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INFRASTRUCTURE WORKING GROUP

DIGITAL INFRASTRUCTURE FINANCE

Issues, Practices and Innovations

G20 Compendium of Case Studies

September 2022

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Edited by Ivan Rossignol and Luke Jordan

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AIIB Headquarters, Tower A, Asia Financial Center
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Table of Contents

Abbreviations

ADB	—	Asian Development Bank
AIIB	—	Asian Infrastructure Investment Bank
APPI	—	Act on the Protection of Personal Information
DI	—	Digital Infrastructure
GDP	—	Gross Domestic Product
G20	—	Group of 20
GDPR	—	General Data Protection Regulation
IADB	—	Inter-American Development Bank
ICT	—	information and communication technology
IsDB	—	Islamic Development Bank
ITU	—	International Telecommunication Union
MDB	—	Multilateral Development Bank
OECD	—	Organisation for Economic Co-operation and Development
PIPA	—	Personal Information and Protection Act
PPP	—	Public-Private Partnership
PSN	—	Pasifik Satelit Nusantara
UN	—	United Nations

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- **Backhaul—SATRIA-1, Indonesia** by Asian Infrastructure Investment Bank (AIIB) and Pasifik Satelit Nusantara Group PT, with support from the Indonesian Government
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- **Submarine Cable, Bangladesh & Djibouti** by Islamic Development Bank
- **Fiber Access—Oman** by Asian Infrastructure Investment Bank (AIIB)
- **Fiber Access—Dominican Republic** by Inter-American Development Bank (IADB)
- **Fiber Access—Nicaragua Republic** by Inter-American Development Bank
- **Rural Broadband—Italy** by the Government of Italy
- **Remote Broadband—European Union** by the European Commission
- **The View from the Private Sector: Data Centers in China, Korea and Nigeria** by ACTIS
- **Soft Digital Infrastructure—Madagascar** by the World Bank
- **Community Networks—India PM-WANI** by the Digital Empowerment Foundation, India

Executive Summary

It is now generally accepted that digital infrastructure has been critical to the resilience of the global economy in recent years and will be a major driver of global growth and enabler of social equity tomorrow. Yet, as technological developments have radically changed our society, the financing landscape for how digital infrastructure is financed as an asset class, has too.

Over the past 20 years, the market dynamics have shifted radically with a rebalancing of the roles between the public and the private sector. The infrastructure supply now responds directly to technological advances in the mobile handset market as well as changes in applications and underlying technology, and not overly to the universal access objectives of governments. This situation has led governments to address complex market failures, with limited public resources.

Yet, digital infrastructure financing is still characterized by a lack of best practice approaches in the use of financial instruments and in managing regulatory risks, such as data privacy or cybersecurity. As the sector is facing a rapidly expanding and unmet financing demand, a more informed approach to structuring transactions is required. This is the proposed additionality of this compendium: to become a resource for any government seeking ideas on how to facilitate the financing and development of cost-efficient and better-quality digital infrastructure.

Through the analysis of case studies provided by G20 members, multilateral banks, and development finance institutions, as well as the input from high level experts who participated in the G20 Bali High Level Seminar on Digital Infrastructure, this Compendium provides a view as to what the issues, practices and innovations are in digital infrastructure financing today. The cases cover a wide range of regions, instruments and objectives: from the launch of a satellite in Indonesia to micro-providers in remote villages in India, from cross-border transmission and fiber optic lines in Southern Africa to first-loss funds in Europe. Each of the cases is fitted to its context, but each also has elements that might be replicated. Those elements are identified in the cases, and considerations for replication identified, as well as common themes analyzed.

The conclusions that emanate from this analysis are the following:

- The level of innovation in transactions and strategies fundamentally depends on some critical factors, including, (i) the implementation status of a country's universal coverage strategy, (ii) a well-established and transparent regulatory regime, (iii) the legacy and status of the network structure. As in other infrastructure classes, the risk level and expected returns influence the structure of the financing too.

- Some governments are showing a striking level of innovation in their use of financial tools; by comparison, the private sector toolkit remains quite static. The toolkit used by governments includes, *inter alia*, lowest subsidy auctions

for rural connections, universal service fund backed public private partnerships, time-limited demand vouchers, open-source and free platforms for communities. This innovation level is the result of governments having had to manage a complex equation of limited resources, growing digital divides, and numerous exogeneous constraints.

- The question of the appropriate level and direction of subsidies is not solved. This impacts governments' ability to allocate resources optimally. The lack of a common metric used across projects, such as the cost of connecting additional household, makes any comparison exercise nearly impossible. Economic return analysis are often not available, hence making the right-sizing of subsidies difficult and not necessarily transparent. Developing benchmarks and transparent comparisons on, for example, last-mile subsidy levels across different instruments, could be a useful public good for multilateral organizations and forums to develop.

- Synergies with other infrastructure sectors allow for significant financial and environmental savings. Some case studies demonstrated the efficiency of associating digital infrastructure to power lines or to urban developments and health and education facilities.

- Institutional arrangements remain critical to the success of projects. The most ambitious cases found ways to blend multiple funding sources and deploy them quickly by matching their constraints to different components and contexts. Yet the perceived strength of country-level institutions but also of providers of public finance, including multilateral banks, informed the level of risk instruments deployed.

- A state of play review of data governance in G20 countries shows that there might be some level of convergence on data privacy regulations emerging now, with countries recognizing same basic principles such as fundamental rights and purpose limitation. Countries are also broadly using the same definition of what constitutes data and data processing operations. The complexity of regulations may however raise the issue of cost of compliance, especially for small- and medium-sized firms.

- The speed of innovation has introduced new risks and vulnerabilities that are now difficult to ignore in transactions. The recent wide-ranging cyberattack in Costa Rica is a strong reminder that policy makers need to focus on cyber security and projects include components that help strengthen capacity and protections systems.

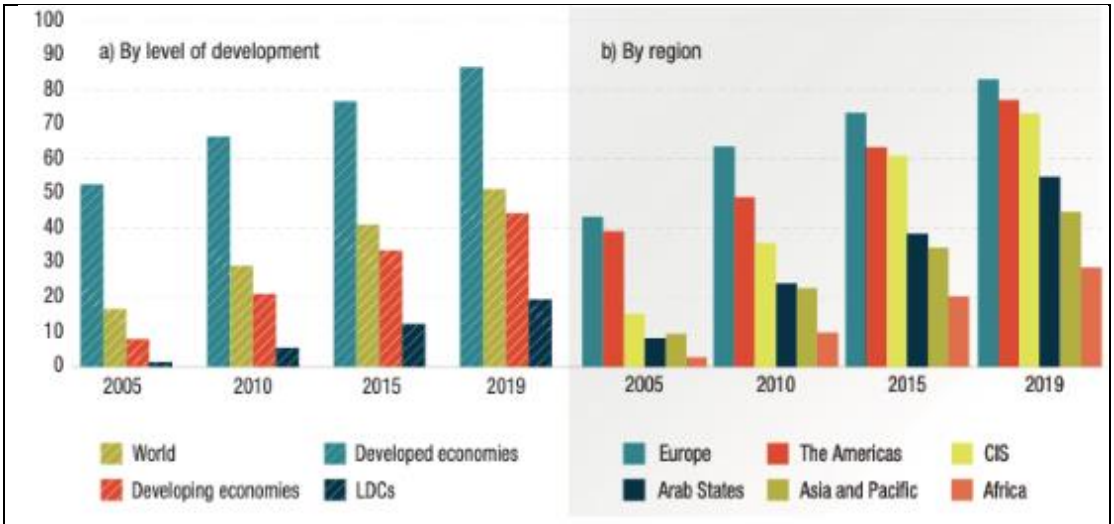
The case studies that are attached to this compendium show a wide variety of examples of innovative finance in all regions of the world. Many of the financing features are replicable beyond their regional or project context. We think that multilateral banks, play a critical role in helping achieve this, by using their capacity to promote financial innovation, and mobilize more resources to the digital infrastructure sector. We also believe that the G20 and other global forums will continue to play a

critical role in developing exchanges of knowledge and critical information, in the continued pursuit of eliminating the digital divide.

Background

Digital technologies contribute to growth.[1] The accumulation of information and communication technology (ICT) capital amounted to almost 20 percent of global growth during the period 1995-2014 (World Bank, 2016, p. 55). It is estimated that the footprint of the digital economy can range to up to 22.5 percent of global gross domestic product (GDP) (United Nations Conference on Trade and Development [UNCTAD]; Knickrehm et al, 2016).[2] In 2017, up to 44 percent of total jobs in the Group of Twenty (G20) were provided in high and medium-high digital-intensive sectors (Organisation for Economic Co-operation and Development [OECD], 2020)[3].

Figure 1: Global Internet Use, by Level of Development and Region, Selected Years (%)



Source: UNCTAD, based on ITU Statistics database, available at www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx.
Notes: Country groups are those of the source.

CIS = Commonwealth of Independent States, LDC = least developed country.
Source: United Nations Conference on Trade and Development (2021), Figure 1.7.

[1] Measurement referring to the size of the digital economy or the size of Digital Infrastructure vary quite significantly depending on the definition and methodology used.
[2] Knickrehm, M., Berthon, B., & Daugherty, P. (2016). *Digital disruption: the growth multiplier*. Dublin: Accenture. The definition includes the spillover effects of digital infrastructure as an economic sector.
[3] "A roadmap toward a common framework for measuring the digital economy", Report for the G20 Digital Economy Task Force, OECD, 2020, page 76

During the coronavirus disease (COVID-19) crisis, demand for broadband soared in G20 countries due to confinement measures and teleworking, with a net increase of up to 47 percent in total bandwidth produced by individual countries at internet exchange points in the first quarter of 2020 (OECD, 2020)[4]. Yet, the crisis also exposed the limitations of existing digital infrastructure networks and revealed the vulnerability of the unconnected who represented nearly 40% of the global population in 2021[5].

As the world is slowly emerging from the COVID-19 crisis, it is now generally accepted that digital infrastructure has been critical to the resilience of the global economy in 2020-2022 and will be a major driver of global growth and provider of social equity tomorrow. Quality internet access and digital platforms allow for remote work, distance learning, distance medicine and provision of social services. The need for more, better and affordable broadband services is now higher than ever.

The sector is characterized by old and new divides. In 2020, the penetration rate of telephony and broadband in developed countries was double that of developing countries and four times that of least developed countries (LDCs). As much as 23 percent of the population in LDCs had no access to the internet. According to the 2020 ITU's report "The State of Broadband: Tackling Digital inequalities"[6], the gender gap is measured at 17 percent globally, but is more significant in Asia, the Middle East and Africa. The cost of a broadband subscription is 50 percent more expensive in Africa than in Asia. Download speeds can vary up to 70 percent between urban and rural areas in G20 countries (Broadband Commission, 2020). Digital skills are necessary for the full effect of digital infrastructure on productivity, employment and inclusion, but only 30 percent of the global population has digital proficiency (Broadband Commission, 2020).

The remarkable technological progress that marks the development of the internet has also demonstrated the downsides of ever-expanding connectivity. These include privacy infringements, cybercrime, inequitable biases in some artificial intelligence systems and market over-dominance.

More relevant investments for affordable and high-quality internet and connectivity-for-all are necessary. This will require effort from both the public and the private sectors

[4] "A roadmap toward a common framework for measuring the digital economy", Report for the G20 Digital Economy Task Force, OECD, 2020, page 12

[5] "Measuring Digital Development, Facts and Figures", International Telecommunication Union [ITU], 2021, page 1

[6] "The State of Broadband: Tackling Digital inequalities, A decade for actions", September 2020, International Telecommunication Union and United Nations Educational, Scientific and Cultural Organization

to leverage and optimize resources, but also do so in a way that protects people's fundamental rights and gives them equal access and opportunities.

The main objective of this compendium is to discuss different models of digital infrastructure financing, through examples from the private and the public sectors.

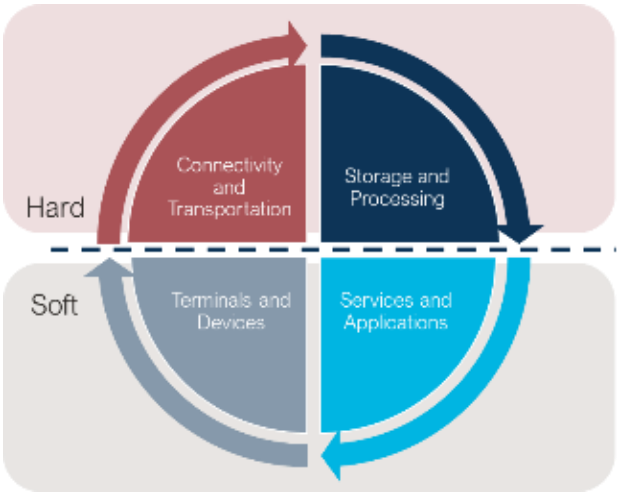
Box 1. Definitions

Lenders do not identify "digital infrastructure" as one economic sector or asset class but several. The taxonomy can differ widely among lenders. For the purpose of this compendium, digital infrastructure is defined as hard infrastructure and soft infrastructure (**Error! Reference source not found.**). Hard infrastructure includes all elements that help connectivity and transportation of data, as well as storage and processing of this data. Soft infrastructure includes services and applications (defined at large) and terminals and devices.

Hard infrastructure includes optical fiber networks, optical ground wires, satellite and towers, cross-border links and adjunct physical infrastructure—which help establish the connectivity of the whole digital infrastructure ecosystem—as well as processing and storage data centers, data repositories, cloud computing providers, content delivery network providers and Internet Exchange Points (IXPs).

Soft infrastructure includes services and applications as well as terminals and devices that are used to optimize all infrastructure sectors. Soft infrastructure would therefore include, but not be limited to, Infratech in this definition[7].

Figure 2: Hard vs. Soft Infrastructure



Source: Asian Infrastructure Investment Bank.

[7] Infratech is defined in the Riyadh G20 InfraTech Agenda: "Infratech can be described as the integration of material, machine and digital technologies across the infrastructure cycle."

Rationale for the Compendium

Previous G20 initiatives have highlighted the importance of digital infrastructure as a key driver of productivity, connectivity, social opportunity and economic growth.

The roadmap under Japan's 2019 Presidency highlighted the importance of quality infrastructure investments and emphasized the role of innovative technology solutions.[8] Saudi Arabia's 2020 Presidency allowed further emphasis on the critical role of infra-tech to help increase the efficiency of assets and capital mobilization[9]. While the COVID-19 pandemic led to a re-focusing of the agenda on health, debt sustainability and economic recovery issues, the Italian 2021 Presidency nevertheless stressed the importance of digital infrastructure as a critical factor for resilience and prosperity[10].

The number of reports covering digital infrastructure is also growing (**Error! Reference source not found.**). These includes the World Bank's *World Development Report 2021: Data for Better Lives* (2021), which provides a comprehensive view of all the issues associated with the development of a digital economy. Meanwhile, the European Bank for Reconstruction and Development (EBRD) *Transition Report* covering the period 2021-2022 focuses on delivering a digital dividend and calls for more investment as it sees divides increasing (2022). In October 2021, the United Nations (UN) Broadband Commission and the G20 issued a toolkit on *21st Century Financing Models for Bridging Broadband Connectivity Gaps*, while the Italian G20 Presidency, with the support of the OECD, issued the *G20 Guidelines for Financing and Fostering High Quality Broadband Connectivity for a Digital World* (2021). These toolkits and guidelines provide, *inter alia,* definitions and a broad method to structure financing.

Despite the multiplication of reports, digital infrastructure financing is still characterized by a lack of best practice approaches in the use of financial instruments and in managing regulatory risks, such as data privacy or cybersecurity. As the sector is facing a rapidly expanding and unmet financing demand, a more informed approach to structuring transactions is required.

This context helps frame the additionality of this compendium. As identified by the Indonesian G20 Presidency and the G20 Infrastructure Working Group, there is a need to better document successful cases of innovating finance at the country and regional level to allow for the emergence of good practices: the compendium can become a resource for any government seeking ideas on how to facilitate the financing and development of cost-efficient and better-quality digital infrastructure.

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[8] G20 Osaka Leaders Declaration, 2019.
[9] G20 Riyadh Leaders Declaration, 2020.
[10] G20 Rome Leaders Declaration, 2021.

Figure 3: Illustrative Examples of Recent Reports on Digital Infrastructure

Sources: European Bank for Reconstruction and Development (2022), Italian G20 Presidency (2021), World Bank (2021), International Telecommunication Union (2022)

Analytical Framework

The analytical approach proposed in this compendium consists of (a) the conclusions of the G20 high-level seminar on Digital Infrastructure in Bali,[11] (b) analysis of selected case studies of digital infrastructure financing to identify which are specific and replicable beyond the geographic or political economy context of each transaction and (c) inferences from a combination of these top-down and bottom-up approaches (**Error! Reference source not found.**).

The case studies presented here have been self-selected by G20 members and multilateral bank partners. As such, they do not constitute a representative sample of case studies in digital infrastructure financing. Because of the size of the sample as well as the specificity of each case, the authors compared some of the lessons learned with the higher-level points shared by the global experts and scholars who participated in the Bali high-level seminar.

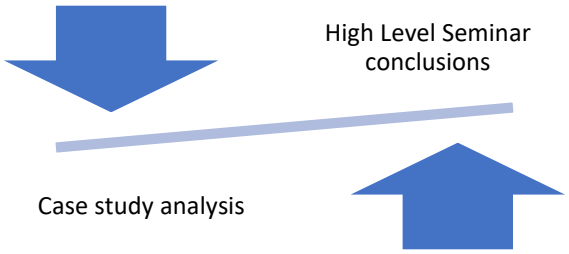
Each case study analysis discussed the context of the transaction, its claimed impact and the nature of its financing. Contributing G20 members and multilateral bank partners used the following guide questions in preparing the case studies:

(a) What part of the financing model used in the case is (or was) different from business-as-usual in financing digital infrastructure?
(b) What market structure or regulation or other context allowed the financing or the innovation?
(c) What do stakeholders in other countries need to consider fitting any innovation in the financing structure to their context?
(d) What is replicable beyond the local context in which the transaction was successfully concluded?

This compendium is the outcome of this process. Several themes emerged from the analysis, which go beyond the strict boundary of the choice of financing type or instrument and yet are critical to successful financing models. Examples include the respective roles of the private and public sectors, the role of multilateral banks as financiers, data governance issues and cybersecurity issues.

[11] The high-level seminar on “Digital Infrastructure—Closing the Digital Divide” was held in Bali, Indonesia on June 9, 2022.

Figure 4. Analytical Framework



Source: Asian Infrastructure Investment Bank.

The 10 case studies are organized by segments of digital infrastructure, with an additional contribution from the private sector comparing cases of three data centers, to provide a comprehensive view of the various financing techniques that are applied. Starting from “hard infrastructure,” i.e., backhaul connections such as satellite, submarine cable, cross-border fiber optic then general fiber networks and data, then following with “soft infrastructure" and finally to the last mile, with community networks and rural shops as Wi-Fi access points.

The sample covers a wide range of regions, instruments and objectives: the first case is the launch of a satellite in Indonesia and the last case turns shop owners into digital infrastructure providers in remote villages in India.

What Is Innovative in Financing Digital Infrastructure?

From ICT to Digital Infrastructure Finance

The financing of digital infrastructure has changed as the digital world has itself evolved. In the age of fixed line telephony, the enormous capital requirements of even a modest size network suggested state or quasi-state monopolies. Universal coverage was a function of state capacity, planning, regulation, and the ability to manage state-owned firms. Capital and funding were primarily public, or quasi-public.

With mobile, the network became more modular and each new or upgraded base station could fund the next one[12], with large-scale leverage and balance sheet management enabling the rapid build out of hundreds and then thousands of such base stations. Profitable areas were so lucrative, and roll-out to low-income areas so easy to implement and monitor, that simple cross-subsidy mechanisms like universal service obligations and universal service funds helped cover funding gaps.

Simple but effective regulatory models spread, and the sector became dominated by large multinational companies with a common set of skills (balance sheet management, complex pricing). Firms worked with a common regulatory regime. Outside of a few economies, the result was fast growth of telephony connectedness towards universal coverage, if at varying quality levels.

