THE GLOBAL "LAST MILE" SOLUTION: HIGH-ALTITUDE BROADBAND INFRASTRUCTURE

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I. INTRODUCTION

High-speed Internet access, otherwise known as broadband,[1] is considered essential for partaking in the 21st-century economy; the Internet today is considered as important as road and energy infrastructure in terms of its potential to enhance socioeconomic development.[2] Broadband, a subset of telecommunications infrastructure that includes wire-based and wireless communications networks, is currently a priority in most countries aiming to bridge the "digital divide,"[3] or the phenomenon of being excluded from the information society, usually for lack of availability and affordability.[4] Well-documented in both developed and developing countries, the digital divide is undeniably global, even after factoring in the increased rates of access in developing countries to less costly wireless-based mobile broadband services,

[1] What constitutes high-speed is usually determined by individual countries and the International Telecommunication Union. In the United States, the Federal Communications Commission broadly defines broadband as high-speed Internet access that is constantly on and faster than traditional dial-up. *See* BERND HOLZNAGEL ET AL., STRATEGIES FOR RURAL BROADBAND AN ECONOMIC AND LEGAL FEASIBILITY ANALYSIS 15 (2010); *Types of Broadband Connections*, FCC (June 23, 2014), https://www.fcc.gov/general/types-broadband-connections [https://perma.cc/3BW7-U3F5].
[2] *See* HOLZNAGEL ET AL., *supra* note 1, at 7.
[3] *See* Dwayne Winseck, *The Geopolitical Economy of the Global Internet Infrastructure*, 7 J. INFO. POL'Y 228, 256–57 (2017). The number of national broadband plans has increased from 38 in 2008 to 151 in 2016. *See id.*
[4] *See* HOLZNAGEL ET AL., *supra* note 1, at 17 (noting that the term was initially used to describe the gap "between information 'haves' and 'have-nots'").

as opposed to fixed wireline services, such as DSL or fiber.[5] In 2016, the proportion of the population covered by a mobile broadband network reached eighty-four percent globally and sixty-seven percent in rural areas; LTE or faster networks covered about one half of the global population.[6] Unsurprisingly, broadband is an important item on the global agenda. The United Nation's (UN) Sustainable Development Goals (SDGs) acknowledge the importance of universal access to broadband, encouraging public and private actors alike to bridge the global digital divide by tackling Information and Communications Technology (ICT) infrastructure underdevelopment.[7]

Historically, the lack of universal access to telecommunications services was addressed nationally—via legislation that enacted pro-competitive policies in the telecommunications sector and universal service mechanisms administered by national communications agencies to spur infrastructure development in high-cost areas. These public interventions were considered warranted to address the "last mile problem," an expensive investment for telecommunications providers also referred to as the "local loop."[8] The local loop entails connecting every home to a network provider's local office and in turn, the backhaul network, which is "large-scale wireline infrastructure" that "permits interconnection between the carrier's network

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[5] *See* Andrew Perrin, *Digital Gap Between Rural and Nonrural America Persists*, PEW RESEARCH CENTER (May 31, 2019), http://www.pewresearch.org/fact-tank/2017/05/19/digital-gap-between-rural-and-nonrural-america-persists/ [https://perma.cc/AM36-SNUW]. One study notes at least a ten percent gap when comparing fixed broadband connections between rural and urban American households. *Id.* In the Least Developed Countries (LDCs), currently comprising 47 countries, an entry-level fixed-broadband subscription is about 2.6 times more expensive than an entry-level mobile-broadband subscription. *See* INT'L TELECOMM. UNION, ICT FACTS AND FIGURES 5 (July 2017), http://www.itu.int/en/ITU-D/Statistics/Documents/facts/ICTFactsFigures2017.pdf [https://perma.cc/MGE8-B9LS]; *Least Developed Countries (LDCs)*, UNITED NATIONS, https://www.un.org/development/desa/dpad/least-developed-country-category.html [https://perma.cc/XR2G-WAHC].

[6] INT'L TELECOMM. UNION, MEASURING THE INFORMATION SOCIETY REPORT 77 (2016), http://www.itu.int/en/ITU-D/Statistics/Documents/publications/misr2016/MISR2016-w4.pdf [https://perma.cc/XAY8-GJQK].

[7] *See generally*, *About the Sustainable Development Goals*, UNITED NATIONS, https://www.un.org/sustainabledevelopment/sustainable-development-goals/ [https://perma.cc/F8TC-ZL6M]. In 2015, the UN General Assembly adopted 17 SDGs as an integral part of the 2030 Agenda for Sustainable Development, and two of the SDGs relate to bridging the global digital divide. *Id.* The first applicable SDG is 9, focusing on infrastructure, industrialization, and innovation. The other SDG that aims to bridge the technological divide is 17, emphasizing the strengthening of global partnerships for sustainable development. *Id.; see also infra* Part IV.A.

[8] *See* Krishna Jayakar, *Universal Service*, *in* . . . AND COMMUNICATIONS FOR ALL: A POLICY AGENDA FOR A NEW ADMINISTRATION 181, 194 (Amit M. Schejter ed., 2009).

and other networks."[9] For a local loop project to be financially viable, the prospective revenues must be greater than the costs, making population density a crucial factor in infrastructure provision.[10] Faced with chronic underprovision in rural areas, extending communications networks to the last mile historically required public intervention and continues to do so today.

Although pro-competitive policies and universal service mechanisms boosted communications infrastructure deployment worldwide, the broadband access gap persists in many countries. Today, telecommunications providers are especially leery of investing in networks in the developing world where "most governments lack the financial resources on their own to make the diffusion of the Internet a major priority."[11] On a global scale, this makes rural communities in the developing world the ultimate last mile. Nevertheless, the last mile problem has motivated some private actors to innovate, hoping to take advantage of the tremendous opportunity to serve unreached markets. With national interventions falling short, some companies are unintentionally following the SDGs; many non-traditional "telecommunications" companies are deploying innovative broadband infrastructure to blanket the globe with high-altitude connectivity. Loon (Google's sister company), Facebook, and satellite companies like SpaceX have announced connectivity agendas and broadband infrastructure projects, which include the development of potentially disruptive satellite and telecommunications infrastructure—namely, Internet-beaming balloons, drones, and low Earth orbit (LEO) satellite mega-constellations.[12]

Besides the promise of new markets and additional profits, it is important to inquire about the ethos underpinning the companies' connectivity infrastructure projects. How should the impact of such projects, which purport to solve the lack of worldwide connectivity, be measured? When extending Internet access to billions in rural and remote areas of the world, the companies with connectivity agendas often assume that broadband infrastructure will lead

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[9] BRETT M. FRISCHMANN, INFRASTRUCTURE: THE SOCIAL VALUE OF SHARED RESOURCES 212–13 (2012) [hereinafter FRISCHMANN, INFRASTRUCTURE] ("Backhaul is a large-scale wireline infrastructure that functions similar to interexchange networks [for wired telephony], and even arterial highways in the transportation infrastructure. It permits interconnection between the carrier's network and other networks (including other wireless carriers or the Internet)."); *see also* Marvin Ammori, *Competition and Investment in Wireline Broadband*, *in* . . . AND COMMUNICATIONS FOR ALL: A POLICY AGENDA FOR A NEW ADMINISTRATION 85 (Amit M. Schejter ed., 2009).

[10] *See* JIM W. HALL ET AL., THE FUTURE OF NATIONAL INFRASTRUCTURE: A SYSTEM-OF-SYSTEMS APPROACH 181 (2016) [hereinafter HALL ET AL., THE FUTURE OF NATIONAL INFRASTRUCTURE].

[11] Geoffrey S. Kirkman, *Out of the Labs and Into the Developing World: Using Appropriate Technologies to Promote Truly Global Internet Diffusion*, 2 J. HUM. DEV. 194 (2001).

[12] *See* Section III.A, *infra*.

to a number of positive developments.[13] Although socioeconomic development is typically the goal for most infrastructure investment, it should not be deemed a natural byproduct of broadband infrastructure deployment. As such, this Article cautions against the "build it and they will come" approach employed by many technology enthusiasts and techno-solutionists—who may enter emerging markets often unaware of the challenges of implementing technology in developing countries.[14] There are limitations to technocratic approaches and solutions to long-standing economic and development problems. Instead of tackling the engineering challenges first, regulatory and market strategies second, and development outcomes last, this Article recommends incorporating Amartya Sen's capability approach from the outset to anticipate and measure the potential development impact of newly available connectivity infrastructure. By sharpening the focus from potential macro- to micro-level considerations, the capability approach may alert connectivity companies to how technology may positively and negatively impact individuals' lives and substantive freedom—and prompt collaboration with existing development actors in this space to mitigate negative impacts.

This Article is organized as follows. Part II explains the reasons for communications infrastructure underdevelopment historically, taking into account the myriad ways governments, usually through national universal service mechanisms, have attempted to correct the underprovision and

[13] ERIC SCHMIDT & JARED COHEN, THE NEW DIGITAL AGE: TRANSFORMING NATIONS, BUSINESSES, AND OUR LIVES 5 (2014). With rising connectivity and the spread of new technology, Google executives believe the future will "help reallocate the concentration of power away from states and institutions and transfer it to individuals." Besides political empowerment, connectivity is believed to yield social and economic empowerment. *See id.*; *see also* Part IV, *infra*.

