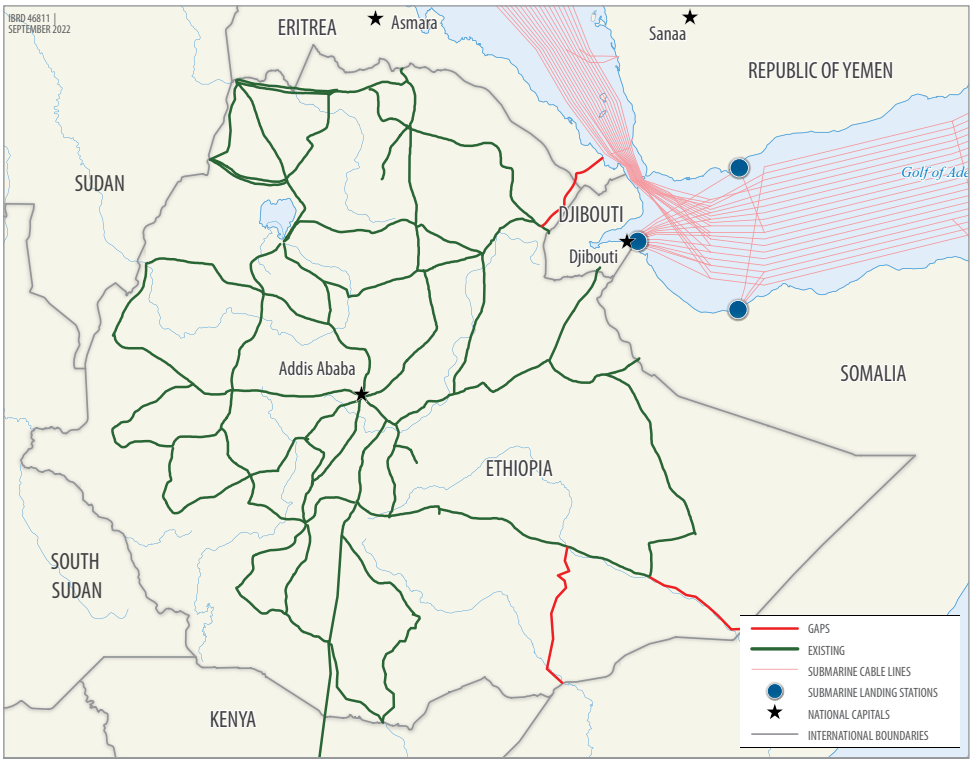
Source: TMG/APTelecom.

TABLE 23. Proposed fiber links: Ethiopia

START	END	DESCRIPTION	DISTANCE (km)
Halli	Balho	Route connecting Halli to the Djibouti border at Balho.	74
Adwa	Asmara and Mitsiwa	Cross-border route connecting Ethiopia (Adwa) and Eritrea (Mitsiwa via Asmara).	275
Halli	Assab	Second cross-border route connecting Ethiopia (Halli) and Eritrea (Assab) for resilience. There is a 60 km overlap with Halli – Djibouti (Balho).	207
Imi	Dolo	Cross-border route connecting Ethiopia from Imi to Dolo at the border with Somalia via IDP camps. Needs another 175 km from Dolo to Mogadishu in Somalia to reach the CLS.	300
Gode	Beledweyne	Cross-border route connecting Ethiopia (Gode) to Somalia (Beledweyne) via IDP camps. Needs another 329 km of domestic central Somalia backbone for onward connectivity to Mogadishu.	210

Source: TMG/APTelecom.
Note: CLS = cable landing station; IDP = internally displaced persons; km = kilometers.

MAP 23. Ethiopia's fiber infrastructure gaps (in red)



Source: TMG/APTelecom.
Note: CLS = cable landing station.

amount of the content needed in the country could be reached with much lower latency from Kenyan nodes than from Europe (mostly via Marseille), Asia, or upcoming nodes in the Middle East. Private sector interests may already be pursuing such an approach, with operators likely considering options to route traffic southward to Kenya. Their options include connecting with the Optic Fibre Backbone Infrastructure (NOFBI) network in northern Kenya and with Liquid, which has invested in the optical ground wire route starting near Nairobi to Ethiopia.

4.2.3 Somalia

4.2.3.1 National fiber backbone

Somalia currently lacks a national fiber optic backbone across the country. Several regions effectively handles international connectivity independently. The creation of a national integrated backbone linking the existing network, including the two operational CLSs in Mogadishu and Bosaso and the CLS in Berbera awaiting cable landings and the cross-border connections to Djibouti, Ethiopia, and Kenya, should be a priority when considering improvements to Somalia's fiber infrastructure. The proposed approach to developing Somalia's backbone infrastructure is presented as a potential two-phase project, including a possible alternative approach to the first phase.

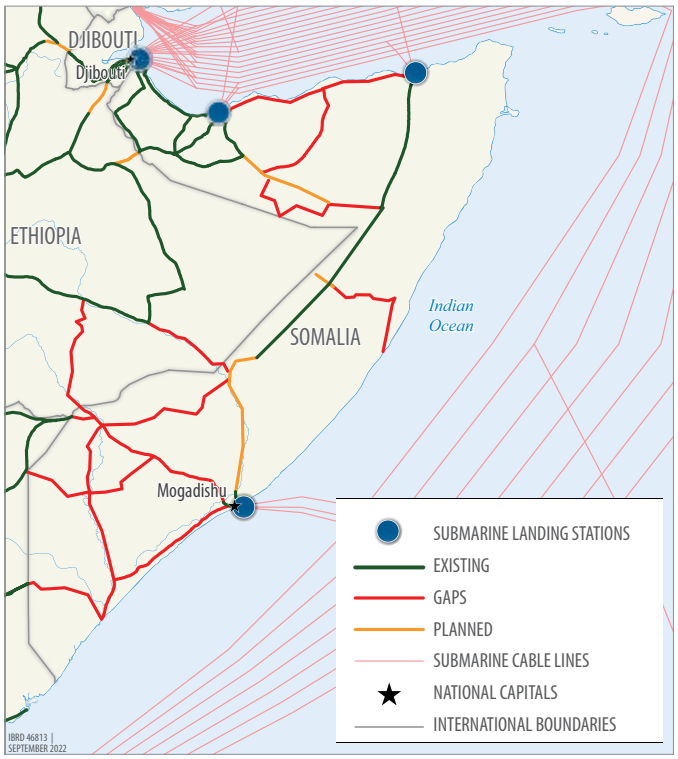
FIRST PHASE OF THE NATIONAL BACKBONE

Reportedly, both Dalkom (including Nationlink, which it acquired) and Hormuud have been planning a route from Mogadishu to Galkayo, but security issues have prevented implementation.[83] If the companies succeed in connecting Galkayo, they could connect onward via the Golis Telecom fiber optic route toward the Bosaso CLS.

In the south, the main proposed route is Mogadishu-Kismayo-Liboi, with the latter city representing the Kenyan border and the endpoint of Liquid's Kenya network. Currently, microwave links are being used to link the end of Liquid's network in Liboi with points in Mogadishu and Kismayo.

Once the main domestic route connecting Somalia end-to-end from the Kenya border to the Djibouti border is in place, a redundant and resilient topology will be possible, as there is ample submarine connectivity on different cable systems connecting Mombasa (Kenya), Mogadishu, Bosaso, Berbera (planned), and Djibouti. This will effectively create two domestic rings and a total of four rings with the use of Djibouti and Kenya to close certain rings, as illustrated in map 24.

MAP 24. Somalia phase 1 backbone approach



Source: TMG/APTelecom.
Note: CLS = cable landing station.

As of this writing, only one ring exists: the SomCable Somaliland ring linking Hargeisa and Djibouti. Any other alternative domestic route would depend on much lower capacity microwave connections.

The domestic sections required to create this basic national backbone topology for Somalia would be 1,575 kilometers and are described in table 24. These main routes also include many other major cities in Somalia.

ALTERNATIVE APPROACH VIA A FESTOON CABLE

As an alternative, a festoon cable routed via Djibouti-Berbera-Bosaso-Hobyo-Mogadishu-Kismayo-Mombasa was considered. However, five of the seven landing points are already part of multiple existing and upcoming cable systems that can be used to create similar functionality as a new festoon cable. Therefore, such a festoon submarine cable system would involve significant duplication. A scaled down version involving Bosaso-Hobyo-Mogadishu-Kismayo could be considered instead.[84] The two landing stations are the following:

- Hobyo: 12,564 inhabitants and low-population density inland area up to Galkayo.[85]
- Kismayo: 242,344 inhabitants and many smaller population centers between Kismayo and Mogadishu, as well as into the interior.[86]

A festoon cable is indeed a bypass to supply more capacity in *Kismayo* more quickly (instead of via the current microwave links). However, since additional population centers require connectivity between Kismayo and Mogadishu, as well as further into the interior, there will still be a need for terrestrial fiber routes connecting Kismayo in two different directions (northern and southern routes) to provide resiliency. The benefits of an additional submarine cable system just to connect Kismayo are limited. Focusing deployment on the fiber optic route from the Kenyan border via Kismayo to Mogadishu offers significant benefits in terms of addressable market and lower overall costs. The prerequisite, however, is a stable security situation to allow the deployment of such a terrestrial cable route, which is inherently challenging in this part of the country (see subsection 3.2.3).

Hobyo, by contrast, is a very small market for a cable landing and would be better served via terrestrial connections as well.

Accordingly, the alternative approach of a festoon cable to connect Kismayo and Hobyo is not the most logical or cost-efficient solution to improve the connectivity within Somalia. It is highly recommended to deploy the terrestrial backbone.

SECOND PHASE OF THE NATIONAL BACKBONE

The next phase of development of the domestic backbone would connect more cities and provide more cross-border links in South-Central Somalia (two into Ethiopia and a second one into Kenya).

The resulting map includes the top 17 cities in terms of population as well as more alternative routes within the domestic backbone (map 25).

4.2.3.2 Cross-border links to Ethiopia and Kenya

The cross-border routes to Kenya can couple directly into the fiber optic backbones on the Kenya side, namely the NOFBI network at Mandera and El Wak and Liquid network at Liboi, respectively.

The cross-border routes from Somalia into Ethiopia also require development of the Ethiopian section of that route.

Beyond this phase, further fill-in routes would be required to connect the smaller towns in Somalia.

TABLE 24. Proposed first phase of domestic fiber backbone in Somalia

START	END	DESCRIPTION	DISTANCE (km)
Burco	Garowe	Possibly partial work in progress by SomCable.	362
Garowe	Jowhar (Mogadishu)	Partial work (Garowe-Galkayo) in progress by Golis Telecom (Puntland part). Fiber has been laid from Garowe to near Dhuusamareeb. Galkayo-Balcad (Mogadishu) has been considered by players in Central Somalia, but not yet funded (and security concerns).The Mogadishu-Jowhar section has already been completed.	562
Afgoye (Mogadishu)	Liboi (Kenya border)	Link connecting Mogadishu to Liboi via Kismayo.	

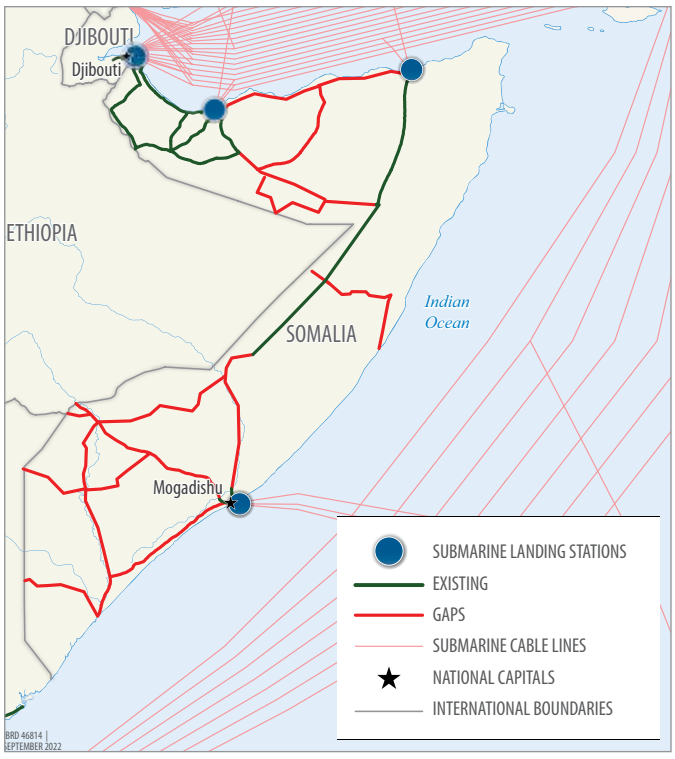
Source: TMG/APTelecom.