Today, the landscape of financing digital infrastructure is more complex. The market dynamics have shifted with the infrastructure supply, now responding directly to technological advances in the mobile handset market. The main growth objective of smartphone manufacturers is not to reach universal coverage but to be supported by an infrastructure network that allows the development of attractive new applications to drive consumer demand. The form of investors has also changed. From a majority of state-owned enterprises mostly focused on creating infrastructure cable loops to connect devices, there are now various forms of private sector actors that can be grouped around device manufacturers, virtual applications providers (e.g., games, cloud services), social platforms, logistics and online trading platforms. This has contributed to the blurring of the lines on whose responsibility it is to attain universal service or broadband for all, and how this is financed.

The cost of bringing broadband to the last 10 percent of households is up to three times higher than to the first 66 percent (Inter-American Development Bank, 2022[13]), and those households will have limited ability or appetite to pay, even in advanced

[12] The deployment of base stations also included backbone and other technical elements

[13] Cited from the G20 3rd IWG High Level Seminar on Digital Infrastructure, Bali, June 9, 2022

economies. The giant internet platforms capture much of the value from profitable users, but often do not pay into universal service funds. Even when they bring subsea cables to countries, they will usually not bring 'fiber to the hinterland'. Modern applications, both for business and users, require data centers, content delivery networks, and other layers, which are simple to fund on one side of the digital divide, and much harder on the other.

This situation is leading to a redefinition of the roles between the public and the private sector as planners and financiers. Bridging the digital divide requires the public sector to address complex market failures, while managing the risk of overly subsidizing highly profitable subsectors of the digital economy and deploying scarce fiscal resources, requiring innovations in financing instruments as well as greater capacity to regulate, plan and monitor. This background—the evolution of digital infrastructure and of the roles within it—explains some of the innovations that are taking place in financing techniques, as well as the shifting balance between the private and the public sector.

Factors Influencing Digital Infrastructure Finance

The following factors guide the availability and structure of digital infrastructure financing.[14, 15] Addressing these often drives the level of innovation in transactions:

(a) **Universal coverage strategy**. Organizations like the International Telecommunication Union (ITU) have brought the adoption of country-level strategies to attain universal coverage to the forefront. While not an obligation, priorities on infrastructure deployment derive from these strategies, and these strategies shape the feasibility (and in many cases, bankability) of projects.

(b) **A well-established and transparent regulatory regime**. As with other infrastructure sectors, the stability of the regulatory regime and dependent institutions greatly influence the level of direct investments. Most countries are now in a catch-up phase where old regulations are substituted with new ones to adapt to the new digital economy dynamics. Implementation track-records are still unclear in most countries or regions and most regulatory institutions

[14] The G20 Guidelines for Financing and Fostering High Quality Broadband Connectivity for a Digital World, published under the Italian Presidency in 2021, with the support of the OECD, highlight three main guidelines: (a) acknowledge the important role of private investment and ensure related adequate financing opportunities, (b) optimize the domestic enabling environment and financial framework to attract investments in connectivity through appropriate regulatory frameworks and (c) increase coordination and collaboration between the public and the private sector and other stakeholder groups and facilitate the sharing of good practice and successful models.

[15] Some of these principles were revealed at the G20 high-level seminar on "Digital Infrastructure: Closing the Digital Divide" in Bali, Indonesia on June 9, 2022.

still need capacity building. This affects the level of investment as well as the structure of the financing.

(c) **Existing network structure.** The manner in which initial fixed broadband networks have been structured or spectrum has been awarded will strongly influence the way new networks can be deployed. This also includes the interoperability of equipment or networks and the ease with which one operator can use equipment and network deployed by a previous operator, as well as the regulatory or legal changes that are necessary to support the development of new technologies.

(d) **Expected returns and risk assessment**. What is specific to digital infrastructure is that the risk spectrum seems to be wider than in other infrastructure asset classes. This reflects the large range of activities covered under the label "digital infrastructure," as well as the unique challenge posed by the rapid expansion of broadband, the multiple asset classes and limitless exogeneous factors that apply. The general trend seems to indicate generally lower returns and higher risks than in the previous decade.

Emerging Narrative on the Main Issues of Digital Infrastructure Finance

The toolkit for public financing is evolving, with perhaps more innovation than in the private sector

The cases in this compendium show a striking diversity of tools for public action. Lowest-subsidy auctions for rural connections; universal service fund backed public-private partnership (PPP) structures; turning state connectivity into wholesale networks open to private retail operators to extend them to the last mile; time-limited and real-time monitored broadband vouchers; licensing exemptions and common discovery and payment platforms for micro-providers—all find a place in this compendium, and are relatively new (Table 1).

By comparison, the private sector toolkit remains quite static. The combination of telco operators' balance sheet management, asset recycling and spin-offs, and the blend of debt and equity per asset class remains very similar to that found in the early 2000s and also similar to that of other infrastructure asset classes such as traditional energy.

That greater innovation in the public sphere indicates the current push toward more broadbanding driven by the state and, perhaps, an emerging market failure in the private sector that would need to be further understood to facilitate more financial mobilization.

Table 1. Comparing Public and Private Sector Instruments in Case Studies

Public Sector Instruments	Private Sector instruments

• Traditional subsidies (equity and debt) and grants • Direct build (via SOE or budget) • Debt guarantees • Universal fund payments or offtake guarantees • First-loss risk taking layer in private equity funds • Lowest subsidy auctions • Leveraging adjacent-sector greenfield projects • Leveraging public service sites (health, education) for wholesale network nodes and public access points • Demand-stimulus vouchers • "Soft" public goods (payment, access gateways) • PPPs	• Equity (private and corporate) • Corporate debt (e.g., telco operator balance sheet management) • Project-level equity and debt (e.g., VC, data centers) • Consortia (e.g., submarine cables) • Asset spin-offs and carve-outs (e.g., towers) • PPPs

PPP = public-private partnership, SOE = state-owned enterprise, VC = Venture Capital.
Note: This list is not exhaustive.
Source: Asian Infrastructure Investment Bank.

The appropriate level and direction of subsidies remain critical questions

The question of how much should be subsidized or regulated requires careful calibration in each context. Public financing and project-specific regulatory action is often used to overcome market failures, especially when it is designed to reduce the digital divide. Direct supply and demand subsidies, implicit subsidies in PPP structures, direct public provision, tied-debt structures, and obligations in spectrum auctions—all are used, and all contain some level of implicit or explicit subsidies.

The analysis of the case studies did not allow, however, clear demonstrations that the subsidy level was optimal (as measured in terms of economic return). A systematic use of economic return analysis in digital infrastructure projects should allow increasing transparency and enable the government to adequately calibrate its support to the private sector, to achieve development objectives.

Some structural features in digital infrastructure make such calculations and comparisons both more complex and, arguably, more critical than in some other sectors. The cost of connecting an additional household depends crucially on the existing network. Therefore, estimating and comparing input costs is much harder. In addition, limited numbers of operators may create risks, in bidding on lowest-cost subsidy auctions or in providing information on costs and quality.

Several cases in this compendium have introduced innovations to try address these challenges, such as dropping barriers to entry for retail operators to enable greater competition in bidding, as well as making tender processes more systematic and easily comparable. On this, fostering a more transparent transactions context seems critical to achieve appropriate public cost savings and yet reach broadbanding objectives.

A reference to the renewable energy sector may be useful. For instance, the feed-in-tariff auctions structure, used to guarantee a fixed price for the electricity that is fed to the grid, allowed to establish a comparison basis across time and across countries. A similar structure could be considered for digital infrastructure.

Synergies with other infrastructure and public services allow for significant financial and environmental savings

Digital infrastructure financing can be much more efficient when combined with other forms of infrastructure, or other services. In the example of the Mozambique-Malawi fiber optic lines, the basic infrastructure for transmission is used for the expansion of the digital network. Similarly, using industrial zones to set up data centers, allows concentration of power supply and reduced costs, while serving new objectives such as data location requirements.

The gains measure in significantly reduced financial costs since capital expenditures are shared between two or multiple projects. The gains also accrue in the ability to lower the environmental impact of the infrastructure and save associated costs such as environmental and social safeguards impact analysis and mitigation plans. In the Mozambique-Malawi case, the clearing of the area to erect supporting transmission towers is reduced thanks to the synergy found between the two projects. Using less supporting infrastructure, such as towers or ducts, also translates in a lower carbon footprint.

The synergies offer new and surprising opportunities too. In the Mozambique-Malawi case, as in some others, a power distribution company obtained a license to function as a telco.

Institutional arrangements remain critical to the success of projects

The different contexts in which digital infrastructure must be financed and its many different technical components can be a burden of complexity. The most ambitious cases found ways to blend multiple funding sources and deploy them quickly by matching their constraints to different components and contexts. This is the case of the Indonesia Satellite Satria 1 as well as the Italy Ultra Broadband Case. Such cases place significant demands on institutional capacity, though typically in the form of relatively small but experienced and credible coordinating teams, rather than large bodies.

The level of capacity displayed by ministries and regulatory bodies also impacts the financing models. The differences in perception of the capacity of the government or the private sector counterpart can affect the choice of financing instruments, and may lead to the use of guarantees and counter guarantees to secure financial flows: cross-government guarantees appear in some cases (e.g., the subsea cable connecting Bangladesh and Djibouti, among other countries). This is also affecting the allocation of resources regionally, with some regions benefitting from a large influx of capital (i.e., East Asia) while other regions do not benefit from such an appeal (e.g., South Asia, Africa).

There is some indication that perceptions of risk leads to a tiering of institutions or government sources. This not only includes countries and private lenders but also multilateral banks. Second- or third-tier financiers will require more recourse instruments or guarantees than first-tier ones.

Some financing areas seem replicable beyond their geographic and political economy contexts

While each of the cases was implemented in a specific context, each one has elements that could be replicated in other contexts. Each case contains a specific discussion of its enabling context as well as what elements might be replicated and the necessary considerations when replicating. These are summarized in **Error! Reference source not found.**.

Table 2. Summary of Potentially Replicable Elements from Case Studies

Case Study Number	Name and Country	Main Instrument	Replicability Elements
1	Indonesia SATRIA-1 satellite	Availability payments (PPP), guarantees	Creative structure of cash flows and guarantees to de-risk and mobilize private sector capital while retaining some possible returns for public sector agencies
2	Mozambique and Malawi interconnector	DFI grants	Utilization of electricity transmission line to provide backhaul fiber optic
3	Bangladesh and Djibouti subsea cable branches	DFI loans and cross-national consortiums	Cross-consortium guarantees and governance structures; Islamic finance
4	Oman broadband access	Phased corporate lending facility (MDB and commercial)	Entailing cash-flow from profitable areas to repay debt from remote ones; phased de-risking of new entity

5	Dominican Republic broadband	DFI loan and capacity building	Improved monitoring capacity and use of reverse (lowest-bid) subsidy auctions
6	Nicaragua broadband	DFI loan and capacity building	Utilization of electricity network to create an additional wholesale network, with public service offices as anchor clients
7	Italy broadband	EU, national and regional grants and loans	Deployment of multiple instruments from pooled funding programs; uptake vouchers delivered via telcos
8	European remote broadband	EU budget, regional DFIs and private equity	Multilayered investment fund with MDB and public fund absorbing the highest risk, while retaining the public share of returns
9	Madagascar digital services	MDB grant	Dedicated digital services unit in government to address digital divide
10	India community network	National budget (with SOE and microenterprises)	Provision of open public goods; regulatory exemptions, implied subsidies, for community networks to develop

DFI = development financial institution, EU = European Union, MDB = multilateral development bank, PPP = public-private partnership, SOE = state-owned enterprise.
Source: Asian Infrastructure Investment Bank.

Future Directions

The main digital infrastructure financial market is now characterized by a strong supply asymmetry where some countries and projects attract an inordinate amount of financial resources while others require complex financial structuring and a large public funding element to move forward. This asymmetry cannot be easily solved, except by increasing institutional capacity both in the public and private sectors, strengthening regulatory arrangements and starting to analyze more systematically transactions to encourage innovation, risk management and optimal resource allocation.

It is suggested to develop a global mapping of instruments and of financial flows; and develop common indicators to identify cost allocation and terms of financing across financial markets. This step would contribute to correcting an asymmetry that affects the digital infrastructure financing market. In addition, it is suggested to more systematically use economic return analysis for transactions to better establish the most appropriate level of public funding.

Through appropriate planning across ministries, fiber network build-outs will become more effective as synergies are maximized with other infrastructure. The known cases

include synergies between the energy sector, the urban sector and digital infrastructure. In some cases, digital infrastructure build-up will need to be decentralized to limit project costs and meet financing availability: decentralized community networks may grow further and come to be prominent components in digital infrastructure. These synergies will develop as sponsors and public authorities have a better understanding of the economic returns of such synergies and balance these out against time and financial constraints. Finally, better coordination will allow better management of the ever growing environmental and social impacts of digital infrastructure.

Demand-side measures need to be developed to address critical digital divides issues. As raw access continues to spread, attention will also continue to shift to demand-side measures, including soft infrastructure and skills. The market may continue to shift, as some assets become at risk of being overbuilt (e.g., in some markets, data centers or transmission towers).

Regulations and regulatory practice may slowly converge globally. Data privacy and cybersecurity concerns now seem to have led to the development of fairly similar laws and regulations, when such developments happen. The track record of implementation, however, still varies widely country to country. High-level cooperation has already started between multilateral development banks in the form of the Digital Infrastructure Regulatory Risks (DIRR) Forum, which fosters knowledge sharing. The DIRR Forum is also facilitating the setting-up of a global regulations repository. This push at the multilateral level will help foster the emergence of good practices.

The cases suggest that roles between the public and the private sector have changed. The latest evolution may lead to an unusual situation where the private sector may need to expand its playbook on financial innovation to help achieve common objectives:

- **The private sector may no longer be driving innovation in financing**. The supply of low-risk transactions in mature markets, such as data centers in East Asia or fiber optic loops or towers in urban centers, may soon be exhausted, while digital markets may become more regulated even for very large multinational firms. This shift is disrupting the pace at which the sector has been growing, and the type of assets that have been financed. Without faster financial innovation on the side of the established private sector, new entrants may quickly disrupt this well-established market and challenge established financiers.
- **The public sector plays a leading role in this economic sector.** In many countries, the public sector is slowly reappearing as the driver of a digital strategy and ultimate arbiter of digital activity. Its role as a regulator has been strengthened with the emergence of new regulations in the European Union, Latin America and East Asia. New emphasis on reducing digital divides is also helping shift to more innovation in the use of financial resources. However, the picture is not homogeneous. Institutional capacity varies widely across countries, which leads to

a natural deselection of some countries that appear not competitive. This, in turn, affects the level of investments in basic hard digital infrastructure.

- **Multilateral development banks need to play a stronger role in this sector.** The lending and grant commitments of multilateral development banks (MDBs) to digital infrastructure are much lower than those of other infrastructure sectors. The commitment levels have, however, started to grow again. MDBs are used not only as last-resort financiers or guarantors but also as providers of innovative finance in complex project finance structures like with the Asian Infrastructure Investment Bank (AIIB) in Indonesia SATRIA-1 or in the submarine cable financed by the Islamic Development Bank (IsDB), or finally in the Dominican Republic project financed by the Inter-American Development Bank (IADB). MDBs play a unique role in bringing these innovations from one country or region to the other.

  MDBs may also be uniquely positioned to continue fostering the adoption of regulations at the country level, developing common benchmarks in digital infrastructure financing cost to allow draw cross-project and cross-country comparisons and helping evaluate the adequate amount of subsidy element in project financing to optimize finance mobilization.

Managing Regulatory Risks: Global Privacy and Data Protection Laws, A State of Play

by Dr. Gabriela Zanfir-Fortuna, Sr. VP of the Future of Privacy Forum

Countries around the world are adopting or are planning to adopt comprehensive data protection laws at an unprecedented pace. According to a recent study, since 1970 when the first data protection law was adopted in the German state of Hesse[16] - 157 countries have enacted data protection laws to date, 12 of which did so in 2021/2022.[17] Gartner predicted this year that 75 percent of the global population "will have its personal data covered under privacy regulations", by 2024.[18] At G20 level, 17 of 20 members have comprehensive privacy and data protection laws in place - some of them adopted in the past two years - like the laws in Brazil and China, with the remaining three members being in different stages of considering comprehensive privacy and data protection bills by their legislative bodies (Table 3).

Table 3: State of Play of Privacy and Data Protection Comprehensive Laws in G20

G20 Member	Comprehensive Data Protection Law or Bill	Notes
Argentina	Personal Data Protection Act 25.326 (2000)	A bill to update it was introduced in 2018, but with little traction in the legislature.
Australia	The Privacy Act 1988	Significantly amended in 2014 and 2017, and currently subject to a public consultation for major reform.
Brazil	General Data Protection Law (LGPD) (2020)	The Brazilian Constitution was amended in 2022 to introduce a distinct fundamental right to data

[16] Datenschutzgesetz [HE 1970]. GVBl. HE 1970 S. 625.

[17] Graham Greenleaf, "Now 157 Countries: Twelve Data Privacy Laws in 2021/22", (2022) 176 Privacy Laws & Business International Report 1, 3-8. The 12 countries which adopted laws in 2021 and 2022 are Rwanda, Zimbabwe, Zambia, Sri Lanka, British Virgin Islands, Belize, Mongolia, Belarus, Ecuador, Saudi Arabia, United Arab Emirates and Oman.

[18] "Gartner Identifies Top Five Trends in Privacy Through 2024" (2022), available at https://www.gartner.com/en/newsroom/press-releases/2022-05-31-gartner-identifies-top-five-trends-in-privacy-through-2024.

		protection.
Canada	Personal Information Protection and Electronic Documents Act (PIPEDA) (2000)	In June 2022, the Digital Charter Implementation Act was introduced as a bill to modernize and reform PIPEDA.
China	Personal Information Protection Law (PIPL) (2021)	China also introduced several articles on the protection of personal data in its new Civil Code (2021)
France	EU's General Data Protection Regulation (2018)	The first French Data Protection Law was adopted in 1979.
Germany	EU's General Data Protection Regulation (2018)	The first Federal German Data Protection Act was adopted in 1978.
India	Data Protection Act (JPC Report 2021)	India's Personal Data Protection Bill was introduced in 2019, but a vote in Parliament keeps being postponed. A Joint Parliamentary Committee (JPC) issued a Report with amendments in December 2021.
Indonesia	Personal Data Protection Bill (final draft introduced in January 2020)	The Bill is still under debate in Parliament. A regulation on data protection was passed (N. 20 on Protection of Data in Electronic Systems, 2016) The existing data protection regulatory landscape is fragmented.
Italy	EU's General Data Protection Regulation (2018)	The first data protection law of Italy was adopted in 1996.
Japan	Act on the Protection of Personal Information (APPI) (2013)	The APPI was substantially amended in 2015 and 2020, with the latest amendments entering into force in 2022.
Republic of Korea	Personal Information and Protection Act (PIPA) (2011)	PIPA was significantly amended in 2020.

Mexico	Federal Law on the Protection of Personal Data Held by Private Parties (2010) Federal Law on the Protection of Personal Data Held by Public Bodies (2017)	The protection of personal data is recognized as a distinct right by the Constitution of Mexico since 2009.
Russia	The Russian Federal Law on Personal Data (2006, as amended in 2020)	Russia was excluded this year from the Council of Europe, leaving its participation in Convention 108 for the protection of personal data uncertain.
Saudi Arabia	Personal Data Protection Law (PDPL) (2021)	The PDPL will enter into force in March 2023.
South Africa	Protection of Personal Information Act (POPIA) (2021)	POPIA was adopted in 2013, but only fully entered into force in 2021.
Turkey	Law on the Protection of Personal Data No 6698 (LPPD) (2016)	The legislature enacted several regulations to implement the LPPD.
UK	UK's General Data Protection Regulation (UK GDPR) (2018)	Post Brexit, the UK is considering a reform of the GDPR and recently published a bill to this end.
US	American Data Privacy and Protection Act (ADPPA) (2022)	ADPPA is a bipartisan-bicameral comprehensive federal privacy bill currently considered in the US Congress. Of note, 5 states within the US have passed baseline privacy laws in the past four years (California, Utah, Colorado, Virginia and Connecticut)
EU	EU's General Data Protection Regulation (GDPR) (2018)	The GDPR repealed and replaced Directive 95/46, adopted in 1995, and is directly applicable in all EU Member States.