[14] Such tech-solutionism and optimism have been the cause of much consternation; Silicon Valley's ability to "save the world" has been a matter of debate. *See, e.g.,*Jason Henry, *Hey Silicon Valley, John Kerry Wants You to Help Save the World*, WIRED (Nov. 1, 2016), https://www.wired.com/2016/11/hey-silicon-valley-john-kerry-wants-help-save-world/ [https://perma.cc/3P9E-Q9UZ]; Charles Kenny & Justin Sandefur, *Can Silicon Valley Save the World?*, FOREIGN POL'Y (June 24, 2013), https://foreignpolicy.com/2013/06/24/can-silicon-valley-save-the-world/ [https://perma.cc/TDG6-T7NM]; Kevin Maney, *Why the World Hates Silicon Valley*, NEWSWEEK (June 9, 2016), https://www.newsweek.com/2016/06/17/silicon-valley-takeover-468182.html [https://perma.cc/GS7K-8L9J]; Pankaj Mishra, *Can Silicon Valley Save the World?*, BLOOMBERG (Sept. 29, 2015), https://www.bloomberg.com/opinion/articles/2015-09-30/silicon-valley-can-t-save-the-developing-world [https://perma.cc/L9RP-UNQZ]; *Is Silicon Valley Saving the World or Just Making Money?*, N.Y. TIMES (July 22, 2015), https://www.nytimes.com/roomfordebate/2015/07/22/is-silicon-valley-saving-the-world-or-just-making-money [https://perma.cc/R2UT-5999]; Claire Cain Miller, *Can Technology Save the World? Experts Disagree*, N.Y. TIMES, (May 2, 2014), https://www.nytimes.com/2014/05/03/upshot/can-technology-save-the-world-experts-disagree.html [https://perma.cc/NBZ2-NZLR].

positing why this opportunity to create global broadband infrastructure has surfaced. In essence, this portion of the paper explains the last mile problem that innovative infrastructure projects purport to solve. Part III then describes the broadband infrastructure projects, the consequences of multi-jurisdictional regulatory complexities for bringing the projects to market, and the disruptive potential of the infrastructure to change the economics of broadband access and provision. Lastly, Part IV considers whether the companies are indeed solving the last mile problem beyond mere provision. Accordingly, the potential impacts of Internet access are surveyed using Amartya Sen's capability approach, which seeks to place the individual and his or her freedom at the center of development.

II. HISTORICAL SOLUTIONS TO THE LAST MILE PROBLEM

Encouraging private investment in infrastructure is no small feat when taking into account the economics of infrastructure financing. Although there is no separate field of infrastructure study or settled definitions of infrastructure,[15] the term generally brings to mind large-scale physical resources, usually developed for public consumption.[16] Many infrastructure resources have a similar cost structure, entailing high fixed costs of initial production but low and decreasing marginal costs for each additional use.[17] Fixed costs for infrastructure services are significant, needing to be spread among a large number of consumers for the investment to be deemed profitable and worthwhile.[18] Duplicating resources in some infrastructure sectors is inefficient, leading to the market being supplied by the one firm that

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[15] *See* HALL ET AL., THE FUTURE OF NATIONAL INFRASTRUCTURE, *supra* note 10, at 4 ("[A]nalysis of infrastructure . . . is complicated by the absence of a single comprehensive, functional and practical definition of infrastructure.").

[16] *See* FRISCHMANN, INFRASTRUCTURE, *supra* note 9, at 3.

[17] *See* Jerry A. Hausman, *Valuing the Effect of Regulation on New Services in Telecommunications*, BROOKINGS PAPERS ON ECON. ACTIVITY, 1997, at 27 (discussing implications of prices being set at marginal cost); R. S. Khemani & D. M. Shapiro, OECD, GLOSSARY OF INDUSTRIAL ORGANISATION ECONOMICS AND COMPETITION LAW 62 (1993) [hereinafter OECD GLOSSARY], http://www.oecd.org/regreform/sectors/2376087.pdf ("[N]atural monopolies are characterized by steeply declining long-run average and marginal-cost curves such that there is room for only one firm to fully exploit available economies of scale and supply the market.") [https://perma.cc/8JAA-V8V8].

[18] *See* Brett M. Frischmann, *An Economic Theory of Infrastructure and Commons Management*, 89 MINN. L. REV. 946–47, n. 104 (2005) [hereinafter Frischmann, *Economic Theory of Infrastructure*].

has achieved economies of scale.[19] Such natural monopolies commonly exist in industries relating to public consumption, such as energy, transportation, and telecommunications.[20]

The above holds true for telecommunications infrastructure in both developed and developing countries. For many years, economists treated telephone networks as a token example of natural monopolies: telecom was a sector in which competition was unlikely due to large fixed costs, as well as decreasing average and marginal costs, resulting in economies of scale.[21] Moreover, to this day, the most expensive investment for telecommunications providers is the "local loop," or the last mile of the network that connects every home to a network provider's local office, which is connected to the backhaul network.[22] For a last mile project to be financially viable, the prospective revenues must be greater than the investment costs; in other words, the large fixed capital costs common to infrastructure resources need to be spread over many potential customers, making population density an important factor for telecom providers when considering market expansion.[23] That is why coverage gaps and insufficient infrastructure upgrades persist in low-density areas: rural markets are the least profitable.[24]

In order to increase public access to and usage of communications infrastructure and solve the last mile problem, the regulatory response in most countries has been two-fold, sometimes pursued simultaneously and other times discretely: (1) address the *market efficiency gap* using liberalization policies to enhance competition in the sector; and (2) address the *access gap* by designing financing mechanisms in compliance with universal service mandates.[25] These two gaps and corresponding regulatory responses are discussed below.

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[19] *See id.* at 929. *See also* Mariana Mota Prado, *Regulatory Choices in the Privatization of Infrastructure*, *in* PRIVATE SECURITY, PUBLIC ORDER: THE OUTSOURCING OF PUBLIC SERVICES AND ITS LIMITS 123 (Simon Chesterman & Angelina Fisher eds., 2009) (discussing rationales for competition).

[20] *See* HALL ET AL., THE FUTURE OF NATIONAL INFRASTRUCTURE, *supra* note 10, at 5 (noting infrastructure resources show characteristics of public goods); OECD GLOSSARY, *supra* note 17, at 62.

[21] *See* OECD, THE DEVELOPMENT OF FIXED BROADBAND NETWORKS, 11 (2014), http://dx.doi.org/10.1787/5jz2m5mlb1q2-en [hereinafter OECD, FIXED BROADBAND NETWORKS] [https://perma.cc/Y6T7-MS3R]. *See also* FRISCHMANN, INFRASTRUCTURE, *supra* note 9, at 213 (citing three reasons why "[t]he natural monopoly designation made sense for a while").

[22] Ammori, *supra* note 9, at 85; FRISCHMANN, INFRASTRUCTURE, *supra* note 9, at 212.

[23] *See* HALL ET AL., THE FUTURE OF NATIONAL INFRASTRUCTURE, *supra* note 10, at 181.

[24] *See id.* at 191.

[25] Luis D. Emiliani, *Universal Service and Universal Access to Telecommunications: A Review*, 36TH RES. CONF. ON COMM., INFO. & INTERNET POL'Y, 10 (Sept. 2008) (explaining the *market efficiency* gap versus the *access gap* with a chart).

Before proceeding, it is important to note that the last mile problem, and the resultant policies that attempt to solve it, historically focused on voice telephony and copper wire deployment. Nevertheless, the same principles discussed in this Part endure and are applicable to broadband infrastructure development.[26] This is because Internet access and data flow relies on the same mediums as voice telephony: cables (usually copper wire or optical fiber) and electromagnetic waves (for satellite, wireless, and mobile networks). Moreover, broadband development falls within the scope of the regulatory authority in each country that deals with telecommunications. Telecommunications regulatory agencies exercise authority over physical wired networks, as well as determine spectrum allocations required for wireless networks.[27] In other words, regulatory telecommunications agencies oversee the physical layer of communications infrastructure, which includes the Internet.

A. Addressing the Market Efficiency Gap: Liberalization in Fixed Wireline Services

During the 20th century, governments dealt with the last mile problem by requiring cross-subsidies to keep urban and rural rates equal. In 1934, instead of nationalizing the then unregulated AT&T, Congress established the Federal Communications Commission (FCC) to regulate AT&T's monopoly in exchange for universal access included in the Communications Act of 1934: "to make available, so far as possible, to all the people of the United States . . . a rapid, efficient, nationwide, and worldwide wire and radio communication service with adequate facilities at reasonable charges."[28] The term universal access then meant that "everyone gained access at a (somewhat) flat fee, regardless of his or her geographical location . . . AT&T was required to amortize connection charges across all customers."[29] In other countries, state-owned (rather than privately-owned) telecommunications companies similarly pursued cross-subsidies among rural and urban areas.[30] Eventually, governments realized that although monopolies (if regulated) could provide

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[26] *Id.* at 9 (noting convergence of services over TCP/IP, expanding the definition of universal access policies to include not only voice services but broadband Internet access).

[27] 47 U.S.C. § 151 (2018). With the passing of the Communications Act of 1934, Congress created the FCC, an independent agency with a mandate to regulate interstate communications by radio, television, wire, satellite, and cable. The name of the act was slightly changed when it was amended decades later to the *Telecommunications* Act of 1996. *Id.*

[28] *Id.*

[29] Ted G. Lewis, *Telecommunication: Critical Infrastructure Protection*, *in* COMMUNICATIONS AND INFORMATION INFRASTRUCTURE SECURITY 6 (John G. Voeller ed., 2015).