TABLE 25. Proposed second phase of domestic fiber backbone in Somalia

START	END	DESCRIPTION	DISTANCE (km)
Jilib (Kismayo)	Luuq	Link connecting Kismayo to Luuq to connect to backbone.	409
Berbera	Bosaso	Link connecting the coastal towns of Berbera and Bosaso, both of which house CLSs.	475
Inaafmadow	Maydh	Link connecting Inaafmadow to the coastal fiber route between Bosaso and Berbera near Maydh.	260
Baidoa	Bur Ache	Link connecting Baidoa (along the Southern Backbone) to the Kenyan border at Bur Ache.	384
Luuq	Beledweyne	Link connecting Luuq to the central backbone in Beledweyne	357
Galkayo	Hobyo	Link connecting Galkayo to the coast at Hobyo.	299
Laascaanood	Kirit	Link connecting Laascaanood and Kirit via Bohotle at the Ethiopian border.	270
Luuq-Dolo road	Mandera (Kenya)	Link connecting Luuq en Dolo to Kenya.	56

Source: TMG/APTelecom.
Note: CLS = cable landing station.

MAP 25. Somalia's terrestrial fiber infrastructure gaps (in red)



Source: TMG/APTelecom.
Note: CLS = cable landing station.

4.2.3.3 Summary of the national fiber backbone and cross-border gap assessment

Map 25 and tables 24 to 26 summarize the identified fiber infrastructure gaps in Somalia.

4.2.4 South Sudan

4.2.4.1 National fiber backbone

As noted in subsection 2.4.4, South Sudan lacks an operational domestic backbone and depends on the fiber optic route from Juba to Uganda and satellite links for international connectivity.

4.2.4.2 Cross-border links to Uganda, Kenya and the Central African Republic

Map 26 shows the existing operational Juba-Uganda border route.

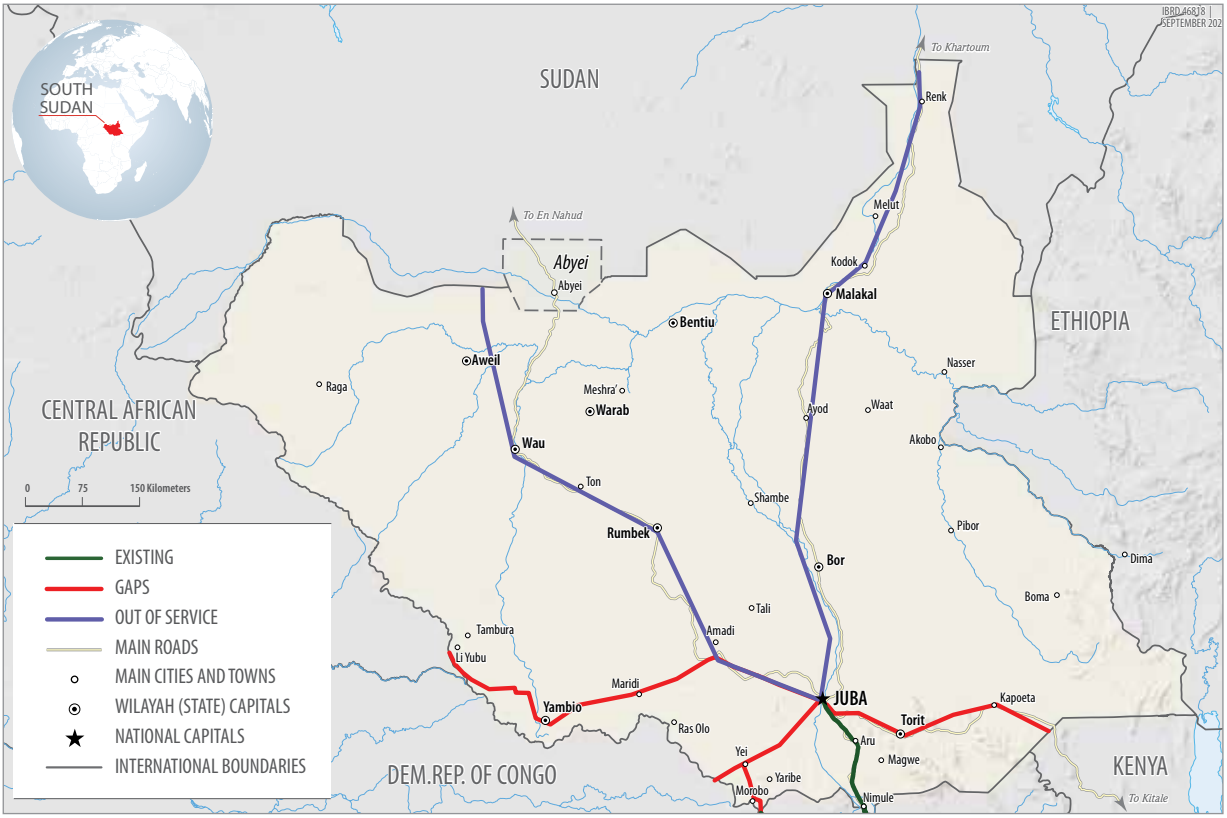
Given the relatively good connectivity in Kenya along the road from Nairobi to the South Sudan border, and the presence of content in Kenya, a route into Juba from the Kenyan border is a priority gap to be closed. The area is known to face issues with ammunition caches, mines, and other explosive remains of previous fighting. Work to build a new or upgraded road would need to resolve those issues. However, if a fiber optic route is deployed

TABLE 26. Proposed cross-border fiber links in Somalia

START	END	DESCRIPTION	DISTANCE (km)
Dolo	Mogadishu	Cross-border route connecting Ethiopia (Dolo) to Somalia (Mogadishu) via IDP camps. Needs another 300 km from Dolo to Imi in Ethiopia to reach the existing fiber optic backbone.	175
Gode	Beledweyne	Cross-border route connecting Ethiopia (Gode) to Somalia (Beledweyne) via IDP camps. Needs another 210 km of domestic Ethiopian backbone for onward connectivity to existing fiber backbone and requires the central Somalia backbone to be in place at least from Mogadishu to Beledweyne (294 km).	35

Source: TMG/APTelecom.
Note: IDP = internally displaced persons; km = kilometers.

MAP 26. South Sudan's fiber infrastructure gaps



Source: TMG/APTelecom.
Note: CLS = cable landing station.

along the existing road, additional measures might be required (for example, mine clearing).

The Juba-Makala and Juba-Wau routes are important gaps covering many population centers. Potentially, some sections can be rehabilitated if they have indeed been deployed. Otherwise, those two routes should be considered as important gaps to be closed.

Further, several routes are important both domestically and in the longer term cross-border:

- Route to Yei with subsequent onward connections to:
  - The Democratic Republic of Congo border, where there are also plans for large-scale fiber optic deployment
  - The Uganda border at Kaya to establish a second route into Uganda.
- Route to Ri Yubu at the border with the Central African Republic.

4.2.4.3 Summary of the national fiber backbone and cross-border gap assessment

- Map 26 and table 27 summarize the identified fiber infrastructure gaps in South Sudan.

TABLE 27. Proposed fiber links in South Sudan

START	END	DESCRIPTION	DISTANCE (km)
Juba	Malakal	Restoration of the existing East-Central backbone route from Juba to Malakal.	925
Juba	Wau	Restoration of the existing West-Central backbone route	800
Juba	Narus and Nakodok	Route to existing interconnection point in Kenya (Nakodok) via Narus.	345
Juba	Kaya and Democratic Republic of Congo/Uganda	Route to existing interconnection points in Uganda via Kaya and an under-construction interconnection point in the Democratic Republic of Congo.	244
Juba	Ri Yubu and Central African Republic	Route to existing interconnection points in the Central African Republic via Ri Yubu. This route overlaps for 160 kilometers with the Juba-Wau route.	583

Source: TMG/APTelecom.

Notes

80. In October 2021, the Ethiopian Communications Authority published for consultation a report identifying priorities for universal service funding in the country, including extending fiber to existing and new mobile sites primarily in rural areas. See ECA, Universal Access and Service Framework, Draft for Stakeholder Consultation (October 2021), https://eca.et/wp-content/uploads/2020/10/Universal-Access-and-Service-Framework-UASF-Draft-for-Consultation.pdf.
81. Data Center Dynamics, Wingu.Africa breaks ground on hyperscale data center in Addis Ababa, Ethiopia (January 21, 2021), https://www.datacenterdynamics.com/en/news/winguafrica-breaks-ground-hyperscale-data-center-addis-ababa-ethiopia/.
82. See, for example, Addis Fortune, Technology Park Price Tag Vexes Investors (October 2021), https://addisfortune.news/technology-park-price-tag-vexes-investors/.
83. Strategy and PPP Options for Supporting the ICT Sector and Broadband Connectivity in Somalia. https://ppiaf.org/documents/5419/download?otp=b3RwIzE1MzEzNTY0NjM=.
84. Note that the PEACE Cable system had announced landings in Kismayo and Hobyo. However, interviews indicated that these landings are no longer part of the PEACE Cable system.
85. https://worldpopulationreview.com/countries/cities/somalia.
86. https://worldpopulationreview.com/countries/cities/somalia.

5

Potential Commercial Options

5.1 Introduction

The target countries are among the most complex in Africa, facing long-standing civil conflicts and unrest and myriad political and security risks. As of this writing, Ethiopia's military conflict in the Tigray region has broadened in scope and scale, although it has de-escalated somewhat. Recent events have demonstrated how easily unrest in one target country can reverberate across the border with another, threatening regional stability.

This analysis has taken this context into account when considering the submarine and terrestrial fiber infrastructure gaps in the region. Each opportunity discussed in this section was assessed and evaluated independently to identify those that are expected to have a positive impact in their respective marketplaces. The analysis starts from a long list of opportunities covering the gaps identified in section 4 to then undertake a deep dive into a narrower set of opportunities deemed to have a high potential ranking. In terms of prioritization of the links, they were based on what an ideal regional network configuration would look like that would benefit the Horn of Africa (HoA) as a whole, and based on demographic needs. This section considers each of the opportunities, the investment required, which telecommunications operators might be involved, and how they might participate in infrastructure deployment. Where possible, the review seeks to identify opportunities aimed at crowding-in private investment within the target countries.

It will be important to consider the opportunities alongside the role of the public sector in each country's context. Although there are degrees of variability in the level of intervention and scope of involvement of the public sector, areas in which the public sector can be involved include maintaining security and stability, leveraging different sources of funding to realize commercial opportunities (where possible, private financing through development finance institutions (DFIs) can also be explored), and enhancing the enabling legal and regulatory environment to crowd-in private investment.

Possible project overview and evaluation

Consideration of the infrastructure gaps in the target countries resulted in the identification of 18 potential projects that would benefit the broadband markets in the HoA region. Table 28 summarizes these projects, providing a project name, the relevant country or countries impacted, a short project description, and a description of potential project benefits. A rank is also assigned to each project in terms of its relative importance and impact in the target countries: primary versus secondary.

Table 29 synthesizes these projects into potentially financeable opportunities for DFI consideration. The table also includes potential network operator partners. The rankings have been especified from the point of view of:

- Impact from table 28. Primary contributes to a "high" ranking, secondary to a "low" ranking
- Whether or not the project is likely without public financing. Requiring public financing contributes to a "high" ranking.

Based on an evaluation of each opportunity, subsection 5.2 provides further discussion of the following six opportunities with a "high" initial ranking:

i. Bameza to Ad-Damazin
ii. Central Somalia backbone
iii. Northern Somalia backbone
iv. Southern Somalia backbone
v. South Sudan backbone restoration
vi. Juba connectivity.