Note: All the hyperlinks have last been accessed on July 27, 2022, and they lead to unofficial English translations of the laws and bills where they were available online.

Opportunities for Convergence or Interoperability

All the existing data protection laws of the G20 Members, the three Bills referred to above, as well as most of the other data protection laws around the world have in common several elements that provide an opportunity for convergence or, at least, interoperability:

- **Broad definitions of the data and the processing operations they cover**, usually referring to any information related to an identified or identifiable individual, subject to any type of processing – from collection, to use, sharing, making available, to storing and other processes.
- **Recognition of some basic principles**, like **purpose limitation** (personal data should be collected for a specific purpose and not further processed for a purpose which is not compatible with the original one) and **data minimization** (only the personal data necessary to achieve the declared purpose should be processed, and not more).
- **Recognition of the fact that a justification is generally needed for processing personal data**, such as individual consent, or contractual necessity, or – in most laws and bills, but not all - legitimate interests of the organizations processing the personal data, as long as they are balanced against the rights and interests of the individuals whose personal data is processed.
- **Recognition of a set of individual rights or prerogatives**, like requesting and receiving access to one's own personal data, obtaining correction of inaccurate data, being informed about the processing taking place, being able to object to at least some form of processing of personal data, and, in most laws and bills, a right to ask for erasure of personal data in certain circumstances[19].

Accountability mechanisms, like data protection impact assessments that must be conducted by the covered organizations, appointing Data Protection Officers, obligations to report data breaches to those affected and to regulators, or obligations to embed privacy and data protection by design in processing activities are also featured in most data protection laws passed or updated in the late 2010s and early 2020s.

[19] See also David Erdos, Krzysztof Garstka, "The 'Right to be Forgotten' Online within G20 Statutory Data Protection Frameworks", International Data Privacy Law, https://doi.org/10.17863/CAM.55135.

Significantly, **most of the data protection laws and bills have some restrictions on international transfers of personal data** – usually requiring that the same or an equivalent level of protection of the personal data offered within the borders where they originate should be ensured in the jurisdiction where the personal data is transferred or made available. This can usually be ensured through different mechanisms, like whitelisting (by providing adequacy decisions to third-country jurisdictions), through contractual tools supported by technical or organizational measures, certifications etc. The purpose of this type of rules is to allow for the flow of personal data across borders in a way that is protective of the data. On the contrary, some of the new data protection laws and bills propose at least partial data localization measures – which impose that all or certain personal data (for example: "important data", "sensitive data", "public sector data", "health data", "financial data") must either be stored within the borders of the country where they originate, or only a copy of them may be transferred or made available outside that country.

The increasingly complex nature of data protection law obligations comes with increased complexity of implementing these laws. According to a Global Privacy Benchmark Study by CISCO published in 2021,[20] the average privacy budget (meaning the budget organizations spend on implementing a privacy compliance program) doubled in 2021 from 1.2 million USD among respondents in the 2020 survey, to 2.4 million USD in 2021. The average privacy budget of smaller enterprises (50-249 employees) was 1.1 million USD in 2021, while the average privacy budget of the largest organizations surveyed (more than 10.000 employees) was USD3.7 million in 2021—indicating thus that the small enterprises proportionately need to allocate more resources towards privacy compliance programs than the largest enterprises. However, the same study revealed that "privacy laws are viewed very favorably around the world, with 79 percent of organizations indicating they are having a positive impact (and only 5 percent negative impact)".

Some of the most significant differences of modern data protection laws and bills around the world can be spotted in their **scope of application** and in their **enforcement mechanisms**. This is because some comprehensive data protection laws apply to both private and public/government bodies, others only apply to the private sector. Most of the laws create a dedicated supervisory administrative authority (generally known as a Data Protection Authority – 'DPA') to enforce the law and to provide guidance on how the law should be applied, or empower an existing one with this task. Some DPAs have very broad powers in addition to fining – for instance they can order the suspension of processing activities found unlawful, or the erasure of existing data sets or algorithms. Some DPAs are independent from the Executive in

[20] CISCO 2021 Data Privacy Benchmark Study, "Forged by the Pandemic: The Age of Privacy", 2021, available at https://www.cisco.com/c/dam/en_us/about/doing_business/trust-center/docs/cisco-privacy-benchmark-study-2021.pdf

their jurisdictions, while others may be an autonomous structure within an existing Ministry.

The overwhelming interest in adopting data protection laws in very different jurisdictions across the world comes at a time where digital transformation often fueled by algorithms optimized on personal data occurs not only in big or small organizations, national or local governments, but in the daily lives of people. Even if the engine behind each data protection and privacy law or bill is admittedly different from jurisdiction to jurisdiction - sometimes driven by diverse culture, local context, national priorities, digital trade opportunities, ensuring trust in innovation, or actual concern for fundamental rights, they all recognize that the way in which personal data fuels societies, economies, and everyday life in all its aspects is transformational. It may significantly impact communities and individuals in the absence of safeguards and rules providing transparency, individual control over how one's personal data is collected and used, basic principles like data minimization, as well as accountability measures for the organizations processing personal data.

About Dr. Gabriela Zanfir-Fortuna:
Dr. Gabriela Zanfir-Fortuna is Vice-President for Global Privacy at the Future of Privacy Forum, a think tank based in Washington DC. She is a member of the Reference Panel of the Global Privacy Assembly - the international organization of Data Protection Authorities, and previously served as legal officer for the European Data Protection Supervisor in Brussels.

The Role of Cybersecurity

by Melissa Hathaway, Cybersecurity Expert and President of Hathaway Global Strategies

The internet, together with the information and communication technology (ICT) that underpins it, is a critical national resource for governments, a vital part of national infrastructures and services, and a key driver of economic growth. Over the last 40 years, and particularly since the year 2000, governments and businesses alike have embraced the internet and ICT's potential to transform society, including improving competitiveness, productivity, efficiency, innovation, and modernization; generating more revenues; and advancing human and social development.

Today, at least 15 percent of the global economy is generated by the digital economy.[21] Of course, this is why promoting digital transformation, increased connectivity, and modernization of critical infrastructures and services has become a key priority to support sustainable digital, economic, and social development. International organizations such as the United Nations, multilateral development banks, other large donors, and countries involved in development assistance are also prioritizing digitization as one of the key enablers of inclusive and sustainable economic growth and social development.

Yet, the speed of innovation — underpinned by affordable communications and cheap devices — has introduced new risks and vulnerabilities that developed as well as developing countries cannot ignore. The decision to embrace and embed often poorly coded or engineered, commercial-off-the-shelf technologies into every part of our connected society — from government systems to critical infrastructures and services to businesses and households — has led to a growing number of disruptions of essential services, breaches of privacy, and other negative consequences for people's health and safety.

In the last year, malicious actors have ransomed[22] hospitals, schools, and essential government services. In May 2022, the Conti ransomware disrupted the Costa Rican government's computer systems, knocking the country's tax collection system offline

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[21] World Bank, Digital Development Overview, April 2022, https://www.worldbank.org/en/topic/digitaldevelopment/overview.

[22] Ransomware is a type of malicious software that encrypts computer systems and files and restricts or disrupts access to infected devices until a ransom is paid (usually in Bitcoin or other cryptocurrencies). Many ransomware operators have created data leak sites to publicly shame their victims and threaten to publicly release the stolen data and/or perpetually block access to it unless their demands are met.

and exposing citizens 'personal information (over 600 GB of sensitive data was allegedly stolen), and shuttering the country's public health service — known as the Costa Rican Social Security Fund (CCSS). The ongoing attack has forced Costa Rica to declare "a state of national emergency in the entire public sector" in response to the disruption of over 27 government bodies and agencies.[23] After the government declined to pay Conti's ransom demand, the malicious actors released stolen data on their leak site and threatened more serious attacks – including overthrowing the government.

Over a decade ago, in 2007, Estonia had already suffered a wave of distributed denial-of-service (DdoS) attacks that overloaded the country's servers and targeted public and private sectors' infrastructures, telecommunications, name servers, websites, e-mail, and domain name systems (DNS), including the websites of the Prime Minister, the Parliament, almost all of the government ministries, as well as banks, telecommunications operators, and news organizations. This highly coordinated, well-funded attack lasted over three weeks and caused millions in damages.

Cyber heists are also increasing, targeting financial institutions and cryptocurrency exchanges. In February 2021, the United States Financial Services Information Sharing and Analysis Center (FS-ISAC) announced that, in 2020, more than 100 financial services firms across multiple countries were targeted in a wave of ransom DdoS attacks conducted by the same malicious actor. That malicious actor methodically moved across jurisdictions in Europe, North America, Latin America, and the Asia Pacific, targeting the full gamut of financial services companies, including consumer banks, exchanges, payments companies, card issuers, payroll companies, insurance firms, and money transfer services. In each instance, the criminals sent extortion notes to the targeted victims threatening to disrupt their websites and digital services with a DdoS attack if the demanded ransom was not paid.[24]

There have also been wiper viruses designed to destroy ICT systems that have been deployed against wind generation companies in Europe, national rail systems in the Middle East, and national identity databases in Africa and Asia-Pacific. These malicious activities built on the successes of past destructive wiper virus deployments, which never received the level of international attention or condemnation given the negative impacts caused to global businesses everywhere.

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[23] Matt Burgess, "Conti's Attack Against Costa Rica Sparks a New Ransomware Era," Wired Magazine, 12 June 2022, https://www.wired.com/story/costa-rica-ransomware-conti

[24] Melissa Hathaway, "Hijacked and Paying the Price - Why Ransomware Gangs Should be Designated as Terrorists," Institute for New Economic Thinking, May 2021, https://www.ineteconomics.org/perspectives/blog/hijacked-and-paying-the-price-why-ransomware-gangs-should-be-designated-as-terrorists.

In June 2017, for example, a destructive malware called NotPetya was released into the world's networked businesses by way of a software update for a widely used Ukrainian accounting program (M.E.Doc). The NotPetya malware contained a wiper program similar to others used against countries and organizations in the past (e.g., Stuxnet, Flame, Gauss, DuQu, etc.). Within minutes, the malware infected and destroyed tens of thousands of internet-connected systems in more than 65 countries, including those belonging to government institutions, banks, energy firms, and other companies. Many companies were forced to halt business operations, including A.P. Moller-Maersk (shipping), Merck (pharmaceuticals), Mondelez (confections), and DLA-Piper (legal services).

Dutch shipping giant A.P. Moller-Maersk was one of the companies most affected by this attack. The company was responsible for the management of 76 port facilities worldwide and roughly 20 percent of the world's container shipping capacity at the time of the attack. It took weeks for Maersk to resume operations and the malicious attack also negatively affected Denmark's overall gross domestic product (GDP) since Maersk contributed at least 7 percent of the country's GDP. The primary and ancillary losses of NotPetya to the digital economy were significant and the harm (damage) to critical services and infrastructures took months to recover from.[25]

Despite the significant consequences of these malicious activities, most countries are not yet mitigating the risks associated with their cyber-insecurity and, therefore, continue suffering from critical infrastructure failures, possible financial destabilization, and data exploitation — all of which are magnifying social and economic inequalities, and amplifying the "digital divide" between the connected and unconnected.

A number of international organizations have published guidance and frameworks to help nations better understand, assess, and address their digital risks and insecurities. For example, in 2007, the International Telecommunications Union (ITU) published the Global Cybersecurity Agenda (GCA) as a framework for international cooperation aimed at enhancing confidence and security in the information society. The GCA was built on five strategic pillars: (1) Legal Measures; (2) Technical & Procedural Measures; (3) Organizational Structures; (4) Capacity Building; and (5) International Cooperation). It was designed for cooperation and efficiency, encouraging collaboration with and between all relevant stakeholders and building on existing initiatives to avoid duplicating efforts.[26]

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[25] Melissa Hathaway. "*Getting Beyond Norms: When Violating the Agreement Becomes Customary Practice,*" in The Oxford Handbook of Cyber Security (Oxford University Press, November 2021).

[26] ITU, "Global Cybersecurity Agenda," https://www.itu.int/en/action/cybersecurity/Pages/gca.aspx.

As part of the GCA, the ITU has fostered several other initiatives, such as the Child Online Protection program, and in 2017, it formed a consortium of partner organizations that developed and published the Guide to Developing a National Cybersecurity Strategy (NCS) in 2018, updated in 2021. This Guide intends to support national leaders and policymakers in their efforts to develop, update, implement, and evaluate national cybersecurity strategies, including cyber-preparedness and digital resilience, and discusses important questions that every government should tackle when working to transform the topic of cybersecurity from a mere technical discussion/problem into a cross-cutting strategic national policy area and operational priority.[27]

In 2015, the Organization for Economic Co-operation and Development (OECD) published the OECD Recommendation on Digital Security Risk Management for Economic and Social Prosperity[28] to better inform the development of national strategies aimed at managing digital security risks and optimizing the economic and social benefits expected from digital transformation. The framework encouraged countries to adopt an approach grounded in risk management and based on eight interrelated, interdependent, and complementary high-level principles, including (1) awareness raising, skills acquisition, and empowerment; (2) stakeholders' responsibility; (3) human rights and fundamental values; (4) cooperation; (5) risk assessment and treatment cycle; (6) security measures appropriate to and commensurate with the risk and the economic and social activity at stake; (7) innovation; and (8) preparedness and continuity planning.

The OECD advocated that if national leaders implemented these eight general and operational principles, coupled with other international frameworks, their countries would be better positioned to develop sound policies (and strategy) grounded in digital security risk management. The eight principles are not a framework per se, rather they were intended to be key components to establish or enhance coordination mechanisms within the government and with non-governmental stakeholders. The OECD was also among the first international organizations to recognize that private-public cooperation was essential to cyber risk reduction.[29]

Governments play a central role in championing the integration of cybersecurity, digital resilience, and cyber capacity building into the international (digital) development

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[27] "Guide to Developing a National Cybersecurity Strategy — 2nd Edition 2021," https://www.un.org/counterterrorism/sites/www.un.org.counterterrorism/files/2021-ncs-guide.pdf.

[28] OECD (2015), Digital Security Risk Management for Economic and Social Prosperity: OECD Recommendation and Companion Document, OECD Publishing, Paris, https://www.oecd.org/sti/ieconomy/digital-security-risk-management.pdf.

[29] Melissa Hathaway, "Managing National Cyber Risk," Organization of American States, (2018): https://www.oas.org/es/sms/cicte/ENGcyberrisk.pdf.

agenda. At a foundational level, decision-makers need to gain a deeper understanding of the threats emanating from the potential misuse of ICTs and emerging technologies, such as becoming tools for unauthorized surveillance, disinformation, digital authoritarianism, data exploitation, espionage, etc. This understanding can guide the international community in supporting countries 'digital adoption and increasing their maturity in maximizing the use of new digital technologies as enablers of sustainable and secure development.

On a more practical level, it is clear that integrating these aspects into digitization strategies and development programs worldwide would lead to achieving better outcomes; streamlining processes and maximizing resources; as well as building stronger resilience, safety, security, and trust in countries 'digital transformation projects.[30]

The GDP erosion that all nations are suffering places cybersecurity within the legitimate processes and "architecture" of international economic governance. Countries and groups of countries like the G20 play a specific role in helping de-escalate the militarization and balkanization of the internet, already underway. In that context, several reforms could be considered:

1. Connecting cybersecurity and digital resilience to the economic aspirations, digitization strategies, and development priorities of all countries — with a specific focus on those providing funds to modernize the infrastructures of low- and middle-income countries;
2. Framing the cybersecurity narrative in the context of international development in terms of digital resilience, safety, trust, sustainability, and risk management rather than just security;
3. Using international and local development organizations as a conduit to raise cybersecurity awareness and build capacity in low- and middle-income countries;
4. Understanding that ICTs are commodities with a shelf-life of 7-10 years — they are not capital assets. ICTs that are still in use and no longer supported by hardware and software updates make a country (or critical infrastructure or service) more vulnerable to digital risks. This creates national and potentially international instability; and
5. Promoting greater coherence and stronger coordination between stakeholders to deliver more effective, scalable, and sustainable approaches and solutions — including by developing digital public goods and services to make all nations more stable and resilient.

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[30] Melissa Hathaway and Francesca Spidalieri, "Integrating Cyber Capacity into the Development Agenda," Global Forum on Cyber Expertise, November 2021, https://thegfce.org/wp-content/uploads/2021/11/Integrating-Cybersecurity-into-Digital-Development_compressed.pdf.

About Melissa Hathaway:
Melissa Hathaway is globally recognized as a thought leader in the fields of cybersecurity and digital risk management and has relationships with the highest levels of governments and international institutions. She served in two U.S. presidential administrations, spearheading the Cyberspace Policy Review for President Barack Obama and leading the Comprehensive National Cybersecurity Initiative (CNCI) for President George W. Bush. Ms. Hathaway has a B.A. degree from The American University in Washington, D.C. She has completed graduate studies in international economics and technology transfer policy and is a graduate of the US Armed Forces Staff College, with a special certificate in Information Operations. Her publications can be found here:
https://www.belfercenter.org/person/melissa-hathaway

Case Study: Backhaul—SATRIA-1, Indonesia

by AIIB and PT Pasifik Satelit Nusantara (PSN Group)

Summary

Backhaul connectivity is provided to an estimated 45 million people in Indonesia's outlying islands through the use of an innovative financial structure that combines a PPP, different (and limited) guarantees, universal service funds (implicitly), and both multilateral and commercial funds. Key elements might be replicated at a high-level to mobilize private finance for building backhaul to remote regions, with details fitted to context.

Project Description

Development Objectives. Due to its geographical barriers, Indonesia has continuously aimed to bridge digital divides that are difficult to close using traditional methods. For many outlying areas of Indonesia, satellite connectivity is the only feasible access technology for backhaul connectivity. However, even with the decline in satellite launch costs in the last decade, upfront capital expenditures for procuring and launching satellites are formidable, with total costs of up to half a billion dollars for a single satellite incurred before any revenue is generated. Making such capital expenditure viable when the satellite is intended to support remote, low-income communities is a formidable challenge.

Investments. SATRIA-1, Indonesia's first national strategic project for a multifunctional satellite, met this challenge through a complex and innovative financing structure. The financing scheme involved a public-private partnership (PPP) agreement between PSN Group and the Government of Indonesia, with an interlocking set of guarantees and recourse arrangements (described in detail below). Through this, large amounts of private capital were mobilized and more than 149,000 unserved public service points will be connected to broadband in the least developed, frontier and outermost areas of Indonesia, including schools, health centers and local government locations.

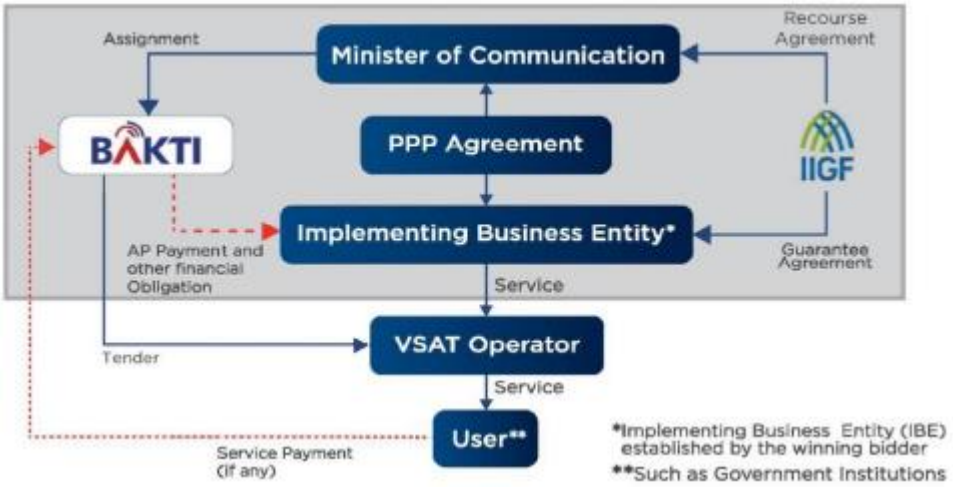
Financing Structure and Key Terms

Availability payment. The financing structure is anchored on a PPP-agreement over a 15-year concession period. The agreement is based on an "Availability Payment" (AP) rather than a volume payment, to remove market risk in serving outlying and least-developed areas. In a PPP, an "availability payment" is made so long as the contracted infrastructure is available according to set technical standards, i.e., is

independent of how much the infrastructure is used. For SATRIA-1, the AP is structured into both a USD component and an Indonesian Rupiah (IDR) component.