[30] Emiliani, *supra* note 25, at 13–14.

universal access, the consequence was decreased innovation and underprovision absent the incentives provided by competition.

In the last thirty years, governments have stepped in by liberalizing the telecommunications market and enforcing pro-competitive regulations.[31] In countries where telecom liberalization policies were pursued, sectoral authorities were also established to regulate the sector and "safeguard [the] public interest in the provision of these essential services."[32] The U.S. Congress, for instance, passed the Telecommunications Act of 1996 "to provide for a pro-competitive, de-regulatory national policy framework" in a market that was *already* occupied by the private sector.[33] In India and some countries in Africa the pro-competitive policies sanctioned the first move away from full state ownership, encouraging the entry of private sector operators and partially-privatized national monopolies. In India specifically, liberalization and private investment were recommended after the government realized it had insufficient resources to fulfill its universal service targets codified in the National Telecom Policy of 1994,[34] and the government pursued a strategy of "encouraging the entry of multiple Indian private sector operators with foreign partners in different regions and market segments."[35] In Kenya, the government also struggled to meet its universal service obligations under the Kenya Communication Act (KCA) of 1998, which spelled out a pathway towards liberalization. Although state-run Telkom Kenya was to hold an interim monopoly for five years, it needed the support of other regional operators to fulfill the universal service obligation spelled

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[31] Emmanuel O. Arakpogun, Roseline Wanjiru & Jason Whalley, *Impediments to the Implementation of Universal Service Funds in Africa–A Cross-Country Comparative Analysis*, 41 TELECOMM. POL'Y 617, 617–20 (2017) [hereinafter *Universal Service Funds in Africa*].

[32] Paolo Gerli, Marlies Van der Wee, Sofie Verbrugge & Jason Whalley, *The Involvement of Utilities in the Development of Broadband Infrastructure: A Comparison of EU Case Studies*, 42 TELECOMM. POL'Y 726, 727 (2018).

[33] H.R. REP. NO. 104-458, at 1 (1996) (Conf. Rep.) (noting that the legislation aimed "to accelerate rapidly private sector deployment of advanced telecommunications and information technologies and services to all Americans by opening all telecommunications markets to competition.").

[34] Krishna Jayakar & Chun Liub, *Universal Service in China and India: Legitimating the State?*, 38 TELECOMM. POL'Y 186, 191 (2014). ("With respect to universal service, the National Telecom Policy aimed to provide telephone on demand by 1997, connect all villages to the telephone network by 1997, provide a public call office (PCO) for every 500 persons in urban areas, and introduce value added services in India, on par with those available internationally.").

[35] Stephen McDowell & Jenghoon Lee, *India's Experiments in Mobile Licensing*, 27 TELECOMM. POL'Y 371, 373 (2003).

out in the UN's Millennium Development Goals and the KCA.[36]

Although some initially did not support liberalization, believing that universal service would not be sustainable in a competitive market absent cross-subsidies in monopolists' prices, it was generally agreed upon that competitive policies resulted in greater access by making services cheaper.[37] Coupled with requirements for carriers to serve underserved populations, these policies regularly increased coverage in the U.S. and other countries.[38] For instance, in Kenya, competition led some telecommunications companies to develop areas previously considered uneconomical.[39] Today, a total of 108 World Trade Organization (WTO) members have made commitments to facilitate trade in telecommunications services, and many of them have had to give up price support regimes for telecom operators and devise other methods of support.[40]

Pro-competitive policies increased coverage and brought significant changes to the once monopolized landline market, yet advances in mobile phone technologies and competition between mobile and fixed-line services

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[36] Monica Kerretts, *ICT Regulation and Policy at a Crossroads: A Case Study of the Licensing Process in Kenya*, 5 SOUTHERN AFR. J. INFO. & COMM. 49, 52 (2005); MILLENNIUM DEVELOPMENT GOALS AND BEYOND 2015, UN, http://www.un.org/millenniumgoals/global.shtml ("In cooperation with the private sector, make available benefits of new technologies, especially information and communications.") [https://perma.cc/F4NE-2S8R].

[37] *See* Carolyn Gideon & David Gabel, *Disconnecting: Understanding Decline in Universal Service*, 35 TELECOMM. POL'Y 737, 738 (2011). In India, telecommunications workers' unions and the general public opposed privatization. The promise of universal service made "privatization . . . more palatable: the National Telecom Policy explicitly stated that the newly licensed telecommunications operators would be required to maintain 'a balance in their coverage between urban and rural areas' as well as acquiesce to tariff regulation and revenue sharing arrangements." Jayakar & Liub, *supra* note 34, at 194.

[38] FCC, CONNECTING THE GLOBE: A REGULATOR'S GUIDE TO BUILDING A GLOBAL INFORMATION COMMUNITY, at i (1999) [hereinafter CONNECTING THE GLOBE], https://transition.fcc.gov/connectglobe/regguide.pdf [https://perma.cc/VU7C-T4G2]; Cristina Casanueva-Reguart, *Institutions, Telecommunications Reform, and Universal Service Policy in Mexico (1990–2014)*, 9 INT'L J. COMM. 2092, 2095 (2015) (noting that competition is now viewed as essential to the development of modern telecommunications infrastructure).

[39] Omae Malack Oteri, Langat Philip Kibet & Ndung'u Edward N., *Mobile Subscription, Penetration and Coverage Trends in Kenya's Telecommunication Sector*, 4 INT'L J. ADVANCED RES. ARTIFICIAL INTELLIGENCE 1, 5 (2015).

[40] *See* Do Manh Thai & Morten Falch, *Universal Service in Vietnam: An Institutional Approach*, 42 TELECOMM. POL'Y 323, 329 (2018). For example, in the United States-Colombia and United States-Peru trade agreements, "the universal service clause (article 14.8) indicates that each party has the right to manage their USO definition in a competitively-neutral fashion, and Clause 14.4 forbids each party to engage in cross subsidization." Emiliani, *supra* note 25, at 16.

contributed even more toward achieving universal service.[41] Today, mobile services account for about forty percent of the global telecommunications market, with mobile subscribers outnumbering fixed telephone line users by more than two to one.[42] Competition among mobile operators has helped narrow the digital divide: it reduced tariff rates and increased the affordability of communication services for many.[43] For instance, both India and China have been ranked among the fastest growing mobile markets in the world during the last two decades as a result of competition policies.[44] Similarly, with four mobile network operators in the last two decades, Kenya now has one of the highest mobile penetration rates in Africa.[45] The dramatic growth in mobile phone usage in Kenya has increased Internet penetration, with most Kenyans accessing the Internet via mobile phone rather than fixed wireline connections.[46] International comparisons identify few countries where liberalization and advances in mobile telephony did not dramatically increase access to communication services.[47]

For those countries that pursued liberalization policies and saw advances in mobile innovations, the market efficiency gap in the telecommunications market has mostly closed, but only in commercially viable locations. There are and continue to exist some remote and high cost areas where market forces alone do not guarantee satisfactory deployment of infrastructure, and universal service remains an unrealized promise.[48] These areas, which are beyond the "market efficiency frontier," point to "access

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[41] *Telecommunications Services*, WORLD TRADE ORGANIZATION, https://www.wto.org/english/tratop_e/serv_e/telecom_e/telecom_e.htm [https://perma.cc/V4HC-7QU2].

[42] *Id.* In some Latin American countries, the "number of mobile subscribers has surpassed the number of fixed lines installed. Due to market liberalization and the low number of restrictions to handset acquisition and activation, mobile telephony has become crucial in closing the market gap in urban and rural areas." Emiliani, *supra* note 25, at 19.

[43] Oteri et al., *supra* note 39, at 6.

[44] Jayakar & Liub, *supra* note 34, at 194.

[45] In 2016, Kenya had a 90% mobile penetration rate, more than the African continent average of 76.2%. Idi Jackson Mdoe & George Kariuki Kinyanjui, *Mobile Telephony, Social Networks and Credit Access: Evidence from MSMEs in Kenya*, 6 COGENT ECON. & FIN. 1, 4 (2018).

[46] In 2011, about 17 million Kenyans used the Internet (roughly forty three percent of the population). Though more than 6 million were subscribed to the Internet, about 23,000 subscribed to fixed fiber-optic, with the rest receiving access via mobile phones. GEORGE NYABUGA & NANCY BOOKER, OPEN SOC'Y FOUNDS., MAPPING DIGITAL MEDIA: KENYA 1, 17 (2013).

[47] Casanueva-Reguart, *supra* note 38, at 2094. Teledensity in mobile services in Africa is greater than in Mexico, and Mexico's teledensity is below the average for Latin America. *Id.* Teledensity in mobile services was 88.3% in Mexico, 104.6% in Africa, and 113.0% in Latin America. *Id.* Mexico's teledensity is low when taking into account countries in the region with a similar level of wealth. *Id.*

[48] CONNECTING THE GLOBE, *supra* note 38, at i.

gaps."[49] Another term to capture this phenomenon is the "territorial divide," or a gap in infrastructure availability between rural and urban areas.[50] For example, in Mexican rural areas especially, mobile density is low and residential landline availability is even more limited.[51] Additionally, many parts of Kenya also have no mobile coverage, especially the arid and semi-arid areas, pointing to a general trend in Africa, India, and elsewhere: liberalization and mobile telephony have drastically reduced coverage gaps in urban areas and decreased prices, but the same cannot be said of less densely populated areas, where people continue to be unserved or underserved.[52] This reflects the commercial orientation of network operators, where "[m]anagement decisions made by firms regarding the pace and geographic coverage of network roll-out may be guided by attempts to reach the highest density of customers, and those with the greatest purchasing power."[53] The exorbitant costs of network infrastructure continue to present a challenge for universal service by discouraging investment in high-cost areas. To fully close this access gap, a different kind of public intervention is needed and has typically come in the form of various universal service obligations and mechanisms.

