Combinations for Connectivity

Background Paper

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Pathways for Prosperity Commission
Technology & Inclusive Development

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This paper is part of a series of background papers on technological change and inclusive development, bringing together evidence, ideas and research to feed into the commission's thinking. The views and positions expressed in this paper are those of the author and do not represent the commission.

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1. Glossary

Action-based payment models
Pricing structure in which companies provide vouchers for limited internet access after consumers fulfill a given task

Backhaul
Connection between the middle-mile and the national backbone or an internet exchange point

Bandwidth
Amount of data that can be processed in a certain amount of time (sometimes called channel capacity or net-bit-rate)

Broadband
Type of high-capacity connectivity that allows large amount of data to move simultaneously

Capital expenses
Upfront expenses connected to investment in infrastructure

Community / cooperative networks
Small local wireless networks created and managed by communities, often using Wi-Fi and off-the-shelf technology

Complementary infrastructure sharing policy
Requirement that new connectivity infrastructure installations evaluate and, when feasible, reuse existing complementary infrastructure (e.g., utility poles)

Content caching
Storage of content on local servers for offline viewing

Content delivery network
System of geographically distributed servers and data centers

Data localization requirement
Mandate that citizens' data be stored and processed within a country's borders

Dig once policy
Requirement that stakeholders coordinate and preemptively dig trenches for future infrastructure installation as part of other infrastructure deployment efforts

Digital divide
The gap between individuals who do not have access to internet connectivity and/or do not use the internet and those who have access to and regularly utilize the internet

Digital literacy
An individual's ability to navigate online content and understand its context

Digitization of government services
Policy efforts that move government information and services online to encourage connectivity uptake

Fiber-optic cable
Glass fibers insulated in wire casing that can transmit data at a high capacity

Fixed broadband
Data transmission to a fixed location, such as home or business

Free public Wi-Fi
Provision of free, publicly-funded Wi-Fi using unlicensed spectrum at key locations or hot spots

Government data consumption commitment
Policy that encourages ISP and/or MNO market development by establishing the public sector as an anchor client

High-earth-orbit satellites (HEOs)
Satellite orbiting above 36,000 kilometers in geosynchronous orbit

Incremental pricing models
Bundled internet service offerings that provide tiered options for users of different income levels

Information and Communication Technology (ICT)
Technologies that provide access to information through telecommunications, with emphasis on the internet, wireless networks, and other digital methods

Internet exchange point (IXP)
Physical infrastructure that allows ISPs and CDNs to directly interconnect and exchange traffic, lowering cost-of-service for ISPs and improving latency and bandwidth for user

Internet service providers (ISPs)
Company or service offering subscribers access to the internet

Local content platforms
Open-source platforms that make it easy to post content online and engage with other users

Local distribution models
Targeted recruitment and hiring community members for sales, outreach and marketing in order to increase likelihood of uptake

Local loop unbundling
Regulation that makes local access lines available to multiple competitors at wholesale prices

Long Term Evolution (LTE)
Standard of wireless communication that designates specific spectrum frequencies to support mobile roaming

Low-earth-orbit satellites (LEOs)
Satellites orbiting below 2,000 kilometers that relay radio signals between high earth orbit satellites and individual mobile phones

Medium-earth-orbit satellites (MEOs)
Satellites orbiting the earth between 2,000 and 35,000 kilometers that relay radio signals between transmitters and receivers

Metered mindset
Individuals' tendency to ration data and/or minutes to avoid overage charges on prepaid subscription plans

Mobile broadband
Data transmission to mobile devices, primarily using cellular data

Mobile network operators (MNOs)
Companies providing wireless and/or cellular communication services

National backbone
Collection of high-capacity links and nodes connecting dispersed regional and local networks throughout a country

Operating expenses
Ongoing costs to ISPs/MNOs accrue when providing services

Passive site sharing
Partnerships established between MNOs to govern the sharing of passive infrastructure, particularly mobile towers

Regulation of illegal content
Creation and enforcement of transparent rules around legal use of internet and processes to identify and remove illegal content

Reservation of the "“digital dividend" spectrum band
Regulation that sets aside the 700/800 MHz band for inclusive connectivity efforts for social purposes

Spectrum
Radio frequencies that transmit multiple signals simultaneously

Spectrum allocation
Assignment of radio frequencies to ISPs and MNOs, usually via exclusive license

Support for mobile money
Incorporation of mobile money systems into government programs paired with a public commitment to not impose additional taxes on mobile transactions

Training for public employees
Provision of digital literacy training for public-sector employees

TV White Space (TWVS)
Buffer channels previously used for analog TV broadcasting that often sit unused after the switch to digital

Universal service funds
Funds that collect fees on annual revenue from service providers to address inequitable access challenges

User-centric mobile tax strategy
Assessment and design of mobile broadband tax structures to encourage uptake

Wi-Fi
Service allowing devices to connect to the internet or each other wirelessly using a router in a particular location

Wi-Fi mesh networks
Interconnected Wi-Fi routers that extend the signal range beyond that of a single router

Zero rating
Private-sector subsidized access to particular application or service that does not count against a consumer's monthly data limit

2. Introduction

Internet connectivity provides a wide range of benefits to society, including free exchange of information, stronger social bonds, and new economic opportunities. The internet is the greatest source of news and the world's most vibrant and diverse marketplace. From healthcare, education, and government services to job opportunities and essential daily activities, the internet offers the tools and services that individuals across the world increasingly need.

DEFINITIONS

Digital Divide
The gap between individuals who do not have access to internet connectivity and/or do not use the internet and those who have access to and regularly utilize the internet

Information and Communication Technology (ICT)
Technologies that provide access to information through telecommunications, with emphasis on the internet, wireless networks, and other digital methods

Internet service providers (ISPs)
Company or service offering subscribers access to the internet

However, these benefits remain beyond the reach of nearly 4 billion people, most of whom reside in developing countries. These populations experience fewer opportunities, lower levels of engagement, and reduced benefits from internet access compared to their counterparts in more developed countries. Lack of access to internet connectivity disproportionately affects these populations and will continue to do so, particularly as more essential services become dependent on technology.

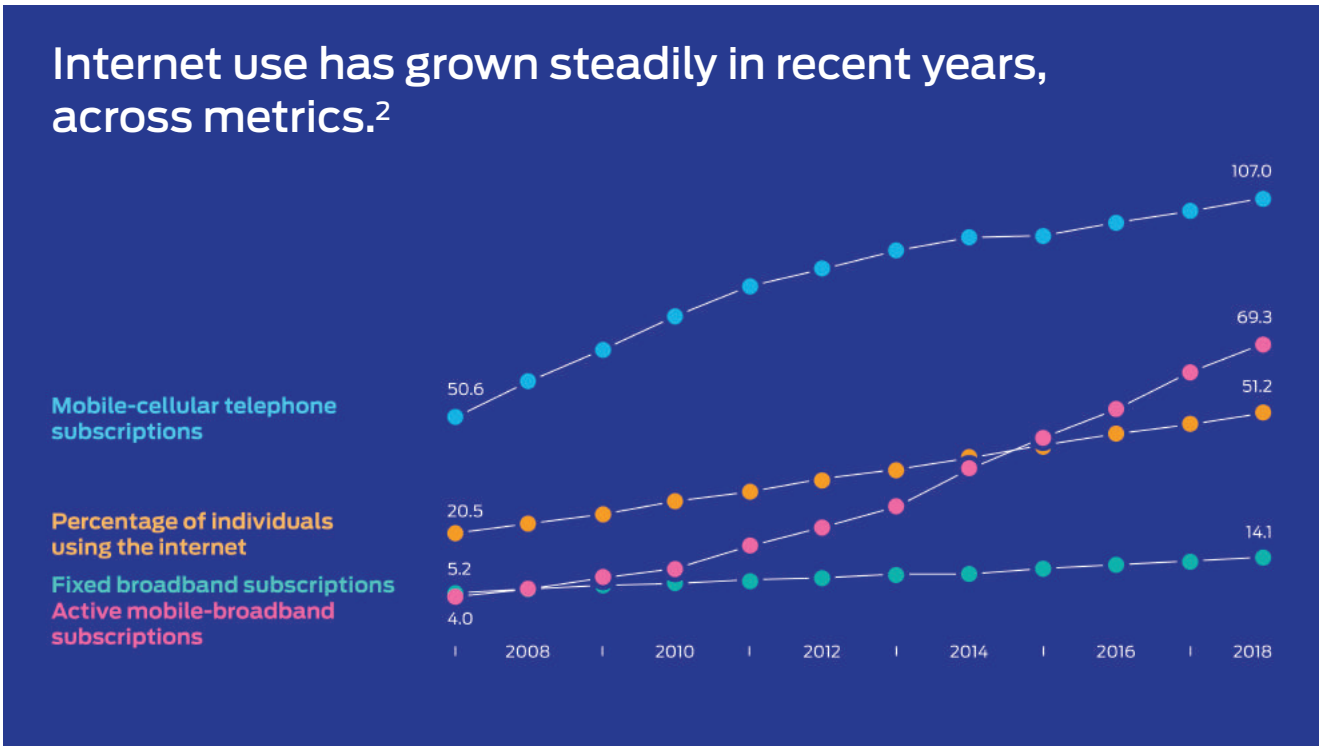
This report examines the barriers that prevent access to or uptake of the internet in developing countries. We start by providing context on the status quo by describing the digital divide, broadband connectivity, and recent trends in the *Information and Communication Technologies (ICT)* sector. Then, we provide an overview of the main barriers faced by those in the digital divide, and by those seeking to close it. We conclude by providing an overview of system components that are well-positioned to change the status quo, separating these levers into technology, policy and business models.

The Digital Divide

The digital divide refers to the gap between those who have access and those who do not, as well as the distance between those who have and have not used the internet in meaningful and productive ways. This divide can be exacerbated by factors such as poverty and gender inequality, further separating poor and marginalized communities from their more privileged counterparts.

There are a number of different ways to quantify the extent of the digital divide. Counting the number of subscriptions to fixed and/or mobile broadband, the number of internet-enabled devices owned, and the number of app downloads or visits to a website all offer insights, as do the coverage maps generated by *internet service providers (ISPs)*.[1] This wide range of metrics reflects the numerous ways that users can access and experience the internet, and how efforts to bridge the digital divide should approach the problem holistically.

1 Donner, J. (2015). After Access: Inclusion, Development, and More Mobile Internet. MIT Press.



By the end of 2018, 51.2% of the global population—or 3.9 billion people—used the internet,[3] a 95% increase from the 2 billion online in 2010.[4] However, despite these continued gains, progress in the developing world has not kept up with that in the developed world. At the end of 2017, 79.5% of people in developed countries used the internet compared to just 19.5% in least-developed countries.[5] The fact that 2.5 billion of the 4 billion people currently not using the internet live within the coverage footprint of 3G networks affirms that connectivity is not the only barrier to internet use. Studies have found that lack of knowledge of what the internet can offer is the most frequently cited reason for not using the internet (the second being cost).[6]

2 ITU. (2019). Global & regional ICT data [dataset]. Retrieved from https://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx

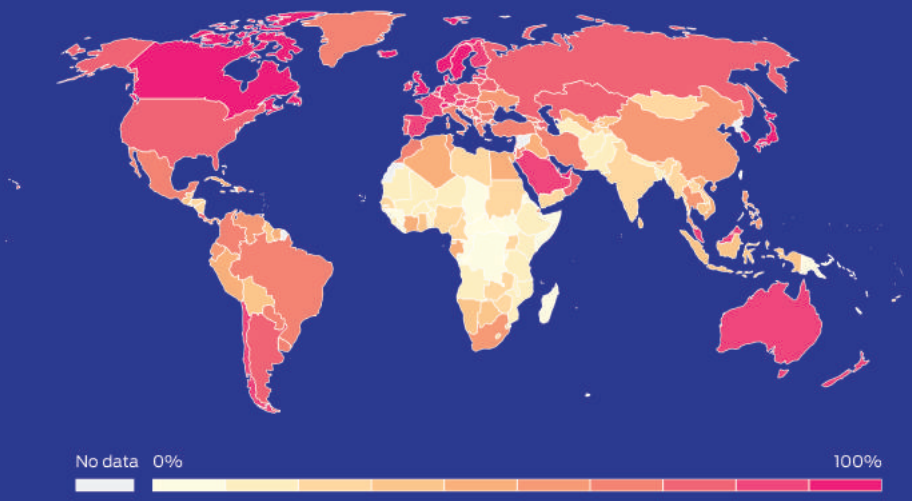
3 ITUNews. (2018, December 11). New Measuring the Information Society Report 2018 shows big process, big gaps. ITU. Retrieved from https://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx

4 Murphy, J. & Roser, R. (n.d.). Internet. OurWorldInData. Retrieved from https://ourworldindata.org/internet

5 *These data are available in ITU country classifications of developed, developing, and least-developed countries. Elsewhere in the paper, we primarily use World Bank income classifications: high-income, middle-income, low-middle income, and low-income.*

6 Schmida, S., Bernard, J., Zakaras, T., Lovegrove, C., & Swingle, C. (2017). Connecting the Next Four Billion: Strengthening the Global Response for Universal Internet Access. USAID, Dial, SSG Advisors. Retrieved from https://www.usaid.gov/sites/default/files/documents/15396/Connecting_the_Next_Four_Billion-20170221_FINAL.pdf

The least developed countries often have the lowest share of their population online



Broadband

Internet connectivity typically refers to two main services: *fixed broadband* and *mobile broadband*. Differences between the two types aof connectivity include the type of infrastructure required, the type of device likely to be used, the quality of service, and the type of content users are most likely to encounter. Fixed broadband is characterized by wired transmission of data to a fixed location, such as a building or house. There are three types of connections: DSL, coaxial cable or fiber.[7] It meets a minimum of 1GB monthly data usage and a minimum download speed of 256 kbits per second.[8] At this speed, it is possible to browse basic web pages and send emails, but streaming any type of media such as movies or music would be slow at best (if not impossible).[9]

DEFINITIONS
Fixed broadband Data transmission to a fixed location, such as a home or business
Mobile broadband Data transmission to mobile devices, primarily using cellular data
Mobile network operators (MNOs) Companies providing wireless, or cellular, communication services

7 Iowa Communications Network. (2018). What are wired broadband technologies? Broadbandmatters.com. Retrieved from https://broadbandmatters.com/what-are-wired-broadband-technologies

8 International Telecommunications Union. (2019). ICT Price Basket Methodology. Retrieved from https://www.itu.int/en/ITU-D/Statistics/Pages/definitions/pricemethodology.aspx

9 Highspeedinternet.com. (2019). How much internet speed do I need? Retrieved from https://www.highspeedinternet.com/how-much-internet-speed-do-i-need

Mobile broadband, by contrast, uses radio waves to transmit connectivity from mobile towers to phones, laptops, tablets, and other enabled devices. These towers can utilize improved fixed broadband infrastructure, such as fiber-optic cable, for higher service quality and speeds. Subscription plans usually offer prepaid and postpaid options that impose various limitations on the amount of data transferred in a given time period.[10]

Trends in Service Provision

Internet service initially developed in high-income countries (HICs) countries via fixed broadband. The internet could be accessed via a desktop computer and a dial-up connection, using subscription plans without usage caps that allowed for uninhibited exploration and an open platform that supported wide participation.[11] Globally, the private sector has often driven infrastructure buildout providing significant upfront capital in order to achieve scale rapidly. As a result, consumer pricing models have typically been designed to recoup these private-sector investments.

The telecommunications industry has been rapidly changing in recent years as the world has moved away from fixed-line broadband in favor of mobile communications.[12] This shift has been particularly evident in developing countries.[13] Across the globe, the poorest households are more likely to have access to a mobile phone than to sanitation infrastructure or clean water.[14]

These trends have implications for ISPs and *mobile network operators (MNOs)* in low- and middle-income countries (LMICs). ISPs are facing declining revenue growth, regulatory pressure, and limited electricity and telecommunications infrastructure. Meanwhile, some MNOs have expressed concern that emphasis on extending wireless access using Wi-Fi networks will dilute their average revenue per user (APRU), which could potentially undermine the stability of existing business models.[15] These issues limit what we can expect from incumbent providers and conventional models, particularly with regard to reaching those on the wrong side of the digital divide.[16] Covering those currently without access will likely require greater experimentation and collaboration between the public and private sectors.