Contract term and agencies. The agreement is conducted between the Ministry of Communication and Information Technology (KOMINFO), and is specifically assigned to the Telecommunication and Information Accessibility Agency (BAKTI). The agreement lasts for 15 years and is a build, own and operate agreement. Payments to the implementing business entity are made by BAKTI, which, in some cases, recovers service payments, for example from connected government institutions. This basic structure is shown in **Figure** .

Figure 5: PPP Structure



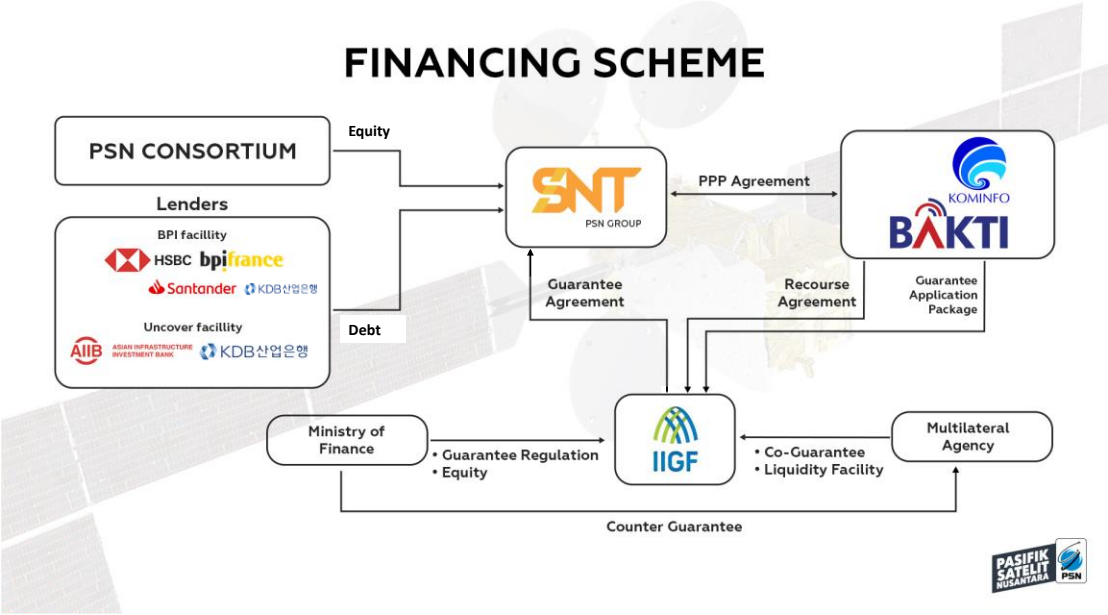
Source: AIIB

Public sector upside and universal service funds. It is not clear, and likely will not be clear until a few years have elapsed after the satellite is launched, how much such fees will amount to. BAKTI is in effect then taking the demand risk, appropriately given the areas being serviced, backstopped by its own funding from KOMINFO. If the remote areas develop quickly and generate significant demand, BAKTI may be able to cover the availability payments only from service fees, or may even generate a surplus. If not, BAKTI will need to cover the availability payments from other sources. In that regard, it is significant that BAKTI itself has been empowered with the management of Indonesia's Universal Service Obligation Fund (USOF), and in 2019 proposed a framework for next generation universal service obligations ("USO2.0"). As such, the USOF funds could backstop the availability payments—appropriately, given SATRIA-1's purpose—if the USO2.0 framework allowed, or through the ordinary budget process within its home Ministry.

Perceived renegotiation risk. On the other hand, BAKTI has formally existed since 2006, but received its current form as a Public Service Agency only in 2017. At least

half of PPPs are renegotiated, usually to the advantage of the winning bidders, but in some cases to their disadvantage (as a result of political pressures on tariffs, for example).[31] A 15-year contract for availability payments by a relatively new agency, receiving service fees of an unknown size, could appear too high risk to mobilize the commercial funds required to build and launch a cutting-edge satellite, at a project cost of USD 500 million. As a result, the financing structure of the project was enhanced through several means (**Error! Reference source not found.**).

Figure 6: Overall Financing Scheme



Source: PSN Group

Guarantee enhancement of availability payment. The PPP structure was enhanced through a guarantee provided by the Indonesia Infrastructure Guarantee Fund (IIGF). The IIGF was created in 2009 as an independent state-owned entity (SOE) to provide guarantees on contracting obligations for PPPs in Indonesia. The IIGF was supported by World Bank technical assistance during its creation, but is fully funded by the Government of Indonesia, and its capital structure is both somewhat levered and ring-fenced from the rest of the fiscus.[32] The guarantee is also provided on the contracted

[31] Engel, Eduardo, Ronald D. Fischer, and Alexander Galetovic. When and how to use public-private partnerships in infrastructure: lessons from the international experience. No. w26766. National Bureau of Economic Research, 2020.

[32] The World Bank project that provided assistance to the IIGF originally included a component to also add World Bank funds for additional support to IIGF guarantees. However, the World Bank funds could not be used in practice for procedural reasons (related to safeguards processes) and so the project was restructured to remove the funds. The IIGF is therefore purely GoI funded.

payments, between the satellite operator and the IIGF, not on the capital structure, i.e., not between the DFIs and commercial banks and the IIGF. Overall, the guarantee does not create overlapping obligations or double up on balance sheet utilization within the MDB system or within the Government of Indonesia. Instead, similarly to implicit guarantees of offtake agreements in renewable energy financing, it simply provides additional clarity to market participants who may otherwise be uncertain about the strength of commitment to a payment flow by a specific agency (and some funders considered KOMINFO's support for BAKTI sufficient).

Export credit cover. Financing was further enhanced through the provision of an export credit agency (ECA) agreement through Bpifrance[33]. The satellite itself will be manufactured by Thales in France, the largest satellite manufacturer in Europe, and allowing for the ECA cover. Between the clear visibility of the cash flows provided by the AP structure, including its USD component, and the interlocking guarantees, enough comfort was provided for large commercial banks to provide some of the debt funding. The remaining portion, as a commercial tranche, was then primarily filled by AIIB with a 15-year loan (substantially longer tenor than otherwise available in the market) for USD150 million and the Korea Development Bank (which also participated in the ECA facility).

Timing and purely-virtual close. The project reached financial close in April 2021. That was approximately six months later than originally planned, given the operational challenges of the pandemic. On the other hand, the funding was arranged and concluded purely virtually—one of the first of such a size and magnitude to be done in this way. Otherwise, as the project's initiation has been so recent, it is too early to have encountered significant implementation challenges.

Enabling Context

Experience of PSN. The private sector company that won the PPP tender and implemented the project, Pasifik Satelit Nusantara (PSN), has more than 30 years of experience and had successfully conducted multiple satellite launches and concluded multi-decade operational agreements. PSN in 2019 had launched the Nusantaru Satu satellite, Indonesia's first broadband satellite using High Throughput Satellite (HTS). The contractors on SATRIA-1 were also a source of comfort, given the world-class reputations of SpaceX for launch and Thales for satellite manufacturing. Overall, the operating and technical track record of the lead entity (PSN) and the contractors substantially mitigated the satellite construction and technology risk, which would otherwise be difficult for the market to assess in depth.

[33] Bpifrance is French public investment bank

Multi-layered public sector backing. Another important factor was the clear priority accorded to the project by the Government of Indonesia. The project was listed as a National Strategic Project and endorsed by Presidential Regulation. That, together with the overlapping guarantees and recourse arrangements, provided sufficient confidence that the usual political and regulatory/renegotiation risks associated with long-duration AP-based PPPs could be mitigated. The clear, multi-currency-based structure of the payments then allowed lenders to provide capital with confidence.

Replication Potential and Considerations

Targeting offtake and forex risks, while retaining some upside for public sector. Several elements of the SATRIA-1 project could be considered for replication elsewhere, *if* tailored appropriately to context. The first is the targeting of public support at the risk(s) that mattered to potential investors. That meant, primarily, the market risk related to the provision of services to least-developed areas. The availability payment structure reduced that risk, and its structure further mitigated the foreign exchange risk (necessary given the capital payments would be primarily in USD). On the other hand, the assignment of service fees from the provision of services to the local government entities at least partly compensated the agency providing the availability payments and, given the length of the period, may even provide in time a positive outlook to the overall fiscus.

Acknowledging and addressing differential perceptions through layered support. The second element is the combination of risk-reduction measures that reinforce each other. The relevant agency's multiple revenue sources, including the USOF and such public service fees, may provide resilience in its ability to make the Availability Payments even in the case of adverse regulatory, legal or political changes over the long lifespan of the project. The same reinforcement is provided by the IIGF, as well as finally the export credit arrangement. While some lenders may consider a PPP with a public service agency equivalent to a quasi-sovereign risk and hence find these additional measures unnecessary or secondary, others may be more concerned about the risks of renegotiation in the future and seek greater mitigation of such long-term political and contractual risk. The SATRIA project effectively reduced such risks through the combination of simple and well-known instruments, such as availability payments and guarantees, without also exposing the sovereign to the full contingent liability, given the flexible use of revenue sources.

Case Study: Backhaul—Mozambique-Malawi Interconnector

by Kreditanstalt für Wiederaufbau (KfW)

Summary

The main goal of the Mozambique-Malawi Interconnector project was to connect Malawi to the Southern African Power Pool (SAPP) via a newly constructed power transmission line. The project innovated by leveraging the fiber optic capacity required to operate a transmission line to increase connectivity and provide external services in both the connecting countries.

Project Description

Development objectives. The major goal of the project is to overcome Malawi's power shortage by connecting the country to the SAPP. This also reduces the countries' dependence on climate-damaging forms of energy production such as diesel generators, charcoal, and kerosene. The SAPP was created by the Southern African Development Community (SADC) in 1995 and it allows member states to balance both short-term and long-term energy deficits and surpluses through trade. The long-term vision is to become a fully integrated, competitive energy market and provider of sustainable energy solutions for the SADC region and beyond. Currently, Malawi has one of the lowest electrification rates in all of Africa at 11 percent (Sub-Saharan Africa average: 47 percent). In rural areas, only 5 percent of the population are connected to the national grid. Therefore, most of the population relies on unsustainable energy production from traditional biomass, which has a negative impact on the environment.

Investments. Hence, to improve Malawi's power supply, KfW[34] on behalf of the BMZ[35] and the European Union together with the World Bank and Norway is financing a regional power transmission line between Mozambique and Malawi which physically connects Malawi to the SAPP for the first time. This enables climate-friendly energy imports out of renewable resources to Malawi from Mozambique, as well as from other SAPP member states. Potentially, the transmission line can also be used by Malawi to export electricity to other SAPP countries.

[34] KfW is a German state-owned investment and development bank

[35] BMZ is the abbreviation for the German Federal Ministry for Economic Cooperation and Development

Electricity outcomes. Through the construction of the transmission line, the project will contribute to balancing of the regional power generation capacity through power trading. In the context of the project, EDM (Mozambique) and ESCOM (Malawi) have already entered into a power purchase agreement for the sale of 50 MW to Malawi. In addition, as the project accounts for the first connection of Malawi to the SAPP, it will enable the country to import further energy from other SAPP member countries. The project also contributes to a more efficient, climate-friendly, and reliable power supply. This will benefit end users including households, social institutions, and businesses in Malawi, while the additional source of revenue generated by electricity exports can be used by EDM to invest in its own generation and transmission structure which indirectly benefits electricity consumers in Mozambique.

Real-time grid management. As the use data transmitted via optical fibers integrated in transmission lines is generally the basis for automatic supervision and management of power grids, it also forms the basis for a follow-up project that is partly funded by KfW on behalf of the BMZ, namely a national dispatch center by which the electricity system can be controlled in real time via a SCADA system, thereby ensuring grid stability and rapid restoration of power in the event of an outage. Furthermore, a dispatch center is needed to balance electricity supply and demand in the grid and thus is a prerequisite for the future integration of variable renewable energy.

Possibility for dual use. The use of optical fiber is usually standard in new transmission lines. It is required by operators of power lines for their internal control and monitoring systems, also known as SCADA ("supervisory control and data acquisition") systems. However, only part of the available transmission capacity of the optical fibers is used for the SCADA systems. That creates the possibility to use the fiber to provide information and telecommunication services, leveraging the transmission line's necessary acquisition of right of way. In Sub-Saharan Africa, though, the use of optical fiber in transmission lines to provide such additional ICT services is not yet widespread.

Feeder line retrofitting with fiber optic. In the case of the Mozambique-Malawi Interconnector, equipping the main transmission line as well as retrofitting the two high-voltage lines connecting to the transmission line on the Mozambican side with optic fiber will create the necessary backbone infrastructure in Mozambique for wider use of telecommunications traffic. The expansion of the ICT system also allows the project partners EDM and ESCOM either to start or to expand their offer of commercial services in the telecommunications sector. Overall, using the transmission line to enable fiber optic services in this way required including sufficient fiber optic capacity in the new transmission line, along with retrofit of existing connector lines.

Electricity companies to offer telecom services. The optical fiber infrastructure integrated in the transmission lines can be used both by EDM and ESCOM to start or to expand their broadband internet and telecommunications services. On the

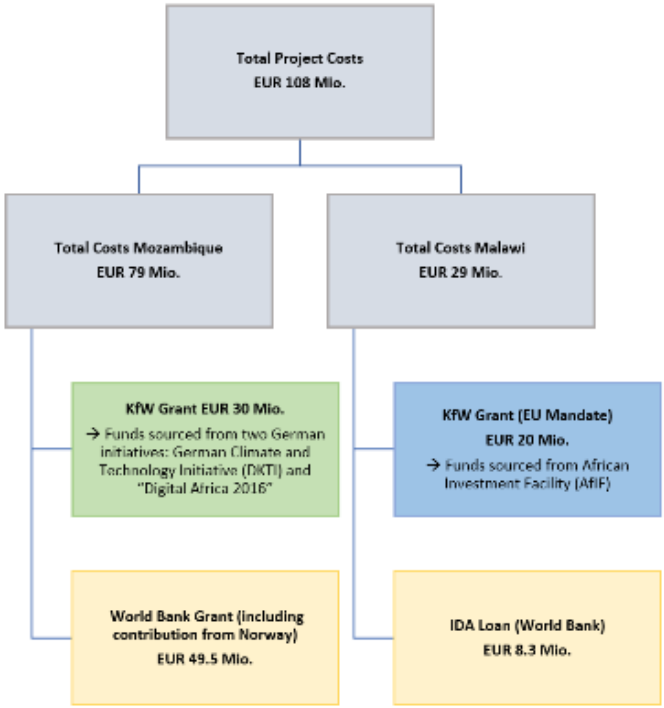
Mozambican side, however, the offering of these services on a commercial basis by EDM will still require the resolution of regulatory issues. At present, EDM by law is not permitted to offer telecommunication services, since EDM's mandate only includes offering electricity. EDM aims to have more flexibility in this regard in the future. However, ESCOM Malawi has the right to offer telco services and is already active in this business.

Financing Structure

Multi-donor cooperation. To raise the total financing of EUR108 million for this project, KfW has cooperated with the EU and the World Bank (**Figure**). In total, EUR30 million were disbursed by KfW in the form of grants with the funds coming from two German initiatives. A further EUR20 million originate from EU's African Investment Facility (AfIF) and were channeled through KfW. The remaining EUR57.8 million were contributed by the World Bank in the form of a grant, including a contribution from Norway, as well as an IDA loan. The cooperation of multiple donors on this project is a key contributor to its results. Moreover, in another project, the World Bank is promoting the expansion of the distribution network in Malawi and is planning a program to improve energy access in Malawi. This targeted measure complements the construction of the interconnector as it improves the distribution of imported electricity to end users.

Fiber costs. The cost of the fiber optic component is not precisely measurable, as the fiber optic costs for the new line (the bulk of costs) are part of a lumpsum contract for the construction of the line. From the retrofitting of the connecting lines, it can be said that approximately one third of the KfW contribution, or roughly 15 percent of the overall project costs, went to the fiber optic component.

Figure 7: Financing Structure for Mozambique-Malawi Interconnecter



Source: KfW

Challenges and Risk Mitigation

Cross-border and cross-entity collaboration. Concerning some of the difficulties phased in implementing the project, delays were expected during the project preparation phase, mainly due to the regional scope of the project and the associated expected longer coordination processes, particularly between the two utilities (EDM and ESCOM). Due to the predictable nature of these implementation difficulties, mitigation measures were developed and taken. These involved the joint supervision of the project by EDM and ESCOM through a Project Implementation Unit, the assignment of the transmission line construction to a single contractor, and supervision of construction activities by an implementation consultant.

Social and environmental safeguards. On the other hand, the agreement on the actions and measures defined in the resettlement and compensation plan took longer than initially expected. The plan was revised several times throughout the project, among other things due to differing views on the adequate compensation amounts and the modification of the width of the corridor under the transmission line on the Mozambican side. Alongside these measures to mitigate the negative social impact of the project on the population, measures were put in place to mitigate environmental risks in accordance with the sustainable guidelines of KfW and the internationally recognized World Bank standards.

Strong Synergies from dual-use. These risks, which are common to long-distance linear infrastructure, and their mitigation, provide again a strong demonstration of the value of leveraging such infrastructure for Digital Infrastructure (since the risks were in effect incurred and the mitigation paid for by both the electricity transmission and fiber optic component of the project jointly). A similar and less obvious benefit of the joint construction is that the Operating Agreement that will be signed between ESCOM and EDM under the power purchase agreement (required by SAPP as member utilities) contains explicit provisions for the protection of data cross-border and the handling of data localization concerns, mitigating upfront one of the key regulatory risks that can arise in cross-border digital infrastructure.

Replication Considerations

Enabling context for cross-border. An important aspect when fitting the innovation to other countries is the existence of a regional strategic vision and coordination as provided through the SADC founded SAPP in the case of the project described here. This provides political prioritization and momentum for such infrastructure investments. This also allows for a scalable orientation of the project as it is carried out as part of a bigger infrastructure plan for the Southern African region. Furthermore, at the donor-partner country level, political compromise and willingness facilitate coordination and implementation.

Synergies across infrastructure types. There is a clear potential for replication in the use of one form of linear infrastructure, here electricity, to be leveraged to provide another, fiber backhaul. This dual use of electricity networks to provide telecoms services will be seen in other cases below too (for example, in Nicaragua). The Mozambique-Malawi case shows that such synergies can be obtained including in low-income countries, and in cross-border projects. Given the complexity and difficulties involved in procurement, safeguards and other implementation challenges for large cross-border projects, the synergies in this case are even more acute than in purely domestic dual electricity-fiber projects. These synergies have clear scope for replication—it may even be argued that any large-scale linear infrastructure project should explore them by default, especially when cross-border. Key enabling actions to capture such synergies will be appropriate regulatory reform on either side—both protective, and also allowing the electricity operators to offer telecoms services—and ensuring that adjacent investments, like retrofitting the older transmission lines in this case, are planned and implemented.

Case Study: Backhaul—Submarine Cable, Bangladesh & Djibouti

by the Islamic Development Bank

Summary

The Islamic Development Bank (IsDB) funded the addition of new subsea cable capacity for Bangladesh using Islamic finance, through the participation of a state-owned entity (SOE) in an international consortium of telecoms operators building the cable. The project increased capacity 7.5x and reduced prices by almost 80 percent. The IsDB also financed Djibouti's participation in the system.

Project Description

Development objective. In May 2015, the Islamic Development Bank (IsDB) approved the financing of Regional Submarine Telecommunications Project in Bangladesh for an amount of USD44 million, to cover approximately half of the cost of Bangladesh's participation in a new submarine cable system. The developmental objective of the project was to provide an alternative submarine cable link for redundancy and to provide sufficient capacity for Bangladesh's future connectivity needs.

Bangladesh investments. The project built on a previous IsDB project in Bangladesh in 2005 that allowed the country to connect to the South-East Asia–Middle East–Western Europe 4 (SEA-ME-WE-4, or SMW-4) submarine cable system through a branch cable from Cox's Bazaar. The 2015 project, described here, connected Bangladesh with the SEA-ME-WE-5 (SMW 5) submarine cable system through a branch cable to Kuakata (**Figure**).