B. Addressing the Access Gap: National Universal Service Mechanisms

To ensure universal service, governments have typically turned to policies that aim to reduce *both* market efficiency and access gaps. This results in pro-competitive policies complemented by universal service mechanisms whose aim is to improve access and social welfare, as well as mitigate the problem of the digital divide between commercially viable and non-viable locations.[54] Not only are there many different variations of universal service visions and definitions, the implementation and funding methods vary by country. The analysis below examines some historic and present-time

[49] Casanueva-Reguart, *supra* note 38, at 2095–97; Emiliani, *supra* note 25, at 11, 18.
[50] Emiliani, *supra* note 25, at 18.
[51] Casanueva-Reguart, *supra* note 38, at 2094. In poorer states of Mexico, where 15% of the country's population resides, residential landline availability is more limited (25.5%), and these states also have low mobile density (71.1%). *Id.*
[52] Oteri et al., *supra* note 39, at 6 ("With a national coverage of about 77% of the population, the mobile industry invariably covers over 31 million people in the country. However, the 38% geographic coverage implies that many parts of the country are not covered, especially the arid and semi-arid areas"); *Universal Service Funds in Africa*, *supra* note 31, at 618; Jayakar & Liub, *supra* note 34, at 191 ("[A]nalysis by the Telecommunications Regulatory Authority of India [in 2004] showed that telecom licensees were far from achieving their targets. Providers often disdained to serve rural areas due to an assumption that they were not viable markets.").
[53] McDowell & Lee, *supra* note 35, at 372.
[54] *Universal Service Funds in Africa*, *supra* note 31, at 622; *see also* Casanueva-Reguart, *supra* note 38, at 2095.

definitions of universal service, government priorities in terms of which services and modes of expansion to prioritize, as well as popular financing mechanisms. The Part ends with a discussion of common reasons for failure of universal service policies and programs to adequately address the access gap worldwide.

1. *Universal Service: History, Priorities, and Modes of Expansion*

The concept of universal service, or the "universal service obligation," has existed and evolved since the 1900s.[55] The concept was initially proposed by AT&T president Theodore Newton Vail, who believed that a telecommunications network should reach all *households* of a country.[56] At that time, the concept was used as a defense for maintaining a monopoly over telephone services in the United States.[57] The principle of universal service was later defined in the U.S. Communications Act of 1934 as "making available, so far as possible, to all the *people* of the U.S., rapid, efficient, nationwide and worldwide wire and radio communication services with adequate facilities at reasonable charges."[58] In the early 1970s, Bell System relied on a cross-subsidy method to implement its universal service obligation and subsidize the last mile.[59] After liberalization of telecom markets in the United States, the notion that the last mile should be in some way subsidized spread around the world.

The problem with analyzing universal service is the lack of a commonly accepted definition. Though the concept has been around for decades, the definition continues to change as certain services and beneficiaries are prioritized.[60] Still, the concept in both developed and developing countries has the same general meaning: wider access to telecommunications services in a manner that, according to the International

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[55] *See* Emiliani, *supra* note 25, at 3.
[56] *See id.*
[57] *See id.*
[58] The Communications Act, 47 U.S.C. § 151 *et seq.* (1934).
[59] *See* Gary Madden, *Economic Welfare and Universal Service*, 34 TELECOMM. POL'Y 110, 111 (2010).
[60] Jayakar & Liub, *supra* note 34, at 187. *See generally,* James Alleman, Paul Rappoport & Aniruddha Banerjee, *Universal Service: A New Definition?*, 34 TELECOMM. POL'Y 86, 86–91 (2010).

Telecommunication Union (ITU), is available, accessible, and affordable.[61] Today, there are differences among countries about which services should be available, accessible, and affordable.

Although some countries emphasize access to telephone service in every home or aim to provide a public telephone within a given distance, others focus on access to fast Internet.[62] The service to be prioritized once depended on a country's wealth and stage of telecommunications development. For example, in Canada, Europe, and the United States, historically, there has been a greater emphasis on ensuring universal access to broadband.[63] However, recognizing that universal connectivity through broadband infrastructure is vital in today's digital era, many developing countries are now including broadband in their universal service definitions and have started adopting National Broadband Plans (NBPs) to articulate their growth plans and broadband targets.[64] The number of NBPs increased from 38 in 2008 to 151 in 2016.[65] Some NBPs focus on the design, construction, and financing of wholly new high-speed broadband networks and fiber deployment, while others articulate a more medium-term goal of improving existing telecommunications infrastructure.[66] For example, the Nigerian NBP

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[61] More broadly, the ITU defines universal service as making telecommunication services (of specified quality and in light of national conditions) available at affordable prices to currently unserved potential users. *See* Emiliani*, supra* note 25, at 7; Madden, *supra* note 59, at 111; Thai & Falch, *supra* note 40, at 324; *Universal Service Funds in Africa*, *supra* note 31, at 619; *Universal Service*, in *Telecommunications Services: Glossary,* WORLD TRADE ORGANIZATION, https://www.wto.org/english/tratop_e/serv_e/telecom_e/tel12_e.htm [https://perma.cc/Q8YD-NS34].

[62] *Universal Service Funds in Africa*, *supra* note 31, at 626; *Telecommunications Services: Glossary*, *supra* note 61.

[63] Broadband describes "high-speed, 'always-on' access to the Internet," enabling enhanced online shopping and banking experiences, downloading and sharing larger files, as well as videoconferencing. Nathaniel E. Uramaab & Osita Ogbuc, *Evaluating Consumer Perception and Willingness to Pay for Broadband in Nigeria*, 42 TELECOMM. POL'Y 421, 423 (2018) [hereinafter *Willingness to Pay for Broadband in Nigeria*]. In Europe, the attention has been on increasing household access to Internet connections above 100 Mbps. *See Europe 2020: A European Strategy for Smart, Sustainable and Inclusive Growth*, EUROPEAN COMM'N, 12 (Mar. 3, 2010). The EU Strategy 2020 aimed for all European households to have broadband access by 2013, access to much higher Internet speeds (30 Mbps or above) by 2020, and for fifty percent or more of European households subscribing to Internet connections above 100 Mbps. *Id.* The targets were updated in 2016 towards achieving a "European Gigabit Society" by 2025. *Id.*; Gerli et al., *supra* note 32, at 728.

[64] *See generally Benchmarking 15 National Broadband Plans*, ERICSSON (2014).

[65] *See* Winseck, *supra* note 3, at 256–57.

[66] *See* PHILLIPPA BIGGS ET AL., INT'L TELECOMM. UNION, PLANNING FOR PROGRESS: WHY NATIONAL BROADBAND PLANS MATTER 12 (2013), http://www.broadbandcommission.org/documents/reportNBP2013.pdf [https://perma.cc/9GKQ-4LXM]; *Digital Single Market: Investment Models,* EUROPEAN

targets a five-fold increase in broadband penetration in five years via numerous access initiatives and fiber network build-out plans.[67] Similarly, the Kenyan plan focuses on providing connections that are at least 5 mbps, extending national fiber optic cables by 30,000 kilometers, building neutral national data centers, as well as enhancing digital literacy.[68]

One point of differentiation between developed and developing countries is the greater emphasis on mobile broadband in universal service policies of developing countries. For example, in the NBPs for Kenya, Mexico, and India, there is a greater focus on building out wireless rather than fixed wireline infrastructure.[69] The belief is that mobile phones are "the best candidate for connectivity," since mobile phones in these countries are usually substitutes, and not complements, for wireline access to the Internet.[70] For instance, mobile operators using wireless technologies are the primary providers of Internet services in Kenya, accounting for ninety-eight percent of total Internet subscriptions.[71] The prominence of mobile infrastructure in policies is due to mobile networks costing about half as much as fixed-line networks.[72] Moreover, rollout is more flexible and faster, enabling swifter reach to rural areas. Although in some areas closing the market efficiency gap with competitive policies is enough to ensure adequate supply of mobile infrastructure, developing countries still require public intervention, because their market forces are insufficient to cover even lower mobile network

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COMMISSION (Oct. 3, 2017), https://ec.europa.eu/digital-single-market/investment-models (examples of investment models for broadband plans) [https://perma.cc/ATW8-SB6V].

[67] *See Willingness to Pay for Broadband in Nigeria*, *supra* note 63, at 422. The Nigerian Telecommunications Commissions initiatives include ensuring that no place is more than thirty miles away from backbone infrastructure; encouraging the private sector to build and manage wireless broadband services in many state capitals, cities and towns; financing the community centers via a universal service fund; and various rural initiatives. *Id.*

[68] GOV'T KENYA, THE NATIONAL BROADBAND STRATEGY, 6–7 (2013), http://icta.go.ke/pdf/The_National_Broadband_Strategy.pdf [https://perma.cc/772L-J9R2].