TABLE 28. Potential projects

#	PROJECT NAME	COUNTRY (IES)	DESCRIPTION/ LENGTH	BENEFITS AND OTHER RELEVANT CONSIDERATIONS	IMPACT
1	Obock-Tadjourah-RN9/RN1 Intersect	Djibouti	Route connecting Obock to Djibouti (150 km)	Addresses IDP/refugee camp demand; addresses other unserved communities.	Primary
2	Tadjourah-Balho-Ethiopia	Djibouti, Ethiopia	Cross-border Djibouti to Ethiopia (125 km)	Third cross-border link Djibouti to Ethiopia for resilience. Ethio Telecom interest is likely low.	Secondary
3	Regional Festoon Cable between Eritrea and Djibouti	Djibouti, Eritrea	Eritrea, Djibouti (1,305 km)	Requires Ethiopia links #4 and #5 to generate sufficient traffic and some other connections for onward connectivity. Together with #4 and #5, this provides two alternative routes out of Ethiopia and connects Eritrea to fiber optic cables from different directions instead of relying on satellite links.	Secondary
4	Adwa- Amsara-Misiwa	Ethiopia to Eritrea to future CLS	Cross-border link Ethiopia to Eritrea and onward to future CLS (275 km)	In combination with #3.	Secondary
5	Halli-Assab	Ethiopia to Eritrea	Second cross-border link Ethiopia to Eritrea and onward to future CLS (207 km)	In combination with #3, secondary to #4.	Secondary
6	Mogadishu-Galkayo-Garowe	Somalia	Central Somalia backbone (948 km)	Of primary importance to national backbone.	Primary
7	Gode to Beledweyne	Ethiopia to Somalia	Backbone extension in Ethiopia + cross-border to Somalia (245 km)	Dependency on #6, addresses unserved communities, including IDP/refugee camps; important alternative cross-border route for Ethiopia.	Secondary
8	Imi-Dolo-Mogadishu	Ethiopia to Somalia	Cross-border Ethiopia to Somalia via IDP camps (475 km)	Addresses unserved communities, including IDP/ refugee camps; adds to national backbone.	Secondary
9	Burco-Laascaanood-Garowe	Somalia	Northern Somalia backbone (367 km)	Important section of national backbone, addresses unserved communities.	Primary
10	Mogadishu-Kismayo-Liboi	Somalia	Southern Somalia backbone (740 km)	Addresses unserved communities, including IDP/ refugee camps; provides a cross-border link to Kenya.	Secondary
11	Additional Somalia backbone	Somalia	Southern Somalia backbone (575 km)	Dependency on #7 and #11, addresses unserved communities; provides an additional cross-border link to Kenya.	Secondary
13	Juba-Malakal]	South Sudan	Restoration of existing East-Central backbone route (925 km)	Not clear how much existing infrastructure is intact; addresses some unserved communities.	Primary
14	Juba-Wau-]	South Sudan	Restoration of existing West-Central backbone route (800 km)	Not clear how much existing infrastructure is intact; addresses fewer unserved communities than #13.	Secondary
15	Juba-Narus-Kenya	South Sudan	Route to existing interconnection point in Kenya (345 km)	Addresses unserved communities; adds international connectivity resilience.	Primary
16	Juba-Kaya-Democratic Republic of Congo/ Uganda	South Sudan	Route to existing interconnection points in Uganda via Kaya and an under-construction interconnection point in the Democratic Republic of Congo (244 km)	Addresses unserved communities to some extent; adds international connectivity resilience; could be added later when partner network exists in the Democratic Republic of Congo.	Secondary
17	Juba-Ri Yubu Central African Republic	South Sudan	Route to existing interconnection in the Central African Republic (583 km)	Addresses unserved communities to some extent; adds international connectivity resilience; fighting ongoing in the Central African Republic.	Secondary

Source: TMG/APTelecom.
Note: CLS = cable landing station; IDP = internally displaced persons; km = kilometers.

TABLE 29. Potentially financeable opportunities

#	OPPORTUNITY NAME	COUNTRY(IES)	PROJECT #S	RANKING FOR DFI	COMMENT
A	Djibouti North	Djibouti	#1, #2	Low	This is likely to be of interest to the private sector and to be built on its own; not a high priority.
B	Regional connectivity	Djibouti, Eritrea, Ethiopia	#3, #4, #5	Low	The two routes to the coast (#4 and #5) might be important alternative routes for Ethiopia, but less impactful for target countries than other opportunities under consideration.
C	Central Somalia backbone	Somalia	#7 (#8 and #9 could be a secondary stage of development)	High	Impactful, would require public financing.
D	NorthernSomalia backbone	Somalia	#10	High	Impactful, would require public financing.
E	Southern Somalia backbone	Somalia	#11 (#12 could be a secondary stage of development)	High	Impactful, would require public financing.
F	South Sudan backbone restoration	South Sudan	#13, #14	High	Impactful, would require public financing.
G	Juba connectivity	South Sudan	#15 (#16 and #17 could be a secondary stage of development)	High	Impactful, would require public financing.

Source: TMG/APTelecom.
Note: DFI = development finance institution.

5.2 Opportunity Deep Dives

5.2.1 Central Somalia backbone

This opportunity envisages the deployment a 1,100 km backbone in Somalia via the Mogadishu-Galkayo-Garowe corridor, which would provide fiber connectivity to hundreds of unserved or underserved communities, including camps for internally displaced persons, and would provide two additional cross-border links (Gode to Beledweyne and Imi-Dolo-Mogadishu). The proposed project is illustrated in map 30.

The underserved Somali communities to benefit are presented in table 27.

5.2.1.1 Expected outcome

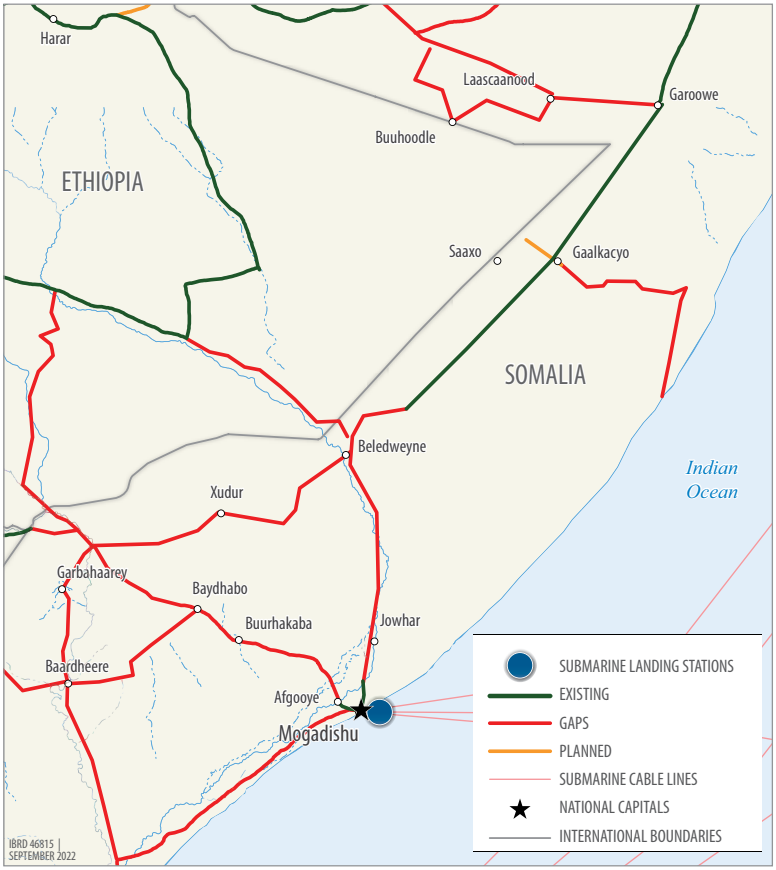
The benefits from the opportunity are increased revenue to the investing network or networks. The networks could gain additional revenue from an increase in the fixed subscriber base and fixed and mobile broadband usage made possible by the increased capacity in the areas served. The deployment may also allow increased cross-border traffic from Ethiopia's sizable population, and Somalia may use the route for resiliency. The expected outcome is growth in data usage by the population addressed by the fiber backbone network and increased cross-border traffic.

TABLE 30. Estimated population impacted by the project: Central Somalia Backbone

COMMUNITY	POPULATION
Wanlaweyn	22,022[a]
Burrhakaba	125,616[b]
Baydhabo (Baidoa)	129,839[a]
Luuq	33,820[a]
Dolo (southeastern Ethiopia)	N/A[d]
Jowhar	269,851[c]
Mahadaay	51,230[b]
Buulobarde	16,928[a]
Beledweyne	55,410[a]
Ferfer	N/A[d]
Dhussaamarreeb	9,000[a]
Mereer-Gur	N/A[d]
Galkayo	N/A[d]
Beyra	N/A[d]
Gori Rit	N/A[d]
Total	701,716

Sources: a. World Population Review 2021; b. UNOCHA 2005; c. UNICEF 2014; d. population data unavailable from official government and multilateral sources.
Note: N/A = not available.

MAP 27: Central Somalia backbone opportunity



Source: TMG/APTelecom.
Note: CLS = cable landing station.

5.2.1.2 Enterprise structure

This opportunity most likely involves partnering with Hormuud, Dalkom/NationLink, or Somlink as these are the operators licensed to deploy backbone in this region of the country. There are some smaller players, such as Somtel and Amtel, but they are unlikely to be major participants. The enterprise structure could therefore follow one of two generic forms:

1. An investment project of one of the existing operators in Somalia
2. A joint venture involving co-investment of multiple operators in Somalia to gain shared access to the backbone and backhaul segments.

Of course, an Ethiopian party would need to participate in the project as well to facilitate the cross-border connectivity. The most likely candidate for this would be Ethio Telecom as it has in the past expressed interest in cable landings in Berbera (Somaliland region) and could see the benefit in additional cross-border connectivity to Mogadishu, but this would have to be validated. Safaricom Ethiopia and any additional licensed new entrant in Ethiopia likely would be more focused in the near term on other deployments (that is, building out more basic infrastructure for its new network).

5.2.1.3 Revenue/pricing strategies

As in each of these opportunities, the facilities will be used as inputs in the production of downstream services. The pricing for the network operator(s) will depend on the enterprise structure chosen. If this is an investment by a single existing operator, it will simply be part of the cost base for providing the incremental services to itself. If it is a joint venture, there will be some internal cost-based rate to ensure the joint venture is viable.

For third-party Somali operators, national capacity pricing will reflect competitive market conditions. For international connectivity services, the owner(s) will have to offer attractive wholesale prices to attract incremental Ethiopia-originated or Ethiopia-terminated traffic.

5.2.1.4 Open access considerations

Given the importance and scale of the investment, it would be advisable to ensure that an open access model is adopted in exchange for financing.

5.2.1.5 Additional studies recommended

To quantify the incremental revenue associated with this project, a study of the increase in broadband use that can be associated with this deployment is recommended. An analysis of Somali cross-border traffic to assess how much market share the route might secure is also recommended.

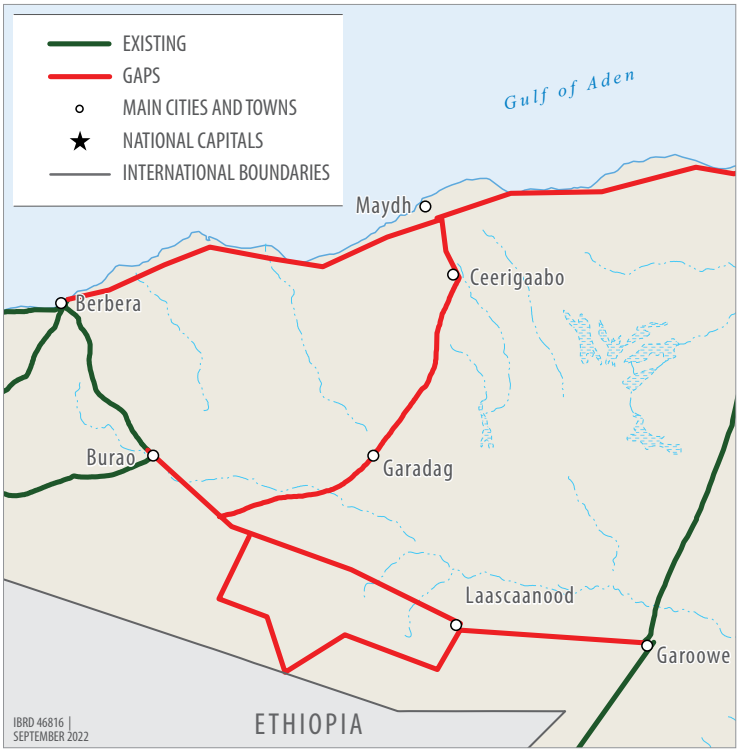
Another significant aspect to be studied is how interconnection among the disparate Somali networks could be encouraged and secured. The economics of the opportunities will improve with an increase in traffic from and to as many regions in Somalia as possible.