Figure 8: Cable Landing

Source: IsDB

Cable capacity and redundancy. The SMW-5 submarine cable system was designed with the latest upgradable technology, very high capacity (24 Terabits per second for the full cable), and low latency. The cable system further enhanced the diversity and resilience on the heavily loaded Asia to Europe telecommunication route. The branch line to Bangladesh provided redundancy to the country's submarine cable connectivity—after the successful inauguration of SMW-5 in 2017, the system has served successfully as an alternate to the older SMW-4, providing restoration circuits during repaid and upgrade work on SMW-4 between October 2017 and May 2018. As well as redundancy, the new cable link increased the total bandwidth capacity for Bangladesh from 200 Gbps (Gigabit per second) in 2014 to 1500Gbps in 2018. Due to this addition of capacity, BSCCL is now able to serve the growing demand of internet bandwidth in Bangladesh and this capacity can even be augmented by participating in future upgrades of the SMW-5 system.

Effects on tariffs and connectivity in Bangladesh. As well as raw capacity, the SMW-5 system further improved the quality and cost of international connectivity. The new technology in the cable versus the SMW-4 reduced round trip delays. The cable enabled Bangladesh Submarine Cable Company Limited (BSCCL) to reduce tariff to its customers by roughly 80 percent.[36] Due to the flexibility of capacity entitlement in SMW-5 system, BSCCL can offer services to and from cable landing stations in Singapore, Sri Lanka, Djibouti, Saudi Arabia, Egypt, Italy, and France along with its own landing station in Kuakata, Bangladesh.

Parallel Djibouti investments. Earlier in the same year, in January 2015, the IsDB also approved financing for Djibouti's portion of the submarine cable in January 2015, via Djibouti Telecom. The new cable allowed an increase in capacity from 35 Gbps in 2014 to 500 Gbps for Djibouti. The new capacity shall be utilized to cater for the domestic and internal telecommunication services demand for the next 20 years. In addition, Djibouti Telecom has become a center of international transit traffic since 2010 coming from and going to East and Southern Africa. The total cost for Djibouti was USD24 million out which IsDB financed USD16.5 million. The physical implementation of the submarine cable commenced in August 2014 and completed ahead of planned schedule in November 2016.

Financing Model

Consortium members. The submarine system project overall comprised of a consortium coming from multiple countries belonging to private and public sectors. Bangladesh participated through BSCCL, an SOE previously established in 2008 to hold Bangladesh's share of the SMW-4 cable and operate an International Internet

[36] IP bandwidth price of BSCCL for IIG (International Internet Gateway) at 10 Gbps level was 1,969 BDT/Mbps (Megabit per second) in 2013 and as of July 2018 it is 429 BDT/Mbps

Gateway (IIG). The other consortium members were primarily telecom operators, coming from multiple countries and belonging to private and public sectors. Alongside BSCCL, the consortium members were: Bangladesh Submarine Cable Company Limited (BSCCL), China Mobile, China Telecom, China Unicom, Djibouti Telecom, Emirates Integrated Telecoms (du), Myanmar Post and Telecom (MPT), Ooredoo, Orange, PT Telekomunikasi Indonesia International (Telin), Saudi Telecom, Singtel, Sri Lanka Telecom PLC (SLT), Telecom Egypt, Sparkle, Telekom Malaysia, Turk Telekom International (TTI) and TWA Pakistan.

Bangladesh share. The total cost of Bangladesh's portion of the SMW-5 system was USD83.5 million, to cover the cost of Bangladesh Branch Cable Section and partial cost of Core Cable Section which passes through Singapore, Sri Lanka, Saudi Arabia, Italy, and France. The IsDB financed USD44 million of BSCCL's share, and the Government of Bangladesh covered the remaining cost of the project.

Cross-government Guarantees. During the due diligence, IsDB ensured the commitment of all parties able to provide their financial commitments and provided debt financing only to concerned countries, which in this case were Bangladesh and Djibouti. Both governments provided standard sovereign guarantees to the consortium and to IsDB. In the case of Bangladesh, IsDB covered the financing for Core segment of the cable and the branch segment whereas for Djibouti, it was only for the Core segment.

Consortium management structures. The SMW-5 consortium established an Interim Management Committee (IMC) comprising one (1) representative from each party for administering the activities of the SMW-5 until the signing of the Construction and Maintenance Agreement (C&MA). Under the IMC, two subcommittees were formed, namely the Interim Procurement Group (IPG) and the Interim Investment & Agreement Subcommittee (II&ASC). The IPG selected two contractors for the project to mitigate the risk of implementation delays and negotiated the agreements with them. Moreover, there was a provision of penalizing the contractors for delay in completion (without the proper justifications) by 0.1 percent of the cost of unfinished works per day. On 7 March 2014, the Construction and Maintenance Agreement (C&MA) was signed by all the consortium members in Kuala Lumpur.

Consortium penalties for non-fulfillment. There were clear penalties defined for members failing to fulfil their financial commitments. Each party was required to fulfil their first installment, a 50 percent advance payment for core cost of the Supply Contract, upon effectiveness of the C&MA. That first payment would not be refunded if any party was unable to continue payment of the subsequent installments, providing lock-in and mutual confidence among consortium members.

Islamic Finance

The installment sale model. The IsDB's financing to BSCCL was provided through the Installment Sale mode of Islamic finance. In such a financing arrangement, the Bank itself purchases the asset (the share of the submarine in this case), and appoints the recipient (BSCCL) to act as the Bank's agent in procurement and take delivery of the asset on behalf of the Bank. On delivery, the asset will be sold and transferred by the Bank, as the vendor, to the recipient, as the purchaser, which then pays for the asset in installments (hence the name). The price the purchaser pays for the asset—which determines the installment payments—will typically be higher than the price the Bank purchases the asset for prior to completion and delivery. The Djibouti financing was executed through the Istisna'a method, which is very similar to the instalment sale but allows for slightly greater flexibility in the original purchasing/construction of the asset. (Figure 9)

Figure 9: Installment Mode of Islamic Finance

Source: IsDB

Replication Elements and Considerations

Islamic finance. The use of installment sale and Istisna'a allowed the structuring of a complex multi-country, multi-sponsor operation, within the guidelines of Islamic finance, while mobilizing significant financial resources from both the public and private sector.

Joining consortia of global players. The project provided an example of how the right financing instruments can enable lower-middle income countries to actively join in consortia of giant global companies building submarine cables.

Priori capacity in SOEs and implementation teams. The project benefited from the existence of an entity, BSCCL, with substantial experience. BSCCL was and is an experienced SOE, having maintained Bangladesh's portion of SMW-4 for a decade at the time of the project. Djibouti Telecom is the state-owned and only telecommunications company in the country and only company with access to submarine cable systems so there was no market risk for the Djibouti loan. On both projects, the implementation team had the right capacity and experience, so that the chances of successful and timely completion of the project were considered high.

Consortium members and commitment structures. The partners in the SMW-5 consortium overall included some global giants in the telecoms market, with substantial balance sheets and extensive experience. The consortium itself had strong commitment mechanisms built into it, as well as clear structures for initial management followed by strong supervision of the implementation works. The technical knowledge and experience of the consortium teams overseeing the procurement and implementation was of a high standard.

Fast-moving and robust procurement. Operationally, effective tendering processes were important to ensure the proper selection of competent contractors to implement a cable installation project of this scale in time (20,000 km of cable laid in two and a half years). The supply and construction of the submarine cable and supporting equipment was procured through Limited International Bidding (LIB), as there are few reputable companies in the world specialized in this field at such scale. The consortium structure, with its mutual commitments and governance structures, were again important in giving each member sufficient confidence to allow such procurement at a rapid pace.

Figure 1: Cable Installation toward Beach Manhole

Source: IsDB

Case Study: Fiber Access—Oman

by the Asian Infrastructure Investment Bank

Summary

A recently formed, state-owned wholesale fiber operator mobilized Multilateral Development Bank's financing and private capital to build out a wholesale fiber network in dense and rural areas. The operator and its financiers used a phased corporate finance facility and delimited guarantee to gradually de-risk itself and use cash flows from the bankable side of the digital divide to partially bridge the divide.

Project Overview

Development Objective. The project involves a corporate finance loan to Oman Broadband Company (OBC), a wholesale-only operator, to support its national rollout of broadband network in Oman. The project will improve Oman's infrastructure in the information and communication technology sector, thereby increasing the attractiveness of Oman as a destination for manufacturing business and strategic logistics services. The Project is in alignment with the country's goal to progressively diversify the economy away from its current dependence on the export of hydrocarbon products.

Investments. OBC is a state-owned, joint-stock company, established in 2014 under the National Broadband Strategy of Oman. OBC is mandated as a *wholesale only operator* of fiber broadband network to provide *passive infrastructure* service to telecom operators. OBC is deploying such a network to provide equal and open access to: (a) telecommunication service providers on a wholescale basis, and; (b) owners and operators of private networks on a retail basis. Such access shall enable end-users to efficiently leverage high speed fiber in Oman.

Phased and segmented roll-out. For the rollout, OBC has divided Oman into three key segments with distinct geography and demography, namely: (a) Muscat, (b) other urban areas, and; (c) rural areas. The rollout is being executed in two consecutive phases:

- *Phase 1*: from 2015 to 2021, focused on Fiber-To-The-Home (FTTH) coverage to home users in Muscat, plus some urban areas outside Muscat.
- *Phase 2*: from year-end 2021 to 2025, OBC plans to cover the target number of homes across high-density and medium-density urban areas using a mix of FTTH and 5G Fixed Wireless Access (FWA) technologies. Phase 2 aims to complete the deployment of OBC's Basic End User Connection (BEUC) network in 2025, by which time it expects to have passed 226,000 homes.

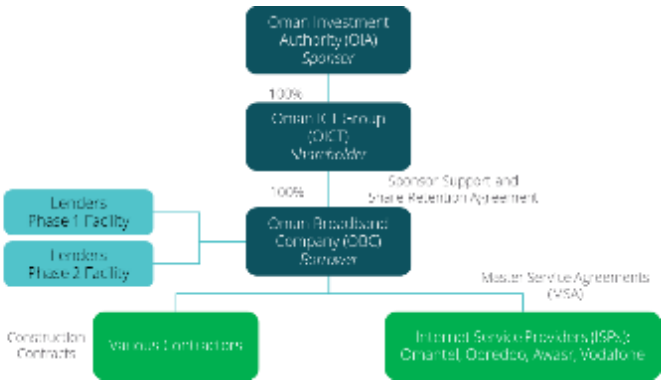
Learning between phases. Such strategic phasing ensures that the rollout can be done in a stepwise approach that is cost-efficient. Phase 1 rollout was relatively less complicated, as Muscat and certain urban areas have higher population densities. OBC is using the operational experience from Phase 1 to effectively plan and execute Phase 2, which is more complex due to the country's vast geography combined with less favorable terrain conditions in certain urban areas.

Financing Structure and Key Terms

Corporate loan. From a financing structure standpoint, it is a limited-recourse loan to an operating entity, resulting in a corporate loan with project finance features and an innovative financing structure utilizing debt, equity and operating cashflows. From the lending point of view, the financial plan considered the use of a A/B Loan structure, where AIIB is the lender of record, and two commercial banks and one fund joined as participants, motivated by AIIB's participation.

Sponsor support guarantee. One key feature of the structure which gives comfort to lenders is a Sponsor Guarantee, in the form of a Sponsor Support Agreement. Under that agreement, the Sponsor will be required to provide a cash infusion (either via equity or shareholder loan) as a form of Cash Deficiency Support (CDS). The requirement to infuse cash will be triggered by performance tests to be conducted on a periodic basis during both construction and operation phases. In terms of monitoring OBC's performance, during construction period, where the network was put in place and new customers were connected, revenue generation and EBITDA were closely monitored, to verify OBC's ability to implement the network as originally planned, properly operate, and ultimately generate revenues to prove its financial sustainability. Since OBC was a relatively new entity and as a joint-stock company is not explicitly sovereign-backed, the support agreement was important to allay risk perceptions. The guarantee, however, was specifically scoped to the performance of the state-owned entity.

Figure 2: Oman Broadband Project Structure and Counterparties



Source: AIIB

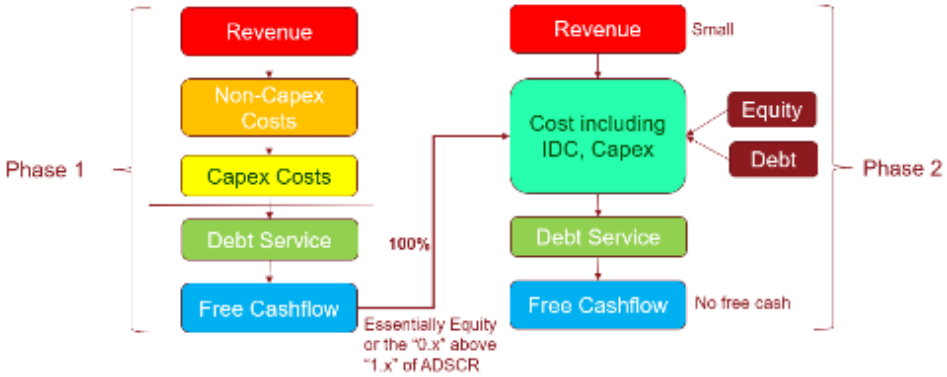
Utilizing phases to enhance bankability. Even with the Sponsor Support Agreement, ensuring the bankability of the transaction required additional steps. OBC was a newly established entity, mandated to initiate the rollout of the nationwide broadband network for the first time. In response, the borrower and the financiers structured the financing to both align with and be supported by a phased roll-out approach. The first phase of the financing was structured to be implemented on the more densely populated areas of the capital city of Muscat and its surrounding out of Muscat first, and after proving the financial viability of OBC's business plan with successful phase 1 implementation, the second phase deployment focused on less densely populated urban areas and rural areas. Geographically, as of 2020, 57 percent of the population resided in the Muscat governorate and Al Batinah governorates. Rolling out fiber to the population in these urban areas is relatively less costly, compared to more dispersed, mountainous, or desert terrains in rural areas in Oman, which is the reason for OBC to focus on urban areas initially.

Funding cascade utilizes Phase I revenue to underwrite Phase II build-out. The financial model is designed to support the roll-out strategy by splitting into 2 phases. Unlike typical corporate finance where the financial model is mingled in one structure, OBC's financial model is optically structured covering each phase as well as corporate basis as one entity. In terms of development of Phase 2, the funding cascade works as follows: i) all costs are first funded by Phase 2 revenue; ii) second by Phase 1 post-debt service cashflow which is essentially cashflow available for distribution; and iii) finally any remaining costs will be funded by Phase 2 Facility and fresh OBC equity.

Benefits of funding cascade. The ultimate benefit of splitting the financial model into 2 phases is to have the flexibility to segregate optimally the financial position of each phase. It enables the financial model to calculate the DSCR covenant only for Phase 1 during Phase 2 construction, and to implement a cash sweep repayment for Phase 2 Facility. The best protection that is provided to Phase 1 and Phase 2 Facility lenders is through: i) diverting all the cash available for distribution to incentivize OBC to complete Phase 2 on time and within budget, and; ii) optimize the size of the Phase 2 Facility, which also involves an A/B loan structure. Once Phase 2 construction is completed, the artificial split between Phases 1 and 2 falls away.

Figure below illustrates the funding and cash cascade structures.

Figure 3: OBC Financing Cascade during Phase 2 Construction



Source: AIIB

Replication Elements and Considerations

OBC creation and regulatory coordination was a critical part of the enabling context. Although OBC was a new entity when the program began, the government made clear its long-term support for a dedicated entity to develop broadband infrastructure and prove financial viability to attract private investments. Regulatory support was provided by coordinating the nationwide broadband rollout. After few years of operations, OBC had become the essential stakeholder in Oman's route to digital society, providing wholesale access to its extensive fiber network to the three broadband service providers, Omantel, Ooredoo and Awasr, and most recently Vodafone Oman. The Telecommunications Regulatory Authority (TRA) of Oman will continue such coordination to minimize duplication in OBC's FTTH coverage areas by other ISPs, which is important for the subscriber take-up and overall revenue projections to enhance the financial viability of OBC's business.

Leveraging other public services' demand and networks. In the early years of OBC's operation, the Ministry of Finance issued a Circulation urging all ministries, government entities, and establishments with telecommunication infrastructure (whether channels, fiber optics), to coordinate with OBC for the purpose of leasing and managing such assets. As a result, OBC was able to gain access to the existing utilities' fiber, which enabled the company to construct a backbone network in a relatively short time. The government also provided support in the form of asset transfers, specifically transferring entails to tranches that were built by the government or using available space in underground infrastructure, where all or part of the space was reserved for OBC's fiber optics. These steps both provided OBC with a baseload of demand (similarly to the case in Nicaragua), and allowed the leveraging of adjacent infrastructure, including for land and right-of-way and similar purposes (as in multiple other cases).

Targeted, contingent sponsor support during first phase of a greenfield roll-out. The contingent sponsor support provided by the Oman Investment Authority helped mobilize private investment in the greenfield phase when OBC was new and its network under development. Ultimately, the support has not been needed during Phase 1, which has been successfully completed and attracted significant private capital mobilization through an A/B loan structure. The participation of three B-lenders demonstrated acceptance of market risk in the telecommunications sector in Oman and should gradually diminish the need for such sponsor support as OBC's track record is established.

Separation of wholesale fiber (SOE) and retail service roles (private). OBC focused on the passive layer of the fiber broadband network deployment, which means OBC provided the physical fiber, ducts, and associated equipment to the connection points, which laid foundation for the ISPs to come into the market by sharing OBC's passive layer infrastructure. This allowed ISPs to come into the market and concentrate in offering innovative services and solutions to the end-users, as opposed to ISPs needing to build their own network at higher cost, and highly possibly generating duplication of networks. Such segregation of active and passive layers of fiber broadband network allowed for efficient use of financial resources, promoted fair market competition and better service for end-users.

Using cash flows from more-bankable phase to underwrite crossing the divide. The two-phase lending structure with tied cash-flows meant that the quick and reliable cash generation from the more lucrative areas covered in phase I supported the debt taken on for phase II. In a theoretical sense, this replicates the basic cross-subsidy mechanism of universal service obligation funds—but in a targeted and efficient manner, which also mobilizes substantial private capital on top of the implicit cross-funding. Where the more straightforward imposition of USOF fees on retail ISPs might be counter-productive or costly or infeasible given local market realities, the tranching and phasing structure used in the OBC corporate debt facility may provide an alternative mechanism—and a complementary one, especially for wholesale build-out, even where more traditional structures already exist.

Case Study: Fiber access—Dominican Republic

by the Inter-American Development Bank (IADB)

Summary

As part of a unified strategy for digital transformation, regulatory reforms were introduced to closely monitor the quality of service obligations; innovative reverse auctions (bids for lowest subsidies) were used to extend service to remote areas.

Project Description

Development objective. Recently, the Dominican Republic has undertaken a series of public and regulatory policy actions that have led the country to substantially improve digital development access indicators. As of today, more than 90 percent of the country has access to mobile telephony and of these, 80 percent have access to mobile broadband. This level of penetration, however, requires significant investments in fiber deployment to support growing traffic levels. Reducing the gap to the OECD targets would require, in the IADB's estimates, more than USD866 million, which would have a direct impact on the economy, since it would increase GDP by almost 11 percent, in addition to improving the country's productivity by 9 percent and creating more than 250,000 direct jobs.

Investment components and MDB support. Aware of this situation, the Government of the Dominican Republic requested USD115 million in financing from IADB to support investments in three specific areas: (i) analog switch-off process, (ii) deployment of fiber infrastructure to increase digital equality and (iii) development of digital skills, to support women's contribution to the labor market.

Institutional set-up. The government's actions began with the publication of the decree 539-2020, which declares access to broadband as a fundamental right and instructs the Dominican Institute of Telecommunications (INDOTEL) to develop a National Broadband Plan. The decree also created the Digital Transformation Cabinet and promulgated the 2030 Digital Agenda. The creation of the Digital Transformation Cabinet and the publication of the 2030 digital agenda allow not only to define the specific programs and goals in digital matters, but also to develop an institutional model that orders the sector by introducing the necessary legal certainty to facilitate investments.