10 International Telecommunications Union. (2019). ICT Price Basket Methodology. Retrieved from https://www.itu.int/en/ITU-D/Statistics/Pages/definitions/pricemethodology.aspx

11 Surman, M., Gardner, C., & Ascher, D. (2014). Local Content, Smartphones, and Digital Inclusion. Innovations: Technology, Governance, Globalization, 9(3-4), 63-74. Retrieved from https://www.mitpressjournals.org/doi/abs/10.1162/inov_a_00217

12 Sengupta, C. (2018, February 14). The Next Billion Users Are the Future of the Internet. Google. Retrieved from https://www.blog.google/perspectives/caesar-sengupta/next-billion-users-are-future-internet/

13 Pisa, M. & Polcari, J. (2019)."Governing Big Tech's Pursuit of the "Next Billion Users"" CGD Policy Paper. Washington, DC: Center for Global Development. Retrieved from https://www.cgdev.org/publication/governing-big-techs-pursuit-next-billion-users

14 Pisa, M. & Polcari, J. (2019.) "Governing Big Tech's Pursuit of the "Next Billion Users"" CGD Policy Paper. Washington, DC: Center for Global Development. Retrieved from https://www.cgdev.org/publication/governing-big-techs-pursuit-next-billion-users

15 Schmida, S., WIlliams, I., & Lovegrove, C. (2016, April). Business Models for The Last Billion: Market Approaches to Increasing Internet Connectivity. USAID from the American People. Retrieved from https://mstarproject.files.wordpress.com/2016/05/business-models-for-the-last-billion.pdf

16 Caribou Digital. (2016). Digital Access in Africa. Farnham, Surrey, United Kingdom: Caribou Digital Publishing. Retrieved from https://www.cariboudigital.net/wp-content/uploads/2019/01/Caribou-Digital-DFID-Digital-Access-in-Africa.pdf

ISPs and MNOs are also feeling pressure from big tech players such as Google and Facebook. In recent years, these global companies have tried to reach a wider audience by either developing new technology to expand the reach of infrastructure or providing free or low-cost content to drive demand in order to secure a foothold in the market. While this market is typically associated with low APRU, many tech companies are betting that LMIC markets will develop.

Skepticism about the efforts of these and other big-tech companies stems from two issues: First, these companies often make establishing effective monopolies their primary objective.[17] While these Such effective monopolies can occasionally add value with a certain level of centralization but competition is important for innovation to bridge the digital divide. Second, the proportion of revenue that these companies receive from developing countries is extremely small. For both Google and Facebook, over 40% of revenue is generated by users in the United States alone, despite having billions of users elsewhere. Over 70% of Facebook users are in Asia and Africa, and Google has well over 80% market share for online searches across the roughly 200 countries where they operate.[18] The lack of revenue generated by LMICs diminishes the strength of consumer voices in these markets. Questions remain with regard to the potential impact on local communities and cultures and the ability of local consumers to hold multinational corporations accountable.

When we look at the international development space, approaches to ICT investment has been fragmented at best. International donors structured funding to be designated for specific sectors, such as health or education, instead of tools like internet connectivity which could benefit all sectors. This led to a number of redundant investments, and only recently have investments been aimed towards a coordinated effort.[19] Advancement through sector-specific approaches will not result in the type of tools, programs, or policies needed to make widespread changes. Reaching those who still lack meaningful access to the internet will require a coordinated approach that pays particular attention to communities in LMICs. Greater spending on initiatives like interoperability and ecosystems may improve national-level strategies and result in smarter, structured investments.

17 Song, S. (2019, February 13). Rethinking Affordable Access. Alliance for Affordable Internet. Retrieved from https://a4ai.org/rethinking-affordable-access/

18 Pisa, M. & Polcari, J. (2019.)"Governing Big Tech's Pursuit of the "Next Billion Users"" CGD Policy Paper. Washington, DC: Center for Global Development. Retrieved from https://www.cgdev.org/publication/governing-big-techs-pursuit-next-billion-users

19 Caribou Digital. (2016). Digital Access in Africa. Farnham, Surrey, United Kingdom: Caribou Digital Publishing. Retrieved from https://www.cariboudigital.net/wp-content/uploads/2019/01/Caribou-Digital-DFID-Digital-Access-in-Africa.pdf

3. Barriers to Demand

Certain segments of the world's population face disproportionately greater challenges to accessing or engaging with the internet. A wide range of factors limit access to connectivity, including poverty, geographic location, and gender norms.[20]

Poverty and service affordability often represent the highest barriers for those in developing countries.

One of the most intractable barriers to internet connectivity is poverty. Low incomes prevent initial access through purchase and ownership of a connected device and ongoing subscription and maintenance fees. While the International Telecommunication Union (ITU) reports that fixed and mobile broadband costs have decreased globally over the last ten years,[21,22] they remain out of reach for many at the lowest end of the income distribution. ITU analysis estimates that the affordable monthly communications spending for the last billion to be $2.25,[23] making even the most affordable option a significant expense.

> *"For me, the minimum entry point is affordable access. None of these conversations happen unless access is available and affordable."*
>
> —Steve Song; Senior Fellow, Mozilla Foundation

The most basic elements of cost to the user are the price of the device and the cost of ongoing service. People typically choose between computers, laptops, and internet-enabled phones However, given the popularity of mobile phones, many of the next billion users may never even use a computer.[24]

20 Sprague, K., Grijpink, F., Manyika, J., Moodley, L., Chappuis, B., Pattabiraman, K., & Bughin, J. (2014). Offline and falling behind: Barriers to Internet adoption. McKinsey & Company, Tech. Rep. Retrieved from https://www.mckinsey.com/~/media/McKinsey/Industries/High%20Tech/Our%20Insights/Offline%20and%20falling%20behind%20Barriers%20to%20Internet%20adoption/Offline_and_falling_behind_barriers_to_internet_adoption_full%20report_FINAL.ashx

21 International Telecommunications Union. (2019). ICT Price Basket Methodology. Retrieved from https://www.itu.int/en/ITU-D/Statistics/Pages/definitions/pricemethodology.aspx

22 Sample, I. (2019, January 10). Universal internet access unlikely until at least 2050, experts say. The Guardian. Retrieved from https://www.theguardian.com/technology/2019/jan/10/universal-internet-access-unlikely-until-2050-experts-say-lack-skills-investment-slow-growth

23 Schmida, S., WIlliams, I., & Lovegrove, C. (2016, April). Business Models for The Last Billion: Market Approaches to Increasing Internet Connectivity. USAID from the American People. Retrieved from https://mstarproject.files.wordpress.com/2016/05/business-models-for-the-last-billion.pdf

24 Pisa, M. & Polcari, J. (2019.)"Governing Big Tech's Pursuit of the "Next Billion Users"" CGD Policy Paper. Washington, DC: Center for Global Development. Retrieved from https://www.cgdev.org/publication/governing-big-techs-pursuit-next-billion-users

Many factors influence one's choice of mobile phone, including cost, availability, features, and the status it signals to others. Owning the cheapest device available enables communication, but can also suggest a lower social status.[25] On the other hand, a pricier smartphone may boost social status but is of limited value if the owner cannot take advantage of features due to connectivity issues.

DEFINITIONS

Metered mindset
Individuals' tendency to ration data and/or minutes to avoid overage charges on prepaid subscription plans

As for subscription costs, The Alliance for Affordable Internet (A4AI) has proposed that a 1GB, enough to watch 68 videos per month, mobile data plan should cost no more than 2% of monthly income,[26] a standard that was adopted by the UN Broadband Commission for Sustainable Development.[27] Africa and the Americas show the greatest gap from this benchmark, costing 8% and 2.7% of monthly income respectively in 2018.[28]

The cost of transferring data varies widely across the globe. In Trinidad and Tobago it costs more than $29 to buy enough data to watch one half-hour of YouTube videos or send over 3,300 WhatsApp messages.[29] The same functionality costs ~$12 in Argentina and just $0.42 in India.[30]

Most users in developing countries pre-purchase credits and draw down their balance over time, which gives them greater awareness of how they spend their online time and data. This awareness has direct implications on what type of experience users have online. When costs increase based on time spent or data used, user behavior will tend toward a *metered mindset*. In this situation, users will ration their use rather than spend extra time (and money) exploring the internet. The metered mindset can often be magnified by a lack of clarity around billing practices, a common anxiety across both novice and experienced internet users.[31]

25 Caribou Digital. (2016). Digital Access in Africa. Farnham, Surrey, United Kingdom: Caribou Digital Publishing. Retrieved from https://www.cariboudigital.net/wp-content/uploads/2019/01/Caribou-Digital-DFID-Digital-Access-in-Africa.pdf

26 Alliance for Affordable Internet. (n.d.) Redefining broadband affordability: Adopting a "1 for 2" Target to Enable Universal, Affordable Access. Retrieved from https://1e8q3q16vyc81g8l3h3md6q5f5e-wpengine.netdna-ssl.com/wp-content/uploads/2016/09/Redefining-Affordability_1-for-2-Target.pdf

27 International Telecommunications Union. (2018, January 23). UN Broadband Commission sets global broadband targets to bring online the world's 3.8 billion not connected to the internet. ITU Press Release. Retrieved from https://www.itu.int/en/mediacentre/Pages/2018-PR01.aspx

28 NAlliance for Affordable Internet. (2019, March 20). New mobile broadband pricing data shows uneven progress on affordability. A4AI Blog. Retrieved from https://a4ai.org/new-mobile-broadband-pricing-data-reveals-stalling-progress-on-affordability/

29 Confused.com. (2019). How much is 500MB, 1GB, 2GB of mobile internet data? Retrieved from https://www.confused.com/mobile-phones/mobile-data-calculator

30 Alliance for Affordable Internet. (2018) Mobile Broadband Pricing Data for Q4 2018. Retrieved from https://a4ai.org/extra/mobile_broadband_pricing_usd-2018Q4

31 Caribou Digital. (2016). Digital Access in Africa. Farnham, Surrey, United Kingdom: Caribou Digital Publishing. Retrieved from https://www.cariboudigital.net/wp-content/uploads/2019/01/Caribou-Digital-DFID-Digital-Access-in-Africa.pdf

The reliability of connectivity can create an additional layer of potential cost. Users must be able to trust that time spent obtaining and using connectivity will be rewarded with high-quality service. Traveling to a community hotspot only to discover an outage can dissuade users from internet use. Other questions that assess reliability issues include:

- How often is an SMS message left unsent?
- How long does it take to download a video?
- How many times does the service drop on a call?
- Is there an affordable supply of electricity?

All of these factors influence whether individuals meaningfully engage with the internet or instead decide against incorporating a new and potentially costly tool into their lives.

Remote rural geographies often struggle with access.

Rural regions are often outside the coverage footprint of connectivity infrastructure. The reasons for this are twofold. First, as with other types of infrastructure, ISPs need high population density, and the consumption and economies of scale that comes with it, to recover their investments in infrastructure. Second, stable, affordable electricity is critical for reliable, valuable internet service.

Individuals may not be compelled to take on the financial and time costs if they have urgent needs or an inability to leave their jobs / household responsibilities to access a service that may not be reliably supported through infrastructure anyway. Individuals will need to travel to an urban center to find a store and may need identification to purchase a SIM card and mobile phone. Pre-paid subscriptions are more affordable but also impose a metered-mindset that limits the depth of users' online experience.[32] If owning a device is unaffordable, a user can instead participate in a shared arrangement or travel to community centers/telecenters with connectivity. Shared arrangements within a household or among family members or friends decrease costs but also inhibit immediate access to connected offerings and reduce opportunities for developing the skills that lead to meaningful experiences online. All of these barriers add up to a non-compelling value proposition for a rural individual to engage with the internet.

Multiple factors contribute to lower connectivity among women.

Analysis by the Pathways for Prosperity Commission has shown that women are 40% less likely to use the internet,[33] regardless of income or educational attainment. This reduced use stems from a number of factors, including gendered cultural norms around privacy and technology use. Patriarchal household dynamics and concerns about public perception deters some women from owning a phone, being active online, or even from traveling to a community telecenter, as those activities might be seen as challenges to a woman's traditional position in the home.[34]

32 Song, S. (2019, February 13). Rethinking Affordable Access. Alliance for Affordable Internet. Retrieved from https://a4ai.org/rethinking-affordable-access/

33 Pathways for Prosperity Commission. (2018). Digital Lives: Creating Meaningful Connections for the Next 3 Billion. Retrieved from https://pathwayscommission.bsg.ox.ac.uk/sites/default/files/2018-11/digital_lives_report.pdf

34 Pathways for Prosperity Commission. (2018). Digital Lives: Creating Meaningful Connections for the Next 3 Billion. Retrieved from https://pathwayscommission.bsg.ox.ac.uk/sites/default/files/2018-11/digital_lives_report.pdf

In terms of device ownership, women may not feel comfortable purchasing and using a connected device if stores are staffed primarily by men. While publicly available access points may seem to solve for this, this approach assumes that cultural norms around technology use encourage women to use technology safely in public. If this is not the case, women may face poor treatment and/or harassment both in person and online.

Assuming that safe and reliable access is available, having a strong network of users can be a significant incentive to connect. Even still, this does not guarantee meaningful online exploration. Some women report that they lack exposure to uses of the internet beyond those employed by their immediate social circle.[35] Furthermore, most devices, applications, and content are designed and developed by men and may not take into account the lived realities of potential women users.

Users may not perceive sufficiently compelling value.

Connectivity alone does not guarantee value to users and communities. Value comes when users are able to harness the information and opportunities available in the digital world to improve their own experiences, and many within the coverage footprint choose not to engage. Each user balances the benefits of connecting against the costs or risks of connecting, both real and perceived.

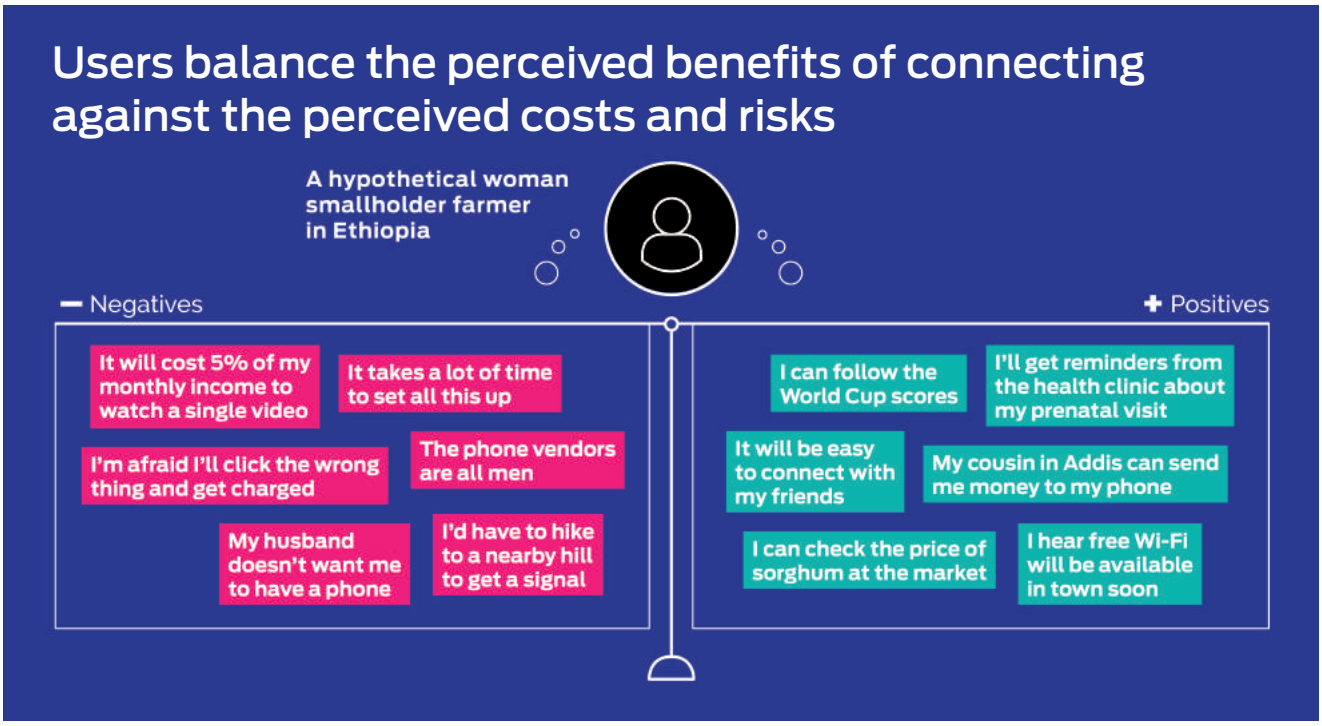
On the benefits side, the questions a user asks are:

- What does this offer me?
- What are the reasons to believe it will add value to my life?
- What differentiates the internet from alternative resources?