These analyses would be part of a larger feasibility study for the opportunity.

5.2.2 Northern Somalia backbone

This opportunity involves the deployment of a 367 km fiber backbone network in Northern Somalia (Somaliland and Puntland region), from Burco to Laascaanood to Garowe, which would provide fiber connectivity to multiple unserved or underserved communities. The proposed project is illustrated in map 28.Map 28

MAP 28: Eastern Somalia backbone opportunity



Source: TMG/APTelecom.
Note: CLS = cable landing station.

TABLE 31. Estimated population impacted by the project: Northern Somalia backbone

COMMUNITY	POPULATION
Yiroowe	N/A[a]
Kiridh	N/A[a]
Wadamago	N/A[a]
Ainablo	N/A[a]
Oog	N/A[a]
Laascanood	60,100[b]
Boame	N/A[a]
Total	60,100

Sources: a. population data unavailable from official government and multilateral sources; b. World Population Review 2021.
Note: N/A = not available.

Table 31 presents a list of underserved communities that would benefit from the project.

5.2.2.1 Expected outcome

The expected benefits from the opportunity are increased revenue to service providers in Somaliland. SomCable and others could gain additional revenue from an increase in the fixed subscriber base and increased fixed and mobile broadband usage made possible by the increased capacity. At this time, the number of households or small enterprises potentially connected is unknown. The expected market outcome is growth in data usage by the population addressed by the fiber backbone network. There will also be increased revenue from improved connectivity in the surrounding areas, including Ethiopia, since this infrastructure would provide a connection between Ethiopia and the Bosaso cable landing station (CLS) and between the Hargeisa/Berbera CLS and the Bosaso CLS. In addition, this would strengthen network topology and resilience in Somalia and may be used as a route to strengthen Ethiopian network resilience.

5.2.2.2 Enterprise structure

The opportunity and likely enterprise structure are straightforward. This will simply be an investment by an operator, with financial support from DFIs also likely needed. There may be interest from several operators seeking access to Puntland via Golis and to Central Somalia.

5.2.2.3 Revenue/pricing strategies

The pricing strategy for wholesale and retail services will be determined by the operator's market power, demand conditions, and price regulation.

5.2.2.4 Open access considerations

Despite the relatively modest size of the opportunity, DFIs may be able to work with Somaliland regulatory authorities to leverage the investment to secure open access.

5.2.2.5 Additional studies recommended

To quantify the incremental revenue associated with this project, a study of the increase in broadband use that can be associated with this deployment is recommended.

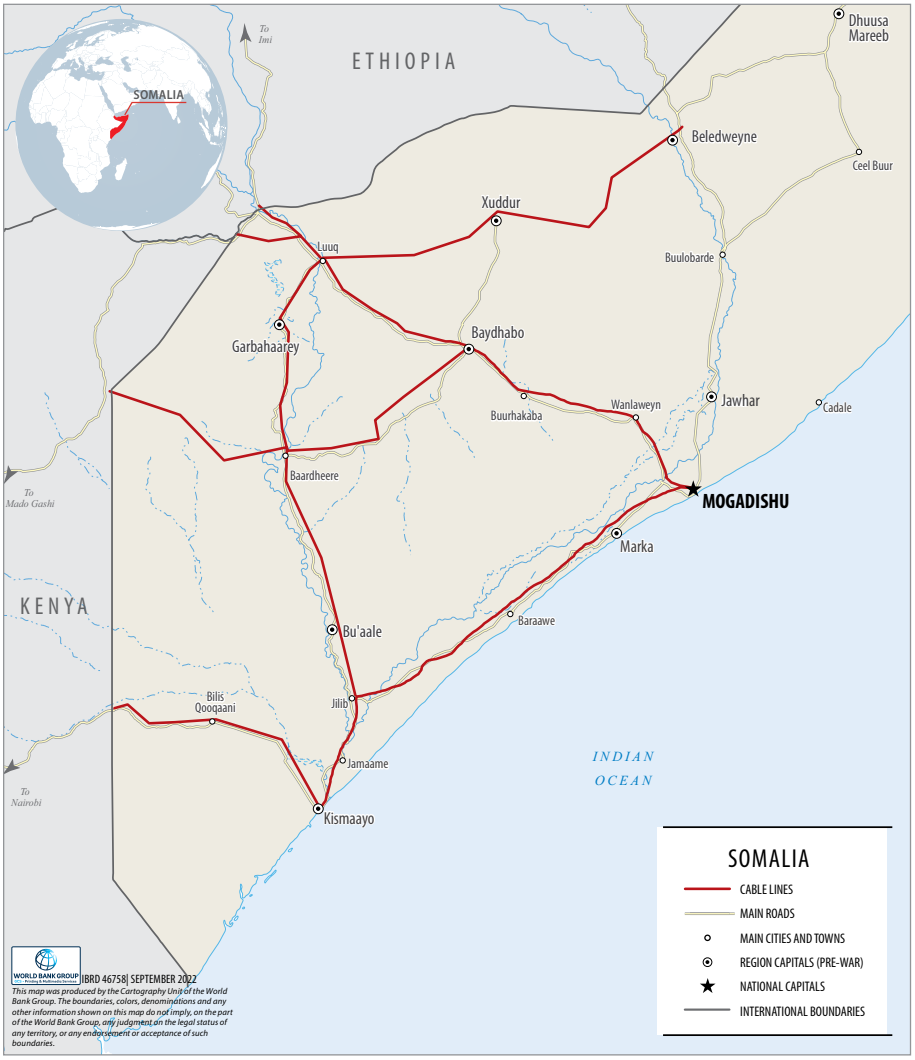
As with any Somali investment, another significant aspect to be studied is how the interconnection among the disparate Somali networks might be encouraged and secured.

These analyses would be part of a larger feasibility study for the opportunity.

5.2.3 Southern Somalia backbone

This opportunity envisages the deployment of 1,300 km of backbone in the south of Somalia via the Mogadishu-Kismayo-Liboi corridor, which would provide fiber connectivity to hundreds of unserved or underserved communities and enable two additional

MAP 29: Southern Somalia backbone opportunity (routes in red)



Source: TMG/APTelecom.
Note: CLS = cable landing station.

TABLE 32. Estimated population impacted by the project: Southern Somalia backbone

COMMUNITY	POPULATION
Marka (Merca)	230,100[a]
Cagaarane/Shalan Boot	N/A[b]
Golweyn	N/A[b]
Buulo Mareer	N/A[b]
Baraawe	57,652[c]
Jamaame	185,270[a]
Kismaayou	234,852[a]
Buur Gaabo	N/A[b]
Bilis Qooqaani	N/A[b]
Jilib	43,694[a]
Bu'aale	59,489[c]
Baardheere	42,240[a]
El Beru Hagia	N/A[b]
Diinsoor	75,769[c]
Total	929,066

Sources: a. World Population Review 2021; b. population data unavailable from official government and multilateral sources; c. UNOCHA 2005.
Note: N/A = not available.

cross-border links with Kenya (at El Wak and Mandera). This opportunity is illustrated in map 29.

The underserved communities that would benefit from the project are indicated in table 32.

5.2.3.1 Expected outcome

The benefits from the opportunity are increased revenue to the investing network or networks. They could gain additional revenue from an increase in the fixed subscriber base and increased fixed and mobile broadband usage made possible by the additional capacity in the areas served. The deployment may also allow an increase in cross-border traffic as Somalia will use the route to substitute current microwave links connecting the country to Kenya. The expected outcome is a growth in data usage by the population addressed by the fiber backbone network and an increase in cross-border traffic.

5.2.3.2 Enterprise structure

As with the Central Somali opportunity, this likely involves partnering with Hormuud, Dalkom/NationLink, or Somlink as these are the operators most appropriately licensed to deploy backbone networks. There are some smaller players, such as Somtel and Amtel, but they likely are not major participants. The enterprise structure could therefore follow one of two generic forms:

1. An investment project of one of the existing operators in Somalia
2. A joint venture involving co-investment of multiple operators in Somalia to gain shared access to the backbone and backhaul segments.

5.2.3.3 Revenue/pricing strategies

As in each of these opportunities, the facilities will be used as inputs in the production of downstream services. The pricing for the network operator(s) will depend on the enterprise structure chosen. If this is a single existing operator investment, it will simply be part of the cost base for providing the incremental services to itself. If it is a joint venture, there will be some internal cost-based rate to ensure that the joint venture is viable.

For third-party Somali operators, national capacity pricing will reflect competitive market conditions. For international connectivity services, the owner(s) will have to offer attractive wholesale prices to attract incremental Kenya-originated or Kenya-terminated traffic.

5.2.3.4 Open access considerations

Given the importance and scale of the investment, it would be advisable to ensure that an open access model is adopted in exchange for financing.

5.2.3.5 Additional studies recommended

To quantify the incremental revenue associated with this project, a study of the increase in broadband use that can be associated with this deployment is recommended. An analysis of Somali cross-border traffic to assess how much market share the route might secure is also recommended.

As with any Somali investment, another significant aspect to be studied is how the interconnection among the disparate Somali networks might be encouraged and secured.

These analyses would be part of a larger feasibility study for the opportunity.

5.2.4 South Sudan backbone restoration

This opportunity envisages the deployment of restoration of around 1,725 km of fiber in two routes, as shown in map 30. These routes existed in the past, but it is not clear how much infrastructure currently remains. In addition to adding cross-border links for the two links, the project would provide broadband connectivity for several unserved or underserved communities, as indicated in tables 33 and 34.

5.2.4.1 Expected outcome

The benefits from the opportunity are increased revenue to the investing network or networks. The deploying entity(ies) could gain additional revenue from an increase in mobile broadband usage made possible by the increased capacity in the areas served (fixed broadband is almost nonexistent in South Sudan). The expected outcomes are growth in the population's data usage addressed by the fiber backbone network and an increase in cross-border traffic.

5.2.4.2 Enterprise structure

The appropriate partner or partners for this investment are not clear. Certainly, Liquid is first among the candidates as it is the only licensee operating a wholesale fiber backbone network in South Sudan today. However, it is not clear how interested Liquid would be in one or both of these routes. The two main mobile operators, MTN and Zain, would be ideal candidates as well, but they face licensing

TABLE 33. Estimated population impacted by the project: South Sudan backbone restoration, eastern route

COMMUNITY	POPULATION
Terekaka	33,012[a]
Malek	11,895[a]
Bor	93,890[a]
Jonglei	1,873,176[b]
Kangor	33,818[a]
Malakal (Central, Eastern, Northern, and Southern Payams)	165,373[a]
Kodok	14,647[a]
Kaka	14,576[a]
Umm Barbit	N/A[b]
Renk (North and South Payams)	111,107[a]
Total	2,351,494

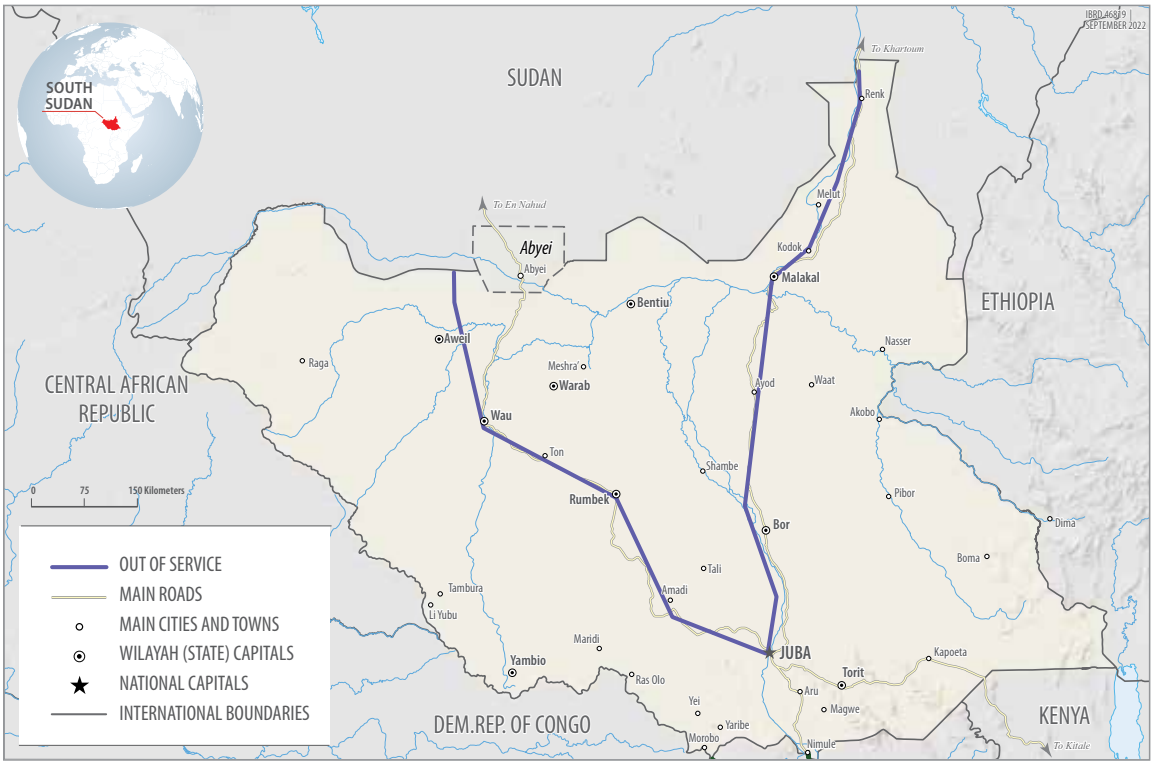
Sources: a. South Sudan National Bureau of Statistics 2015 (2020 projections); b. population data unavailable from official government and multilateral sources.