[69] *See* FERNANDO BERMEJO ET AL., OPEN SOC'Y FOUNDS., MAPPING DIGITAL MEDIA: GLOBAL FINDINGS 299 (2014) (describing the history of India's Universal Service Obligation Fund, which now intends to help with expansion of mobile telecom infrastructure in rural, commercially non-viable areas); Jayakar & Liub, *supra* note 34, at 193 (noting how India's universal service fund supports infrastructure for mobile services, such as the set-up and maintenance of cellular towers in remote areas without mobile service); *Universal Service Funds in Africa*, *supra* note 31, at 622 (noting that many universal service funds in Africa provide some financial incentives for mobile network operators to deploy networks in economically unattractive areas).

[70] *See* Alleman et al., *supra* note 60, at 87–88. Many services like e-mail, web surfing, movies, photos are now available on smart mobile phones. Mobile phone subscribers exceed fixed connection subscriptions in 200 countries; in 166 countries the mobile penetration is over twice that of fixed connections. *See id.*

[71] *See* THE NATIONAL BROADBAND STRATEGY, supra note 68, at 15.

[72] *See* Casanueva-Reguart, *supra* note 38, at 2093.

infrastructure costs.

Many governments and regulators are challenged by how to effectively design and implement universal service policies and programs that will truly increase access.[73] Variations in the definition of universal service result in differing priorities, use of policy tools, and degrees of public sector intervention.[74] Several well-regarded individuals in the field explain that universal service policies and programs call for demographic, territorial, and/or layered modes of expansion, which directly benefit people, high cost areas, or discrete programs, respectively.[75] Some countries choose to pursue all three modes "simultaneously, or in varying sequential combinations."[76]

In the demographic expansion mode, universal service programs aim to provide access to end-users of communication services in order to gradually expand access to more *people*. The most common method is to provide subsidies or rate reductions to end-users. The Lifeline program in the United States does exactly that: it targets assistance to low-income households, making up the difference between the cost of the service and the amount consumers can pay.[77] Some credit these programs with the high telephone penetration rate in the United States these past decades.[78] Today, the program has expanded to provide subsidies for mobile and Internet service. In comparison, until recently universal service policies in India and China mostly lacked the demographic expansion mode. Some note this is because "universal household access would be too expensive, considering the population, geographical area and stage of economic development of these two countries."[79] Others note that greater *mobile* penetration makes policymakers less compelled to add household access as a universal service goal.[80] However, to advance broadband growth in rural areas, the regulatory agency in India is considering implementing subsidized tariffs for rural subscribers.[81] Overall, by implementing strategies that are directly targeted at end-users, policies

[73] *See* CONNECTING THE GLOBE, *supra* note 38, at I-7, V-2, V-10, VI-4, VII-2.
[74] Thai & Falch, *supra* note 40, at 323.
[75] *See* Harmeet Sawhney & Krishna Jayakar, *Universal Service: Migration of Metaphors*, *in* MAKING UNIVERSAL SERVICE POLICY: ENHANCING THE PROCESS THROUGH MULTIDISCIPLINARY EVALUATION 32-37 (Barbara A. Cherry et al. eds., 1999).
[76] Jayakar & Liub, *supra* note 34, at 188.
[77] Whereas Lifeline provides a discounted monthly fee for one telephone line in a residence, the Link-Up program discounts the initial installation fee. *See* Gideon & Gabell, *supra* note 37, at 740 ("Optimal policy provides assistance only to those who otherwise would not subscribe."); CONNECTING THE GLOBE, *supra* note 38, at i ("These universal subsidy schemes are most effective when they are targeted, explicit and competitively neutral.").
[78] *See* Gideon & Gabell, *supra* note 37, at 740.
[79] Jayakar & Liub, *supra* note 34, at 194.
[80] *See id.*
[81] *Id.* at 192.

tackle factors inherent in rural and low-income areas, such as low purchasing power, low usage, and seasonal income; and through subsidies, increase potential demand for services.[82]

In the territorial expansion mode, universal service programs seek to extend network infrastructure across geographical space. The distinction between territorial and demographic expansion can be blurry, since both aim to connect people to services as a final goal. Territorial expansion, however, is more about increasing access in a certain location rather than for a specific end-user.[83] In Colombia, Peru, and India, for example, universal access initiatives initially aimed to place services within a certain distance of a person or habitation.[84] The classic example of a territorial expansion policy is the U.S. Connect America Fund, which is one of four initiatives under the Universal Service Fund and provides subsidies to eligible telecommunications carriers who develop infrastructure in high-cost areas.[85]

The layered expansion mode refers to the gradual increase in the number of services or programs that receive public support. In many countries, such as the United States and Mexico, this has meant expanding universal service to directory assistance and 911 emergency services, schools and libraries, and rural hospitals.[86] In developing countries, layered expansion somewhat overlaps with territorial expansion as it refers to supporting digital community centers, or "telecenters," usually located in rural areas. In Kenya, the government is funding "digital villages" that will enable rural inhabitants to access broadband Internet,[87] and in Mexico a similar program has led to a 500 percent increase in Internet access points in public places.[88]

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[82] *See* Arturo Muente-Kunigami & Juan Navas-Sabater, *Options to Increase Access to Telecommunications Services in Rural and Low-Income Areas* 11 (World Bank, Working Paper No. 178, 2010).

[83] *See id.* at 28.

[84] *See* Emiliani, *supra* note 25, at 19 (describing universal access initiatives in Colombia and Peru). In India, the government initially made targets for telephone access, where a public phone had to be available within a certain distance from any habitation.) The government also focused on providing access to 290,000 "uncovered villages." Jayakar & Liub, *supra* note 34, at 191.

[85] *See* Sanford V. Berg et al., *Universal Service Subsidies and Cost Overstatement: Evidence from the U.S. Telecommunications Sector*, 35 TELECOMM. POL'Y 583, 590 (2011).

[86] *See* Telecommunications Access Policy Division, FCC, *Universal Service,* https://www.fcc.gov/general/universal-service [https://perma.cc/PDP6-96M8]; *Punto México Conectado Program*, INT'L TELECOMM. UNION, https://www.itu.int/net4/wsis/archive/stocktaking/Project/Details?projectId=1487175478 [https://perma.cc/E33S-YQDW].

[87] NYABUGA & BOOKER, *supra* note 46, at 6.

[88] Casanueva-Reguart, *supra* note 38, at 2111.

2. *Universal Service Financing Mechanisms*

Besides the variation of which services and beneficiaries' countries prioritize, countries also use different approaches to finance their universal service agendas. Historically, the most common mechanisms were cross-subsidies among long-distance and local rates, as well as carrier mandates for development in rural areas. First, monopolies or state-owned companies used internal cross-subsidies where they charged high prices for international calls to subsidize local calls.[89] However, this was soon not feasible in competitive and liberalized environments.[90] Another common mechanism national regulators used was to mandate carriers to rollout certain services in underserved areas and to underserved populations. Such a rollout obligation in India, for example, required operators who received a spectrum license to extend services within a specific time period in their territories as a condition of the license.[91] At one point, Indian operators were required to have at least ten percent coverage in rural areas under their licensing agreement.[92] These rollout obligations have been largely ineffective. In Mexico, Telmex's designated network operator status at times led to evasion of obligations to rural communities.[93]

Today, the preferred mechanism to finance universal service is through a publicly-administered Universal Service Fund (USF). Studies show that USFs have been adopted by numerous countries in Africa and Latin America.[94] Nations usually finance USFs through fees charged during the licensing process or, more commonly, levies on telecommunications

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[89] Madden, *supra* note 59, at 111 ("In former monopoly markets universal service obligations are mostly provided through cross-subsidies on profitable market segments."); *see generally* Muente-Kunigami & Navas-Sabater, *supra* note 82, at 30.

[90] Emiliani, *supra* note 25, at 12 (noting five strategies in a liberalized market: imposing the universal service obligation on the incumbent; imposing the obligation on all firms; procuring universal service from one firm; procuring universal service from several firms; and offering universal service subsidies).

[91] VIBODH PARTHASARATHI ET AL., OPEN SOC'Y FOUNDS, MAPPING DIGITAL MEDIA: INDIA 94–95 (2012); Jayakar & Liub, *supra* note 34, at 191.

[92] Jayakar & Liub, *supra* note 34, at 191.

[93] Telmex was the designated network operator in Mexico and after negotiations with regulators, it was freed from its obligation to serve communities with fewer than 500 people—at one point, that was 47.2% of rural inhabitants in Mexico. *See* Casanueva-Reguart, *supra* note 38, at 2102.