In direct opposition to this are questions of cost or risk, including:

- How much money will I have to spend?
- How difficult will it be to actually log on?
- What are the dangers or emerging risks once I get online or am seen connecting?

35 Pisa, M. & Polcari, J. (2019.)"Governing Big Tech's Pursuit of the "Next Billion Users"" CGD Policy Paper. Washington, DC: Center for Global Development. Retrieved from https://www.cgdev.org/publication/governing-big-techs-pursuit-next-billion-users



The power of governments and corporations over the internet can discourage uptake.

The ability of powerful stakeholders, such as governments or big tech players, to shape the internet and misuse an individual's data adds another layer of concern for potential users. In addition, internet blackouts can reduce confidence in the internet as a useful tool. Between 2016 and 2017, there were 119 complete blackouts across sub-Saharan Africa—not including social media blockages and delayed Internet.[36] Blackouts discourage individuals use because costs seem to outweigh benefits and can undermine opportunities for digital entrepreneurship since they compromise people's ability to use online tools and services. Even further, the entire Bulgarian adult population recently had their personal data compromised in a data breach, exposing tax information, social security numbers, birthdates and addresses.[37] If individuals cannot trust their data will be kept safe, they have little incentive to uptake the internet. Although these concerns exist for all internet users, historically marginalized groups may experience or perceive these risks much more intensely. Concerns about government surveillance[38] and how data are collected, used, and shared can be much more troubling for historically marginalized communities, which often have real reason to fear their governments.[39]

36 Dendre, C. (2019, January 30). Why are so many African leaders shutting off the Internet in 2019? The Washington Post. Retrieved from https://www.washingtonpost.com/news/monkey-cage/wp/2019/01/30/why-are-so-many-african-leaders-shutting-off-the-internet-in-2019/?utm_term=.dbbc7b274f1c

37 Ikeda, S. (2019, July 30). Massive Data Breach in Bulgaria Compromises the Country's Entire Adult Population. CPO Magazine. Retrieved from https://www.cpomagazine.com/cyber-security/massive-data-breach-in-bulgaria-compromises-the-countrys-entire-adult-population/

38 Freedom House. (2018, October). Freedom of the Net 2018. Retrieved from https://freedomhouse.org/sites/default/files/FOTN_2018_Final%20Booklet_11_1_2018.pdf

39 Pisa, M. & Polcari, J. (2019.)"Governing Big Tech's Pursuit of the "Next Billion Users"" CGD Policy Paper. Washington, DC: Center for Global Development. Retrieved from https://www.cgdev.org/publication/governing-big-techs-pursuit-next-billion-users

Available content often fails to reflect the contexts and languages of users in developing countries.

Many users in the developing world do not see their own languages, culture, or lived experience in existing online content. Relevant content is critical for stimulating and sustaining user demand. From the consumer's perspective, key considerations include the discoverability of content, the format of the content (e.g., text, voice, video), and the value of the content for their own lives. For local content creators, content creation costs (including production and language translations), ease of distribution, and the viability of revenue models (ads, subscriptions, etc.) can make the development of relevant content that much more difficult.

The rise of mobile connectivity in the developing world also raises questions about the relevance of existing platforms used to access content. The bias toward content for developed-nation users is striking; 85% of user-generated content indexed by Google originates in Western countries.[40] Apple and Google have become the de facto gatekeepers for online content. For example, the app store model, which has been long dominated by Apple Store and Google Play Store, largely determines which apps and related content that users in developing countries can access. Other structural barriers imposed by these companies constrain content creation in the developing world. For example, Google bars developers in many developing countries from monetizing their creations through its app store because the company has not allowed developers in LMIC countries to create merchant accounts and link bank accounts. Difficulty negotiating the details of taxes, exchange rates, and export regulations may play a role in Google's decision to exclude certain countries[41] but the net result is that the apps available in developing countries are rarely tailored to those users' needs and context.

Language also poses a challenge for potential users in the developing world. There are more than 6,900 languages in the world—400 of which with at least 1 million speakers[42]—but this linguistic diversity is not seen online. A World Economic Forum report states that 80% of online content is written in one of ten languages, despite the fact that half of the world does not speak any of those languages.[43] Non-Roman scripts are difficult in Unicode, making use of text-based content difficult if not impossible. Voice and video offer an important alternative to text but must be optimized to work within technical constraints, available platforms, and subscription plan structures.

40 Schmida, S., Bernard, J., Zakaras, T., Lovegrove, C., & Swingle, C. (2017). Connecting the Next Four Billion: Strengthening the Global Response for Universal Internet Access. USAID, Dial, SSG Advisors. Retrieved from https://www.usaid.gov/sites/default/files/documents/15396/Connecting_the_Next_Four_Billion-20170221_FINAL.pdf

41 Caribou Digital. (2016). Winners and Losers in the Global App Economy. Farnham, Surrey, United Kingdom: Caribou Digital Publishing. Retrieved from https://www.itu.int/en/mediacentre/Pages/2018-PR01.aspx

42 West, D. M. (2015). Digital divide: Improving Internet access in the developing world through affordable services and diverse content. Brookings Institution. Retrieved from https://www.brookings.edu/wp-content/uploads/2016/06/West_Internet-Access.pdf

43 World Economic Forum. (2018). Internet for All: Platform for Financing ICT Connectivity Infrastructure. Presentation. Retrieved from https://www.itu.int/en/ITU-D/Regional-Presence/Europe/Documents/Events/2018/WSIS/Sess4_Wong(new)_ICT%20platform%20overview%20WSIS%20Mar%202018(2).pdf

"Calculations that present cost of megabyte per user don't tell the whole story. A megabyte isn't just a megabyte. On WhatsApp, it's everything. On YouTube, it's nothing."

- Chris Locke, Founder of Caribou Digital

Digital literacy skills are difficult to develop without practice and reliable access.

DEFINITIONS

Digital literacy
An individual's ability to navigate online content and understand its context

Digital literacy refers to the skill sets that let users locate, evaluate, and use information online.[44] As countries throughout the world become more connected to the internet, those who are not connected will be at a significant disadvantage in terms of access to information and services and ability to contribute to the economy (whether as consumers or employees).[45]

There are a number of initiatives that aim to increase digital literacy in the developing world by incorporating these skills into national curriculum and community training programs.[46] Over time, individuals will need to acquire advanced digital literacy skills, such as how to evaluate the credibility of information online.[47] Meanwhile, more inclusive approaches to digital product design can support skills acquisition by providing better user experience / user interaction (UX/UI) design that delivers relevant content effectively.

44 Common Sense Media. (n.d.) What is digital literacy? Retrieved from https://www.commonsensemedia.org/news-and-media-literacy/what-is-digital-literacy

45 World Bank. (2016). World Development Report 2016: Digital Dividends. Retrieved from http://www.worldbank.org/en/publication/wdr2016

46 World Economic Forum. (2016). Internet for All: A Framework for Accelerating Internet Access and Adoption. In World Economic Forum. Retrieved from https://www.weforum.org/reports/internet-for-all-a-framework-for-accelerating-internet-access-and-adoption

47 Chakravorti, B., Bhalla, A., & Chaturvendi, R.S. (2017). 60 Countries' Digital Competitiveness, Indexed. Harvard Business Review. Retrieved from https://hbr.org/2017/07/60-countries-digital-competitiveness-indexed

4. Barriers to Supply

At the most basic level, Internet connectivity, requires access. As no single technology or model holds all the answers for everyone, barriers must be considered relative to their content. In this section, we'll provide an overview of major barriers to the supply of internet connectivity with emphasis on infrastructure and technology, major cost drivers in implementation, and ongoing financing challenges for expanding access.

Where infrastructure ends, the digital divide widens.

Fiber-optic cables that criss-cross the Earth provide the underlying physical architecture of the internet. If we think about this system as a tree, the submarine fiber-optic cables represents the trunk, with an array of terrestrial fiber optic "branches" reaching into individual countries. Each branch comprises what is known as a *national backbone* that connects all of the internet within a given country.

Continuing with the tree metaphor, the next part of the network, the *middle-mile* are the smaller branches that extend from the main branch. The national backbone often connects major cities, but the middle-mile connects the national backbone to other urban areas.[48] Middle-mile technology is fairly straightforward in that it connects to the national backbone using one of three options:

- Fiber-optic cable to a radio tower or other fiber-optic cable
- Broadcast spectrum to a tower via microwave
- Connections to a terrestrial satellite dish that transmits the spectrum to a orbiting / atmospheric satellite[49]

The *last-mile* is where service providers bring the internet to the users.[50] Last-mile technology varies, with implications for available bandwidth and speed. For fixed broadband, existing fiber connects to homes directly. Mobile broadband, by contrast, takes the spectrum delivered through fixed broadband infrastructure[51] and broadcasts it via cell towers. Mobile options typically reach users via Wi-Fi or satellite connectivity.[52] Unfortunately, the last-mile currently does not reach everyone. Deployment of drones, low-earth-orbit (LEO) satellites, and high-altitude balloons can extend internet access but all will require long-term investment to achieve scale.

48 World Bank. (2018, December). Digital Development Partnership: Innovative Business Models for Expanding Fiber-Optic Networks and Closing the Access Gaps. Retrieved from http://documents.worldbank.org/curated/en/674601544534500678/pdf/132845-7-12-2018-17-20-11-InnovativeBusinessModels.pdf

49 World Bank. (2018, December). Digital Development Partnership: Innovative Business Models for Expanding Fiber-Optic Networks and Closing the Access Gaps. Retrieved from http://documents.worldbank.org/curated/en/674601544534500678/pdf/132845-7-12-2018-17-20-11-InnovativeBusinessModels.pdf

50 *In international development, the last mile refers to the final leg of service delivery and logistics.*

51 Sprague, K., Grijpink, F., Manyika, J., Moodley, L., Chappuis, B., Pattabiraman, K., & Bughin, J. (2014). Offline and falling behind: Barriers to Internet adoption. McKinsey & Company, Tech. Rep. Retrieved from https://www.mckinsey.com/~/media/McKinsey/Industries/High%20Tech/Our%20Insights/Offline%20and%20falling%20behind%20Barriers%20to%20Internet%20adoption/Offline_and_falling_behind_barriers_to_internet_adoption_full%20report_FINAL.ashx

52 World Bank. (2018, December). Digital Development Partnership: Innovative Business Models for Expanding Fiber-Optic Networks and Closing the Access Gaps. Retrieved from http://documents.worldbank.org/curated/en/674601544534500678/pdf/132845-7-12-2018-17-20-11-InnovativeBusinessModels.pdf

The internet travels across the world to reach the user.

LAST MILE

The digital divide includes those outside the coverage footprint, often due to remote or rugged geography, and those within the coverage footprint who remain unconnected due to barriers such as cost, digital literacy, cultural/social norms, and other societal risks.

4 Connection

The middle mile connects to end users in the last mile of infrastructure (i.e., the coverage footprint) through fiber-optic cable, copper cable, or wireless which is broadcast from a radio tower, satellite, or base station antenna. Wi-Fi can extend networks about 100 meters.

MIDDLE MILE

3 Distribution

The national backbone connects with the middle mile using more fiber-optic cable or antennae to broadcast bandwidth through radio- or microwaves.

NATIONAL BACKBONE

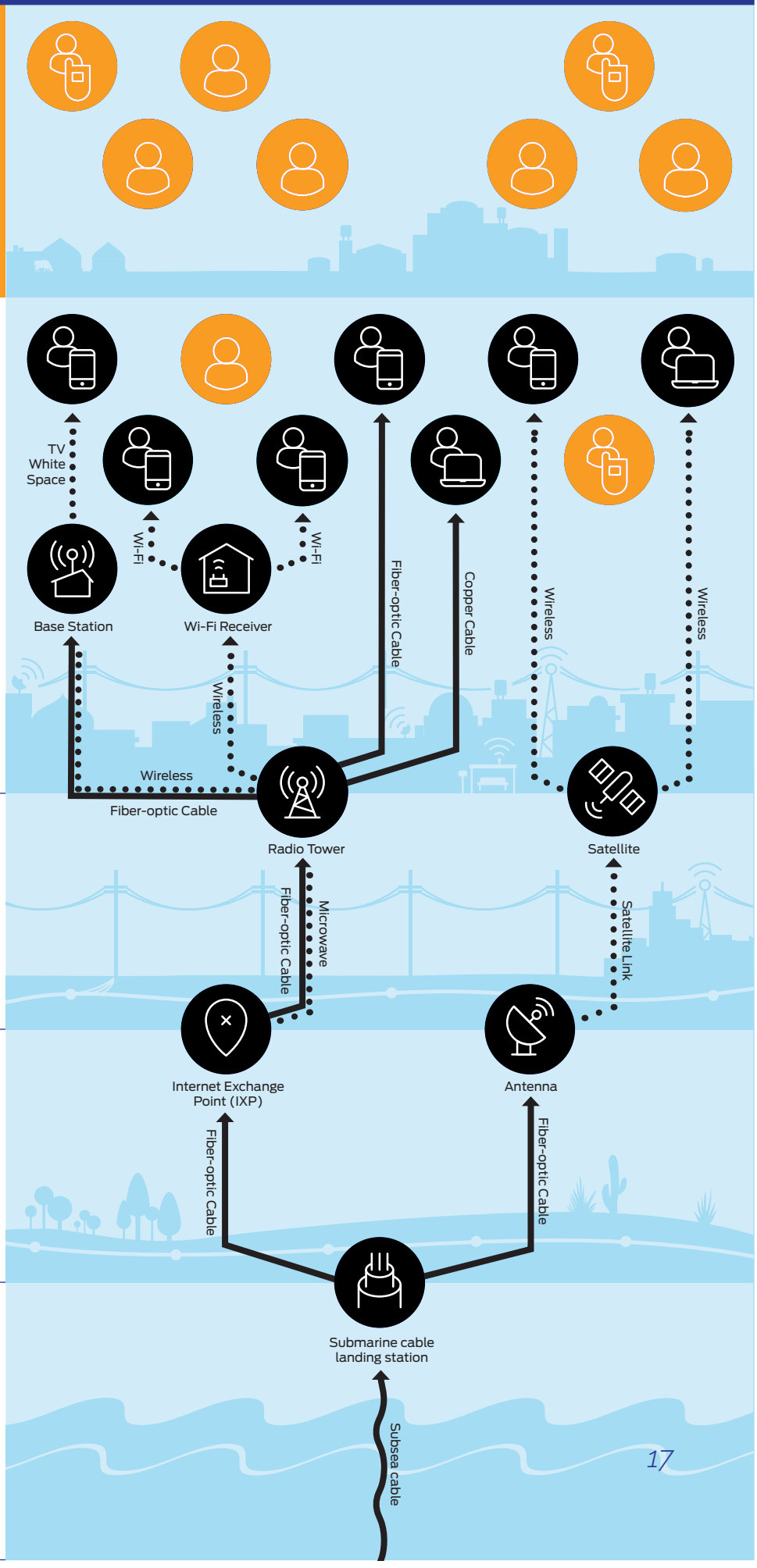
2 Core Network

Fiber-optic cable stretching from the landing station creates the core of the national network. These cables can be extended through Internet Exchange Points through densely populated areas.