TABLE 34. Estimated population impacted by the project: South Sudan backbone restoration, western route

COMMUNITY	POPULATION
Bunduqiyah	N/A[a]
Lanya	41,108[b]
Amadi	3,445[b]
Mvolo	14,523[b]
Lol	N/A[a]
Rumbek (North, Centre, and East Counties)	377,771[b]
Tonj	47,597[b]
Wau	48,484[b]
Aweil	93,185[b]
Total	626,113

Sources: a. Population data unavailable from official government and multilateral sources; b. South Sudan National Bureau of Statistics, 2015 (2020 projections).
Note: The population data for each location, except Rumbek, is for the Payam (the second-lowest administrative division, below counties). N/A = not available.

MAP 30: South Sudan backbone restoration opportunity (routes in mauve)



Source: TMG/APTelecom.
Note: CLS = cable landing station.

restrictions. Finally, given that existing assets are involved, there may be a need to involve other players that currently are not providing service in South Sudan.

Ultimately, however, the enterprise structure could follow one of two generic forms:

1. An investment project of one of the existing operators in South Sudan
2. A joint venture involving co-investment of multiple operators to gain shared access to the backbone and backhaul segments.

5.2.4.3 Revenue/pricing strategies

As in each of these opportunities, the facilities will be used as inputs in the production of downstream services. The pricing for the network operator(s) will be dependent on the enterprise structure chosen. If this is a single existing operator investment, it will simply be part of the cost base for providing the incremental services to itself. If it is a joint venture, there will be some internal cost-based rate to ensure that the joint venture is viable.

For third-party South Sudanese operators, national capacity pricing will reflect competitive market conditions. For international connectivity services, the owner(s) will have to offer attractive wholesale prices to attract incremental foreign-originated or foreign-terminated traffic.

5.2.4.4 Open access considerations

Given the importance and scale of the investment, it would be advisable to ensure that an open access model is adopted in exchange for financing.

5.2.4.5 Additional studies recommended

To quantify the incremental revenue associated with this project, a study of the increase in broadband use that can be associated with this deployment is recommended. An analysis of South Sudanese cross-border and Sub-Saharan African transit traffic to assess how much market share the route might secure is also recommended.

This would be part of a larger feasibility study for the opportunity.

Given that existing assets are likely involved, there will be a need to conduct a legal analysis to establish whether and to what extent property rights may exist and which entity(ies) hold such rights over any legacy fiber infrastructure to be rehabilitated.

5.2.5 Juba connectivity

This opportunity involves deploying 1,000 km of backbone in South Sudan, which would provide fiber connectivity to hundreds of unserved or underserved communities as well as additional cross-border links. Two of the routes foreseen are low priority due to the lower number of unserved or underserved communities addressed (the Democratic Republic of Congo route described in the case of project #16) or ongoing armed conflicts (the Central African Republic route described in the case of project #17), but these could be put off until a later stage (map 31).

The major underserved communities covered by this opportunity are identified in table 35.

TABLE 35. Estimated population impacted by the project: Juba connectivity

COMMUNITY	POPULATION
Torit	58,684[a]
Nagishot	10,622[a]
Kapoeta	28,837[a]
Yei	176,780[a]
Marida (Maridi)	77,993[a]
Yambio	148,753[a]
Li Yubu	N/A[b]
Total	501,669

Sources: a. South Sudan National Bureau of Statistics 2015 (2020 projections); b. population data unavailable from official government and multilateral sources.
Note: The population data for each location, except Rumbek, are for the Payam (the second-lowest administrative division, below counties). N/A = not available.

5.2.5.1 Expected outcome

The benefits from the opportunity are increased revenue to the investing network or networks. The deploying entity(ies) could gain additional revenue from an increase in the fixed subscriber base and increased fixed and mobile broadband usage made possible by the increased capacity in the areas served. This would also improve access to Kenya, a burgeoning hub for content delivery networks, cloud providers, and other content. The deployment may also allow increased cross-border traffic as the region could use the routes as part of a pan-Africa route. The expected outcomes are growth in data usage by the population served by the fiber backbone network and an increase in cross-border traffic.

5.2.5.2 Enterprise structure

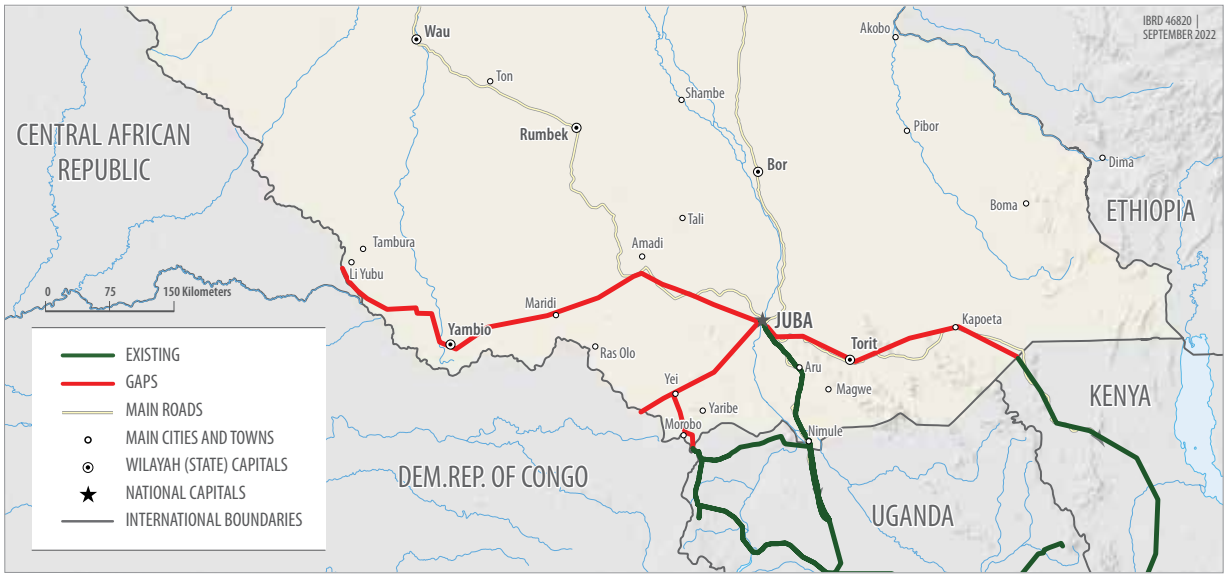
Liquid is the most likely partner for this opportunity. It already has backbone in the south of the country. Indeed, Liquid would have to be involved in any case for local and cross-border interconnections. The two main mobile operators, MTN and Zain, face licensing restrictions. The enterprise structure could follow one of two generic forms:

1. An investment project with Liquid
2. A joint venture involving co-investment of multiple operators to gain shared access to the backbone and backhaul segments.

5.2.5.3 Revenue/pricing strategies

As in each of these opportunities, the facilities will be used as inputs in the production of downstream services. The pricing for the net-

MAP 31: Juba connectivity opportunity (route in red)



Source: TMG/APTelecom.
Note: CLS = cable landing station.

work operator(s) will depend on the enterprise structure chosen. If this is a single existing operator investment, it will simply be part of the cost base for providing the incremental services to itself. If it is a joint venture, there will be some internal cost-based rate to ensure that the joint venture is viable.

For third-party South Sudanese operators, national capacity pricing will reflect competitive market conditions. For international connectivity services, the owner(s) will have to offer attractive wholesale prices to attract incremental foreign-originated or foreign-terminated traffic.

5.2.5.4 Open access considerations

Given the importance and scale of the investment, it would be advisable to ensure that an open access model is adopted in exchange for financing.

5.2.5.5 Additional studies recommended

To quantify the incremental revenue associated with this project, a study of the increase in broadband use that can be associated with this deployment is recommended. An analysis of South Sudanese cross-border and Sub-Saharan African transit traffic to assess how much market share the route might secure is also recommended. This would be part of a larger feasibility study for the opportunity.

6

Public versus Private Financing Needs

6.1 Introduction and Approach

This section discusses the public and private financing needs of the opportunities identified in the target countries. It involves estimating the scale of the investment required, which operators might be involved and how they might be involved in the infrastructure deployment, and the potential financing options.

The analysis is based on the opportunities identified in section 5 that would have significant, positive impacts on cross-border connectivity and the broadband market in the target countries and be likely to require public financing.

Development finance institutions (DFIs) in this sector and access to capital by local operators are almost nonexistent, and laying fiber and upgrading networks to 4G are very difficult. DFI funding could be leveraged to crowd-in private investment if private operators are currently unwilling to make the investments due to business, market, regulatory, or stability risks. DFI investments can be structured to crowd-in private investment through bulk purchase programs, risk assurances, an enhanced regulatory environment, and so forth.

For ease of reference, the six opportunities with a "high" initial ranking are presented again in table 36.