[94] U.N. Conference on Trade and Development, *Financing Mechanisms for Information and Communication Technology for Development*, 14, UNCTAD/DTL/STICT/2009/5 (2010) (noting the popularity of USFs); *Universal Service Funds in Africa, supra* note 31, at 618 (noting studies showing that universal service funds are the most adopted universal service strategy across Africa); Emiliani, *supra* note 25, at 14 (citing data from 2006 that indicates that twelve Latin American countries use special funds; thirteen rely on contributions from international agencies and NGOs; and three continue to use cross-subsidies).

operators. To finance USFs, telecommunications operators pay (1) a fixed fee in exchange for a spectrum and operating license, and/or (2) a variable fee calculated as a percentage of the company's revenues.[95] In India, the regulatory authority initially set the levy at five percent of adjusted gross revenue,[96] and in various countries in Africa, the levies have ranged from 0.2 to 5 percent.[97] In some countries such as Burkina Faso, Ghana, Tanzania, and Uganda, the government and international donors like the World Bank also contribute to USFs.[98] Telecom companies in the U.S. usually recover their USF levies by passing the cost directly to their customers, which some argue is essentially a tax.[99] Once funded, the USF is then administered by a regulatory or independent agency, whose mandate typically entails the allocation of funds "to provide financial support to rural access and other ICT development projects, often through a competitive bidding process, in which the same operators that contribute to the fund are invited to bid for the subsidies and the mandate to deliver rural access and services."[100]

In addition to financing commercially nonviable projects with levies, some countries fund universal service projects via direct grants. Some argue universal service obligations should in fact be financed in accordance with democratic principles, meaning that the government should fund the program through general tax revenues.[101] In the United States, the Obama Administration allocated $7.2 billion to broadband infrastructure deployment in accordance with the National Broadband Plan.[102] The turn to direct grants

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[95] Mark A. Jamison et al., *Competition in Wireless: Spectrum, Service and Technology Wars*, 27 TELECOMM. POL'Y 319, 321 (2003). Some mobile operators defend high service charges because of high licensing fees paid to the government as a result of a licensing process that leads to high bids. *See* Kerretts, *supra* note 36, at 57.

[96] Jayakar & Liub, *supra* note 34, at 192.

[97] *Universal Service Funds in Africa*, *supra* note 31, at 622 (reporting that thirty-four countries' universal service funds were surveyed in Africa and most of those funds were financed by levies contributed by mobile network operators. Only Morocco and Togo financed with a "pay or play" strategy. The levies ranged from 5% (Tunisia), to 0.5% (Mauritius and Kenya), as well as 0.2% (South Africa)).

[98] *Id*.

[99] Although the FCC does not require this, most companies do it anyway. *See* Berg et al., *supra* note 85, at 583; Rob Frieden, *Killing with Kindness: Fatal Flaws in the $5.7 Billion Universal Service Funding Mission and What Should Be Done to Narrow the Digital Divide,* 24 CARDOZO ARTS & ENT. L. J. 448, 456 (2006).

[100] U.N. Conference on Trade and Development, *supra* note 94, at 14; *see* Jayakar & Liub, *supra* note 34, at 191 (explaining how the universal access levy in India was collected from licensed telecom operators as a percentage of their revenues; the funds were then used to reimburse service providers who provide universal service in remote areas); *see also* Berg et al., *supra* note 85, at 585 (noting that the Universal Service Administrative Company (USAC) was created in 1997 to administer the universal fund for the FCC).

[101] Alleman et al., *supra* note 60, at 88.

[102] *Id*. at 90; Gideon & Gabell, *supra* note 37, at 737.

in the United States, however, was in addition to USF levies and was intended to serve as a financial stimulus package after the economic downturn.[103] While in the United States this was a one-off stimulus package, in Chile universal access projects are funded directly by the national treasury rather than levies on telecom companies.[104]

After years of relying on market mechanisms and universal service levies to fund infrastructure development, governments are adopting a new wisdom regarding the advantages of increased public funding for faster development of broadband networks.[105] In fact, many national broadband plans tackle backbone infrastructure challenges by increasing public funding for such projects and partnering with private actors via public-private partnerships (PPPs) to collaborate in the design, construction, operation, and financing of the infrastructure.[106] Developed and developing countries are both pursuing the PPP model.[107] Some countries like Australia and Nigeria are

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[103] Alleman et al., *supra* note 60, at 88.

[104] Emiliani, *supra* note 25, at 23; Muente-Kunigami & Navas-Sabater, *supra* note 82, at 31.

[105] *See generally* Bronwyn Howell & Bert Sadowski, *Anatomy of a Public-Private Partnership: Hold-up and Regulatory Commitment in Ultrafast Broadband*, 42 TELECOMM. POL'Y 552 (2018).

[106] *See id.* at 553; *see generally* WORLD BANK, PUBLIC-PRIVATE PARTNERSHIP IN TELECOMMUNICATIONS INFRASTRUCTURE PROJECTS: CASE OF THE REPUBLIC OF CONGO 5, https://openknowledge.worldbank.org/bitstream/handle/10986/12540/687020ESW0P1220cover0PO1223950Congo.pdf [https://perma.cc/2ZNB-PDL6].

[107] For example, in New Zealand, the government has partnered with four firms to fund a fiber-to-the-home (FTTH) network aimed to reach eighty-five percent of the population by 2024. *See* Howell & Sadowski, *supra* note 105, at 553. In the United States, rural towns are joining together using consortium and PPP models to extend fiber cables to the home, pushing "for much higher speed connectivity than is likely in the near term to be provided by existing service providers." *Case Studies on PPP Arrangements for Telecommunications*, PUBLIC-PRIVATE-PARTNERSHIP LEGAL RESOURCE CTR. (Sept. 12, 2019), https://ppp.worldbank.org/public-private-partnership/sector/telecom/telecom-laws/case-studies-telecommunications [https://perma.cc/57E2-RNTC].

establishing infrastructure corporations,[108] turning to a wholesale open access model where they share the national backbone infrastructure with retail service providers.[109] Because most projects are still in the early stages, reports on investment partnerships are limited.[110] Further research is needed regarding the extent of risk sharing among partners and the role of international investors and institutions in infrastructure development including, for example, the implications of Chinese engagement in many African countries' backbone telecommunications development.[111]

3. *Failure of Universal Service Funds*

Overall, in liberalized telecommunications markets, universal service policies have played a critical role in mitigating persistent access gaps in commercially non-viable locations. Scholars note that the universality of voice telephone service in the United States two decades ago was a result of a

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[108] Australia's National Broadband Network project resulted in a fully funded government corporation, which designs, builds and operates Australia's wholesale broadband access network. The project started with the aim of FTTH network deployment to most residences, "supplemented by satellite and wireless connections to the remainder." Howell & Sadowski, *supra* note 105, at 553; *see also* Matthew L. James, *National Broadband Network*, PARLIAMENT AUSTL., https://www.aph.gov.au/About_Parliament/Parliamentary_Departments/Parliamentary_Library/pubs/rp/BudgetReview201314/NBN [https://perma.cc/GX66-KHNR]. In Nigeria, several InfraCos were licensed for geographic zones of the country and are utilizing the Open Access Model to offer fiber penetration and backbone infrastructure available on a non-discriminatory basis to telecommunications operators. *See* Paul Adepoju, *60 Bidders Compete for Fibre Deployment Licenses*, ITWEB AFRICA (June 20, 2017), http://www.itwebafrica.com/networks/270-nigeria/238034-60-bidders-compete-for-fibre-deployment-license [https://perma.cc/838U-L78W]. This ensures reliable and fast broadband services for the country. *Id.*

[109] *See* OECD, FIXED BROADBAND NETWORKS, *supra* note 21, at 26 ("In nearly all countries in the OECD area, incumbent telecommunication providers that operate copper-based broadband networks are required to offer unbundled wholesale access to competitors at regulated rates. Such open access mandates ensure that even if competition among physical network infrastructure is infeasible, there is the opportunity for competition at the retail level to drive consumer benefits and innovation.").

[110] Howell & Sadowski, *supra* note 105, at 553 (noting that information is scant since most projects are in the early stages, and it is hard to compare projects since scopes vary by country).

[111] *See generally* VIVIEN FOSTER ET AL., WORLD BANK, BUILDING BRIDGES: CHINA'S GROWING ROLE AS INFRASTRUCTURE FINANCIER FOR SUB-SAHARAN AFRICA xiii (2008). Kenya's National Optic Fibre Backbone Infrastructure (NOFBI) project takes on a multi-stakeholder approach towards governance and is being financed by many actors, including China's Export-Import Bank. *See* Ewan Sutherland, *China and Africa: Alternative Telecommunication Policies and Practices*, 17 AFR. J. INFO. & COMM 120, 183–84 (2016) (table showing Chinese support of backhaul networks).

liberalized market and universal service funding strategies.[112] However, the recent turn to national broadband plans and increased public funding supports scholars' conclusions that universal fund mechanisms are not well positioned to bridge the digital divide and close the broadband access gap. This is consistent with some scholars' findings that USFs are failing around the world, citing the cause as partially ill-conceived policies.[113]

One reason for USF's failure to close the access gap is government corruption and lack of accountability. Many funds in developing countries lack detailed public information—specifics which are necessary to keep the government and operators accountable—calling the transparency and accountability of funds into question.[114] Concerns about corruption are especially persistent in countries where service expansion by telecom operators is mandated. The lack of performance monitoring and enforcement of mandated universal service commitments in African countries and other developing countries have often been noted.[115] More commonly, sometimes operators under-prioritize truly unserved markets, upgrading broadband infrastructure for existing slower networks instead.[116] Predictably, the potential success of universal service policies is limited if operators are not held accountable to expand coverage in rural areas.

Another reason for the failure of USFs to bridge the access gap is unsatisfactory operations and implementation of USFs by governments, marked by operator cost overstatements and inefficient outcomes. Typically, after levied funds have been collected (1) the cost of universal service is

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[112] Penetration of telephone service in the U.S. increased from 91.4% in 1983 to 95.5% in March 2003. Gideon & Gabell, *supra* note 37, at 738.

[113] *Universal Service Funds in Africa*, *supra* note 31, at 625.