INTERNATIONAL LINKS

1 Cross Border Network

The World Wide Web is created by fiber-optic cables traveling across oceans and between countries. These cables enter countries at landing stations where national backbones begin.



LMICs working to construct middle-mile and last-mile networks face a variety of challenges.[53] Countries must build connections from the national backbone to a greater number of communities (particularly those in small, remote towns and rural areas) while at the same time establishing sustainable last-mile solutions that meet users' needs. In some cases these efforts also require strengthening existing middle- and last-mile infrastructure to meet increased higher demand in urban centers can be met.[54]

DEFINITIONS
Capital expenses Upfront expenses connected to investment in infrastructure
Operating expenses Ongoing costs that ISPs/MNOs accrue when providing service

Existing complimentary infrastructure—such as roads, railways, electricity, pipelines, and communication networks—can make internet access expansion easier by allowing strategic reuse and lower capital costs as well as the potential for cost-sharing. Of these various types of infrastructure, the power grid is of particular concern for developing nations. In 2016, 1.1 billion people (largely in Asia and sub-Saharan Africa) did not have access to electricity.[55]

Infrastructure deployment costs are higher in remote and rugged geographies, and other sparsely populated areas.

Infrastructure deployment and operation involves both *capital expenses* (e.g., investment in laying cable, building factories and power plants, constructing cell towers) and *operating expenses* (e.g., maintenance, upkeep, licenses, and operations).[56] Initial buildout requires significant upfront investment and often must contend with pressure to achieve scale rapidly. ISPs and MNOs have been major investors in this regard and designed consumer pricing models with an eye toward recouping this investment. As a result, they have tended to focus on urban areas, where users are more concentrated and have higher incomes. Rural and high-poverty urban areas tend to be excluded because they are seen as less lucrative than urban markets. Even when infrastructure exists in rural areas, operating costs related to power and other factors frequently remain higher than those in urban areas.[57] This added cost represents a barrier to further deployment of infrastructure in remote rural areas. New business models that attend to local needs and capabilities will need to be developed to address these gaps in service provision.

53 World Bank. (2018, December). Digital Development Partnership: Innovative Business Models for Expanding Fiber-Optic Networks and Closing the Access Gaps. Retrieved from http://documents.worldbank.org/curated/en/674601544534500678/pdf/132845-7-12-2018-17-20-11-InnovativeBusinessModels.pdf

54 Sprague, K., Grijpink, F., Manyika, J., Moodley, L., Chappuis, B., Pattabiraman, K., & Bughin, J. (2014). Offline and falling behind: Barriers to Internet adoption. McKinsey & Company, Tech. Rep. Retrieved from https://www.mckinsey.com/~/media/McKinsey/Industries/High%20Tech/Our%20Insights/Offline%20and%20falling%20behind%20Barriers%20to%20Internet%20adoption/Offline_and_falling_behind_barriers_to_internet_adoption_full%20report_FINAL.ashx

55 International Energy Agency. (2017). Energy Access Outlook 2017: From Poverty to Prosperity. Retrieved from https://www.iea.org/publications/freepublications/publication/weo2017specialreport_energyaccessoutlook.pdf

56 World Bank. (2018, December). Digital Development Partnership: Innovative Business Models for Expanding Fiber-Optic Networks and Closing the Access Gaps. Retrieved from http://documents.worldbank.org/curated/en/674601544534500678/pdf/132845-7-12-2018-17-20-11-InnovativeBusinessModels.pdf

57 Caribou Digital. (2016). Digital Access in Africa. Farnham, Surrey, United Kingdom: Caribou Digital Publishing. Retrieved from https://www.cariboudigital.net/wp-content/uploads/2019/01/Caribou-Digital-DFID-Digital-Access-in-Africa.pdf

A country's geographic location and population density impact cost and potential return on investment

SMALL AND SPARSELY POPULATED COUNTRIES,
can find it difficult or impossible to realize economies of scale, which greatly reduces their ROI

LANDLOCKED COUNTRIES,
especially those surrounded by poor countries, have trouble leveraging the submarine or terrestrial fiber optic cable systems

COUNTRIES ISOLATED BY WATER,
specifically islands and archipelagos, are also without neighbors able to defray the cost of submarine cable

A country's geography has a major influence on the affordability of deploying certain types of infrastructure, determining how effective different technologies will work for providing access. The Alliance for Affordable Internet described three geographic instances that impact infrastructure deployment and costs:

- Small countries can find it difficult or impossible to realize economies of scale if they are not adjacent to already well-connected countries
- Landlocked countries have trouble leveraging the existing submarine or terrestrial fiber-optic cable systems, to which other countries typically connect
- Island countries and archipelagos, isolated by water, are similarly unable to defer the cost of submarine cable by sharing it with neighboring nations[58]

Finally, population density determines where most infrastructure is directed. As pricing models are set to recoup investment, most urban centers are targeted first as more individuals and higher incomes provide the consumption needed to ease the infrastructure, marketing, and distribution costs facing ISPs. Some MNOs are concerned that the emphasis and growth on extending wireless using Wi-Fi networks will further dilute their average revenue per user, which could potentially undermine the stability of the MNOs existing business models.[59] Innovation around business models can also help MNOs with the high costs of initial capital needed to move towards universal access.

58 Alliance for Affordable Access. (2018). The 2018 Affordability Report. Retrieved from https://a4ai.org/just-released-2018-affordability-report/

59 Schmida, S., WIlliams, I., & Lovegrove, C. (2016, April). Business Models for The Last Billion: Market Approaches to Increasing Internet Connectivity. USAID from the American People. Retrieved from https://mstarproject.files.wordpress.com/2016/05/business-models-for-the-last-billion.pdf

Spectrum allocation represents a structural barrier in business model development.

A key issue for ISPs is *spectrum allocation*, or assignment of certain bands to ISPs of the electromagnetic spectrum to transmit signals. How spectrum is regulated plays an important role in determining what providers have access to broadcast, the quality of that service, and whether or not it is a competitive marketplace that allows for new entrants.

DEFINITIONS
Spectrum Radio frequencies that transmit multiple signals simultaneously
Spectrum allocation Assignment of radio frequencies to ISPs, usually via exclusive licenses

Spectrum use is either licensed or license-exempt, with the latter form typically providing connectivity through Wi-Fi technology.[60] It is able to work without a license because it has lower power requirements. Licensed spectrum enables higher power and a wider range of coverage, and are typically allocated to ISPs and MNOs through government-led auctions. However, experts suggest that in many cases these auctions are not priced to create a thriving market but rather to generate revenue for the public sector. There is little connection between the price of the starting bids and the relative economic value. This process also stifles competition because only the incumbent or large companies can afford to purchase spectrum licenses.[61] This barrier is regularly recognized as one of the highest costs for MNOs, and contributes to the strongholds of incumbents which reduces competition in the market. Because of this, spectrum goes unused, despite demand. Further, this system doesn't allow for responsiveness to technological innovation, such as preparing for 5G, and suppresses market competition. Decisions around spectrum allocation rarely include civil society groups, which could help with affordable access.[62]

There aren't many established regulatory models to guide policy development.

Internet regulation is relatively new terrain for governments, which complicates the process of designing clear, easy-to-implement regulations. Compared to other industries, where regulations have had time to evolve, digital services has little in the way of guidance from existing models and thought leaders. There are no best practices to manage monopolies in digital services.[63] Furthermore, legacy industry regulation (e.g., telecom, publishing) often proves inadequate a completely new paradigm for data and privacy requires even higher regulatory responsiveness. National regulations that restrict tech companies' activities are common[64] but many countries have allowed tech companies to be self regulated—with limited success.[65]

60 Song, S. (2019). Spectrum Auctions Are Killing Competition And Failing Rural Access. Many Possibilities Blog. Retrieved from https://manypossibilities.net/2019/04/spectrum-auctions-are-killing-competition-and-failing-rural-access/

61 Song, S. (2019). Spectrum Auctions Are Killing Competition And Failing Rural Access. Many Possibilities Blog. Retrieved from https://manypossibilities.net/2019/04/spectrum-auctions-are-killing-competition-and-failing-rural-access/

62 Song, S. (2017, April 21). The Failure of Spectrum Auctions in Africa. Many Possibilities. Retrieved from https://manypossibilities.net/2017/04/the-failure-of-spectrum-auctions-in-africa/

63 Pathways for Prosperity Commission. (2018). Digital Lives: Creating Meaningful Connections for the Next 3 Billion. Retrieved from https://pathwayscommission.bsg.ox.ac.uk/sites/default/files/2018-11/digital_lives_report.pdf

64 Pisa, M. & Polcari, J. (2019.)"Governing Big Tech's Pursuit of the "Next Billion Users"" CGD Policy Paper. Washington, DC: Center for Global Development. Retrieved from https://www.cgdev.org/publication/governing-big-techs-pursuit-next-billion-users

65 MacKinnon, R., Hickok, E., Bar, A., & Lim, H. I. (2015). Fostering freedom online: The role of internet intermediaries. UNESCO Publishing. Retrieved from https://repository.upenn.edu/cgi/viewcontent.cgi?article=1000&context=cgcs_publications

There are potential lessons from analogous sector development, such as electrification and rural access. In the past, the public sector has devised interventions to ensure that people are not left out of the adoption of key technologies. During the Great Depression, the US government recognized the importance of radio for delivering official government communication but also knew that radio ownership was much more common in urban households.[66] To remedy this imbalance, the US Communications Act of 1934 mandated infrastructure improvements to bring radio to rural populations.[67] Unfortunately, many of the countries that struggle most with the digital divide do not have the public funds or political will to formulate similar interventions.

DEFINITIONS

Universal service funds (USFs)
Funds that collect fees on annual revenue from service providers to address inequitable access challenges

In order to craft more effective regulations, the public sector also should gather data in a more holistic way. Unfortunately, data collection practices can mask disparities in digital access. For example, when country-wide uptake statistics are reported, they are often done at the household level and not broken down along gender lines. As a result, it is impossible to gauge whether women's internet use has increased.[68] Data collection at the individual level (e.g., through women-only focus groups) would help reveal the true magnitude of the gender gap. Likewise, including women in the design of infrastructure deployments and outreach programs can help ensure that women's specific needs are taken into account in any solutions that emerge.[69]

Taxation practices haven't been designed or implemented in ways that have led to sustained access.

Financing infrastructure and service expansion projects continues to present many challenges. Governments and multilaterals have been slow to invest in internet infrastructure compared to other types of infrastructure.[70] From the private sector perspective, there is no clear investment pipeline. When opportunities do arise, it can be difficult to get the information needed to vet potential investments.[71] The public sector could help address these market failures by increasing transparency, reworking tax policies, and streamlining bureaucracy.

66 Smith, S. (2014, November 10). Radio: The Internet of the 1930's. American RadioWorks. Retrieved from http://www.americanradioworks.org/segments/radio-the-internet-of-the-1930s/

67 World Bank. (2016). World Development Report 2016: Digital Dividends. Retrieved from http://www.worldbank.org/en/publication/wdr2016

68 MacKinnon, R., Hickok, E., Bar, A., & Lim, H. I. (2015). Fostering freedom online: The role of internet intermediaries. UNESCO Publishing. Retrieved from https://repository.upenn.edu/cgi/viewcontent.cgi?article=1000&context=cgcs_publications

69 Thakur, D. and Potter, L. (2018) Universal Service and Access Funds: An Untapped Resource to Close the Gender Digital Divide. Washington DC: Web Foundation. Retrieved from https://webfoundation.org/docs/2018/03/Using-USAFs-to-Close-the-Gender-Digital-Divide-in-Africa.pdf

70 World Economic Forum. (2018). Financing a Forward-Looking Internet for All. White Paper. Retrieved from http://www3.weforum.org/docs/WP_Financing_Forward-Looking_Internet_for_All_report_2018.pdf

71 World Economic Forum. (2018). Internet for All: Platform for Financing ICT Connectivity Infrastructure. Presentation. Retrieved from https://www.itu.int/en/ITU-D/Regional-Presence/Europe/Documents/Events/2018/WSIS/Sess4_Wong(new)_ICT%20platform%20overview%20WSIS%20Mar%202018(2).pdf

Taxation in the telecommunications sector is a balancing act that must be tailored to support the goal of universal access. Taxes on consumers do create revenue but can also hamper adoption given that affordability is a key barrier to universal access and meaningful use. In Africa, nearly 20% of the total cost of mobile device ownership stems from tariffs and taxes on certain types of digital services such as mobile payment transactions.[72] Some countries have imposed taxes on social media use as an attempt to limit use or manage risk of harm, such as mis-information campaigns.[73]

THE IMPACT OF CONNECTIVITY TAXES

Uganda has experimented with different types of internet service taxes In 2014, it instituted a mobile money tax for transactions. In 2018, this tax was expanded to include almost all movements of mobile money (deposits, payments, etc.). This action reduced usage and created intense political pressure that prompted the government to roll back the policy significantly.[74] That same year, the Ugandan government also instituted a social media tax that unintentionally reduced the overall number of internet users.[75,76]

There are several examples of relaxed taxes yielding positive outcomes for consumers and the public sector alike. In 2009, the Kenyan government paused taxes on mobile phones, which at that time accounted for more than 20% of the total cost of ownership. As a result, mobile phone ownership doubled in the two years that followed. Kenya also experienced growth in penetration, mobile-related employment, and their economy at large.[77] In Brazil the government estimates that tax breaks on computers between 2014 and 2018 boosted economic growth and job creation that greatly outweigh the lost revenue from the tax.[78]

On the other hand, supply-side taxes are often criticized. GSMA cites sizable inter-country variation in the tax burden on the mobile industry, with most countries imposing a tax burden of more than 30%.[79] There are estimates that lower supply-side taxes on mobile service providers could increase uptake by over a million people in Brazil and more than half a million people each in Mexico, Malaysia, and South Africa.[80] Studies also argue that decreased taxation on mobile inter-

72 Caribou Digital. (2016). Digital Access in Africa. Farnham, Surrey, United Kingdom: Caribou Digital Publishing. Retrieved from https://www.cariboudigital.net/wp-content/uploads/2019/01/Caribou-Digital-DFID-Digital-Access-in-Africa.pdf

73 Pisa, M. & Polcari, J. (2019.)"Governing Big Tech's Pursuit of the "Next Billion Users"" CGD Policy Paper. Washington, DC: Center for Global Development. Retrieved from https://www.cgdev.org/publication/governing-big-techs-pursuit-next-billion-users

74 Ferracuti, Anna. (2018). Understanding the Consequences of Mobile Money Taxes in Uganda. UNCDF: Unlocking Public and Private Finance for the Poor. Retrieved from https://www.uncdf.org/article/3892/understanding-the-consequences-of-mobile-money-taxes-in-uganda

75 Alliance for Affordable Access. (2018). The 2018 Affordability Report. Retrieved from https://a4ai.org/just-released-2018-affordability-report/

76 Dahir, A.L. (2019, February 18). Uganda's social media tax has led to a drop in internet and mobile money users. Quartz Africa. Retrieved from https://qz.com/africa/1553468/uganda-social-media-tax-decrease-internet-users-revenues/

77 World Economic Forum. (2016). Internet for All: A Framework for Accelerating Internet Access and Adoption. In World Economic Forum. Retrieved from https://www.weforum.org/reports/internet-for-all-a-framework-for-accelerating-internet-access-and-adoption

78 World Economic Forum. (2016). Internet for All: A Framework for Accelerating Internet Access and Adoption. In World Economic Forum. Retrieved from https://www.weforum.org/reports/internet-for-all-a-framework-for-accelerating-internet-access-and-adoption

79 World Bank. (2018, December). Digital Development Partnership: Innovative Business Models for Expanding Fiber-Optic Networks and Closing the Access Gaps. Retrieved from http://documents.worldbank.org/curated/en/674601544534500678/pdf/132845-7-12-2018-17-20-11-InnovativeBusinessModels.pdf

80 West, D. M. (2015). Digital divide: Improving Internet access in the developing world through affordable services and diverse content. Brookings Institution. Retrieved from https://www.brookings.edu/wp-content/uploads/2016/06/West_Internet-Access.pdf

net infrastructure could increase expansion, GDP, and investment in the mobile sector.[81] For many countries focused on increasing access, value, and equity, lower taxes on the consumer side and more modest taxes on the supply side should have positive impacts on the market and their goals.