TMG co-authored a study for the World Bank Group in 2018 that presented a methodology considering the causes of the lack of broadband infrastructure investment and the appropriate role of the state in infrastructure promotion. Figure 12, reproduced from that study, shows that it is helpful to think in terms of the sequence of possible causes for the absence of a needed deployment. The first cause to consider is the possibility of *market failure,* or a situation in which the free market is not delivering services in the quantities in which they are desired or otherwise inefficiently. There are two main types of market failure in broadband infrastructure deployment: abuse of dominance and missing markets due to scarcity of capital, excessive uncertainty, and/or undervaluation of benefits. In all the opportunities identified, there is market failure.[87]

The second cause to identify is whether *dominance* is the primary aspect of this market failure. In some of the countries, notably Djibouti and Ethiopia, dominance can be seen as a primary aspect of market failure because the countries are "scenario 2" cases (in figure 12).[88] For the other countries, and therefore for

TABLE 36. Recommended opportunities for further consideration

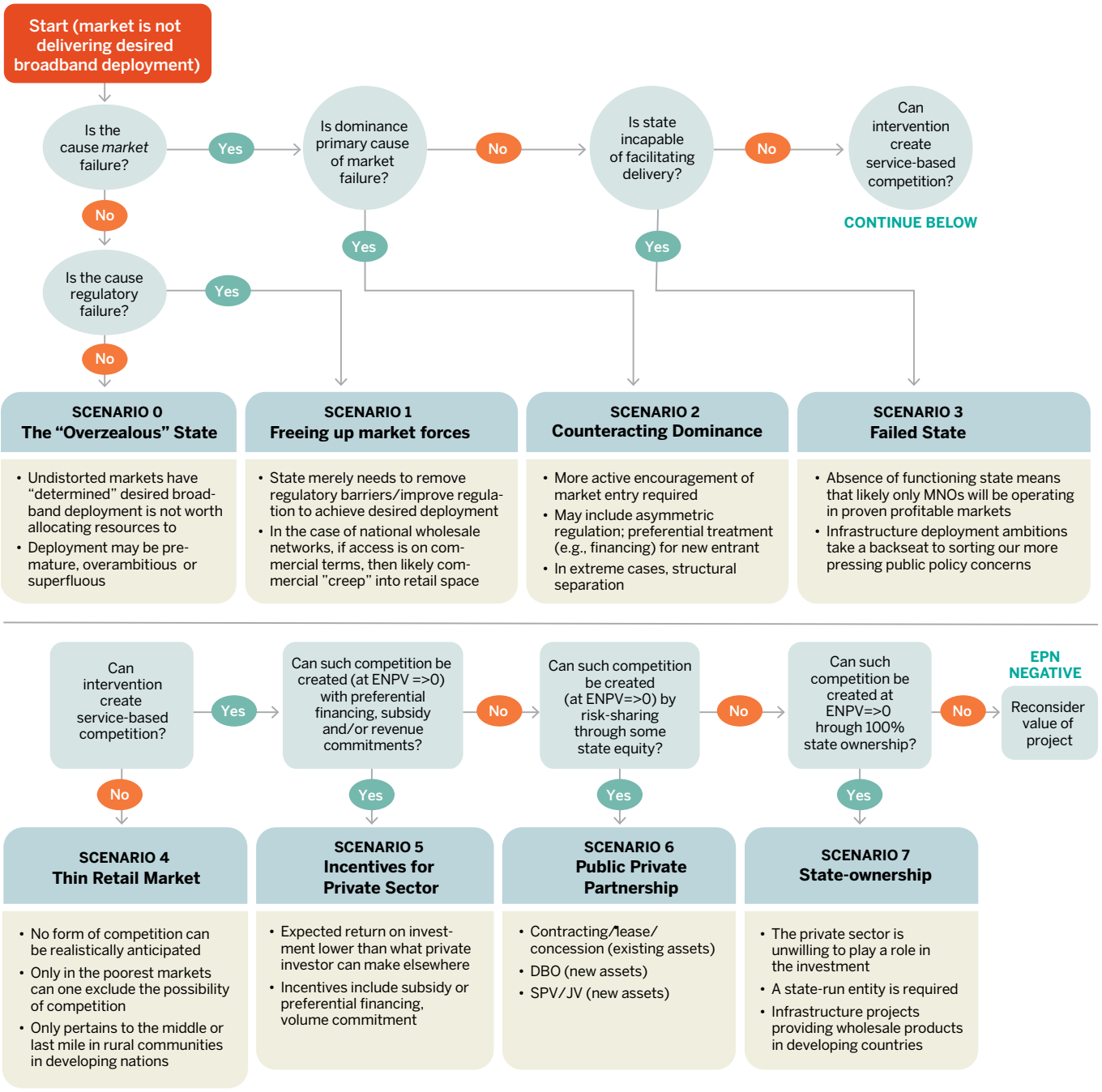
#	OPPORTUNITY NAME	COUNTRY(IES)	PROJECT #S	RANKING FOR DFI	COMMENT
ii	Central Somalia Backbone	Somalia	#7 (#8 and #9 could be a secondary stage of development)	High	Impactful, would require public financing.
iii	Northern Somalia Backbone	Somalia	#10	High	Impactful, would require public financing.
iv	Southern Somalia Backbone	Somalia	#11 (#12 could be a secondary stage of development)	High	Impactful, would require public financing.
v.	South Sudan Backbone Restoration	South Sudan	#13, #14	High	Impactful, would require public financing.
vi.	Juba Connectivity	South Sudan	#15 (#16 and #17 could be a secondary stage of development)	High	Impactful, would require public financing.

Source: TMG/APTelecom.
Note: The project numbers in the table refer to those in table 28, in section 5. DFI = development financing institution.

the six opportunities identified above, the question of what role the state may play in the infrastructure deployment is whether it can undertake constructive activity. Arguably, due to civil war and the dissolution of state institutions, Somalia, and South Sudan, are currently still failed states, that is, scenario 3, so the state's role is to focus on establishing and maintaining security, as well as recreating basic institutions so that it can—at some point in the future—deal with potential market failure and build optimal regulatory regimes.

Should the target countries resolve their problems of institutional integrity, regulatory failure, and market failure, but the problems of

FIGURE 12. Methodology and sequence to assess possible causes of the absence of a needed infrastructure deployment



Source: World Bank Group, 2018, Innovative Business Models for Expanding Fiber Optic Networks and Closing the Access Gaps, World Bank, Washington, DC.
Note: DBO = Design – Build - Operate ; ENPV = Expected Net Present Value ; JV = joint venture; MNOs = Mobile Network Operators ; SPV = special purpose vehicle.

TABLE 37. Taxonomy of fiber infrastructure financing

PRIVATE	PUBLIC	COMMUNITY	VENDOR	DFI
• Project bonds • Direct loans • Syndicated loans • Corporate bonds • Subordinated bonds • Listed equity capital • Unlisted equity capital • CSR grants	• Equity capital • Debt capital • Subordinated loans • Minimum guarantees • Off-take agreements • Tax increment financing • Infrastructure bonds • PPP project finance	• Asset transfer (rights of way) • Community bonds • Community • Subscriber equity • Subscriber finance	• Terms finance • Lease option finance • Bank guaranteed loans • Documentary credits	• Investment project financing • Trust funds and grants • Development policy financing • Loans and equity capital to the private sector • Syndications • Blending concessional finance

Source: World Bank Group, 2018, Innovative Business Models for Expanding Fiber-Optic Networks and Closing the Access Gaps, World Bank, Washington, DC.
Note: CSR = corporate social responsibility; DFI = development finance institution; PPP = public-private partnership.

missing infrastructure still exist, then they may be expected to find a justified role in financing, that is, scenarios 5, 6, and, in the rare case, 7. However, this is not the situation in the Horn of Africa (HoA) region. Thus, the recommended primary focus of DFI activity in the area should be partnering with the *private sector* service providers in these countries—mainly those that are supplying services in the upstream and downstream markets for mobile service.

The same report presents a summary taxonomy of financing (table 37). With respect to private financing, the absence of local private financial markets in the target countries means that only an investing party that can access international markets will be able to make use of private finance.

6.2 Central Somalia Backbone Opportunity

As described in subsection 5.2.2, this opportunity involves the deployment of a 1,100 km backbone in Somalia. The project would provide fiber connectivity to hundreds of unserved or underserved communities, including camps for internally displaced persons, and make possible two additional cross-border links.

6.2.1 System cost estimate

Based on an estimated of USD 15,000 to USD 20,000 per kilometer, the estimated investment cost of the Central Somalia backbone opportunity is around *USD 16.5 million to USD 22 million,* including an initial phase of USD 6 million to USD 8.5 million for the Mogadishu to Garowe route.[89]

6.2.2 Partnering possibilities

Presently, as discussed in subsection 5.2.2, the likely partners are service providers that are currently active in this part of Somalia and appropriately licensed for this type of activity. These are the following:

- Hormuud
- Dalkom/NationLink
- Somlink.

TABLE 38. Central Somalia backbone opportunity financing options

PARTNERING POSSIBILITIES	PRIVATE	VENDOR	DFIS
Local service providers		✔	✔

Source: TMG/APTelecom.
Note: DFIs = development finance institutions.

6.2.3 Financing options

There is effectively no market for debt in Somalia, and none of the possible partners is of the scale to have access to international financial markets. It is assumed, therefore, that only vendor and DFI financing is possible, as reflected in table 38.

6.3 Northern Somalia Backbone Opportunity

As described in subsection 5.2.3, this opportunity is the deployment of a 367 km backbone in the North from Burco to Garowe, which would provide fiber connectivity to multiple unserved or underserved communities.

6.3.1 System cost estimate

Based on an estimated cost of USD 15,000 to USD 20,000 per kilometer, the estimated investment cost of the Eastern Somalia backbone opportunity is around *USD 5.5 million to USD 7.3million.*[90]

6.3.2 Partner possibilities

Currently, as discussed in subsection 5.2.3, the likely partner for this opportunity is SomCable, due its current fiber footprint in the Somaliland region and its stated intention to extend its network via further investment.

6.3.3 Financing options

There is effectively no market for debt in Somalia, and none of the possible partners is of the scale to have access to international financial markets. It is assumed, therefore, that only vendor and DFI financing is possible, as indicated in table 39.

TABLE 39. Northern Somalia backbone opportunity financing options

PARTNERING POSSIBILITIES	PRIVATE	VENDOR	DFIS
Local service providers		✔	✔

Source: TMG/APTelecom.
Note: DFIs = development finance institutions.

TABLE 40. Southern Somalia backbone opportunity financing options

PARTNERING POSSIBILITIES	PRIVATE	VENDOR	DFIS
Local service providers		✔	✔

Source: TMG/APTelecom.
Note: DFIs = development finance institutions.

6.4 Southern Somalia Backbone Opportunity

As described in subsection 5.2.4, this opportunity is the deployment of 1,300 km of backbone in the south of Somalia. The project would provide fiber connectivity to hundreds of unserved or underserved communities and make possible two additional cross-border links with Kenya.

6.4.1 System cost estimate

Based on an estimated cost of USD 15,000 to USD 20,000 per kilometer, the estimated investment cost of the Southern Somalia backbone opportunity is around *USD 19 million to USD 27 million,* including an initial phase of USD 11 million to USD 15 million for the Mogadishu to Liboi route.[91]

6.4.2 Partnering possibilities

As discussed in subsection 5.2.4, the likely partners are service providers that are currently active in this part of Somalia and appropriately licensed for this type of activity. These are the following:

- Hormuud
- Dalkom/NationLink
- Somlink.

6.4.3 Financing options

There is effectively no market for debt in Somalia, and none of the possible partners is of the scale to have access to international financial markets. It is assumed, therefore, that only vendor and DFI financing is possible, as indicated in table 40.

6.5 South Sudan Backbone Restoration Opportunity

As described in subsection 5.2.5, this opportunity is the deployment of 1,725 km of fiber in two routes. These routes existed in the past, but it is not clear how much infrastructure currently remains. In addition to adding cross-border links for the two segments, the project would provide broadband connectivity for several unserved or underserved communities.

6.4.4 System cost estimate

Based on an estimated cost of USD 10,000 per kilometer and involving at least some restoration as opposed to greenfield deployment, the estimated investment cost of the South Sudan backbone restoration opportunity is around *USD 17.3 million.*[92]

6.4.5 Partnering possibilities

As discussed in subsection 5.2.5, only Liquid currently provides fiber infrastructure on a wholesale basis, suggesting that it would be the obvious implementing partner for this project.

Although MTN and Zain do not currently have licenses to act as wholesale providers, it may be possible that one or both (on a co-investment basis) could invest in the route for own capacity purposes while working with the regulator to obtain authorization—on a sale or swap basis—to provide capacity to third parties.

6.4.6 Financing options

Given the nature of the partnering possibilities, the financing options in South Sudan (summarized in table 41) may be the most auspicious among the projects considered.

TABLE 41. South Sudan backbone restoration opportunity financing options

PARTNERING POSSIBILITIES	PRIVATE	VENDOR	DFIS
Liquid	✔ (corporate)	✔	✔
MTN/Zain	✔(corporate)	✔	✔

Source: TMG/APTelecom.
Note: DFIs = development finance institutions.

TABLE 42. Juba connectivity opportunity financing options

PARTNERING POSSIBILITIES	PRIVATE	VENDOR	DFIS
Liquid	✔ (corporate)	✔	✔
MTN/Zain	✔(corporate)	✔	✔

Source: TMG/APTelecom.
Note: DFIs = development finance institutions.

TABLE 43. Summary of potential investment opportunities

OPPORTUNITY	ESTIMATED COST (USD, millions)	POTENTIAL PARTNERS	FINANCING OPTIONS
Bameza to Ad-Damazin	2–2.6	Sudatel/Canar • Railway SOE • MTN/Zain	Private (partial) • Vendor • DFIs
Central Somalia backbone	16.5-22	Local service providers	Vendor • DFIs
Northern Somalia backbone	5.5–7.3f	Local service providers	Vendor • DFIs
Southern Somalia backbone	19–26	Local service providers	Vendor • DFIs
South Sudan backbone restoration	17.3	Liquid • MTN/Zain	Private • Vendor • DFIs
Juba connectivity	17–24	Liquid • MTN/Zain	Private • Vendor • DFIs

Source: TMG/APTelecom.
Note: DFIs = development finance institutions; SOE = state-owned enterprise.