Axes of the 2030 digital agenda. But what are the main axes of the 2030 digital agenda? This question is important to understand where the country is headed. The 2030 digital agenda defines the following 7 strategic axes:

- Connectivity and Access (15 projects, coordinated by INDOTEL)

- Education and digital skills
- Digital Government
- Digital Economy
- Cybersecurity
- Technological innovation
- Governance and regulatory framework

Formation of the Digital Transformation Cabinet. To achieve the different goals and objectives identified in each one of them, a Digital Transformation Cabinet was formed. This is headed by the Presidency of the Republic, and contains the key Ministries and state institutes and SOEs among its ten members. A transversal Cabinet headed by the President himself not only allows the entire administration to be digitally transformed but also makes the entire Government responsible for it, thus undertaking an unstoppable process towards the digitalization of the country.

National Broadband Plan. With the leadership of the Dominican Telecommunications Institute (INDOTEL), a National Broadband Plan was defined that includes actions to improve connectivity with the support of the IADB loan. Likewise, a 2020-2021 Biannual Plan was also developed with resources from the Telecommunications Development Fund, which in addition to providing infrastructure to 17 unserved communities, developed the Digital Basket by which 2,000 families led by women have a mobile service subsidy, and digital skills training.

Detailed regulatory reforms. INDOTEL conducted regulatory reform at the same time. It carried out a successful auction of spectrum in the 3.5 GHz band that included coverage obligations and that will be complemented with the re-launch of the auction of the 700 MHz band. INDOTEL also carried out specific regulations aimed at improving competition and modernizing the sector, as well as improving its ability to monitor and enforce service obligations. These included signing contracts that had been pending for many years with the main telecommunications providers in the country, to bring legal certainty to the sector, while reviewing resale regulations to crack down on irregular suppliers and developing legislation for the protection of personal data (as well as the use of digital signatures).

Monitoring upgrades. There were substantial reinforcement of Service Network Quality Control Policies and strengthening of inspection and monitoring, as well as performance measurement systems for mobile networks. The Network Operation Center was upgraded to provide periodic reporting about the performance of the infrastructure that has been deployed. Those reports are important tools for policy makers since they provide invaluable information about the level of adoption and usage of the infrastructure deployed to meet coverage obligations or with public subsidies.

Strengthening competition. At the same time, reforms to competition regulation involve defining indicators and ex-ante and ex-post control measures for effective and sustainable competition. The process of regulatory modernization is expected to culminate with an update of the General Telecommunications Law. The update will allow the intensification of competition and investment, simplify and strengthen relevant public institutions, expand connectivity and promote the use and operation of ICTs to provide services and facilities to citizens and to improve the competitiveness and productivity of the sectors of the economy.

Financing model for remote broadband

Efficiency principle. The regulatory and institutional reforms have taken place alongside, and have enabled, a substantial increase in investment into fiber. The objective of the fiber investment program is to improve the living conditions of the population with fewer resources and access to broadband, offering them the opportunity to have a quality connectivity service. The key principle is to encourage private sector investment with as efficient as possible investment on the public side, and this principle was implemented using a lowest-subsidy auction (Table 4).

Reverse auction design. The model adopted a reverse auction design, i.e., one where the lowest bid—in this case for the value of public subsidies required in a given area—wins. The auction is for the connection of public sites or locations, subject to certain minimum technical quality requirements and considering the existing infrastructure. The Government offers a subsidy, in the form of a transfer to the telecom operators to offer services at affordable prices in areas from urban centers, which would not be economically profitable through standard means. The public tender will be awarded to the bidder who, offering at least the minimum requirements, requests the least subsidy.

Table 4: Objective and instruments

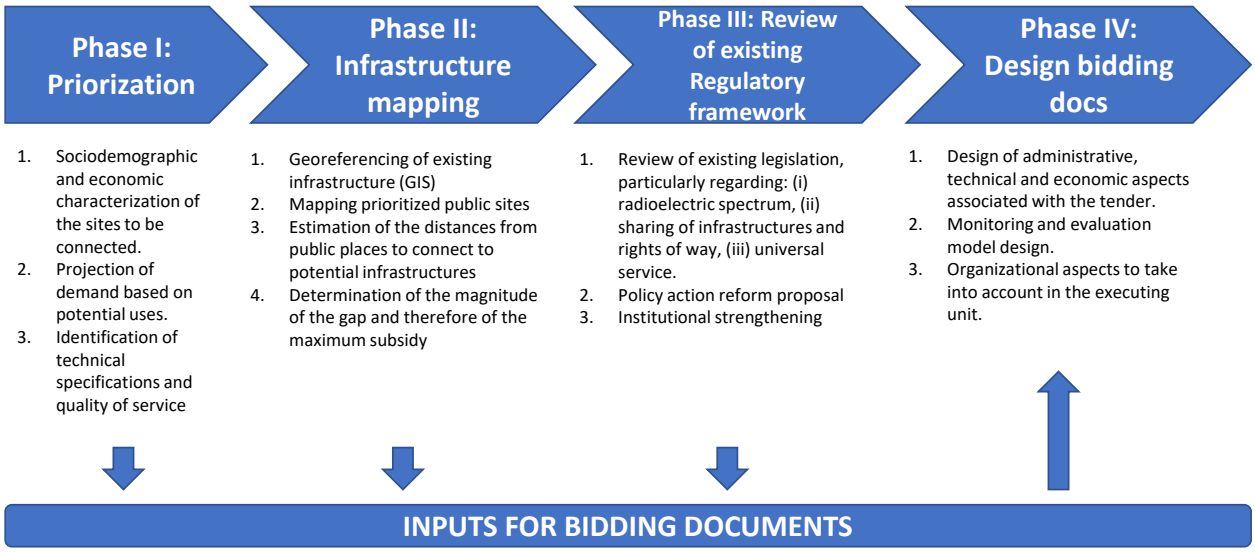
Motivation for the indirect subsidies	Causes	Objective	Intervention mechanism
Promotion and encouragement to supply	Inequality Distance from urban centers: remote location	Close gaps in access, use and affordability	**Primary**: Lowest Subsidy Auction Other instruments can be VAT exemption on import of terminal equipment or subsidy for the acquisition of certain equipment or low-cost financing

Supply-side. The subsidy is supply-side, as it is granted to telecommunications companies so that their retail prices can be set overlooking some elements of OPEX

and/or CAPEX. The supply-side subsidy is an adequate state intervention when there is a need to generate the deployment of infrastructure, because of high potential to generate social benefit, but there is no profitability of the private business model.

Technical preparation work. The implementation of the least subsidy auction has involved significant technical work. Each such auction requires a set of bidding documents to be prepared (**Figure**). Those bidding documents must show, *inter alia*, the characteristics of the sites to be connected (including public ones), projected demand to be served, quality of service requirements, and existing infrastructure. Crucially, a connectivity gap is estimated and used to establish the maximum subsidy, setting a reserve price on the auction. Thereafter, the bidding documents are published, and the auction run.

Figure 4: Phases of the Program



Source:

Replication Considerations

Still early stages. The program is still ongoing, and so retains several unknowns. For example, how to guarantee the sustainability of the program, as the subsidies should not be indefinite? As fundamentally, how to develop a competency model in digital skills adapted to the degree of digital maturity that each of the connected areas has? These questions are interrelated, since the right skills programs will be necessary to enable people to generate new opportunities and income from digital access, which will in time generate sufficient demand to support the self-standing economic case for fiber in those areas.

Information and coordination requirements to mitigate collusion and other risks. The implementation of this scheme requires access to information and coordination between the public and private sectors that cannot be achieved if the relationship of trust that the 2030 Digital Agenda has brought to the dialogue table, is not established. It also requires significant competition in the market, and a regulator with the technical skills to understand cost bases. Otherwise, the risks of collusion on the auctions, or of miscalculated maximum and target subsidy levels, is very high.

Potential for the model. Overall, though, just as reverse-subsidy auctions—in the form of lowest-tariff bidding—have been immensely successful in spurring renewable energy development, this model may (with sufficient competition and clarity of information, as in renewables), open the door to network expansions to rural or hard-to-reach areas where the private sector would not be willing to go if it were not through this investment support from the public side. Recently approved World Bank projects in Mozambique and the Republic of Congo, for example, have adopted it, which will test the model's potential including in low-income and fragile and conflict state contexts.

Case Study: Fiber access—Nicaragua

by the Inter-American Development Bank (IADB)

Summary

Nicaragua combined piggybacking fiber on electricity lines and utilizing public agencies as anchor clients, to expand rural fiber and broadband access. The electricity transmission company upgraded its fiber optic capabilities and, on the back of competition reforms in the sector, private sector players were induced to enter and provide services in rural areas through a wholesale reference offer.

Project Description

Development objective. Nicaragua's Broadband Program deployed fiber optic cables along electricity lines to connect health centers and capacity building centers for farmers**.** The purpose of the network expansion was two-fold: connecting health and agriculture training facilities, and then offering wholesale services to retail telecommunications operators to expand broadband services amongst the neighboring population and firms.

Investments and MDB support. The Program, which counted with the financial and the technical support of IADB, was jointly executed by the National Electric Transmission Company (ENATREL) and the national regulatory authority: the Nicaraguan Institute of Telecommunications and Postal Services (TELCOR). The Program was structured in three components:

(i) expanding digital connectivity infrastructure;
(ii) strengthening the regulatory framework; and
(iii) developing software applications for the connected health and agricultural centers.

ENATREL was in charge of executing the first component, while TELCOR was in charge of the second and third ones.

Network expansion. The Program execution period ranged from 2016 to 2022 and connected more than 300 health centers and capacity building centers for farmers. The health and agriculture training facilities were key anchor clients to ensure a minimum capacity usage of the newly deployed connectivity infrastructure. That minimum usage then justified the public investment return through important socioeconomic impacts, which were multiplied by enabling retail telecoms operators to expand their services utilizing the wholesale network.

Leveraging electricity network. Before the project, ENATREL was already operating its fiber optic network, albeit with a significantly smaller geographic footprint. Moreover,

since the project laid aerial fiber through ENATREL's electricity poles and towers, and leveraged its electricity transformation substations across the country, where ENATREL staff was already present, ENATREL already counted with most of the real state and other passive infrastructure assets, as well as skilled staff, required to operate the network. Those assets and manpower naturally had to be reinforced, but more in the nature of scaling up than building anew or spinning off.

Technical and financial support facilitating coordination. Technical and financial support by IADB to both the national regulatory authority (TELCOR) and the public utility operator (ENATREL) facilitated smooth interinstitutional coordination. The Program's institutional framework encompassed the creation of a Technical Committee and an Executive Committee, both composed of the key institutions for its financial and technical execution, including ENATREL and TELCOR. Prior to starting the Program execution, formal collaboration agreements were signed with the two institutions managing the health and agricultural centers: the Ministry of Health (MINSA) and the Nicaraguan Institute for Agricultural Technology (INTA), respectively.

Early coordination with health and agriculture Ministries. Upfront coordination with the health (MINSA) and agricultural (INTA) institutions was instrumental in securing the proper setting of the centers to be connected. Eligibility criterion for the health and agricultural centers to be connected included: (i) adequate facilities for hosting the IT equipment and the events and activities for its intended use; (ii) enhanced security barriers to prevent theft of IT equipment; (iii) adequate air-cooling to ensure proper working conditions; (v) qualified technical staff and systematized maintenance plans to ensure a proper operation of the IT equipment; and (v) digital skills capacity building programs to ensure that both facilitators and final users are capable to effectively use the provided equipment and connectivity services for their intended uses.

Financing Model

Public wholesale operator enabling retail competition. The core of the project's financing model was public financing of a public wholesale telecommunications operator, in combination with tailored regulatory reforms and the observance of international best practices, setting the foundation for fostering private sector competition in the retail market. The Program's financial scheme followed a simple investment loan by the IADB to Nicaragua's Ministry of Finance, who channeled the funds to the public wholesale telecommunications operator ENATREL to invest in expanding its fiber optic network along its electricity lines. The expansion generated new revenue for ENATREL through connecting health and agricultural centers, and offering additional capacity to the private sector, in combination with the competition reforms, induced private capital to invest in expanding access from the public service nodes to remote populations around them.

Extensive technical assistance in coordination and reform. Technical support was provided by the IADB to finetune the network design and deployment, and economic sustainability. Complementing the financial and technical support to the ENATREL, the IADB also provided financial and technical support to the national telecommunications authority regulatory TELCOR to update the sector's normative framework; thus, leveling the playing field for private sector operators to compete in the retail market and therefore benefiting final users in the geographic areas impacted by the Program belonging to the public sector (e.g., MINSA, INTA), the private sector (e.g., firms), and the civil society (e.g., households).

Establishment of the wholesale reference offer. Once the health and agricultural institutions were connected and provided a baseload of demand, fiber capacity was offered on a wholesale basis to retail firms. Implementing the wholesale offer required the development of a costs model of the fiber optic network expanded under the Program. This was done through close interinstitutional collaboration and the support of international experts, allowing for the setting of reference prices for the services offered in the geographic areas benefitting from it.

Components of the offer. Thus, the public wholesale reference offer specified: (i) the services offered; (ii) the geographic location in which those were available; (iii) the conditions in which those would be provided; (iv) their reference price subject to potential discounts (e.g., for prompt payment, for bulk purchase, for long-term commitment); and (v) a contract model. The public wholesale reference offer was officially submitted by ENATREL to TELCOR, who approved it, and was finally published by ENATREL on its website for the reference of all interested stakeholders, including prospective wholesale customers. Close coordination between the national regulatory authority and the national electricity company was again crucial.

Importance of open access. The support of the IADB and international experts facilitated aligning the wholesale reference offer with international best practices on open access to infrastructure and services. Since the fiber optic network expanded under the Program was for wholesale purposes only, ensuring that it was operated according to open access principles was key for promoting competition in the retail market and through it pursuing goals such as increasing broadband penetration amongst neighboring households and firms. The open access principles guiding the public wholesale reference offer included: (i) no discrimination of any kind -including those of economic and technical nature- of any telecommunications operator requesting access to the network; (ii) granting disaggregated access to infrastructure and services when technically feasible; (iii) setting cost-oriented prices; and (iv) mitigating information asymmetries by making the wholesale reference offer publicly available.

Donor coordination. Co-financing of an international donor (Korea) allowed for a multiplying effect that maximized the Program's socioeconomic impact**.** The IADB and

Korea -through the Korea Infrastructure Development Co-financing Facility for Latin America and the Caribbean- pooled resources to equally co-finance the USD50 million Program budget.

Replication Considerations

Some of the key elements of Nicaragua's Broadband Program, such as the direct public funding of a national wholesale network, has been implemented in other countries, such as Mexico. Other national wholesale networks funded by public funds can be found in the Latin American and the Caribbean region, such as Mexico's Shared Network, aiming at providing 4.5G mobile broadband coverage to at least 92.2 percent of the population. The IADB also contributed to financing this initiative, channeling funds through Mexico´s Development Bank in charge of financing international trade (BANCOMEXT) for the Financing of the Shared Telecommunications Network to foster private sector competition in the mobile broadband retail market. A public wholesale reference offer is also foreseen in the Program to Improve Connectivity for Digital Transformation in the Dominican Republic (also in this Compendium).

Delimiting the scope of the public wholesale reference offer encompassing new and legacy assets was an unexpected challenge and will need to be factored into replications. Given that the establishment of a public wholesale reference offer was decided under the umbrella of IADB's technical and financial support, its scope was supposed to include only the services provided by means of the assets financed by the Program. Hence, wholesale services provided only through ENATREL's own legacy assets were not supposed to be part of it. Such delimitation was obvious for passive infrastructure-based services, such as dark fiber and co-location in towers. However, the delimitating line was blurred for active infrastructure-based services such as internet access because the Program financed the modernization of ENATREL's core network equipment, which was the foundation for all active infrastructure-based services, regardless of the geographic location of its provision. Finally, the decision made was to geographically delimit the scope of the public wholesale reference offer for passive infrastructure-based services based on the Program's geographic scope and to include all active infrastructure-based services regardless of their geographic location. Such nuanced and complex issues are likely to emerge in other contexts as well, but the case shows these can be resolved with constructive determination.

The approach of connecting public sector facilities to improve social services delivery and leverage its spillover effects to spur private sector competition in neighboring retail markets has also been adopted in Guatemala and El Salvador. For instance, the Program for the Digital Transformation of Guatemala for Inclusive Access to Connectivity aims at connecting more than 3,000 public schools and municipal sites in the northwestern part of the country. In the case of El Salvador, the Social Digital Connectivity Program aims at connecting more than 2,000 public schools

and education centers. Both projects, which count with IADB's technical and financial support, aim at spurring digital connectivity spillover effects to benefit neighboring communities.

Drawing on multiple DFIs. The financial support by a multilateral financial institution (IADB), also bringing international technical expertise and conveying power, was a powerful catalyzer for the required interinstitutional coordination and observance of best practices. The financial agreement reached between Nicaragua's Ministry of Finance and the IADB put in place several institutional coordination mechanisms (e.g., Technical Committee, Executive Committee, formal collaboration agreements with MINSA and INTA), regulatory reforms (e.g., public wholesale reference offer), and international best practices (e.g., open access principles). Such political, institutional, and legal commitment with a regional multilateral public stakeholder facilitated that all national institutions involved in the execution of the Program shared the incentive to collaborate closely in the pursue of the Program's strategic objectives. Leveraging multiple donors' funds allows for maximizing the socioeconomic impact of deploying digital connectivity infrastructure—the IADB and Korea have combined to positive effect in Guatemala and El Salvador as well as Nicaragua.

Case Study: Rural Broadband—Italy

by the Government of Italy

Summary

Italy's National Ultra-broadband (UBB) Plan utilizes a combination of supply-side measures drawing on a combination of local, national, and European funds and demand-side measures, including take-up vouchers, to meet ambitious goals for broadband connectivity in remote areas.

Program Description

Development objectives. The Italian Broadband Strategy was launched in 2015 with the aim of supporting the deployment of broadband digital infrastructures over the Italian territory, according to the connectivity targets set by the European Digital Agenda (EDA) of the European Commission. In particular, the connectivity targets of the EDA, to be addressed by 2020, were:

(i) over 30 Mbps connectivity subscriptions for 100 percent of the population,
(ii) over 100 Mbps connectivity subscriptions for 50 percent of the population.

Interventions. The support interventions were split in two lines of action:

(i) support to the broadband infrastructure deployment (supply-side),
(ii) support to the demand for broadband connectivity (demand-side).

Supply-side Phase I. Phase I addressed "white areas", those which were neglected by the deployment investment plans of telecom operators. It focused on building out wholesale ultra broadband networks that retail telco operators could then utilize to offer services. In these areas of market failure, the Italian Government used several instruments to make UBB networks available:

- Subsidies, with conditions: the telco operators invested in market failure areas and the State supported part of the capital expenses. The operators remain the owners of the built networks, but offer wholesale access to the network at subsidized rates.
- Concession: The public institutions (national and local) charged a private entity, following a tender process, with building the UBB networks in market failure areas and to manage the networks for a period of 20 years. The public institutions remain the owners of the built networks, with the private entities managing them.
- Direct construction: The state built and manages the access network but in wholesale only to the retail operator and does not offer access to retail customers.

Demand-side vouchers. Concerning the support to the demand for broadband connectivity subscriptions, a voucher-based intervention was planned. Offer and demand are two faces of the same coin, and without sufficient ongoing demand, the

supply-side interventions would have either failed or involved unsustainable costs. There can be a market failure regarding demand if there are lumpy costs involved in establishing a connection that certain households cannot afford, or if lack of familiarity with the utility and opportunities afforded by digital services means that latent demand does not materialize. Vouchers limited to initial installation and the first months of subscription fees may then help to overcome such barriers. The vouchers in this case targeted families with a gross income per year lower than EUR20,000, and provided for a contribution of up to EUR500 to upgrade fixed lines or to activate a new line with an over 30 Mbps connectivity speed.

Financing Model and Results

Funding sources. Several sources of funding were available, at different levels. One was the European Regional Development Fund (ERDF) and the European Agricultural Fund for Rural Development (EAFRD). These funds are originated by the European Commission and provide transfers to local regional administrations in Europe (in Italy, the Regions). Another source of funds originated from the Italian Ministry of Economic Development (MiSE), as Cohesion Funds also provided to the Regions. These funds were blended in the pursuit of the Strategy.

Flexibility in fitting context. The combination of multiple instruments allowed the program to tailor for regional context and find the fit of public support and specific market failure. The mix of multiple instruments and multiple funding sources might have been expected to cause significant confusion, but innovative governance arrangements were pursued to avoid that possibility.