There are also informal barriers related to historical use of funds gathered. *Universal Service Funds (USFs)* has been one approach by the state to tax revenue from ISPs to fund expansion into underdeveloped markets. These funds aim to provide services or devices to end users, but are rarely used for core access infrastructure. There are mixed results on the effectiveness of these funds, but in some instances, ISPs cite that these funds do not go towards their goal but instead become absorbed into a broader state budget. This type of corruption or lack of transparency is problematic when USFs are not created within the normal procedures of a national budget, but rather as their own entity. A study of USF policies in 37 African countries found that the collective total of $408 million in unspent funds in USFs could bring almost 6 million women online as a subsidy for a mobile handset and ongoing data costs.[82]

81 https://www.mckinsey.com/~/media/McKinsey/Industries/High%20Tech/Our%20Insights/Offline%20and%20falling%20behind%20Barriers%20to%20Internet%20adoption/Offline_and_falling_behind_barriers_to_internet_adoption_full%20report_FINAL.ashx

82 Thakur, D. and Potter, L. (2018) Universal Service and Access Funds: An Untapped Resource to Close the Gender Digital Divide. Washington DC: Web Foundation. Retrieved from https://webfoundation.org/docs/2018/03/Using-USAFs-to-Close-the-Gender-Digital-Divide-in-Africa.pdf

5. Ideas for Closing the Digital Divide

Barriers to greater internet connectivity stem from the fact that existing technology, policy, and business models cannot fully address key market failures. While each of these domains can be a powerful lever of change on its own, they are necessarily intertwined, which means that the most powerful solutions will come from creative, coordinated efforts on all three fronts.

This section examines each domain individually to better understand innovations underway, challenges that each domain is best-positioned to solve, and issues that remain unresolved. At the end of this section, combinations of these domains are then analyzed for their capacity to achieve greater impact.

Technology innovations are positioned to improve the reliability and quality of a user's connection.

Different innovations are emerging across the infrastructure value chain in response to intractable access challenges. We present a sampling of emerging technologies below, noting advantages and drawbacks for each across various contexts. Technologies aim to improve backhaul connections from core networks to the last mile. While these are more directly relevant to providers, each technology affects the experience a user has when connecting to and using the internet.

A range of technologies hold promise to help close the digital divide

TECHNOLOGY	DESCRIPTION	ADVANTAGES	DRAWBACKS
Content caching	Storage of content on local servers for offline viewing	• Adapts to wide range of deployments • Provides opportunity for developing digital literacy • Reduces cost to user • Decreases operating costs for providers • Increase quality of service	• Displays static content that can become out-of-date • Requires technical capacity to operate and maintan
Fiber-optic cable	Cable that uses the transmission of light to send communications	• Provides high bandwidth • Supports high-quality service • Offers relatively high infrastructure longevity • Yields high return on investment • Adapts as standards and service improve (e.g., 5G)	• Costly to initially install • Requires high degree of coordination to connect transnationally
Long Term Evolution (LTE)	Standard of wireless communication using specific spectrum frequencies to support mobile roaming	• Mature technology with high longevity • Coverage provides higher speeds for mobile phones compared to other wireless options	• Reliant on mobile towers and middle-mile infrastructure • Requires both licensed and unlicensed bands to operate

TECH	DESCRIPTION	ADVANTAGES	DRAWBACKS
Low-earth-orbit satellites	Satellites orbiting below 2,000 kilometers that relay radio signals between high-earth-orbit satellites and individual mobile phones	• Creates opportunities for seamless wireless connection where existing options are unstable	• Remains unproven • Requires high level of upfront investment
Medium-earth-orbit satellites	Satellites orbiting the earth at altitudes between 2,000 and 35,000 kilometers that relay radio signals between transmitters and receivers	• Provides an alternative when expansion of ground infrastructure is not feasible • Wider geographic coverage than low-earth-orbit satellites • Resilient during natural disasters	• Costly to launch and operate • Higher latency affects user experience with sophisticated media (videos, gaming, etc)
TV White Space (TVWS)	Buffer channels previously used for analog TV broadcasting that often sit unused after the switch to digital	• Covers long distances and rough terrain • Provides wide coverage (~10 km range)	• Requires a geolocation database • Investments seen as risky when regulations are unclear • Bandwidth constraints may not support sophisticated media
Wi-Fi	Service allowing devices to connect to the internet or each other wirelessly using a router in a particular location	• Low cost, off-the-shelf technology • Does not require a spectrum license for use • Often used by the public sector to provide free access points	• Quality of service depends on national backbone • Users must be within a relatively small coverage footprint (<100 m) • Buildings can block wireless signals
Wi-Fi mesh networks	Connected Wi-Fi routers that extend the signal beyond that of a single route	• Easily managed without extensive technical expertise • Relatively easy to install and operate	• Capacity limits • More effective when users are in a concentrated area

Fiber-optic cables are often cited for their ability to handle more capacity, travel farther distances, and last longer than alternative forms of internet access. The lifespan of a 228-strand fiber-optic cable is 20 years while most forms of wireless technology average 3-5 years.[83] These cables connect the core network to submarine cables, but are often lacking in national backbones or middle mile networks. From the perspective of the user, ISPs that use fiber instead of DSL or cable offer faster speeds and better performance with data-intensive media such as videos. However, fiber is not as widely available in rural areas compared to DSL / copper connectivity, in part because laying fiber—whether for new connections or to replace legacy infrastructure—can be cost-prohibitive.[84]

83 Interview: Steve Song, April 8, 2019

84 BroadbandNow. (2019, March 25). DSL vs Cable vs Fiber: Comparing Internet Options. Retrieved from https://broadbandnow.com/guides/dsl-vs-cable-vs-fiber

Fiber-optic cables offer a better user experience via faster speeds and more reliable connections.

FIXED CONNECTION TYPE	DOWNLOAD SPEED RANGE / UPLOAD SPEED RANGE
DSL	5-35 Mbps / 1-10 Mbps
Cable	10-500 Mbps / 5-50 Mbps
Fiber	250-1,000 Mbps / 250-1,000 Mbps

TV White Space (TVWS) refers to buffer channels previously used in analog TV broadcasting to prevent interference. These channels are often in the range of 450 to 800 MHz[85] and tend to sit unused once countries make the switch to digital TV broadcasting. Helping small providers tap into these unused resources may reduce the cost of backhaul by avoiding high spectrum license fees, which in turn will increase market competition and drive innovation. TVWS is well-suited for rural access because it can transmit over long distances without danger of disruption by difficult terrain. By contrast, standard microwave links require line-of-sight transmission for stable connections.[86]

Wi-Fi is a service allowing enabled devices to connect to the internet or each other wirelessly. It does not require a spectrum license, thereby eliminating a major operating expenditure for providers.[87] [88] As a last-mile intervention, this low-cost technology relies on fixed-line infrastructure,[89] creating an upper limit on access expansion. It also has a very limited reach of approximately 100 meters and is sensitive to physical obstructions. [90,91] Despite these constraints, Wi-Fi can mitigate the challenge of unaffordable mobile data in densely populated areas with proximity to fixed broadband infrastructure. However, 3G coverage or above may provide a better online experience than poorly-placed Wi-Fi. This fact may give MNOs greater incentive to pursue network upgrades in order to diminish the prevalence of Wi-Fi and retain revenue from mobile data usage.[92]

85 World Bank. (2018, December). Digital Development Partnership: Innovative Business Models for Expanding Fiber-Optic Networks and Closing the Access Gaps. Retrieved from http://documents.worldbank.org/curated/en/674601544534500678/pdf/132845-7-12-2018-17-20-11-InnovativeBusinessModels.pdf

86 BroadbandNow. (2019, March 25). DSL vs Cable vs Fiber: Comparing Internet Options. Retrieved from https://broadbandnow com/guides/dsl-vs-cable-vs-fiber

87 World Bank. (2018, December). Digital Development Partnership: Innovative Business Models for Expanding Fiber-Optic Networks and Closing the Access Gaps. Retrieved from http://documents.worldbank.org/curated/en/674601544534500678/pdf/132845-7-12-2018-17-20-11-InnovativeBusinessModels.pdf

88 USAID, Caribou Digital, and DIAL. (2017, Feb). Closing the Access Gap: Innovation to Accelerate Universal Internet Adoption. Retrieved from https://www.usaid.gov/sites/default/files/documents/15396/Closing-the-Access-Gap.pdf

89 Sprague, K., Grijpink, F., Manyika, J., Moodley, L., Chappuis, B., Pattabiraman, K., & Bughin, J. (2014). Offline and falling behind: Barriers to Internet adoption. McKinsey & Company, Tech. Rep. Retrieved from https://www.mckinsey.com/~/media/McKinsey/Industries/High%20Tech/Our%20Insights/Offline%20and%20falling%20behind%20Barriers%20to%20Internet%20adoption/Offline_and_falling_behind_barriers_to_internet_adoption_full%20report_FINAL.ashx

90 Song, S. (2017, April 21). The Failure of Spectrum Auctions in Africa. Many Possibilities. Retrieved from https://manypossibilities.net/2017/04/the-failure-of-spectrum-auctions-in-africa/

91 World Bank. (2018, December). Digital Development Partnership: Innovative Business Models for Expanding Fiber-Optic Networks and Closing the Access Gaps. Retrieved from http://documents.worldbank.org/curated/en/674601544534500678/pdf/132845-7-12-2018-17-20-11-InnovativeBusinessModels.pdf

92 World Bank. (2018, December). Digital Development Partnership: Innovative Business Models for Expanding Fiber-Optic Networks and Closing the Access Gaps. Retrieved from http://documents.worldbank.org/curated/en/674601544534500678/pdf/132845-7-12-2018-17-20-11-InnovativeBusinessModels.pdf

Wi-Fi mesh networks extend connectivity by creating a network of wireless routers or nodes that communicate with each other. This decentralized approach eliminates the danger of a single point of failure.[93] This built-in resilience makes mesh networks ideal for use after natural disasters, extreme weather events, and other situations when centralized ISPs find the entirety of their services disrupted. A drawback of this technology centers on the need to be relatively close to a node. Users may experience poor connections and slow speeds as they move to the edge of a node's coverage. [94]

Long-Term Evolution (LTE) is a standard of wireless communication standard in mobile broadband. It is often lumped in with 4G for marketing purposes, but LTE is an intermediate stage of development where networks provide speeds over 3G and are on the pathway to achieving 4G speeds.[95] 3G connections tends to be the norm in LMICs.[96] Network improvements that adopt LTE as a standard will ultimately result in a higher-quality experience for the user, allowing the possibility to engage with more sophisticated media (e.g. streaming). The ability for users to hear audio or watch videos in their own language may provide greater value and increase the likelihood of deeper engagement.

Each generation of mobile technology enables access to richer media.

GENERATION	SUPPORTED SERVICES
1G	Voice and telephony services
2G	Text services (e.g. SMS) and small amounts of data (e.g. MMS)
3G	Video services (e.g. YouTube)
4G	Streaming services (e.g. Netflix)
5G	Internet-of-Things

93 World Bank. (2018, December). Digital Development Partnership: Innovative Business Models for Expanding Fiber-Optic Networks and Closing the Access Gaps. Retrieved from http://documents.worldbank.org/curated/en/674601544534500678/pdf/132845-7-12-2018-17-20-11-InnovativeBusinessModels.pdf

94 Bocetta, S. (2018, October 9). Why Mesh Networks Are the Future of Free Internet Access. Foundation for Economic Education. Retrieved from https://fee.org/articles/why-mesh-networks-are-the-future-of-free-internet-access/

95 Sarpong, E. (2019, April 24). 5G is here! Can it deliver on Affordable Access to close the digital divide? Alliance for Affordable Internet. Retrieved from https://a4ai.org/5g-is-here-can-it-deliver-on-affordable-access-to-close-the-digital-divide/

96 Sarpong, E. (2019, April 24). 5G is here! Can it deliver on Affordable Access to close the digital divide? Alliance for Affordable Internet. Retrieved from https://a4ai.org/5g-is-here-can-it-deliver-on-affordable-access-to-close-the-digital-divide/

Satellites can help address coverage issues associated with difficult terrain and remote, dispersed populations[97] but they often have higher operating costs and lower service quality compared to fixed broadband.[98] Providers that make use of satellite technology must launch *Medium-earth orbit (MEO)* and *Low-earth orbit (LEO) satellite* constellations into orbit and establish ground stations to relay data to the satellites. MEOs are most commonly used for navigation and connectivity to the North and South Poles,[99] while LEOs are well-suited for communication,[100] In order to access service from an MEO or LEO, users must first install an antenna. These are typically affordable and easy to install and one antenna can be used by an entire community. MEOs and LEOs are also often regarded as complementary services that can help address coverage gaps following natural disasters.[101]

C*ontent caching* is a last-mile technology that directly affects users' online experiences. This technology involves the storage of information on local servers so that content can be accessed offline. By reducing the time needed to fetch information, this approach lowers overall costs and increases efficiency for providers while providing a faster experience for users.[102] One potential drawback of content caching is that stored content can become outdated if it is not refreshed.

Policies focus on infrastructure expansion for providers, and increased value and security for users.

The successful deployment and operation of technology is reliant on an enabling policy environment. The public sector has a range of levers available to them, including:

- Creating incentives for infrastructure development and expansion
- Supporting a competitive marketplace
- Promoting the development of relevant content
- Creating public access options and training opportunities
- Crafting regulations to protect consumers

The effectiveness of each often depends on how well governments are able to balance strong public-private partnerships and the needs of the populace.[103] We review a number of policies in the following table. This list is not meant to be comprehensive, but rather a sampling of policies that are frequently cited for their ability to impact access and uptake.

97 Broadband Commission for Sustainable Development. (2018, September). The State of Broadband: Broadband catalyzing sustainable development. Retrieved from https://www.itu.int/dms_pub/itu-s/opb/pol/S-POL-BROADBAND.19-2018-PDF-E.pdf

98 USAID, Caribou Digital, and DIAL. (2017, Feb). Closing the Access Gap: Innovation to Accelerate Universal Internet Adoption. Retrieved from https://www.usaid.gov/sites/default/files/documents/15396/Closing-the-Access-Gap.pdf

99 EMEA Satellite Operators Association. (n.d.). Satellite Orbits. ESOA. Retrieved from https://www.esoa.net/technology/satellite-orbits.asp

100 Hussaini, U. (2018, November 5). Low earth orbit, medium and high earth orbits – Types of orbits. Technobyte. Retrieved from https://www.technobyte.org/satellite-communication/low-medium-high-earth-orbits-types-of-orbits/

101 Broadband Commission for Sustainable Development. (2018, September). The State of Broadband: Broadband catalyzing sustainable development. Retrieved from https://www.itu.int/dms_pub/itu-s/opb/pol/S-POL-BROADBAND.19-2018-PDF-E.pdf

102 Schmida, S., WIlliams, I., & Lovegrove, C. (2016, April). Business Models for The Last Billion: Market Approaches to Increasing Internet Connectivity. USAID from the American People. Retrieved from https://mstarproject.files.wordpress.com/2016/05/business-models-for-the-last-billion.pdf

103 World Bank. (2016). World Development Report 2016: Digital Dividends. Retrieved from http://www.worldbank.org/en/publication/wdr2016

Policies should be evaluated holistically for their impacts on providers and consumers.