6.6 Juba Connectivity Opportunity

As described in subsection 5.2.6, this opportunity is the deployment of 1,000 Km of backbone in South Sudan, which would provide fiber connectivity to hundreds of unserved or underserved communities as well as additional cross-border links. Two of the routes foreseen are low priority due to the lower number of unserved or underserved communities addressed or due to conflict, but these routes could be delayed until a later stage.

6.6.1 System cost estimate

Based on an estimated of cost USD 15,000 to USD 20,000 per kilometer, the estimated investment cost of the Juba connectivity opportunity is around USD 17 million to USD 24 million, including an initial phase of USD 5.2 million to USD 7 million for the Juba-to-Nakodok route.[93]

6.6.2 Partnering possibilities

The partnering possibilities seem to be limited to Liquid given its existing capacity from Uganda and interest in trans-Africa capacity building and the licensing restrictions on MTN and Zain.

6.6.3 Financing options

Given the nature of the partnering possibilities, the financing options summarized in table 42 may be possible.

6.7 Summary of Potential Investment Opportunities

Based on a review of the projects above, table 43 presents a summary of the investment opportunities assessed. In this table, the distinction is made between "private" sources of financing, meaning private sector operators or financial entities, and "vendors," meaning equipment suppliers.

Notes

87. The fact that market failure can be identified in a given country does not mean there are no other causes for the lack of infrastructure investment, nor indeed that market failure is the primary barrier in the country. For example, in the Horn of Africa region, most countries have problems with market and regulatory failure, as well as with security, stability, and other challenges to national integrity. These fragility and conflict factors tend to outweigh all other causes. However, that does not diminish the usefulness of this framework.
88. Subsection 0 presents recommended regulatory actions that may be adopted to address this form of market failure.
89. The analysis did not include specific work on clearance of mines. In most cases, a new fiber route is planned along existing roads and it is assumed that those roadsides are usable. There could be specific areas where this is an additional issue, but information on this is unavailable at this time. This issue can be studied during detailed route surveys and planning.
90. This range is based on the range estimated in World Bank, "Strategy and PPP Options for Supporting ICT Backbone Connectivity in Somalia" (July 2017) and "Broadband Backbones in Somalia" (December 2019).
91. This range is based on the range estimated in World Bank, "Strategy and PPP Options for Supporting ICT Backbone Connectivity in Somalia" (July 2017) and "Broadband Backbones in Somalia" (December 2019).
92. This range is based on the range estimated in World Bank, "Strategy and PPP Options for Supporting ICT Backbone Connectivity in Somalia" (July 2017) and "Broadband Backbones in Somalia" (December 2019).
93. This range is based on the range estimated in World Bank, "Strategy and PPP Options for Supporting ICT Backbone Connectivity in Somalia" (July 2017) and "Broadband Backbones in Somalia" (December 2019).

Appendix: Submarine Cables

EXISTING SYSTEMS

Djibouti Africa Regional Express 1 (DARE1)

LANDING POINTS	
Djibouti	Djibouti City
Kenya	Mombassa
Somalia	Bosaso
	Mogadishu

CABLE NAME	DJIBOUTI AFRICA REGIONAL EXPRESS 1 (DARE1)	
Length	4,854 km	
RFS date	2021	
Owner	Djibouti Telecom, Africa Marine Express, Telesom, Hormuud Telecom Somalia, Golis Telecommunications, Somtel International, Telkom Kenya	
Capacity	**2021 (Tbps)**	
	Total capacity	36
	Occupied capacity	0.36
Fiber pairs	3	
Wavelengths per fiber pair	40	
Capacity per wavelength (Gbps)	300	
Cost	USD 100 million	
Comment	According to conversations with DT, DARE1 was not able to land in Berbera due to regulations in Somaliland. However, there is a branching unit located 100 km offshore and the wavelength is already integrated on the trunk.	

Gulf2Africa (G2A)

LANDING POINTS	
Somalia	Bosaso (Berbera landing not operational)
Oman	Salalah

CABLE NAME	GULF2AFRICA (G2A)	
Length	1,500 km	
RFS date	2017	
Owner	Ethio Telecom, Golis Telecommunications, Omantel, and Telesom	
Capacity	**2021 (Tbps)**	
	Total capacity	30
	Occupied capacity	0.1
Fiber pairs	2	
Wavelengths per fiber pair	150	
Capacity per wavelength (Gbps)	100	
Cost	USD 60 million	
Comment	According to certain discussions, there has been difficulty accessing the cable landing in Berbera. In addition, there is a branching unit located about 60 km offshore from Berbera.	

Asia Africa Europe 1 (AAE-1)

LANDING POINTS	
Cambodia	Sihanoukville
China	Cape D'Anguilar
Djibouti	Djibouti City
Egypt, Arab Rep.	Abu Talat Zafarana
France	Marseille
Greece	Chania
India	Mumbai
Italy	Bari
Malaysia	Kuala Kurau
Myanmar	Ngwe Saung
Oman	Al Bustan
Pakistan	Karachi
Qatar	Doha
Saudi Arabia	Jeddah
Thailand	Satun Songkhla
United Arab Emirates	Fujairah
Vietnam	Vung Tau
Yemen, Rep.	Aden

CABLE NAME	ASIA AFRICA EUROPE-1 (AAE-1)	
Length	25,000 km	
RFS date	2017	
Owner	China Unicom, Telecom Egypt, Etisalat, Omantel, Djibouti Telecom, OTEGLOBE, Pakistan Telecommunications Company Ltd., PCCW, Ooredoo, Mobily, Viettel Corporation, TeleYemen, Retelit, Reliance Jio Infocomm, VNPT International, Metfone, Hyalroute, and TIME dotCom	
Capacity[94]	**2021 (Tbps)**	
	Total capacity	50
	Occupied capacity	17
Fiber pairs	5	
Wavelengths per fiber pair	100	
Capacity per wavelength (Gbps)	100	
Cost	USD 700 million	

SeaMeWe-5

LANDING POINTS	
Bangladesh	Kuakata
Djibouti	Haramous
Egypt, Arab Rep.	Abu Talat Zafarana
France	Toulon
Indonesia	Dumai Medan
Italy	Catania
Malaysia	Melaka
Myanmar	Ngwe Saung
Oman	Qalhat
Pakistan	Karachi
Saudi Arabia	Yanbu
Singapore	Tuas
Sri Lanka	Matara
Turkey	Marmaris
United Arab Emirates	Mujairah
Yemen, Rep.	Al Hydaydah

CABLE NAME	SEAMEWE-5	
Length	20,000 km	
RFS date	2016	
Owner	Telekom Malaysia, Bangladesh Submarine Cable Company Limited (BSCCL), China Mobile, China Telecom, Orange, Myanmar Post and Telecommunication (MPT), Saudi Telecom, Sri Lanka Telecom, Telkom Indonesia, Singtel, Telecom Italia Sparkle, TeleYemen, China Unicom, du, Turk Telekom International, TransWorld, Ooredoo, Telecom Egypt, and Djibouti Telecom	
Capacity	**2021 (Tbps)**	
	Total capacity	26.6
	Occupied capacity	24
Fiber pairs	3	
Wavelengths per fiber pair	80	
Capacity per wavelength (Gbps)	150	
Cost	USD 700 million	

Europe India Gateway (EIG)

LANDING POINTS	
Djibouti	Haramous
Egypt, Arab Rep.	Abu Talat Zafarana
Gibraltar	Gibraltar
India	Mumbai
Libya	Tripoli
Monaco	Monaco
Oman	Barka
Portugal	Sesimbra
Saudi Arabia	Jeddah
United Arab Emirates	Fuhairah
United Kingdom	Bude

CABLE NAME	EUROPE INDIA GATEWAY (EIG)
Length	15,000 km
RFS date	2011
Owner	AT&T, Airtel (Bharti), Bharat Sanchar Nigam Ltd. (BSNL), BT, Djibouti Telecom, du, Gibtelecom, Libya International Telecommunications Company, MTN, Omantel, Altice Portugal, Saudi Telecom, Telecom Egypt, Telkom South Africa, Verizon, and Vodafone
Capacity[96]	**2021 (Tbps)** Total capacity 36.6 Occupied capacity N/A
Fiber pairs	3
Wavelengths per fiber pair	N/A
Capacity per wavelength (Gbps)	N/A
Cost	USD 700 million
Comment	Depending on the segment, the number of fiber pairs varies between two and four. In addition, the EIG cable reportedly had an initial designed system capacity of 3.84 Tbps in 2011. According to Ciena, the EIG gateway was upgraded with an additional 24.3 Tbps capacity in 2020.

East Africa Submarine System (EASSy)

LANDING POINTS	
Comoros	Moroni
Djibouti	Haramous
Kenya	Mombasa
Madagascar	Toliara
Mozambique	Maputo
Somalia	Mogadishu
Sudan	Port Sudan
South Africa	Mtunzini
Tanzania	Dar Es Salaam

CABLE NAME	EASTERN AFRICA SUBMARINE SYSTEM (EASSY)
Length	10,500 km
RFS date	2010
Owner	Botswana Fibre Networks, Telkom South Africa, Sudan Telecom Company, Telma (Telecom Malagasy), Tanzania Telecommunications Company Limited, Zambia Telecom, Mauritius Telecom, Vodacom DRC, MTN, Comores Telecom, Neotel, BT, Etisalat, Saudi Telecom, Orange, Airtel (Bharti), WIOCC, Djibouti Telecom, Telkom Kenya
Capacity	**2021 (Tbps)** Total capacity 11.8 Occupied capacity 5.18
Fiber pairs	2
Wavelengths per fiber pair	59
Capacity per wavelength (Gbps)	100
Cost	USD 248 million
Comment	The cable launched in 2019 with an initial lit capacity of 0.03 Tbps and was then upgraded to 0.19 Tbps in January 2012.

SEACOM/Tata TGN Eurasia

LANDING POINTS	
Djibouti	Djibouti City
Egypt, Arab Rep.	Zafarana
India	Mumbai
Kenya	Mombasa
Mozambique	Maputo
Saudi Arabia	Jeddah
South Africa	Mtunzini
Tanzania	Dar Es Salam

CABLE NAME	SEACOM/TATA TGN EURASIA			
Length	15,000 km			
RFS date	2009			
Owner	Tata Communications and SEACOM			
Capacity[96]		**2021 SEACOM (Africa-Egypt) (Tbps)**	**2021 Tata TGN-Eurasia (India-Europe) (Tbps)**	**2021 SEACOM (Africa-India) (Tbps)**
	Total capacity	6	6	6
	Occupied capacity	3	3	0.07
Fiber pairs	SEACOM (Africa-Egypt): 1 Tata TGN-Eurasia (India-Europe): 2 SEACOM (Africa-India): 1			
Wavelengths per fiber pair	SEACOM (Africa-Egypt): 60 Tata TGN-Eurasia (India-Europe): 47 SEACOM (Africa-India): 60			
Capacity per wavelength (Gbps)	SEACOM (Africa-Egypt): 100 Tata TGN-Eurasia (India-Europe): 100/150 SEACOM (Africa-India): 100			
Cost	USD 700 million			