National-Regional Agreement. To allow for a coordinated implementation of the plan a National-Regional agreement was signed, with the Regions charging the National government, represented by MiSE, with managing the regional funds to address their own connectivity targets. According to the agreement, the whole share of European funds addressing the connectivity development on the supply side was managed by the Ministry in a virtual transfer from the Regions.

Regional Technical Plans. The transfer followed an analysis of financial needs for the connection of each town, codified in Regional Technical Plans. These Technical Plans were elaborated by Infratel Italia, an inhouse company of the MiSE and in charge of the UBB plan implementation. Each plan was signed between Infratel, MiSE and the involved Italian Region, with the aim to harmonize the blend of different funding sources, each one following a different regulation and related constrains, among the towns to be connected within the plan. For example, EARDF funds are limited to address the rural towns only, whereas cohesion funds require 80 percent funding to be located in less developed Regions (in Italy represented by the southern Regions). The Regional Technical Plans matched these funding sources and allowed implementation by Infratel on behalf of the regions.

Governance Mechanisms. For reporting and monitoring between the national and regional governments, two principal mechanisms were used:

- regional committees ("Cabina di Regia" in Italian), called every six months and involving the specific Region, the Ministry of Economic Development (MISE) and Infratel.
- a web platform, named Geo4Wip Plus, made accessible by local and regional authorities to enable a complete progress monitoring of all the different steps of the network creation, from network design to civil works of network buildings and the final testing. Dynamic reporting tools included into the platform make a real time analysis and monitoring available, both at single town level and at aggregate level.

Supply-side results. As of December 2021, 32 percent of the households included in the Plan in white areas have been reached by at least 1Gbps connectivity. The Plan is scheduled to be completed by 2023. Considerable progress has been made in this respect in 2021: almost 1 million new households were connected and 1 168 municipalities were reached. Within the same Strategy, the Small Islands intervention was launched in 2021 to support the ultrabroadband connectivity deployment over the small Italian islands, being part of the afore mentioned white areas. The Small Islands Plan was entirely supported by the National Cohesion Fundings delivered by MiSE.

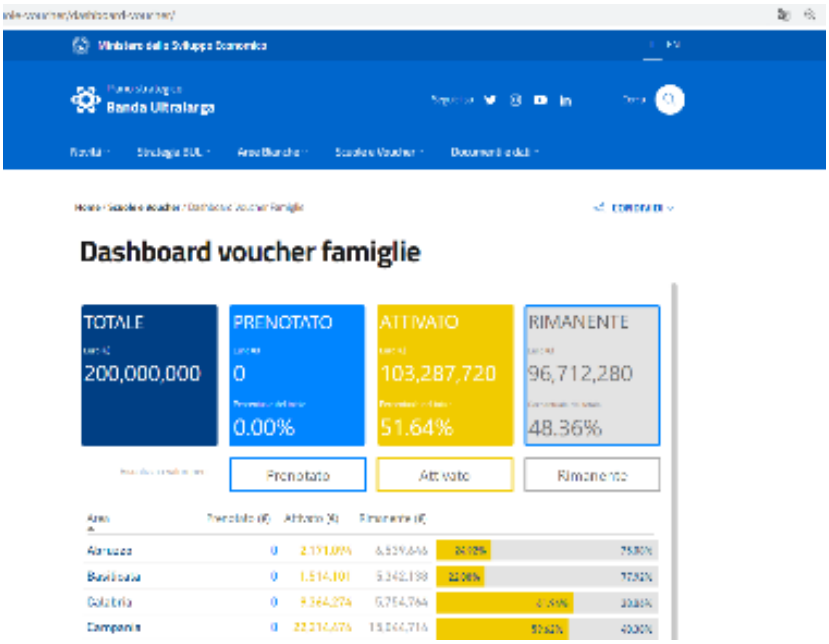
Demand-side

Voucher design. For the vouchers, operators play the role of trusted intermediary between the public administration and the end users, so that a voucher is delivered only when the user subscription is activated. The Voucher Plan is entirely supported by the National Cohesion Fundings delivered by MiSE. In this case, no blending with EU funds was involved.

Voucher monitoring. To monitor the Voucher Plan and enable rapid management, allowing for voucher requests by the operators and confirmation by MiSE as fast as possible, an online monitoring platform was set up and maintained by the MiSE in-house company Infratel. The take-up of the voucher program is transparently available on the UBB program's website (https://bandaultralarga.italia.it/en/). At the time of writing, approximately half of the vouchers have been taken up (

Figure), representing roughly 200,000 households.

Figure 5: Dashboard Showing Voucher Take-up



Source: https://bandaultralarga.italia.it/en/

Demand-side results. Phase I of the 'Voucher Plan' was launched in 2020 and expanded in 2021. More recently, in 2022 the Italian Government launched Phase 2 of the Voucher Plan, implemented over a financing scheme for EUR610 million to support SMEs access high-speed broadband services with over 30 Mbps download connectivity. Such vouchers will cover partly the setting-up costs of high-speed broadband services and the subscription fees up to a maximum of 24 months, and can be used to subscribe to new connections or to upgrade existing ones.

Replication

Several individual elements (e.g., installation vouchers) may be replicable on their own, and some are echoed in other cases. Some of the individual elements of the program may be replicable on their own in other contexts. For example, the use of time-limited vouchers to encourage low-income households and SMEs with limited digital experience to take up broadband and trigger latent demand could be explored elsewhere. If households do not have experience of the utility of such services there may be market failures in demand as well as the better-known market failures in supply, and such vouchers, targeted at initial uptake and administered with transparency and controls could be explored to overcome such failures. Other elements, such as subsidies conditional on set prices or direct wholesale network construction have been seen in other cases, including in this compendium.

The overall architecture was most impactful and is itself an innovation that might be considered for replication, if the technical capacities exist. The more general innovation is the overall structure of effectively pooling different funding sources within a general framework, matching different sources to different areas to effectively utilize funds having different constraints. The critical element is the set of arrangements between different levels of government, with their planning and monitoring arrangements. To the program's knowledge, the National-Regional agreement under the UBB plan was the first of its kind in Italy. But there will likely need to be some agency in place that can establish and implement the program. The existence of Infratel within the Ministry of Economic Development (MiSE) provided the kernel of implementation capabilities as well as an agency the Regions could form an agreement with. It was first formed in 2005 so by the time of the UBB Plan it had accumulated more than a decade of experience. In such a context, the use of agreements and technical plans to blend multiple financial sources and deploy them flexibly can produce significant results.

Case Study: Remote broadband—European Union

by the Directorate-General for Communications Networks, Content and Technology (DG CNECT) of the European Commission

Summary

The Connecting Europe Broadband Fund (CEBF) utilizes financial engineering to absorb risk for greenfield investments in fiber to the home (FttH) and mobilize private capital while retaining upside for the public sector. It draws on local financial and fund management expertise, and is an example of the public sector starting to innovate in financial instruments beyond the private sector.

Program Description

Development objectives. The CEBF is a Private Equity (PE) fund that was set up to meet the growing demand for financing of smaller-scale broadband projects across Europe, which did not have easy access to funding. Projects (whether broadband fixed line or mobile) should make a significant contribution to the achievement of the targets of the European Gigabit Society, through the deployment of networks upgradable to 1 Gigabit as well as to projects based on open access wholesale-only models.

Background of incumbency and private hesitation to invest. When creating the fund, prevailing telecom market structure and regulatory environment in Europe was giving incumbent operators a natural incentive to continue harvesting their existing copper access networks as long as no alternative broadband operator challenged them. However, alternative operators are not always in a position to cope with the large capital expenditures and long payback periods required to build FttH networks. This is particularly true for the roll-out in rural areas where the lower density results in typically very high payback periods exceeding sometimes 10 years and going up 20 years.

Regulatory reforms had created competition but not as much greenfield FttH as hoped. Against this backdrop, specific initiatives to foster the emergence of open-access networks and support alternative operators across Europe were launched. Telecom players are more and more relying on infrastructure mutualization (sharing agreements) or on open access networks and compete primarily at the service layer. Although these models have proven efficient in a number of cases, there was always a reluctance from institutional investors and long-term funds to substantially invest in greenfield FttH infrastructures. Beyond the traditional risk of greenfield projects (that are not cash/yield producing assets as in the case of brownfields) these projects carry additional risks principally due to the lack of visibility of revenue ramp-up and the strong IRR sensitivity to market penetration speed.

Intent to mobilize private capital and retain upside for public sector. The European Commission asked its financial partner, the EIB, to help design an innovative layered investment fund that could encourage the involvement of private funds and institutional investors in the broadband infrastructure market. The European Commission was already active in that space through grants but CEBF allowed to more effectively attract private investors in the sector and have a positive return on its investments. Indeed, as assets are sold at the end of the fund the European Commission will not only recoup the initial financial commitment but also potentially make a gain, which can be used for other initiatives.

Fund capital and tenor. The CEBF raised EUR555 million and through its equity investments in individual projects it is expected to unlock total investments for EUR1-1.7 billion in broadband projects. The CEBF invests in underserved areas in the European Union, as well as Norway and Iceland. The Fund`s investment period will last until June 2023 but if necessary, it could be extended by one year twice. The overall duration of the fund is planned for 20 years (until 2038) but there is the possibility of an early termination clause for the fund at 12 years, which is closer to a standard infrastructure PE fund.

Greenfield only, focus on underserved. CEBF invests only in greenfield projects predominantly deploying fiber broadband networks in underserved areas, which would be typically classified as grey Next Generation Access (NGA) networks (i.e. only one NGA network exists or is planned) and white NGA areas (no NGA network exists), for state aid purposes. The creation of the CEBF was driven by the need to stimulate the appetite of funds and institutional investors for the sector, by mitigating some inherent risks of smaller greenfield ultrafast broadband projects and by making this investment risk match better with the investment criteria of long-term investors. This was achieved with some financial engineering, as described below.

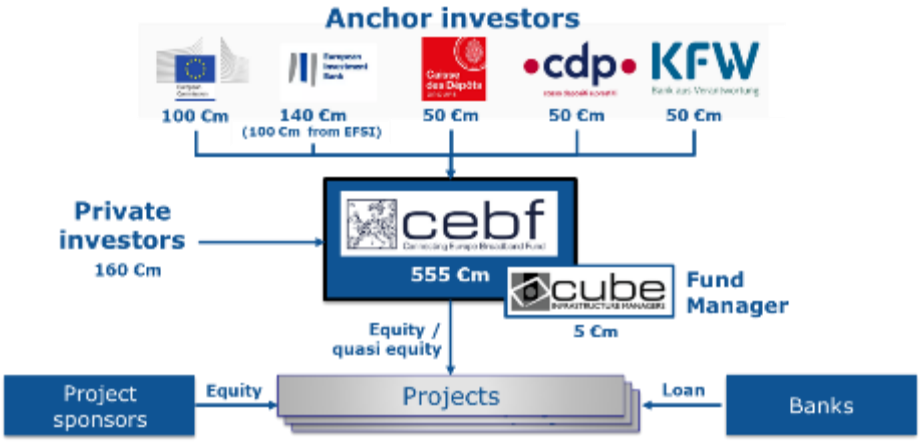
Financing Structure

Sources of funds. The Fund was launched on June 27, 2018 with EUR420 million at first closing through commitments from the European Commission via the:

- Connecting Europe Facility for EUR100 million (committed in the junior equity tranche, subordinated to all other investors);
- European Investment Bank (EIB) for EUR140 million (out of which EUR100 million are backed by the EFSI guarantee);
- German *Kreditanstalt für Wiederaufbau* (KfW) for EUR50 million;
- Italian *Cassa Depositi e Prestiti* (CDP) for EUR50 million;
- French *Caisse des Dépôts et Consignations* (CDC) for EUR50 million and
- An additional EUR25 million contributed by a European private investor.

Fund manager selection and final closing. The fund manager, Cube IM, was selected via an open and competitive selection process. For alignment of interests, Cube IM has subscribed into the Fund for an amount of EUR5 million. The last closing occurred in June 2021 and commitments from private investors now reach EUR160 million for a grand total of EUR555 million, effectively outperforming the initial target of EUR500 million.

Figure 6: Financing Structure



Source: DG CNECT

Multi-layered structure to absorb risk. In order to mobilize additional funds, CEBF was designed to be a multi-layered fund where the EC and EFSI (provided by EIB) investment are subordinated in the waterfall process of cashflows in order to absorb some of potential losses. This design allows the private investors to be protected and have a Net Asset Value (NAV) > 1 for their share class already from the start. This is never the case for greenfield projects due to the initial implementation phase where assets are still being developed and do not produce cash/yield yet.

Equal returns in some scenarios. Differently from other layered structures, in CEBF there is no separation of return in all scenarios. Indeed, once the target IRR level for the investors in the preferential layer is reached, the subsequent inflows are not subject to any preferential conditions and cashflows are distributed on equal footing ("pari passu") among all investors. The "pari passu" feature was applied as widely as possible in the fund structure to avoid falling under the definition of State aid, which is strictly normed and in principle prohibited in the European single market.

Leverage effect. The layered structure with the subordinated class fully subscribed by the European Commission and EFSI was instrumental in ensuring the viability of CEBF being a special kind of infrastructure fund i.e. single sector fund targeting greenfield projects in underserved areas. The leverage effect achieved with the EU budget was also good, in particular in qualitative terms. Previous funds set up by the European

Commission were much less successful in terms of private investment subscription. For CEBF about 30 percent of the total capital come from the private sector, which makes it possible to consider it like a private investment fund from the point of view of state aids. The participation of funds and institutional investors was key in reaching (and exceeding) the aimed size of the fund.

Replication Elements and Considerations

Layered investment funds. The concept of layered investment fund, where the public sector subscribes the most junior and riskier share class, is easily replicable in different jurisdictions. The European Commission could tap on local expertise in the fund industry in Luxembourg but similar know-how can be found elsewhere too. While the innovative solution described above was used to address the specific needs of the digital infrastructure sector, the general principle can be applied also to other sectors.

Need for a subordinated anchor and experienced fund manager. The key factor when replicating this scheme is to find a stakeholder ready to subscribe the subordinated shares bearing the risk. Large national promotional banks or multilateral development banks who have the capacity and experience to do it and are trying to attract private capital, could play this role. Another critical success factor is finding a fund manager that has vast experience in the sector and ensure that the governance allows it to be independent in running the fund.

Importance of governance and mandates, and need for patience. The main difficulty was in aligning the interest of policy driven public investors with private investors prioritizing profitability. This required a careful design of the fund governance and fiduciary mandates. On one hand, the independence of the governance body (investment committee and board of directors) was important to reassure private investors. On the other hand, public investors, to comply with their internal rules also had to negotiate with the Fund Manager more through reporting requirement.

Need for patience and communication with (traditional) private sector. Because of the uniqueness of the platform (single sector, greenfield only and multi-layered structure) it was challenging to do a regular fund raising. It took more time than anticipated to convince private investors about all the novelties, compared to the somewhat-traditional instruments still often used by private sector digital infrastructure investors.

The View from the Private Sector: Data Centers in China, Korea and Nigeria

by Actis

Actis's Approach to Financing Data Centers

Actis harnesses private capital to acquire, invest in, and build out data centers around the world. It is focused on a buy-and-build approach, assembling a best-in-class platform team to develop facilities that will meet local needs and become attractive to future buyers. This can involve buying existing operations from private or state-owned telecoms operators, allowing them to spin out these assets from their balance sheets and hence freeing up capital to deploy elsewhere, or acquiring brownfield or greenfield sites and investing in them so they can expand to meet the needs of the growing digital economy. Actis has a particular focus in bringing the benefits of digitalization to the fastest growing markets of the world where there are more opportunities, and in embedding sustainability at the heart of every project.

About the Data Centers

In the three cases considered here—in China, Korea and Nigeria—all three investments saw Actis identify opportunities to bring greater connectivity to fast-growing economies, deploying private capital in the most sustainable way possible. The sites in China and Korea involved acquiring land and building new facilities, while our investment in Nigeria involved purchasing an existing, smaller data center and expanding it to greater scale. The different types of investment undertaken highlight both the scale and flexibility of Actis's financing approach.

In China, the investment is in Chayora, a wholesale data center developer-operator focused on providing high-quality infrastructure for companies building or expanding their presence in China. In Korea, we engaged in a joint venture development with the construction arm of one of the largest conglomerates in the country.

Meanwhile in Nigeria, Actis took a majority stake in the country's leading carrier-neutral facility, began an expansion program, and is now focusing on other markets on the continent where it can scale up its operations.

The Importance of Private Capital

Private capital is vital if the world is to meet its digital infrastructure needs. Indeed, investing in this kind of infrastructure is one of the fastest ways of transitioning to a more equitable, efficient and prosperous society. Governments however often have

other priorities such as healthcare, education or transport, so do not have the resources to build assets of sufficient quality and quantity. For their part, large global telecoms operators find assets like these can tie up large amounts of capital, and can therefore often encumber their plans for future growth. Private capital by contrast is able to deliver the required infrastructure more efficiently. Investors meanwhile are supportive because they find such projects typically offer secure, yield-bearing assets with long term contracts, which helps them meet their own investors' needs.

However, success depends on a true sense of partnership between both the private and public sectors. Investors are required to raise the finance, while governments are needed to foster a supportive investment climate, as well as ensure the right critical infrastructure such as power and water are put in place.

Innovation

Actis' innovations include bringing the benefits of data centers to the fastest growing markets around the world, where there are more opportunities and investments can be most impactful, and on embedding sustainability at the heart of all our projects. This means we use private capital to help meet global infrastructure challenges in a way that makes a minimum call on scarce natural resources, and which brings the benefits of digitalization to local communities. Our investments in China, Korea and Nigeria are prime examples of these innovations.

In Nigeria, Actis partnered with the existing land owner and data center operator to best navigate Nigeria's land and infrastructure challenges. Actis actively took initiatives to switch from diesel to natural gas to power the site, reducing carbon intensity and improving operating cash flow, and initiated design changes to substantially improve energy efficiency (see below). The project team improved planning cycles and procured long lead imported components timeously to ensure delivery to completion is not challenged by importation of components not available locally. The project sourced locally to support local economies, realise cost benefits and ensure timeous project delivery. With the data center operator we also developed a "Skills to Employment Program", which will recruit up to 170 lower-middle-income young people in Lagos to participate in a digital skills development program.

Sustainability

The other area of innovation when it comes to investing in data centers is our focus on sustainability. Our investors are increasingly mindful of the issue, while as an organization, sustainability is embedded in everything we do. Data centers underpin more inclusive and more connected economies and are critical to delivering the UN Sustainable Development Goals: nearly 80 percent of them are dependent at least in part on digital infrastructure.

At Actis, we ensure our data centers benefit both the environment and the societies they are located in. We build sustainable value creation into the core operation of the businesses in which we invest. We also apply international Environmental, Social and Governance standards to all our investments. This can involve not only using the most efficient energy sources possible, but also ensuring we are generating positive impacts in the communities we operate in, for example through running training programs or making sure both direct and indirect job creation support local workforces.

In Nigeria, the data center (Rack Centre) is forecast to be 35 percent more energy-efficient than other regional data centers and 16 percent more energy efficient than the global average. Water consumption will be reduced by 41 percent and there will be a 45 percent reduction in the embodied carbon of materials used in construction. The design factors will ensure a lower power usage efficiency (PUE), and we are targeting an operational PUE of ~1.35 which will be a significant achievement considering Nigerian temperatures and humidity. Rack Center is also the first in Africa to receive an IFC EDGE (excellence in design for greater efficiencies) design certification.

Overcoming Challenges

The data center investments we undertook in China, Korea and Nigeria had to overcome a number of hurdles. Each country has its own challenges: there are policy issues to be managed, land to be acquired and a stable power grid secured. Local planning regulations are different in each market, as are the respective governments' approaches to outside investment in sectors such as infrastructure. Data centers must also be built in line with the requirements of the Paris Accords. That means ensuring renewable energy is secured, and the greatest power efficiency possible is built into the project.

A partnership approach is key to success. Working with local partners who understand the market can bring valuable insights to secure positive outcomes, as can engaging with governments to ensure the right infrastructure is provided. Investors should have a proven, long-term track record, both in investing in infrastructure and in operating in the markets where the data centers are to be built. Having on-the-ground teams with the right expertise and local know how is also critical to ensure both a positive outcome for investors and positive impacts for local communities.