POLICY	DESCRIPTION	ADVANTAGES	DRAWBACKS
Complementary infrastructure sharing policy	Requirement that new connectivity infrastructure installations evaluate and, when feasible, reuse existing complementary infrastructure (e.g.,utility poles)[104]	• Reduces capital costs for ISPs • Reduces user costs	• Requires strategic planning and coordination • Might cause delays due to added effort of coordination
Data localization requirement	Mandate that citizens' data be stored and processed within a country's borders	• May protect user security online • Ensures data is protected by national regulations	• May increase ISP costs and user costs • Can be regarded as protectionist • Requires technical capacity for management and processing • Could slow speeds • May decrease security
Dig once policy	Requirement that stakeholders coordinate and preemptively dig trenches for future infrastructure installation as part of other infrastructure deployment efforts[105]	• Reduces and contains infrastructure costs	• Requires consistent strategic planning and permitting
Digitization of government services	Policy that moves government information and services online to incentivize connectivity uptake[106]	• Increases uptake and value to user	• Requires education and behavior change • May increase inequity for those without access
Free public Wi-Fi	Provision of free, publicly-funded Wi-Fi using unlicensed spectrum at key locations or hot spots[107]	• Expands access • Eliminates user costs • Effective in densely populated areas where smartphone penetration is high • May increase demand	• Cannot reach populations outside of coverage footprint • Introduces equity concerns for women, elderly, disabled, very low-income and remote populations
Government data consumption commitment[108]	Policy that establishes the public sector as an anchor client for private businesses to encourage market development	• Reduce risk for ISPs and investors	• Assumes government capacity to collect and use data • Requires digital literacy or training for public servants

104 World Bank. (2018, December). Digital Development Partnership: Innovative Business Models for Expanding Fiber-Optic Networks and Closing the Access Gaps. Retrieved from http://documents.worldbank.org/curated/en/674601544534500678/pdf/132845-7-12-2018-17-20-11-InnovativeBusinessModels.pdf

105 World Economic Forum. (2018). Financing a Forward-Looking Internet for All. White Paper. Retrieved from http://www3.weforum.org/docs/WP_Financing_Forward-Looking_Internet_for_All_report_2018.pdf

106 Caribou Digital. (2016). Digital Access in Africa. Farnham, Surrey, United Kingdom: Caribou Digital Publishing. Retrieved from https://www.cariboudigital.net/wp-content/uploads/2019/01/Caribou-Digital-DFID-Digital-Access-in-Africa.pdf

107 USAID, Caribou Digital, and DIAL. (2017, Feb). Closing the Access Gap: Innovation to Accelerate Universal Internet Adoption. Retrieved from https://www.usaid.gov/sites/default/files/documents/15396/Closing-the-Access-Gap.pdf

108 World Economic Forum. (2018). Financing a Forward-Looking Internet for All. White Paper. Retrieved from http://www3.weforum.org/docs/WP_Financing_Forward-Looking_Internet_for_All_report_2018.pdf

POLICY	DESCRIPTION	ADVANTAGES	DRAWBACKS
Illegal content regulation and enforcement	Creation and enforcement of transparent rules around legal use of internet and processes to identify and remove illegal content[109,110,111]	• Protects users safety and trust in new tool • Increases equity for groups who face online harassment	• Assumes government and IT capacity • Illegality may be subjective even within national contexts • Demands dedicated government capacity
Local loop unbundling	Regulation allowing local access lines to be available to multiple competitors at wholesale prices[112]	• Increases market competition • Reduces user costs	• Resistance from incumbent providers • Could disincentivize new infrastructure development
Reservation of the 'digital dividend' spectrum band	Regulation reserving the 700/800 MHz band for inclusive connectivity efforts as countries transition from analog to digital broadcasting	• Increases coverage • Reaches difficult terrain	• Assumes country has transitioned from analog to digital TV broadcasting
Support for mobile money	Incorporation of mobile money systems into government programs and commitment to not impose special taxes on mobile transactions[113]	• Removes risk for private sector • Increases equity • Adds value to user • Encourages digital commerce	• Assumes government capacity • Assumes existing services that allow mobile money functionality • Can require strong public-private partnership
Training for public employees	Provision of digital literacy training for public-sector employees (e.g. teachers, nurses)[114]	• Increases value to user • Demonstrates value of internet access in sectors such as health and education	• Requires skilled professional to lead instruction • Requires time away from trainee's job • Assumes institutions have capacity to use the internet
Universal Service Funds	Funds that collect fees on annual revenue from service providers to target and solve issues of inequitable access	• May increase uptake • Demonstrated value to user	• Increases costs for providers • May increase costs for users • May be vulnerable to state corruption
User-centric mobile tax strategy	Assessment and design of mobile broadband tax structures to encourage uptake	• Reduces cost for ISPs • Reduces cost for users	• Short-term loss of public revenue

109 Freedom House. (2018, October). Freedom of the Net 2018. Retrieved from https://freedomhouse.org/sites/default/files/FOTN_2018_Final%20Booklet_11_1_2018.pdf

110 MacKinnon, R., Hickok, E., Bar, A., & Lim, H. I. (2015). Fostering freedom online: The role of internet intermediaries. UNESCO Publishing. Retrieved from https://repository.upenn.edu/cgi/viewcontent.cgi?article=1000&context=cgcs_publications

111 Pisa, M. & Polcari, J. (2019.)"Governing Big Tech's Pursuit of the "Next Billion Users"" CGD Policy Paper. Washington, DC: Center for Global Development. Retrieved from https://www.cgdev.org/publication/governing-big-techs-pursuit-next-billion-users

112 World Bank. (2016). World Development Report 2016: Digital Dividends. Retrieved from http://www.worldbank.org/en/publication/wdr2016

113 World Economic Forum. (2016). Internet for All: A Framework for Accelerating Internet Access and Adoption. In World Economic Forum. Retrieved from https://www.weforum.org/reports/internet-for-all-a-framework-for-accelerating-internet-access-and-adoption

114 World Economic Forum. (2018). Financing a Forward-Looking Internet for All. White Paper. Retrieved from http://www3.weforum.org/docs/WP_Financing_Forward-Looking_Internet_for_All_report_2018.pdf

A number of policy approaches seek to improve the ability of suppliers to deploy infrastructure effectively. *Dig once policies* require that governments install conduit piping during other construction projects to prepare for future fiber installation.[115] This approach aims to lower costs of investment and increase opportunity for small providers to enter the marketplace. It also enables bundled investment for donors and funders.[116] *Complementary infrastructure sharing* policies aim to reuse existing infrastructure for connectivity. Other utilities, such as water, gas or electricity, often have existing rights of way that can streamline internet infrastructure deployment.[117] Consideration of these assets in national broadband strategies could lead to greater cost-effectiveness. Both approaches require efficient communication and collaboration across departments and levels of government to ensure effective deployment.

Other policies seek to increase market competition to lower costs and increase the quality of services for consumers. *Local loop unbundling* refers to mandates that require an incumbent to make access lines available to competitors at wholesale prices set by a regulatory body.[118] A local loop refers to the last mile of infrastructure which physically reaches a user's home,[119] An unbundling policy lets competitors deploy their own software using the incumbent's existing infrastructure. Through unbundling, smaller ISPs and MNOs may be able to offer unique services and compete for customers more effectively. However, public-sector leaders should be prepared for resistance from incumbents who initially invested in infrastructure installation.

Reservation of the "digital dividend" spectrum band refers to regulations that set aside a specific spectrum band to be used to bridge the digital divide. To be effective, such policies must include specifications on how to prevent and/or avoid interference.[120] This often requires a geolocation database that tracks all available bands, which in turn requires technical capacity to implement and maintain. A few different management tactics that have emerged as regulators work to repurpose this often unused technology. One approach allows TVWS use for social purposes such as small community networks or non-profits. Another lets private- or public-sector entities apply for specific parts of the available band.[121]

115 North Carolina Department of Information Technology. (2017). "Dig once" Policies. Broadband Infrastructure Office. Retrieved from https://www.ncbroadband.gov/playbook/policy-and-broadband/dig-once-policies/

116 World Economic Forum. (2018). Financing a Forward-Looking Internet for All. White Paper. Retrieved from http://www3.weforum.org/docs/WP_Financing_Forward-Looking_Internet_for_All_report_2018.pdf

117 World Bank. (2018, December). Digital Development Partnership: Innovative Business Models for Expanding Fiber-Optic Networks and Closing the Access Gaps. Retrieved from http://documents.worldbank.org/curated/en/674601544534500678/pdf/132845-7-12-2018-17-20-11-InnovativeBusinessModels.pdf

118 World Bank. (2016). World Development Report 2016: Digital Dividends. Retrieved from http://www.worldbank.org/en/publication/wdr2016

119 Sprigman, C.J. (2016, June 21). Net neutrality is great, but it won't make broadband cheaper. New Yorker. Retrieved from https://www.newyorker.com/business/currency/net-neutrality-is-great-but-it-wont-make-broadband-cheaper

120 International Telecommunication Union. (2017). Evolving spectrum management tools to support development needs: 6th Study Period 2014-2017. Final Report. Retrieved from https://www.itu.int/dms_pub/itu-d/opb/stg/D-STG-SG01.RES09.2-2017-PDF-E.pdf

121 International Telecommunication Union. (2017). Evolving spectrum management tools to support development needs: 6th Study Period 2014-2017. Final Report. Retrieved from https://www.itu.int/dms_pub/itu-d/opb/stg/D-STG-SG01.RES09.2-2017-PDF-E.pdf

A *user-centric mobile tax strategy* seeks to remove taxes that increase costs for mobile providers and users alike. Taxes reduce available funds on hand, which can limit provider investment in infrastructure.[122] These costs often passed directly onto consumers, resulting in higher prices for mobile use.[123] In addition, complex and/or frequently changing taxe codes disincentivize investors and donors.[124] As mobile internet becomes more ubiquitous, governments should seek to understand which taxes are appropriate and which will impact affordability.

A more direct approach to encourage market development and competition involves public-sector purchase and use of internet services. *Government data consumption commitment* establish the public sector as an anchor client for providers, who can in turn present an improved business case to other investors.[125] This type of policy typically includes a guaranteed minimum amount of data will be used in government offices and/or public entities.[126] Consumption commitments are most likely to be effective where there is sufficient public-sector capacity to implement, maintain, and support the adoption of digital tools.

One type of data use that could be included in a consumption commitment is e-Government services. *Digitization of government services* refers to the movement of essential services (e.g., digital identity, entitlements, tax payments) online to incentivize digital adoption among the public.[127] Similarly, *Support for Mobile Money* refers to public-sector programs that integrate digitized payment services. Mobile money has proven to be a key driver in uptake of digital services.
to public programs that integrate digitized payment services.[128] Mobile money has proven to be a key driver in uptake of digital services. Strong partnerships between providers and governments can help ensure successful implementation and maintenance of payment systems. A rising trend of taxation on mobile money transactions could threaten the success of this approach and has prompted a strong backlash from the public.[129] Policymakers should exercise caution before moving forward with such taxes.

122 Buckell, M. & Liberatore, F. (2018). Enabling Rural Coverage: Regulatory and policy recommendations to foster mobile broadband coverage in developing countries. GSMA. Retrieved from https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2018/02/Enabling_Rural_Coverage_English_February_2018.pdf

123 Sprague, K., Grijpink, F., Manyika, J., Moodley, L., Chappuis, B., Pattabiraman, K., & Bughin, J. (2014). Offline and falling behind: Barriers to Internet adoption. McKinsey & Company, Tech. Rep. Retrieved from https://www.mckinsey.com/~/media/McKinsey/Industries/High%20Tech/Our%20Insights/Offline%20and%20falling%20behind%20Barriers%20to%20Internet%20adoption/Offline_and_falling_behind_barriers_to_internet_adoption_full%20report_FINAL.ashx

124 Buckell, M. & Liberatore, F. (2018). Enabling Rural Coverage: Regulatory and policy recommendations to foster mobile broadband coverage in developing countries. GSMA. Retrieved from https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2018/02/Enabling_Rural_Coverage_English_February_2018.pdf

125 Pisa, M. & Polcari, J. (2019.)"Governing Big Tech's Pursuit of the "Next Billion Users"" CGD Policy Paper. Washington, DC: Center for Global Development. Retrieved from https://www.cgdev.org/publication/governing-big-techs-pursuit-next-billion-users

126 World Economic Forum. (2018). Financing a Forward-Looking Internet for All. White Paper. Retrieved from http://www3.weforum.org/docs/WP_Financing_Forward-Looking_Internet_for_All_report_2018.pdf

127 Caribou Digital. (2016). Digital Access in Africa. Farnham, Surrey, United Kingdom: Caribou Digital Publishing. Retrieved from https://www.cariboudigital.net/wp-content/uploads/2019/01/Caribou-Digital-DFID-Digital-Access-in-Africa.pdf

128 Caribou Digital. (2016). Digital Access in Africa. Farnham, Surrey, United Kingdom: Caribou Digital Publishing. Retrieved from https://www.cariboudigital.net/wp-content/uploads/2019/01/Caribou-Digital-DFID-Digital-Access-in-Africa.pdf

129 Ferracuti, Anna. (2018). Understanding the Consequences of Mobile Money Taxes in Uganda. UNCDF: Unlocking Public and Private Finance for the Poor. Retrieved from https://www.uncdf.org/article/3892/understanding-the-consequences-of-mobile-money-taxes-in-uganda

Both approaches can enhance value for users, but may also exacerbate existing inequities among those who cannot access the internet. When designing e-Government services, policymakers should consider the types of connectivity available and already in use in the target area. For example, if a region is covered primarily by 2G service, SMS will likely be the easiest mechanism for individuals to access services (as compared to an online portal).[130]

Other policies attempt to create demand by providing new public access options. *Free public Wi-Fi* iinvolves the funding, installation, and provision of connectivity at central public locations.[131] This approach works best in densely-populated urban areas that are adjacent to existing infrastructure as well as in populations that already own Wi-Fi-enabled mobile phones.[132] Governments avoid the cost of spectrum licenses by using Wi-Fi. Strategic planning, coordination, and sufficient funding is required for deployment and maintenance, which can be challenging if the network grows.[133] Furthermore, these hot-spots can present equity challenges to women, the elderly, and the disabled. Provision of public Wi-Fi in a central location assumes that women feel safe using technology in public, while the elderly and disabled may face additional hurdles in terms of transportation and access.

Universal Service Funds refers to government programs that try to provide internet access to poor individuals or communities. These funds rely on regulatory fees or levies on annual revenue paid by the MNO or ISP, and sometimes additional contributions from the philanthropic sector. These funds are often used to subsidize services, devices, and/or specific applications.[134,135] The structure and management of these funds have a significant influence on their effectiveness, particularly with regard to accountability and transparency. Tension between the public and private sectors tends to arise when USFs are treated as part of the government's overall budget instead of as targeted funding for specific programs that seek to increase access.

Providing opportunities to develop digital literacy skills ensures that users will be more inclined to adopt and engage with the internet. *Training for public employees* provides digital literacy education to public-sector employees such as teachers, administrators, and doctors. These programs can be implemented through the deployment of online public services or applications that educate employees on how to use the tools effectively. Planning and coordination to provide a baseline level of training for all employees will ensure they understand how to use the internet to achieve their professional objectives.

130 Caribou Digital. (2016). Digital Access in Africa. Farnham, Surrey, United Kingdom: Caribou Digital Publishing. Retrieved from https://www.cariboudigital.net/wp-content/uploads/2019/01/Caribou-Digital-DFID-Digital-Access-in-Africa.pdf

131 USAID, Caribou Digital, and DIAL. (2017, Feb). Closing the Access Gap: Innovation to Accelerate Universal Internet Adoption. Retrieved from https://www.usaid.gov/sites/default/files/documents/15396/Closing-the-Access-Gap.pdf

132 USAID, Caribou Digital, and DIAL. (2017, Feb). Closing the Access Gap: Innovation to Accelerate Universal Internet Adoption. Retrieved from https://www.usaid.gov/sites/default/files/documents/15396/Closing-the-Access-Gap.pdf

133 USAID, Caribou Digital, and DIAL. (2017, Feb). Closing the Access Gap: Innovation to Accelerate Universal Internet Adoption. Retrieved from https://www.usaid.gov/sites/default/files/documents/15396/Closing-the-Access-Gap.pdf

134 Song, S. (2019, February 13). Rethinking Affordable Access. Alliance for Affordable Internet. Retrieved from https://a4ai.org/rethinking-affordable-access/

135 Caribou Digital. (2016). Digital Access in Africa. Farnham, Surrey, United Kingdom: Caribou Digital Publishing. Retrieved from https://www.cariboudigital.net/wp-content/uploads/2019/01/Caribou-Digital-DFID-Digital-Access-in-Africa.pdf

Governments also craft regulations to protect users from bad actors. One such policy—*Regulation of illegal content*—is expected to have a positive effect on the user experiences of historically marginalized populations. Data protection, media fact checking, and removal of content that is either defamatory or posted without consent remove risk of engaging with the internet.[136] The explicit affirmation by governments to pursue these initiatives can promote trust among those who have reasonable fears about engaging online. To be effective, however, these regulations require significant government commitment and sufficient IT resources to enable timely monitoring and removal of illegal content.