SMW-3

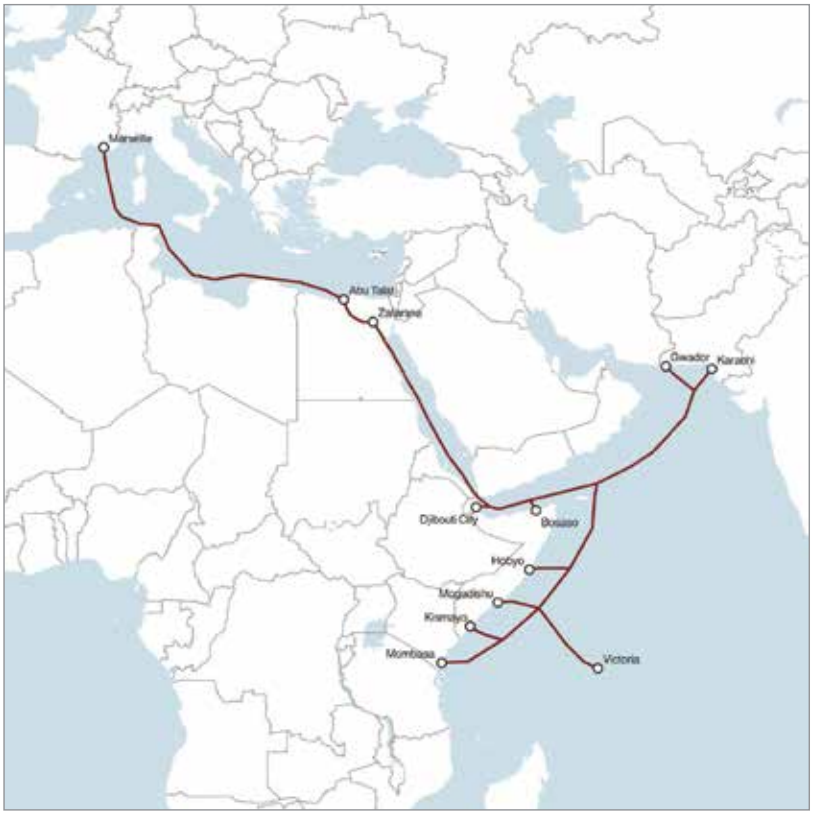
LANDING POINTS	
Australia	Perth
Belgium	Ostend
Brunei	Tungku
China	Deep Water Bay Shanghai Shantou Taipa
Cyprus	Yeroskipos
Djibouti	Djibouti City
Egypt, Arab Rep.	Alexandria Suez
France	Penmarch
Greece	Chania
India	Cochin Mumbai
Indonesia	Ancol Medan
Italy	Mazara del Vallo
Japan	Okinawa
Malaysia	Mersing Penang

LANDING POINTS	
Morocco	Tétouan
Myanmar	Pyapon
Oman	Muscat
Pakistan	Karachi
Philippines	Batangas
Portugal	Sesimbra
Saudi Arabia	Jeddah
Singapore	Tuas
Korea, Rep.	Geoje
Sri Lanka	Mt. Lavinia
Taiwan, China	Fangshan Toucheng
Thailand	Satun
Turkey	Marmaris
United Arab Emirates	Fujairah
United Kingdom	Goonhilly Downs

CABLE NAME	SEAMEWE-3	
Length	39,000 km	
RFS date	1999	
Owner	Orange, BT, KDDI. Singtel, Telecom Italia Sparkle, Telekom Malaysia, OTEGLOBE, AT&T, BICS, National Telecom, China Telecom, Deutsche Telekom, Etisalat, Telecom Egypt, CTM. Indosat Ooredoo, Jabatan Telecom Brunei, KT, Altice Portugal, Maroc Telecom, PLDT, Saudi Telecom, Sri Lanka Telecom, Turk Telekom, Tata Communications, Chunghwa Telecom, Verizon, KPN, Telekom Austria, Singtel Optus, Telstra, VNPT International, Omantel, PCCW, Pakistan Telecommunications Company Ltd., Cyta, eir, LG Uplus, Softbank Corp, Telkom South Africa, Rostelecom, Orange Polska, Telecom Argentina, Myanmar Post and Telecommunication (MPT), Vocus Communications, Djibouti Telecom, Embratel, Vodafone, Turk Telekom International, Ukrtelecom, and Tunisia Telecom.	
Capacity	**2021 (Tbps)**	
	Total capacity	0.755
	Occupied capacity	0.755
Fiber pairs	2	
Wavelengths per fiber pair	N/A	
Capacity per wavelength (Gbps)	10/40/100	
Cost	USD 1.173 billion	

PLANNED SYSTEMS

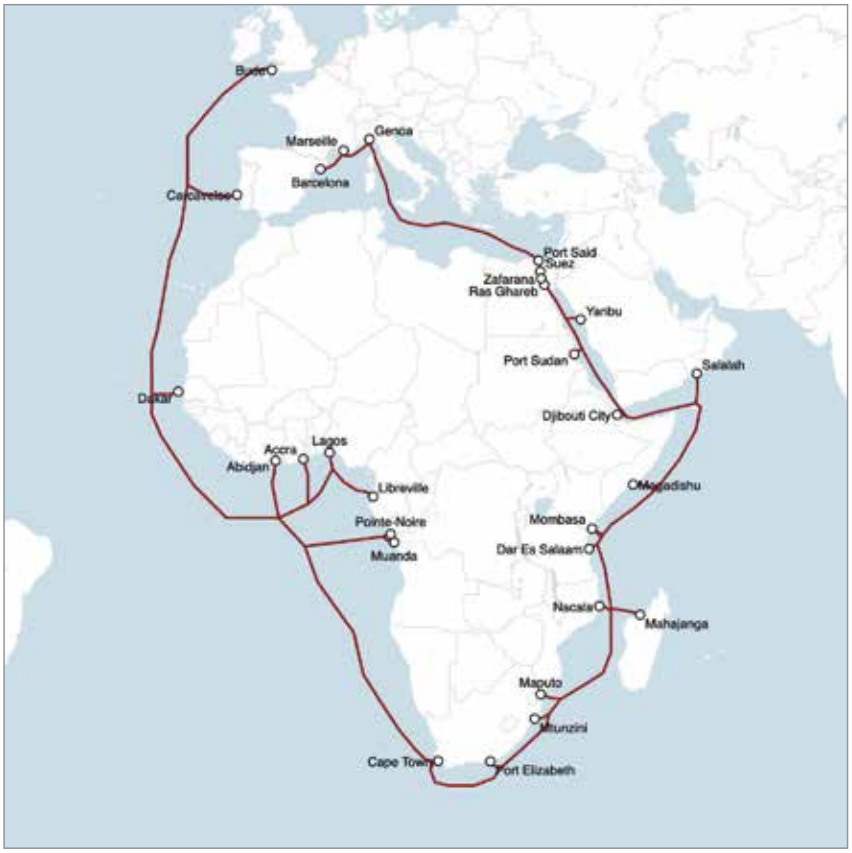
PEACE Cable



LANDING POINTS	
Cyprus	Yeroskipos
Djibouti	Djibouti City
Egypt, Arab Rep.	Abu Talat Zafarana
France	Marseille
Kenya	Mombasa
Pakistan	Gwadar Karachi
Seychelles	Victoria
Somalia	Bosaso Hobyo Kismayo Mogadishu

CABLE NAME	PEACE CABLE	
Length	15,000 km	
RFS date	2022 Q1	
Owner	Peace Cable International Network Co. Ltd.	
Capacity	**2021 (Tbps)**	
	Total capacity	96
	Occupied capacity	N/A
Fiber pairs	6	
Wavelengths per fiber pair	80	
Capacity per wavelength (Gbps)	200	
Cost	USD 425,000,000	
Comment	Note that initially proposed landings in Hobyo and Kismayo have been removed from the system.	

2Africa



CABLE NAME	2AFRICA	
Length	37,000 km	
RFS date	2023	
Owner	Meta, Vodafone, MTN Group, China Mobile, WIOCC, Orange, Telecom Egypt, Saudi Telecom Company	
Capacity	**2021 (Tbps)**	
	Total capacity	180
	Occupied capacity	N/A
Fiber pairs	16	
Wavelengths per fiber pair	N/A	
Capacity per wavelength (Gbps)	N/A	
Cost	USD 9.25 million	

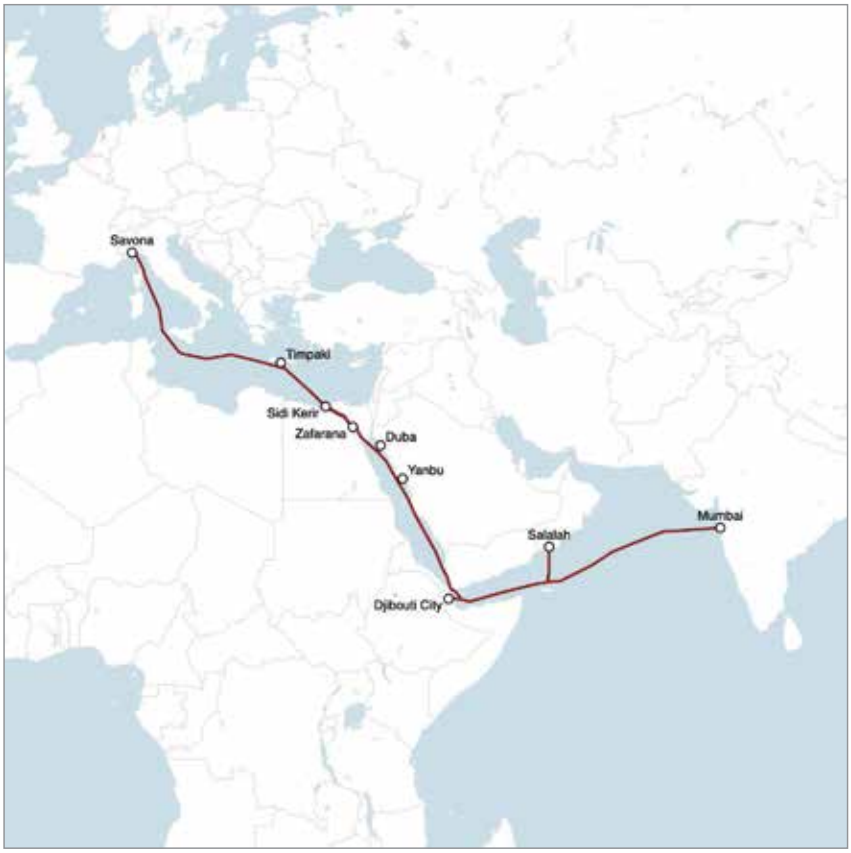
LANDING POINTS	
Angola	N/A
Comoros	N/A
Congo, Dem. Rep.	Muanda
Congo, Rep.	Pointe-Noire
Côte d'Ivoire	Abidjan
Djibouti	Djibouti City
Egypt, Arab Rep.	Ras Ghareb Suez Zafarana
France	Marseille
Gabon	Libreville
Ghana	Accra
Italy	Genoa
Kenya	Mombasa
Madagascar	Mahajanga
Mozambique	Maputo Nacala
Nigeria	Lagos
Oman	Salalah
Portugal	Carcavelos
Saudi Arabia	Yanbu
Senegal	Dakar
Seychelles	N/A
Somalia	Mogadishu Berbera
Spain	Barcelona
Sudan	Port Sudan
South Africa	Cape Town Mtunzini Port Elizabeth
Tanzania	Dar Es Salaam
United Kingdom	Bude

Africa-1

LANDING POINTS	
Algeria	Béjaïa
Djibouti	Djibouti City
Egypt, Arab Rep.	Port Said Ras Ghareb
France	Marseille
Italy	Palermo
Kenya	Mombasa
Pakistan	Karachi
Saudi Arabia	Duba
Somalia	Berbera
Sudan	Port Sudan
Tunisia	Bizerte
United Arab Emirates	Kalba
Yemen, Rep.	Mocha

CABLE NAME	AFRICA-1	
Length	10,000 km	
RFS date	2023 Q4	
Owner	Etisalat, G42, Mobily, Pakistan Telecommunication Company, and Telecom Egypt	
Capacity	**2021 (Tbps)**	
	Total capacity	192
	Occupied capacity	N/A
Fiber pairs	8	
Wavelengths per fiber pair	N/A	
Capacity per wavelength (Gbps)	N/A	
Cost	USD 250 million	

Reliance Jio India-Europe-Express (IEX)



LANDING POINTS	
Djibouti	Djibouti City
Egypt, Arab Rep.	Sidi Kerir Zafarana
Greece	Timpaki
India	Mumbai
Italy	Savona
Oman	Salalah
Saudi Arabia	Duba
Somalia	Yanbu

CABLE NAME	RELIANCE JIO INDIA-EUROPE-EXPRESS (IEX)	
Length	9,755 km	
RFS date	2024	
Owner	Reliance Jio Infocomm (additional owners have yet to be disclosed)	
Capacity	**2021 (Tbps)**	
	Total capacity	210
	Occupied capacity	N/A
Fiber pairs	13	
Wavelengths per fiber pair	N/A	
Capacity per wavelength (Gbps)	100	
Cost	N/A	