Lessons for the Future

Using private capital, focusing on opportunities in the fastest-growing markets and embracing sustainable outcomes are positives both for investment returns and for overcoming global sustainability challenges. Stakeholders seeking opportunities in future projects should be aware of the importance of government support in facilitating the entry of more private capital to help close the digital divide, while investors need to

be focused on building assets as sustainably as possible and in a way that takes account of the needs of local communities.

The success of these particular projects demonstrates both the scalability of such private capital investments and the positive impact they can bring. The facility in Nigeria for example was acquired with a capacity of 2MW, a capacity which is now planned to increase to 13MW. There are also plans to expand further across Africa, bringing the benefits of digitalization to even more places on the continent where they are needed most.

Case Study: Soft Digital Infrastructure—Madagascar

by the World Bank PRODIGY team

Summary

The World Bank's PRODIGY project provides funding for (among other components) a central Digital Government unit to apply modern techniques to build inclusive soft DI, e.g., platforms for key government services that reach all users, showing the potential to leapfrog in capabilities even in environments with challenging legacy contexts.

Project Description

Development objective. Madagascar had its first peaceful and democratic transition of power in 2018. As a legacy of the past, it ranks on the 11th percentile in worldwide governance indicators (compared to the Sub-Saharan Africa average of 26th percentile). Accessing public services is arduous, time-consuming, and often subject to corruption. Almost all tasks need to be carried out in person. The World Bank's Digital Governance and Identification Management System Project (PRODIGY), which began preparation in 2019, aimed to strengthen the government capacity to deliver services in selected sectors.

Hard DI and skills availability. For those who can afford it, internet access speeds in Madagascar are fast (investments in fiber mean the second fastest connections in Africa, only after Ghana). But the cost of mobile connectivity, at 40 percent of GDP per capita for 1 GB of data in 2016, remains prohibitive. Only two thirds of the population have access to a mobile phone. One strong point has been the strong supply of software talent. There is a dynamic ICT private sector in Madagascar that the project saw might be leveraged to provide digital services tailored to the population's needs. That potential was demonstrated by the sharp uptake of government service hotlines, both before and during COVID.

Major components. PRODIGY contained two components. The first is supporting the creation of a consolidated legal identity and secure access to civil registration services for all citizens. The second, covered in this case, seeks to increase the offering, coverage and the quality of public services, by building the Government's infrastructure and capacity to deliver public services that are faster, cheaper and better. The component contains multiple interlocking activities to build the soft digital infrastructure required for inclusive digital services—"the institutional and technological backend infrastructure for required for effective service delivery", in the project documents' words.

Investments in regulations and cybersecurity. The project contains incentives and funding, through results-based financing measures (discussed below), to implement institutional and policy frameworks for data privacy and protection, as well as civilian cybersecurity. Those include the operationalization of a civilian computer emergency response team (CERT) and of a data protection authority. Those steps are mirrored and supported by the development of data management systems and data management structures within the government itself.

Set up of the Digital Governance Unit (DGU). In 2019, as soon as preparation for the project began, the Presidency created a Digital Governance Unit (DGU) to develop and coordinate the implementation of a national digital governance strategy, working with the World Bank team. The DGU was formalized and strengthened once the PRODIGY project became effective. The project supported the establishment of the DGU but also, critically, included incentives and funding for other Ministries to adopt the standards and procedures that the DGU developed. This was critical because the DGU's role is to embed standards for modern, agile, user-focused service design and delivery. The particular sectors prioritized for digital service development are telehealth and tele-education.

First work with private sector. The first work the DGU conducted was with the Economic Development Board (EDBM). The goal was to build a platform for companies to interact digitally with the government, including SMEs. In the past, registering a company formally took four days, but in practice multiple trips in person to the EDBM offices over a period of weeks. The DGU was able to pursue a user-centric design, working collaboratively with the EDBM, and then rapidly develop and iterate a system for registration that when launched cut the registration time to eight hours, wholly online except for a final fee payment and signature. Those two are planned to migrate online in time.

Cross-government interoperability. One of the largest projects the DGU is driving is the implementation of cross-government interoperability. This is a piece of within-government soft digital infrastructure necessary for people to access important public services more straightforwardly—at present, government systems are silo'd and cannot share data, creating inefficiencies both within government and in the delivery of services. The project is implementing an interoperability platform based on the Estonian open-source software and ecosystem model called "X-Road". Some connections are already live. For example, data interoperability between Madagascar's tax directorate, commerce registry, and the statistics agencies, is what allows the application for business registration to be processed in hours at most, but often minutes. As more institutions and information systems connect to the platform, services will become quicker, more efficient, and informed by real time data.

Additional shared platforms. The project is also working on a shared payment platform, allowing for simple and straightforward payments for services or taxes, where

applicable. Universal implementation will require high-level alignment on some complex issues, for example in public financial management (PFM) principles. The project has taken a flexible approach by deciding to build first a payment system that connects mobile money—which is widely prevalent—to the business registration system. The system is being built in a deliberately modular form so that it can be extended to a more general platform as such alignment is reached.

Engagement with the private sector. The project contains a heavy element of interaction with the private sector. At one level, that involves improving procurement for digital services. The project has commissioned a study on "agile procurement", to initiate reforms that will allow the procurement of soft DI in a manner more aligned to good practices in modern software development. It also involves skills development, since the project explicitly acknowledges that building out inclusive digital services will entail substantial demands on local skills, and therefore envisages partnerships with local universities and academies to ensure the continued (and hopefully increasing) strong supply of software and design talent. More generally, private sector partnership runs as a thread throughout the project, down to the manner in which SMSs for the X-Road platform are designed and developed.

Financing Model

Results based financing. The primary funding for the project is in the form of a World Bank investment project with performance-based conditions (PBCs). The grant is heavily weighted towards technical assistance and contains a number of incentives and provisions for necessary investments in regulation and cybersecurity. The outcomes in the PBCs are set to be access to new digital platforms offering essential services, in addition to (as described above) implementation of data privacy and cybersecurity frameworks.

Leveraging other donors. The EDBM was also funded by the European Commission, while other donors funded complementary activities to the DGU. The telehealth and tele-education services in PRODIGY are also intended to complement and leverage World Bank programs in those sectors, and a further complementary project on private sector development is under preparation.

Potential revenues in future. A fundamental challenge for the DGU and several PRODIGY initiatives will be sustainability in the long-term, given the very limited fiscal resources available and the limited ability of the broad base of SMEs and residents to pay for services (e.g., registration fees). However, the DGU has created an institutional framework within which to pursue such initiatives for a number of years, over which period revenues may start to be generated and support sustainability, e.g., EDBM is currently short of funds but may be bridged with additional donor support and in the long term start to be self-sustaining through licensing fees and other services/projects.

Replication Considerations

The DGU and PRODIGY overall still face substantial challenges, but the early results given the legacy institutional context show what can be achieved. A layer of soft digital infrastructure is being actively laid for inclusive services that holds the potential to cross the digital divide and the public services divide. The business registration has rolled out, a shared payment layer is being built, the interoperability platform is progressing and there is active dialogue with the private sector. The challenges have involved continued institutional fragmentation, as well as some damaged trust with the private sector given some financial management issues in the past, such as delays in payments by the government. The strong technical talent that has grown in Madagascar has primarily been active in contracted software development, and so finding the design and product management and stakeholder alignment skills necessary to implement user-centric design in practice. Other contexts may face less challenges—but that provides all the more reason to pursue such initiatives.

The purpose-built Digital Governance Unit pursuing user-centric service investments across government provides one clear possibility for replicability. The DGU brings together a diversity of expertise, from software engineers to agile product owners, user researchers, and content designers. Behind the creation of the DGU is a vision that government capacity is essential to deliver services that are faster, cheaper, and better. Having an in-house team means that digitalization can be truly agile, translating into constant and improvements of products without fixed end-dates. Having in-house capacity also helps institutions understand – and can be far more responsive to – users of public services. Such capacity allows building modularly and flexibility, e.g., building a single payment interface and then expanding it to a shared platform through incremental bolt-ons and expansions. In a similar vein, it mitigates typical challenges in public sector procurement of digital goods and services, allowing the government to better identify needs, solutions, and more effectively negotiate and manage contracts. This in-house capacity is complemented by a government-wide training program, led by the DGU, with training programs tailored to specific needs of senior managers, IT units personnel, and sectoral staff responsible for public service delivery.

Case Study: Community Networks—India PM-WANI

by the editors and the Digital Empowerment Foundation, India

Summary

India's Prime Minister Wi-Fi Access Network Interface leverages small retailers and public sector units to provide easily accessible public telecommunications services (via public Wi-Fi networks) in remote areas by removing licensing barriers and providing a unified way for people to find, register and pay for such services.

Project Description

Development objective. Last mile connectivity among rural, low-income people is among the hardest problems to solve in digital infrastructure. Even in advanced economies with substantial fiscal resources, rural connectivity is difficult to induce (see the Italy case). In low- to middle-income economies, rural or low-income communities are often the last to be connected, and if there is no organization surrounding that connection to provide skills and income opportunities, then the supply of last mile connections may not even result in demand.

Community networks. One approach to this problem is based on neither the public or private sector specific solutions, but relies on community-driven organizations enabled by public goods and connections to existing networks. These are community networks, also called community-based Internet service providers (C-ISPs). They are small-scale, local networks that are built, managed, operated and administered by a community, typically in a rural or far-flung area. The community itself pools resources and works with partners who provide training, coaching and, in some cases, funding.

Development in India. Community networks have been deployed in multiple regions, but have been particularly used in India. There, an initiative (Wireless for Communities, W4C) by some organizations such as the Internet Society and Digital Empowerment Foundation has established over 300 such networks, reaching over 30,000 households. The networks are built using line-of-sight transmission and low-cost Wi-Fi equipment, utilizing the unlicensed spectrum bands (2.4 GHz and 5.8 GHz). They are usually organized and managed through local cooperatives, for example of weavers, creating opportunities for skills transfers and the productive utilization of DI for income improvement. In one of the first community networks, in Chanderi in Madhya Pradesh, weavers' income doubled due to access to an online library of improved designs.

PM-WANI program. To provide public support for last-mile rural connectivity, in December 2020 the Government of India created a program called "Prime Minister's

Wi-Fi Access Network Interface" (PM-WANI). While community networks use unlicensed spectrum bands and are run in general noncommercially, the PM-WANI program provides for local shops and small establishments to become commercial hotspot providers. It does so through waiving all licensing, registration and fee requirements for offering public broadband access at a small scale, while setting up offices and data aggregators to make it simple to find and quickly access such networks.

Financing Structure

Sustainability challenge. By their nature, community networks struggle to be self-funding. That is to be expected, since they are an intervention targeted at precisely those areas where the private returns to providing access are too low—due to low income levels and/or low population density—and the costs of such provision by traditional methods is high. Many community networks have therefore been funded by partnerships with philanthropic foundations, or utilizing corporate social responsibility (CSR) funding. In 2021, Kenya began exploring the use of its Universal Service Obligation Fund (USOF) to support community networks, and Argentina in 2020-21 began and then doubled in size a program to provide small grants to qualifying community networks.

Decentralized approach. India's PM-WANI program aims for self-sufficiency by mobilizing micro-entrepreneurs and piggybacking off their existing physical locations. Specifically, it aims to convert small shopkeepers into providers of local communications networks. The program enables them to charge enough for such access through standard low tariffs, hence motivates the installation of simple routers, and removes the costs and difficulty of any licensing or registration, while enabling end users to discover the services more easily. The program does implicitly rely on non-profit organizations to train the technicians necessary to install and maintain the equipment in shops ("barefoot engineers"), plausible given the large number of programs and funding sources for training in India. The full system therefore has the following components:

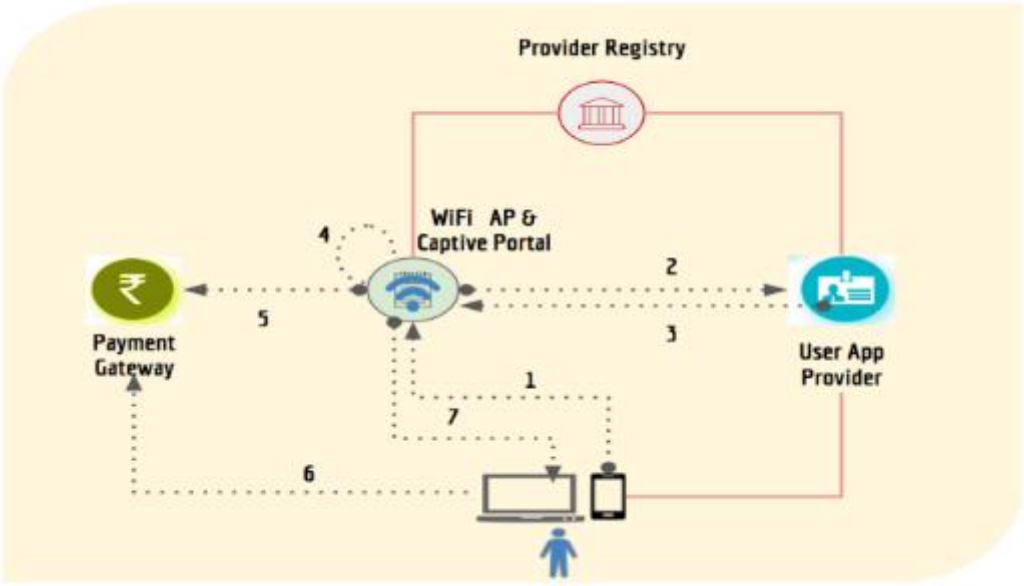
- All license requirements and registration are waived for "public data offices", being any entity establishing, maintaining, and operating a PM-WANI compliant Wi-Fi Access Point. Given the standard licensing requirements for those offering telecommunications services to the public, this is a significant exemption.
- Compliant gateway applications (soft infrastructure layer) allowing users in a standardized way to complete authentication and KYC requirements, as well as make payments for access, using the multiple payment gateways available in India through the Unified Payments Interface (UPI).
- Aggregators, who manage and interact with many local access points, providing routers and recouping the costs and setting up the gateway applications.

- A maintained central registry of the aggregators, but without a requirement for the last-mile shops and small establishments to register.

Provision of "soft" public goods. The public role is primarily then to provide necessary public goods. In the first place there is the "soft infrastructure" layer of payment applications, single user sign-up across many access points, and discovery tools. The waiving of any fees or licensing for providing telecommunications services is itself a further support, if implicit, since for standard service providers such licensing and fees are required to maintain the basic regulatory structure.

Leveraging other infrastructure providers. The PM-WANI program has also provided a simple way to leverage funding for other types of infrastructure easily. In May 2022, for example, the Indian Railways announced that it would knit together its station-based Wi-Fi access points together with other services providers into a PM-WANI using network. That meant many remote train stations, already equipped with backhaul telecommunications infrastructure for train signaling and network management, could now become local access points in a simple way, and combine their access provision with those of small entrepreneurs in adjacent areas.

Figure 7: User Flow for Accessing PM-WANI-related Services



Source: PM-WANI

Replication Considerations

Community Networks are spreading. Community Networks have been pursued in a number of other countries. The UN's Internet Governance Forum and the Internet Society have compiled comparative reports of their deployment. Sustainability has been a common difficulty, one which the PM-WANI program has sought to tackle. It

has generally been a stiff challenge, but one for which multiple different approaches are being developed. Alongside India's program, as mentioned above Kenya has started to explore using its USOF to promote community networks and Argentina has developed an explicit program to do so. The Argentinian program was initially funded with 10 million dollars and soon doubled its budget due to very strong demand from communities.

India had a number of organizations facilitating such networks. Several organizations in India had been working on community networks for several years before the establishment of PM-WANI. The Digital Empowerment Foundation (DEF) and the Internet Society, two well-established civil society organizations, joined forces in 2010 to create the Wireless for Communities (W4C) initiative. The first community network they established was in Chanderi, mentioned above. At that point, the DEF had already been active in the town, and had established a community ICT center that started generating demand for connectivity as well as serving as a base to install the primary relay station for the community network.

Skills development ("barefoot engineers") was a crucial enabler. Over subsequent years, the W4C spread across India, and trained many "barefoot engineers"—community members in the rural towns trained to maintain the simple networks. Other organizations also started to facilitate the building of community networks and training of such barefoot engineers. These organizations also began to engage the government, and in 2016 the Telecom Regulatory Authority of India (TRAI) recognized the potential of community networks and began engaging with the organizations facilitating them. By the time the PM-WANI initiative was set up in late 2020, there was a substantial body of experience regarding the practical impediments and potential sustainability models for last-mile access. There were also several organizations able to both engage in training programs and to monitor and evaluate the on-the-ground reality of the program as it started. The advent of very low cost 4G services reduced demand for community networks for a time, though the end of the implicit cross-subsidies in such networks and the demands of the Covid pandemic restored demand somewhat.

Open public goods and shared platforms will be crucial in any replication. A final enabling factor was India's already-existing systems for simple and universal identity verification and payments. Those allowed the general system for PM-WANI, and had also built a general familiarity with approaches based on providing general systems and interfaces and having small and large entrepreneurs build on top of them. The general approach may be characterized as promoting decentralized initiative through the provision of 21st century public goods (APIs). That approach aligns well with the philosophy and practice of community networks.

Annex. Closing the Digital Divide—the Bali High Level Seminar

Contributions from reputed scholars, former and current policy makers, financiers and private sector operators allowed the identification of three main areas that are critical to the development of digital infrastructure. Innovative finance needs to be shaped around these main issues.

The Role of the State

- There is a financing gap in Digital infrastructure (DI) which cannot be bridged by relying only on the private sector. The public sector has a role to play in helping identify the relevant investments, as well as a responsibility to come up with an overall vision for broadband expansion. The state also has a role to play in growing skills proficiency for all.
- The digital economy presents two faces: One is positive and relates to jobs creation, remote access, and connectedness. One is much darker and affects all users. This darker face has to do with the expansion of Artificial Intelligence and the lack of regulation of social platforms. It is essential to understand that side of DI to invest in relevant infrastructure.

- Bridging the digital divide is not just about laying the pipes, although the pipes must be laid. On top of the pipes must come relevant applications, the right regulations, widespread skills, the right quality of infrastructure, at an affordable price. If not, hard infrastructure will be used sub-optimally in both developing and developed countries. Divides will get worse, within and across countries.

Regulations

- The perceived divergence from East to West on data privacy regulations may not be as stark as one might think. There are a lot of common elements in recently promulgated regulations and laws. An interesting parallel was made between the Chinese Personal Information Protection Law (PIPL) drawing on civil law and the EU's General Data Protection Regulation (GDPR).
- However, the implementation mechanisms of these regulations are yet to be tested, as well as their respective exceptions regimes.
- The EU is pushing a complex model of regulation that is implemented either at the state level or at the EU level. The cost of compliance to these regulations is high.
- Nevertheless, some level of convergence may be attainable in the short term.
- Cybersecurity seems to be an afterthought, if thought at all. Cyberattacks on infrastructure, institutions and people are growing exponentially. This will affect all of us. Given the connectivity level of basic infrastructure through infratech, any financing activity of infrastructure portfolio is at risk. Not mitigating this risk will result in financial loss.

Financing

- Laying down the pipes and building applications require risk-taking capital, public action (the right environment) and smart public subsidies. Rolling out skills is even harder, and there are no easy models.
- Many innovative financing models are starting to emerge. Some aim to leverage more effectively new pools of capital, such as the balance sheets of big tech or the capital spent on other infrastructure (e.g., roads, power lines); others aim to redeploy old tools in new ways, such as the strategic use of spectrum auction proceeds or the use of universal service funds to buttress offtake guarantees. A third set of models achieves impact by recycling assets, (e.g., through carve-outs to free up balance sheet capacity or to reduce the cost of capital for greenfield deployments, to make them viable at lower returns).
- These models offer great scope for replication and scaling up, but must be fitted to the context, both in terms of the environment and the asset's characteristics. Both the stage of a country's network development (not always correlated to income level) and the deep characteristics of specific assets will matter. In other words, financing techniques must be adapted to the economic returns of the investment, which would take into account the potential divides.
- PPPs at large scale are possible even in non-competitive environments (e.g., satellite financing in Indonesia).