A number of countries have proposed *data localization policies* as a way to increase the privacy and security of user data. These policies require that citizens' data be stored and processed within the country's borders and places those data under national regulation.[137] Despite the fact that data privacy and security is a growing concern worthy of government attention, these policies are often described as having unintentional, negative impacts. Powerful governments may find it easier to access citizen data stored on servers inside the country, increasing the risk of online activity for marginalized populations.[138] Further, many countries do not have the necessary infrastructure to store and process data, increasing the cost of doing international business.[139]

When crafting policy solutions to close the digital divide, policymakers should consider the impact that a policy may have on a given population and/or market, the proportion of the population that is connected, and the capacity of government entities to implement and/or enforce the policy over time.

Business model innovations center on creative pricing approaches, joint management, and inclusive supply chains.

Business models need to be able to overcome technical shortcomings and effectively reach users to bridge the digital divide. There are multiple stages across the value chain where innovation can occur, ranging from infrastructure sharing agreements between ISPs to gender-intentional distribution models. The list of business models below offers a window into the broad array of approaches being used to overcome the barriers to connectivity.

136 Freedom House. (2018, October). Freedom of the Net 2018. Retrieved from https://freedomhouse.org/sites/default/files/FOTN_2018_Final%20Booklet_11_1_2018.pdf

137 Pisa, M. & Polcari, J. (2019.)"Governing Big Tech's Pursuit of the "Next Billion Users"" CGD Policy Paper. Washington, DC: Center for Global Development. Retrieved from https://www.cgdev.org/publication/governing-big-techs-pursuit-next-billion-users

138 Bowman, C. (2017, January 6). Data Localization laws: an Emerging Global Trend. Jurist. Retrieved from https://www.jurist.org/commentary/2017/01/Courtney-Bowman-data-localization

139 Pisa, M. & Polcari, J. (2019.)"Governing Big Tech's Pursuit of the "Next Billion Users"" CGD Policy Paper. Washington, DC: Center for Global Development. Retrieved from https://www.cgdev.org/publication/governing-big-techs-pursuit-next-billion-users

Business models are reducing operations costs, varying price structures, and attempting to provide local and desirable content.

APPROACH	DESCRIPTION	ADVANTAGES	DRAWBACKS
Action-based payment models	Pricing structure in which companies provide vouchers for limited internet access after consumers fulfill some task, such as responding to surveys or purchasing select consumer goods	• Increases access by bundling connectivity with regularly purchased goods • Reduces cost for user	• Relies on strong partnerships • May not reach the unconnected or very poor • Insufficient evidence of effectiveness[140]
Community / cooperative networks	Small local wireless networks created and managed by communities, often using Wi-Fi and off-the-shelf technology	• Serve users unreached by other ISPs • Reduces cost for users	• Financing these networks can be a challenge.[141,142] • Requires high level of community commitment and coordination
Local content platforms	Open-source platforms that ease ability to post and engage	• Allows communities to post in their own language	• Assumes technical capacity is locally available • Requires a portion of the community to be already online
Incremental pricing models	Bundled internet service offerings that provide options for users of different income levels	• Increases equity by providing options for low-income individuals • Could enable purchase of more desirable phones[143]	• Relies on established backhaul
Local distribution models	Targeted recruitment and hiring community members to extend reach further into communities and reduce the risk of entry	• Increases community buy-in • More inclusive distribution[144] • Amenable to gender-intentional design	• Requires time and effort to recruit and train local community members

140 World Bank. (2018, December). Digital Development Partnership: Innovative Business Models for Expanding Fiber-Optic Networks and Closing the Access Gaps. Retrieved from http://documents.worldbank.org/curated/en/674601544534500678/pdf/132845-7-12-2018-17-20-11-InnovativeBusinessModels.pdf

141 World Bank. (2018, December). Digital Development Partnership: Innovative Business Models for Expanding Fiber-Optic Networks and Closing the Access Gaps. Retrieved from http://documents.worldbank.org/curated/en/674601544534500678/pdf/132845-7-12-2018-17-20-11-InnovativeBusinessModels.pdf

142 USAID, Caribou Digital, and DIAL. (2017, Feb). Closing the Access Gap: Innovation to Accelerate Universal Internet Adoption. Retrieved from https://www.usaid.gov/sites/default/files/documents/15396/Closing-the-Access-Gap.pdf

143 Schmida, S., WIlliams, I., & Lovegrove, C. (2016, April). Business Models for The Last Billion: Market Approaches to Increasing Internet Connectivity. USAID from the American People. Retrieved from https://mstarproject.files.wordpress.com/2016/05/business-models-for-the-last-billion.pdf

144 Caribou Digital. (2016). Digital Access in Africa. Farnham, Surrey, United Kingdom: Caribou Digital Publishing. Retrieved from https://www.cariboudigital.net/wp-content/uploads/2019/01/Caribou-Digital-DFID-Digital-Access-in-Africa.pdf

APPROACH	DESCRIPTION	ADVANTAGES	DRAWBACKS
Passive site sharing	Partnership between MNOs to share passive infrastructure, particularly towers	• Expands coverage footprint • Reduces costs to users and providers • Increases market competition	• Incumbents may resist calls to share with competitors
Zero rating	Private-sector subsidized access to specific online content	• Often deployed where internet has not been present • Provides opportunity for users to assess value of connectivity	• Does not support competitive marketplace • Presents issues around freedom of internet • Often does not support local content provision

Businesses are attempting to expand the coverage footprint and to establish practices that reduce cost of operation and management. *Community / cooperative networks* are one mechanism for achieving both goals. These small, locally-owned and locally-operated networks often provide service where other connectivity options are scarce or non-existent. Populations usually pool financial resources to fund infrastructure installation with some help from philanthropic donors. Since they are designed by the receiving communities, services tend to be more tailored to local needs and contexts. For example, many communities begin with basic voice services and 2G connectivity to ensure a baseline level of access. These networks typically adopt low-cost technology options to increase affordability. However, this preference for less expensive solutions can limit their ability to scale and expand given that low-cost technology often means low-power and a limited carrying capacity.[146] Furthermore, this approach requires some level of technical capacity within the community in order to administer the network sustainably over time.

Local distribution models hire community members to participate in distribution and marketing activities as a way to establish greater reach and trust from the community. Those employed by these programs reach out to other community members to encourage adoption. Some work in specific physical locations while others travel within the community to try to increase uptake. This model requires some investment in training but takes advantage of existing relationships among community members. This model is well-positioned to address issues of equity, as recruiting women or minorities may increase trust among populations who are may be skeptical.

Passive site sharing refers to the joint use of passive infrastructure (e.g., mobile towers) between service providers to save costs. Unlike local loop bundling mandated by regulators, this management model is more likely to emerge voluntarily among providers in places with more mature

145 Alliance for Affordable Access. (2018). The 2018 Affordability Report. Retrieved from https://a4ai.org/just-released-2018-affordability-report/

146 World Bank. (2018, December). Digital Development Partnership: Innovative Business Models for Expanding Fiber-Optic Networks and Closing the Access Gaps. Retrieved from http://documents.worldbank.org/curated/en/674601544534500678/pdf/132845-7-12-2018-17-20-11-InnovativeBusinessModels.pdf

markets and infrastructure.[147] Management of passive site sharing can occur through either a joint operations agreement between two providers or with the assistance of a specialized third party who can operate the infrastructure on the partners' behalf.

Businesses are also experimenting with creative pricing structures. *Action-based payment models* aim to reduce risk for consumers by providing vouchers for access after the consumer completes a task, such as filling out a survey or purchasing consumer goods.[148] Though largely untested, this approach likely works best when the vouchers offered align with the type of connectivity already popular in a given population, such as minutes redeemable at a local hot-spot or on a mobile subscription plan. This bundled approach may more effective when combined with consumer goods that are ubiquitous and necessary, particularly if the form of access provided is easy to use. Potential risks include the possibility that poor individuals and communities would still be unable to redeem this type of access if they do not own a Wi-Fi enabled device. There is also a possibility that this model's reliance on access provided through a physical hot-spot would alienate remote populations.

Incremental pricing models refer to approaches that vary payment prices based on a user's income level.[149] Most common with mobile data plans, these models allow consumers to choose from a set of prepaid subscription options. This approach has particular promise in urban areas, where mobile can be coupled with Wi-Fi to offset the need for data. For the providers, this approach requires a certain level of existing infrastructure.

Business model innovations can also support the production and distribution of relevant content, which is difficult to find in many LMICs. One approach, *local content platforms,* makes it easy to interact and share content online. These open-source platforms allow for easier posting of locally pertinent content is available in more languages. This model builds on lessons learned from the early days of the internet, when tools that made content creation more accessible also helped users find communities, information, and resources of value to their lives. Given that more recent internet adopters tend to rely on mobile access, platforms that support content creation on mobile devices an effective approach.

Zero rating services provide access to a limited set of content for a reduced cost or for free in order to demonstrate the value of the internet to those who believe it to be unaffordable.[150] These services are usually funded by the private sector and take one of three main forms: limited packs,

147 World Bank. (2018, December). Digital Development Partnership: Innovative Business Models for Expanding Fiber-Optic Networks and Closing the Access Gaps. Retrieved from http://documents.worldbank.org/curated/en/674601544534500678/pdf/132845-7-12-2018-17-20-11-InnovativeBusinessModels.pdf

148 World Bank. (2018, December). Digital Development Partnership: Innovative Business Models for Expanding Fiber-Optic Networks and Closing the Access Gaps. Retrieved from http://documents.worldbank.org/curated/en/674601544534500678/pdf/132845-7-12-2018-17-20-11-InnovativeBusinessModels.pdf

149 World Bank. (2018, December). Digital Development Partnership: Innovative Business Models for Expanding Fiber-Optic Networks and Closing the Access Gaps. Retrieved from http://documents.worldbank.org/curated/en/674601544534500678/pdf/132845-7-12-2018-17-20-11-InnovativeBusinessModels.pdf

150 Surman, M., Gardner, C., & Ascher, D. (2014). Local Content, Smartphones, and Digital Inclusion. Innovations: Technology, Governance, Globalization, 9(3-4), 63-74. Retrieved from https://www.mitpressjournals.org/doi/abs/10.1162/inov_a_00217

free walled-garden, or unmetered.[151] Limited packs offer reduced prices for certain online content, while free walled-garden makes certain websites accessible at no charge even if the user doesn't have a data subscription. Unmetered refers to online content that does not count against a user's monthly data limit.[152] User research has raised questions about the value of these models by demonstrating that less-experienced and lower-income individuals prefer unfettered access to the internet, have hesitations about the complexity of billing practices under this model, and generally distrust such approaches.[153] Concerns about net neutrality and free speech online have also factored into the negative responses to this model.[154]

These examples illustrate the myriad ways businesses are trying to respond to the problem of the digital divide. However, the success of these models is largely determined by companies' understanding of local needs and their ability to operate within national regulations.

Coordination across technology, policy and business models can increase the likelihood of meaningful impact.

Each of the technology, policy, and business model components outlined above can help expand internet connectivity but it is unlikely that any one element will be able to achieve sufficient success on its own. As such, communities would do well to take a holistic approach that considers how different domains complement each other to increase equitable access. That said, coordination of effort alone may not be sufficient to address the challenges communities face. Example combinations presented below illustrate how integrated action can expand (or in some cases hinder) equitable access to connectivity. These examples include both real-life examples as well as hypothetical combinations.

151 Caribou Digital. (2016). Digital Access in Africa. Farnham, Surrey, United Kingdom: Caribou Digital Publishing. Retrieved from https://www.cariboudigital.net/wp-content/uploads/2019/01/Caribou-Digital-DFID-Digital-Access-in-Africa.pdf

152 Caribou Digital. (2016). Digital Access in Africa. Farnham, Surrey, United Kingdom: Caribou Digital Publishing. Retrieved from https://www.cariboudigital.net/wp-content/uploads/2019/01/Caribou-Digital-DFID-Digital-Access-in-Africa.pdf

153 Caribou Digital. (2016). Digital Access in Africa. Farnham, Surrey, United Kingdom: Caribou Digital Publishing. Retrieved from https://www.cariboudigital.net/wp-content/uploads/2019/01/Caribou-Digital-DFID-Digital-Access-in-Africa.pdf

154 World Economic Forum. (2017). Internet for All: An Investment Framework for Digital Adoption. In World Economic Forum. Retrieved from http://www3.weforum.org/docs/White_Paper_Internet_for_All_Investment_Framework_Digital_Adoption_2017.pdf

Universal service funds + Local content platforms =Increased value

Relevant content is essential for maintaining engagement with new users but is often difficult to finance sustainably. This combination addresses this challenge by using funds collected by USFs to support the creation and management of local content platforms. Providing start-up capital to local entrepreneurs or groups to develop locally relevant content could provide greater value to users and increase the representation of multiple languages online. Given that the problem of local content is particularly acute for women globally, this combination may also offer opportunities to help reduce the online gender disparity.

Critiques of USFs focus on the approach's funding mechanism and structure. Under a USF, ISPs and MNOs bear the financial burden. Lack of transparency in fund disbursements can exacerbate mistrust of USFs, as do strategies that treat USF funds as part of the national budget rather than a designated funding source for service expansion efforts. Prioritizing transparency in operations, such as a public bidding process and/or publicly available financial reports can help mitigate these concerns[155]

Another challenge stems from the nature of local content platforms, which can be difficult to develop and sustain where connectivity is low quality or unreliable and/or where digital literacy skills are low in a population. There is also a need for discoverability, distribution, and monetization for content creators, which is nearly impossible in app store models managed by large tech companies.[156]

EXAMPLES

Ms. Geek Africa, Rwanda

This Rwandan USF supports a competition run by Girls in ICT Rwanda, a local organization that supports girls' engagement in STEM. In this program young women create tech-based solutions to pressing challenges in Africa. Programs like this contribute to creating a vibrant and diverse local tech sector while also promoting digital literacy and innovation. Whether or not these efforts translate to gender equity in employment in the local tech sector is yet to be determined.[157]

Digital For Inclusion, Ghana

The Ghana Investment Fund for Electronic Communications supports mobile financial services via a digital payment platform that emphasizes gender inclusivity. In this program, 60% of the local service sales agent positions are reserved for women, which creates jobs for women and also addresses challenges related to area gender norms, which can make women less comfortable interacting with male agents.[158]

MyMaker, Malaysia

This Malaysian USF program encourages the development of skills for creating IoT innovations. This program provides a hosted server and platform, called myMaker.io, for use by students, researchers, and start-ups.[159]

155 World Economic Forum. (2016). Internet for All: A Framework for Accelerating Internet Access and Adoption. In World Economic Forum. Retrieved from https://www.weforum.org/reports/internet-for-all-a-framework-for-accelerating-internet-access-and-adoption

156 Caribou Digital. (2016). Digital Access in Africa. Farnham, Surrey, United Kingdom: Caribou Digital Publishing. Retrieved from https://www.cariboudigital.net/wp-content/uploads/2019/01/Caribou-Digital-DFID-Digital-Access-in-Africa.pdf

157 Thakur, D. and Potter, L. (2018) Universal Service and Access Funds: An Untapped Resource to Close the Gender Digital Divide. Washington DC: Web Foundation. Retrieved from https://webfoundation.org/docs/2018/03/Using-USAFs-to-Close-the-Gender-Digital-Divide-in-Africa.pdf

158 Thakur, D. and Potter, L. (2018) Universal Service and Access Funds: An Untapped Resource to Close the Gender Digital Divide. Washington DC: Web Foundation. Retrieved from https://webfoundation.org/docs/2018/03/Using-USAFs-to-Close-the-Gender-Digital-Divide-in-Africa.pdf

159 Digital Lifestyle Malaysia. (2019, August 15). myMaker.io. Retrieved from https://dlm.skmm.gov.my/myMaker/myMaker-io.aspx

Infrastructure sharing + Dig once policies = Effective infrastructure expansion

Adopting dig once policies and infrastructure sharing in tandem can maximize efficiencies for both existing and planned infrastructure. Strategic reuse and/or advanced planning for future infrastructure deployment can reduce the level of investment needs, which in turn often results in savings for consumers. This combination is a cost-effective way to reduce private-sector capital costs, incentivize service provision in new areas, and encourage competition among providers. By lowering barriers to entry, this approach can increase market competition, which ideally leads to lower costs and larger coverage footprints for users. Key elements for success include collaboration between the public and private sectors, extensive planning and coordination among all stakeholders involved. A focus on areas where users live just outside the coverage footprint offers a strategic way to expand access, provided that outreach activities occur after infrastructure becoming operational.