[114] *Id*. at 624 (noting that a majority of universal service funds in Africa lacked more specific public information about the usage of funds and that financial records were "somewhat patchy and outdated."); Jayakar & Liub, *supra* note 34, at 192 (noting that the universal service fund disbursements in India were problematic because the collected levies were credited to the national treasury as general revenue, and thus available for other budgetary needs).

[115] *Universal Service Funds in Africa*, *supra* note 31, at 625–26 (observing lack of performance monitoring of universal service funds in African countries); Casanueva-Reguart, *supra* note 38, at 2113 (noting that "Telmex's dominance made it difficult for government authorities to enforce the universal service commitments" in the company's operator license and contract under the Social Coverage Fund program); PARTHASARATHI ET AL., *supra* note 91, at 95 (remarking that the government has full discretionary powers to withdraw, modify, or distort certain commitments and initiatives); NYABUGA & BOOKER, *supra* note 46, at 84 (mentioning cases of corruption in spectrum allocation, the lack of enforcement of the use-it-or-lose-it principle with spectrum, and government bias towards Telkom Kenya given the government's ownership stake).

[116] *See* DOUG BRAKE, INFO. TECH. & INNOVATION FOUND., A POLICYMAKER'S GUIDE TO RURAL BROADBAND INFRASTRUCTURE 12 (2017).

assessed, and (2) the provider is compensated for the cost.[117] Considering the information asymmetries regarding infrastructure build-out, the procedure can lead to waste as it entices universal service providers to overstate costs to receive greater compensation.[118] In response, some governments have implemented least-cost auctions, also called reverse auctions, whereby USF administrators award projects on a least quoted subsidy basis, lowering the costs of universal service programs.[119] Though the auctions have improved the disbursement process—resulting in more structure, transparency, and competition among bidders—in many countries USFs remain underutilized, sometimes because of poor implementation.[120] Although not many comprehensive studies on the effectiveness of USFs exist, one study showed that at one point $400 million of funds lay idle in over twenty African countries.[121]

Overall, studies show that USFs have failed to address the limited coverage of telecom services in many countries due to "poor policy formulation, inadequate stakeholder engagement, lack of accountability, inaccurate data, undue political influence and the narrow scope of universal services."[122] As a result, the digital divide persists, especially in the last mile of the globe. Moreover, there has been a shift in solutions, with new rhetoric focusing on innovation and global partnerships to close persisting market access gasps. The UN has notably called for this in the SDGs. Seeing the last

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[117] *See generally* Axel Gautier & Xavier Wauthy, *Competitively Neutral Universal Service Obligations*, 24 INFO. ECON. & POL'Y 254 (2012).
[118] Berg et al., *supra* note 85, at 589.
[119] Jayakar & Liub, *supra* note 34, at 192 (describing a study of the use of a multi-layered bidding process on a least quoted subsidy basis in India, which scholars have credited with lowering of universal service program costs); Alleman et al., *supra* note 60, at 90 (finding that least-cost auctions noticeably reduced subsidies in many countries); *id.* at 90 (explaining that the U.S. FCC is reconsidering auctions in the USF context because of alleged waste and fraud in funds distribution); Emiliani, *supra* note 25, at 15 (detailing the process of a "reverse" auction and a "beauty contest").
[120] *See generally* Jayakar & Liub, *supra* note 34, at 192; Emiliani, *supra* note 25, at 29-30 (explaining that in Latin American countries USFs are not disbursing resources efficiently, there is a lack of a clear "collect-disburse mechanism," and too much "bureaucracy involved in the approval of the disbursements."); Lilian Ochieng, *United Nations Report Lauds Kenya's Broadband Plan*, DAILY NATION (Oct. 5, 2015), https://www.nation.co.ke/business/United-Nations-report-lauds-Kenya-s-internet-plan/996-2899190-rcf3k7/index.html (noting USF implementation challenges in Kenya) [https://perma.cc/Y8P7-2FZ4].
[121] FERNANDO BERMEJO ET AL., OPEN SOC'Y FOUNDS. DIGITAL JOURNALISM: MAKING NEWS, BREAKING NEWS 299 (Marius Dragomir et al. eds., 2014) (citing a watchdog foundation which noted that the Indian government failed to utilize raised resources to develop telecom infrastructure); *Universal Service Funds in Africa*, *supra* note 31, at 622 (observing that implementation of USFs across Africa is inefficient and ineffective, and most funds lack regular financial reporting).
[122] *Universal Service Funds in Africa*, *supra* note 31, at 626.

mile problem and access gaps as a business opportunity, technology and satellite companies have shifted toward developing innovative global infrastructure solutions such as Internet-beaming balloons, drones, and LEO satellite mega-constellations.

III. MOVING BEYOND LIBERALIZATION AND UNIVERSAL SERVICE FUNDS: INNOVATIVE GLOBAL BROADBAND INFRASTRUCTURE PROJECTS

Even though liberalization policies and universal service mechanisms boosted the deployment of communications infrastructure worldwide, the broadband access gap persists in many countries. On a global scale, infrastructure development for rural communities in the developing world represents the ultimate last mile. Seeing that many countries failed to bridge the Internet access gap nationally, the UN reiterated its Internet access targets in the 2030 Agenda for Development, otherwise known as the SDGs. The SDGs discuss ICT infrastructure development and Internet access, identifying ubiquitous connectivity and the digital divide as a global challenge. Ultimately, the challenge is one of global governance.

Two SDGs discuss ICT infrastructure development and universal Internet access. Primarily focused on infrastructure, industrialization, and innovation, SDG 9 notes the paucity of communications infrastructure in developing countries, remarking that sixteen percent of the global population does not have access to mobile broadband networks.[123] One target for SDG 9 seeks to increase access to ICTs significantly, and to provide universal and affordable access to the Internet in least developed countries by 2020. SDG 9 recognizes that the way to close the digital divide is via regional and transborder infrastructure that is affordable and provides equitable access for all. If SDG 9 spells out the *ends* in terms of more infrastructure and innovation, then SDG 17 encapsulates the *means* of implementation to achieve the SDGs: by strengthening global partnerships. SDG 17 envisions a revitalization of multi-stakeholder and public-private partnerships comprising governments, the private sector, and civil society at the global, regional, national, and local levels, as the implementation mechanism for the development agenda. SDG 17's aim is to unlock private resources and foreign direct investment to

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[123] The goal of infrastructure development, articulated in SDG 9, is a notable addition to the global development agenda, as it was not explicitly stated in the Millennium Development Goals (MDGs). One target for SDG 9 communicates the value of infrastructure development and investment—namely, the enabling effects of infrastructure investment in enhancing economic development and human well-being, especially in least developed countries where basic infrastructures are lacking. The indicator used to measure progress towards this SDG is improvement in the "proportion of population covered by a mobile network." *Sustainable Development Goal 9,* UNITED NATIONS, https://sustainabledevelopment.un.org/sdg9 (follow "Targets & Indicators" hyperlink) [https://perma.cc/63U6-YKPH].

achieve development objectives, especially in critical sectors like ICT infrastructure. In fact, SDG 17 directly references the digital divide by citing ICT-related facts, including that more than four billion people do not use the Internet and ninety percent of them are from the developing world. The UN's vision is that global partnerships will enable achievements for the technology-related targets of SDG 17, with progress measured by indicators.[124]

Several companies have recently articulated global connectivity agendas and broadband infrastructure projects which happen to coincide with the SDGs. The companies are responding to the challenge of the last mile for infrastructure provision and are motivated to bridge the global digital divide not through national universal service mechanisms, but with innovative global infrastructure. Believing that everyone should have Internet access, and that provision could be at high altitudes rather than solely terrestrial, companies like Alphabet, Facebook, SpaceX, among others, have begun developing Internet-beaming balloons, drones, and LEO satellite mega-constellations.[125] Whereas universal service mechanisms and funds were an incremental response to the need for more communications infrastructure development, these non-traditional "telecommunications" companies are introducing potentially disruptive infrastructure.[126] Their missions have left many wondering whether the companies' innovations will complement or supplement current communications infrastructure and help developing countries leapfrog certain stages of infrastructure development.

Though these companies are ostensibly working to bridge the global digital divide, the SDGs likely did not motivate the endeavors; the decision to turn to innovation was due to an appetite to reach under-connected markets

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[124] *Sustainable Development Goal 17,* UNITED NATIONS, https://sustainabledevelopment.un.org/sdg17 (the indicators are "fixed Internet broadband subscriptions per 100 inhabitants, by speed" and "proportion of individuals using the Internet.") [https://perma.cc/2PXP-ACRK].

[125] *See* Part III.A and III.B, *infra*.

[126] The U.S. FCC initially determined that broadband services were "information" and not "telecommunications" services. Recently, the FCC reclassified broadband Internet access services as telecommunications services, but it went through "pains to emphasize that it was reclassifying . . . with a 'light touch'"—solely, for net neutrality purposes. Matthew L. Gibson, *Evolution of the FCC's Open Internet*, 54 INFRASTRUCTURE 9 (2014-15); *see also id.* at 9, *citing* FCC Open Internet Order, ¶ 456–542 (2015) ("The FCC has also decided not to impose the following common carrier obligations on broadband Internet access service: Any form of rate regulation . . .; Any requirement that providers of broadband Internet access service contribute to the universal service fund; or any other form of FCC-imposed tax or fees."); *see also* Frieden*, supra* note 99, at 461.

and customers.[127] Still, most of the companies use the SDGs as valuable rhetoric to navigate complex multi-jurisdictional regulatory issues and develop viable market strategies. Moreover, these companies are inadvertently following the UN's development agenda with regards to utilizing multi-stakeholder partnerships. However, as shown in the Section below, the partnerships and support corralled by these companies embarking on connectivity projects are not being pursued at the behest of the UN or the SDGs. The partnerships are a necessary byproduct of the current regulatory landscape concerning global resources, such as spectrum, civil airspace, and outer space, as well as the transnational nature of the Internet.