Because these policies require public-private partnership, they are best suited for contexts where some infrastructure already exists and new infrastructure investments are being planned. The high level of coordination required across government entities and providers can prove a barrier for some communities. In addition, feasibility studies may need to be conducted with utilities to ensure that projected cost savings from infrastructure sharing will be worth the extra effort. Meanwhile, dig once policies should be strongly informed by input from providers and the public in order to make sure that such policies do not deter future investment in needed connectivity infrastructure.

EXAMPLES

Claro and Vivo, Brazil

In 2013, these two mobile operators entered into a network sharing agreement for rural areas. A regional split in spectrum licence that had been previously established by regulators guided the subdivision of the geography, with each operator deploying and operating half of the sites involved, following. This approach allowed the MNOs to focus their infrastructure development and maintenance efforts in smaller units and increase their operational efficiency. Governments were pleased with the accelerated provision of mobile services and increased market competition, while providers saved operating costs related to coverage obligations. Today, the shared network of Claro and Vivo covers 5.6 million people living in rural areas.[160]

Andhra Pradesh, India

This state established over 2,000 sites using existing electrical poles to extend internet service to rural areas, where 70% of the states' 50 million residents reside. This plan was executed in nine months for approximately $50M, with more than 90% of the existing local operators in the state partnering with the government to integrate their networks and bundle services. Area residents can get data, TV, and phone services for approx imately $2 per month per household or $14 per month per office.[161]

160 Buckell, M. & Liberatore, F. (2018). Enabling Rural Coverage: Regulatory and policy recommendations to foster mobile broadband coverage in developing countries. GSMA. Retrieved from https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2018/02/Enabling_Rural_Coverage_English_February_2018.pdf

161 World Economic Forum. (2017). Internet for All: An Investment Framework for Digital Adoption. In World Economic Forum. Retrieved from http://www3.weforum.org/docs/White_Paper_Internet_for_All_Investment_Framework_Digital_Adoption_2017.pdf

Wi-Fi mesh networks + Community / cooperative networks = Affordable access

This combination often arises where service has not been offered by major providers. A cooperative model allows users to have a say in what services are offered and in many cases also includes free in-network voice calls as a way to prove the value of mobile service to new users. Community/cooperative models often adopt Wi-Fi mesh network technology due to its low cost and ease of implementation. The decentralized structure of mesh networks provides resilience to outages. This approach could be compelling in contexts where government outages are common if presented as a way to reduce risk for potential users.

This combination is most likely to be effective where there is a pre-existing level of technical capacity and community organization. Although hardware can be off-the-shelf, a software management system is needed to ensure long-term sustainability.[162] Individuals need to be trained to operate and maintain the network, adding to operational costs. An inherent limitation of mesh networks is the lack of node mobility, which typically means that users must stay in a single building in order to maintain a connection. Device affordability is not addressed through this combination, which may pose a problem given that Wi-Fi-enabled mobile devices tend to be more expensive. Finally, regulatory environments should be supportive of license-free spectrum use to support the possibility of scaling up networks.[163]

EXAMPLES

Village Telco, South Africa

Mesh 2G network model that allows for free local calls within Johannesburg that is designed to be easily installed with limited technical knowledge. Many projects are small, with a range of 10-100 service points. This limits capacity without accompanying technology, which itself requires greater technical training to install. As of 2017, Village Telco has sold approximately 6,000 devices.[164]

Rhizomatica, Mexico

This non-profit model incorporates community design into every aspect of local 2G network development, including issues such as ownership and administration. While relatively inexpensive, infrastructure installation and personnel training costs the community approximately $10,000. Once the network is installed, local government administers the network. The use of open source software reduces cost as well. Membership fees are fixed at $3 per month, which entitles members to free unlimited calls within the Rhizomatica network. While this approach has worked well in some regions, rural communities (those smaller than 5,000) have had trouble accessing basic cell service and many individuals report having to travel to access connectivity.[165]

162 USAID, Caribou Digital, and DIAL. (2017, Feb). Closing the Access Gap: Innovation to Accelerate Universal Internet Adoption. Retrieved from https://www.usaid.gov/sites/default/files/documents/15396/Closing-the-Access-Gap.pdf

163 USAID, Caribou Digital, and DIAL. (2017, Feb). Closing the Access Gap: Innovation to Accelerate Universal Internet Adoption. Retrieved from https://www.usaid.gov/sites/default/files/documents/15396/Closing-the-Access-Gap.pdf

164 USAID, Caribou Digital, and DIAL. (2017, Feb). Closing the Access Gap: Innovation to Accelerate Universal Internet Adoption. Retrieved from https://www.usaid.gov/sites/default/files/documents/15396/Closing-the-Access-Gap.pdf

165 USAID, Caribou Digital, and DIAL. (2017, Feb). Closing the Access Gap: Innovation to Accelerate Universal Internet Adoption. Retrieved from https://www.usaid.gov/sites/default/files/documents/15396/Closing-the-Access-Gap.pdf

TVWS
+ Digital dividend spectrum band policy
= Rural connectivity

This combination is intended to provide security and reduce risks for actors who develop business models that use TVWS. The unused analog broadcasting channels that comprise TVWS can travel long distances, which makes them an ideal solution when remote connectivity is needed. However, using license-free spectrum limits the power available and the ability of connectivity to expand effectively to avoid interference with licensed bands. As a result,small businesses must choose between purchasing a spectrum license to gain sufficient technical power or trying to use TVWS in areas where its deployment may not be formally recognized or regulated. The former option is often beyond the budgets of small entities, while the latter entails serious risk around interfering with licensed bands of large providers. Policymakers can take steps to formalize the use of TVWS, which would eliminate a large start-up license cost and reduce risk for small providers.

Drawbacks to this approach center on government capacity to develop, implement, and enforce effective regulations. Protections are needed for incumbents, which requires evaluation studies to determine the impacts of signal interference.[166] In addition, some level of technical capacity is needed to install and operate the geolocation database that lets regulators identify which channels are available to interested parties. An additional component not addressed by this combination involves ensuring that equipment for both suppliers and consumers is able to pick up TVWS signals for connectivity purposes.[167]

EXAMPLES

ARECOM / INCM, Mozambique

The Mozambique Communications Regulatory Authority (ARECOM, or INCM) recently approved regulations allowing for the dynamic allocation and management of TVWS in the 470-694 MHz bands.[168] This action came out of several successful field trials of TVWS dating back to 2015. Extensive collaboration with the Dynamic Spectrum Alliance to develop regulatory frameworks that enable quick deployments[169] and provide confidence to investors have proved crucial to this effort.[170]

Citizen Connect, Namibia

Citizen Connect is a joint pilot project of My Digital Bridge Foundation and Microsoft that uses TVWS to provide broadband access to rural communities. Although this effort successfully provided connectivity to 27 schools and 7 offices in the Ministry of Education, nationwide rollout did not occur due to an unsupportive regulatory environment and insufficient planning for long-term funding.[171]

166 ITU. (2017). Evolving spectrum management tools to support development needs: 6th Study Period 2014-2017. Final Report. Retrieved from https://www.itu.int/dms_pub/itu-d/opb/stg/D-STG-SG01.RES09.2-2017-PDF-E.pdf

167 ITU. (2017). Evolving spectrum management tools to support development needs: 6th Study Period 2014-2017. Final Report. Retrieved from https://www.itu.int/dms_pub/itu-d/opb/stg/D-STG-SG01.RES09.2-2017-PDF-E.pdf

168 Telecompaper. (2019, August 8). Mozambique approves TVWS spectrum rules. Retrieved from https://www.telecompaper.com/news/mozambique-approves-tvws-spectrum-rules--1303959

169 ITWeb. (2018, September 14). TV white spaces seen as answer to Africa's connectivity woes. Retrieved from https://www.itweb.co.za/content/nWJadvb8m58MbjO1

170 Song, S. (2018). Dynamic Spectrum in Africa in 2018. Many Possibilities Blog. Retrieved from https://manypossibilities.net/2018/05/dynamic-spectrum-in-africa-in-2018/

171 1WorldConnected. (n.d.). Case study: Namibia TV White Space Pilot Project. Retrieved from http://1worldconnected.org/case-study/namibia-tv-white-space-pilot-project/?_sft_region=africa&sf_paged=2

LEOs
+ Government data commitment
= Alternative backhaul

LEOs have been gaining traction in the news as a potential alternative form of backhaul or last-mile service. They are resilient during natural disasters and can support efforts to address significant humanitarian needs during crises. There are various suggested approaches to this combination. In some cases, base stations could be installed to serve entire communities. Other cases would require individual households install antennas.[172] Antenna installation is a relatively affordable and straightforward process for households seeking service.[173] LEOs could be paired with a government data consumption commitment in order to secure initial capital required to launch a LEO satellite constellation. Partnership with philanthropic entities could further extend the benefits of this combination by providing funds to explore viability of LEOs in providing stable connectivity where other options have proven cost-prohibitive. If successful constellations can be established, providers could use LEOs to improve their quality of service.

A significant barrier to proof of concept stems from the high cost of launching constellations. In addition to early-stage funding to evaluate feasibility, providers also need to consider the expense of establishing relationships with potential users. LEOs would first start as an alternative backhaul to other pre-existing forms, such as fiber-optic or copper cables, and would have limited initial impact in reaching those who are not yet connected. Partnerships with existing providers to utilize satellites as an alternative backhaul is the best way to access a sufficiently large customer base, but would also create a dependency on these providers to scale operations further.[174]

EXAMPLES

Pale Blue Group (PBG), UK

PBG seeks to establish a low-earth orbit satellite constellation that would provide connectivity when fiber backhaul installation is cost-prohibitive. While still in the proof-of-concept phase, part of this strategy involves connecting to existing community Wi-Fi networks to determine which local services could be cached on a local server to provide both greater reliability in connection.[175]

Ubiquitilink, UK

Ubiquitilink aims to establish coverage that will directly connect to mobile phones rather than relying on transmitters When the complete constellation is launched, coverage would be continuous across the globe. Value to the user would come from a satellite-based messaging capability, starting with basic SMS messages. One deployment opportunity is with humanitarian relief efforts, where coverage could supplement damaged terrestrial networks after natural disasters.[176]

172 World Bank. (2018, December). Digital Development Partnership: Innovative Business Models for Expanding Fiber-Optic Networks and Closing the Access Gaps. Retrieved from http://documents.worldbank.org/curated/en/674601544534500678/pdf/132845-7-12-2018-17-20-11-InnovativeBusinessModels.pdf

173 Connecting the Next Four Billion: Strengthening the Global Response for Universal Internet Access

174 Caribou Digital. (2016). Digital Access in Africa. Farnham, Surrey, United Kingdom: Caribou Digital Publishing. Retrieved from https://www.cariboudigital.net/wp-content/uploads/2019/01/Caribou-Digital-DFID-Digital-Access-in-Africa.pdf

175 Interview: Dominic Vergine, April 30, 2019

176 Interview: Martin Harris, April 16, 2019

Zero rating + Free public Wi-Fi = Accessible content

This combination attempts to address the problems of affordability, unclear value and digital literacy. Providers curate content in partnership with either large tech firms or content creators and governments then give users access to this curated content via hotspot. Large tech firms can design applications that work within this limited infrastructure, subsidize the cost of provision, or both.[177] Benefits for providers would include opportunities to introduce new service offerings and expand their user base. Zero rating offers a way to help users escape the metered mindset so that they can explore curated content free from concern of data overages and hidden costs.[178]

This combination would require significant planning and coordination across content creators, service providers, and governments. Lengthy negotiations disadvantage local businesses who cannot spend significant time and money advocating to have their content included.[179] For users, this combination also carries considerable equity concerns. Public hotspots often require travel, disadvantaging elderly and disabled populations. In countries with more restrictive gender norms, women can have additional concerns about their safety when using technology in public. There are also documented inconsistencies with user preferences. Multiple surveys have found that low-income users prefer to have no restrictions, have fears around billing practices, and are frustrated by the lack of available local content.[180,181] Importantly, zero rating could offer biased content and threaten net neutrality.[182]

EXAMPLES

Fonatel, Costa Rica

The Costa Rican telecommunications regulator, FONATEL, currently provides free Internet connectivity to 400 rural schools and is working to expand access to public spaces such as parks, libraries, and transit centers. Schools reported improvements both within the classroom and within administration functions.[183]

Wikipedia Zero, USA

Wikipedia Zero offers free access to Wikipedia in over 60 countries. To avoid common pitfalls, operating principles include no subsidization from partner operators, no bundling with other content, and no exclusive partnerships.[184] This arrangement was considerate of potential net neutrality threats, but ultimately had to shut down in 2018 due to rising costs of data and low awareness.[185]

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7. Conclusion

Bridging the digital divide will require concerted and coordinated effort across multiple stakeholders. Multidimensional and inclusive solutions are required to address issues of equity, uptake, and access. Individuals need to be able to access, afford, and use connectivity reliably. Meanwhile, providers must be able to deploy and operate infrastructure cost-effectively and governments need to protect consumers and foster a competitive marketplace for providers. Technological advancements, smart regulations, and creative business models are most effective when implemented in concert. However, proposed combinations need to be tailored to local contexts, with sufficient capacity for stakeholders to adapt solutions to fit area residents' needs.

A starting point is to understand the national context where a combination is being deployed. In areas with high rates of poverty and unconnected users, a strategic approach could include assessing the viability of expanded infrastructure for suppliers, evaluating the impacts of regulations and taxes on the market, and/or deploying public access options for users to generate demand. Key questions for regions where a coverage footprint exists but a high portion of the population remains unconnected could center on improving the affordability of ongoing service provision, the quality of the connection, and the value users perceive from being connected. Taking a holistic view of the system will allow policymakers and providers to identify which combinations are most appropriate for their own needs and where to begin investing in improvements.

Across all contexts, stakeholders should consider their role in systems-level change. The table below offers initial ideas for each actor to consider but there should be an equal emphasis on collaborating productively with all involved.

ROLE	ACTION
Public Sector	• Revamp spectrum allocation and create pricing that encourages competition and allows for license-free spectrum (e.g., TVWS) • Reduce risk for private-sector infrastructure investment • Reduce taxes on users • Establish laws around data ownership/privacy and protection from online harassment • Commit to using internet bandwidth in public institutions • Invest in digital literacy, perhaps by using USFs to ensure that equity is built in at the ground level • Provide grants for the creation of true type fonts so that more languages can be represented online • Collect data on connectivity uptake at the individual level rather than the household level in order to be more inclusive of women
Private Sector	• Partner with government infrastructure projects • Utilize TVWS (if economically viable) for rural/rough terrain communities • Allow monetization of apps available in mobile platforms • Hire female vendors to make the supply chain more inclusive of women
Donors	• Fund research on usage and data disaggregated by gender and other relevant categories • Support local content creation and availability of content in multiple languages • Coordinate efforts around the development of digital tools • Invest in infrastructure expansion


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