To succeed, the global broadband infrastructure these companies envision must accord with various regulatory frameworks. Ultimately these companies may initiate private-led standards, most evidently with regard to satellite mega-constellations. Although SDG 17 articulates governance concerns regarding partnerships and clarifies that the public sector's role is to set clear directions for such partnerships through regulation, to date, regulations have not caught up to the tech companies' innovations. Moreover, by navigating multi-jurisdictional issues and various regulatory frameworks to test viable market strategies, the non-traditional "telecommunications" companies could create regulatory effects. Such effects may be created as these companies informally influence national and global policies regarding global communications and contribute to the development of global and long-lasting infrastructures that have the power to shape lives for decades. Although projects of this nature—which rely on international and national regulatory frameworks—are not *per se* new, the transnational nature of high-altitude network infrastructure coupled with the global development agenda calls for more debate about the proposed last mile solutions and the adequacy of current regulatory frameworks.

The first Section below describes the global infrastructure solutions envisioned by Loon, Facebook, and next-generation satellite companies to bridge Internet access gaps globally, as well as the corresponding regulatory frameworks. The second Section then compares and contrasts the different

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[127] In terms of the revenue potential, one Loon engineer stated it could be a financially viable project if people paid a small portion of their income for access. *See* Ben Popper, *Inside Project Loon: Google's Internet in the Sky is Almost Open for Business*, VERGE (Mar. 2, 2015), https://www.theverge.com/2015/3/2/8129543/google-x-Internet-balloon-project-loon-interview ("Think about it—with 4.5 billion people without Internet access, take 5 percent; you're talking 250 million people . . . If those people pay just a small portion of their monthly income, say $5 a piece, you're going to be in a billion dollars a month in revenue, tens of billions a year in revenue. So it's good business, too.") [https://perma.cc/TNZ5-3H3E]; *see generally* Peter H. Diamandis, *4 Billion New Minds Online: The Coming Era of Connectivity*, SINGULARITYHUB (July 27, 2018), https://singularityhub.com/2018/07/27/4-billion-new-minds-online-the-coming-era-of-connectivity/ [https://perma.cc/U5MN-Q4T5].

broadband infrastructure projects to evaluate their disruptive potential. The last Section assesses the projects' prospective contribution towards telecommunications development, asking whether the innovations will enable some countries to leapfrog certain stages of infrastructure development.

A. High-Altitude Internet Infrastructure Projects and Applicable Regulatory Frameworks

Several companies are seeking to provide Internet access to people in rural and remote areas worldwide from high altitudes: Loon with its Internet-beaming balloons, Facebook with its solar-powered drones, and next-generation satellite companies with their LEO mega-constellations. Floating over various countries at altitudes above 60,000 feet, Loon balloons and Facebook drones trigger the application of mainly national civil aviation laws (and some international civil aviation standards typically implemented by national legislation), given that states have "complete and exclusive sovereignty over the airspace above [their] territory."[128] By floating in LEO, around 100 to 1250 miles high above Earth and sovereign airspace, the satellite mega-constellations must comply with the international and national regulations governing the global commons that is outer space. The projects and the corresponding regulatory frameworks are described below.

1. *Airspace Connectivity: Internet-beaming Balloons and Drones*

Through a network of balloons floating at high altitudes, Loon aims to extend Internet connectivity to help fill coverage gaps and bring people back online after disasters. The mission was conceived in 2011 and was under the supervision of employees at "X," Google's famous experimental division and "moonshot factory."[129] Loon is now among many Alphabet projects to become its own standalone business. Now Loon LLC, the global Internet connectivity project, is Alphabet's fully owned subsidiary and a sister company to Google.[130] Loon balloons are designed to fly roughly twice as high as

[128] Convention on International Civil Aviation art. 1, Dec. 7, 1944, https://www.icao.int/publications/Documents/7300_orig.pdf [https://perma.cc/TRK3-7AQU].

[129] Astro Teller, *The Unexpected Benefit of Celebrating Failure,* TED2016 (Feb, 15, 2016), https://www.ted.com/talks/astro_teller_the_unexpected_benefit_of_celebrating_failure/transcript [https://perma.cc/NG55-NQVF].

[130] Alphabet refers to these projects as 'Other Bets.' The businesses include Waymo (self-driving cars), Nest ("smart" thermostats), Verily (Alphabet's life sciences brand), Google Fiber, Project Loon (Internet connectivity with balloons) and Project Wing (drones), among others. Nick Statt, *Alphabet's Experimental Investments in the Future Continue to Cost it a Fortune*, VERGE (Jul. 23, 2018), https://www.theverge.com/2018/7/23/17604936/alphabet-

commercial air traffic and weather in the stratosphere. Loon engineers use wind forecast data sets from the U.S. National Oceanic and Atmospheric Administration and decision-making algorithms to determine which stratosphere current a balloon should ride when seeking to fly over certain areas.[131] Custom-built autolaunchers launch a new balloon into the network every thirty minutes. The company notes that with its software powered by machine learning, it can send small squads of balloons to where people need service.[132] Media coverage of Loon's test flights reveals that the balloons fly primarily over the southern hemisphere, where "services are needed most."[133]

Loon's balloons serve as "floating cell towers" working to extend wireless broadband infrastructure and coverage to a prescribed area. Each balloon contains a box of solar-powered electronics (transmitter, receiver, etc.) that allows it to make a radio link to a telecommunications network on the ground and beam down high-speed cellular Internet coverage to smartphones and other LTE-enabled devices.[134] From already established ground stations, antennae transmit connectivity across a balloon mesh network and back down to a user's LTE phone. For wireless infrastructure, the fundamental constraint of connectivity has been the proximity of users to ground stations and cell towers. Loon's balloons address this constraint via laser optic technology that enables transmitting connectivity across longer distances between balloons. One ground-based connection point can be leveraged across several nodes, allowing a single terrestrial access point to activate a web of connectivity via multiple balloons. Recent news articles note that Loon has successfully beamed a test connection 1,000 kilometers across seven balloons.[135]

Facebook has also joined the race to extend global connectivity with its own high-altitude Internet infrastructure project, housed under its Connectivity Lab.[136] With the help of an acquired company, Facebook

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google-other-bets-waymo-nest-future-investments-costs-fortune [https://perma.cc/G3FY-SCPH].

[131] *See* Popper, *supra* note 127.

[132] Loon LLC, *Loon–Improving Navigation*, YOUTUBE (Feb. 16, 2017), https://www.youtube.com/watch?time_continue=53&v=eHCKL-fCmk8 [https://perma.cc/7D6Y-PTHG].

[133] The southern hemisphere is less densely populated and full of "remote areas where broadband Internet is less likely to reach." Popper, *supra* note 127.

[134] *See* Tom Simonite, *Project Loon*, MIT TECH. REV. (Feb. 18, 2015), https://www.technologyreview.com/s/534986/project-loon/ [https://perma.cc/44JD-PHTG]. The balloons are made from polyethylene plastic and when fully inflated, are about fifteen meters wide. *Id*.

[135] *See* Kenn Abuya, *Telkom-Loon Partnership Makes Notable Milestone as Loon Sends a Single 1000km Connection Across 7 Balloons*, TECHWEEZ (Sept. 12, 2018), https://techweez.com/2018/09/12/loon-7-balloons-1000-km/ [https://perma.cc/T8UH-2DB9].

[136] Mark Zuckerberg, *The Technology Behind Aquila*, FACEBOOK (July 21, 2016),

designed and developed a solar-powered drone with the wingspan of a Boeing 737, called Aquila, to provide Internet access in remote and rural areas worldwide.[137] Compared to Loon's balloons, drones theoretically could beam broadband coverage to a greater geographic area, provide greater Internet speed, and remain in flight for longer periods of time—some say as long as five years.[138] In addition to Facebook's Internet.org initiative and Free Basics platform,[139] Aquila was one of many ways that Facebook is working to bring people in the developing world and remote areas online.

The future for both projects includes transforming the experimental ideas into viable commercial operations. No outstanding templates exist for bringing radical technologies to market. To be truly transnational and global infrastructure, the projects must follow international and national regulations concerning airspace, outer space, and spectrum. One such regulatory framework pertaining to Loon's agenda and emerging partnerships is discussed below, given that Facebook recently stated that it is no longer building its own Internet drones.[140] Notwithstanding, Facebook intends to keep working with partners on high-altitude Internet systems and to influence international and national policies concerning spectrum and aviation.[141]

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https://www.facebook.com/notes/mark-zuckerberg/the-technology-behind-aquila/10153916136506634/ [https://perma.cc/YWM2-R7AE].

[137] Sean Gallagher, *Facebook's Fleet of Solar-Powered Internet Drones Grounded Forever*, ARSTECHNICA (June 27, 2018), https://arstechnica.com/information-technology/2018/06/facebook-drops-solar-powered-internet-drone-business-cans-aquila/ [https://perma.cc/H3AC-TZYY].

[138] Soujanya Katikala, *Google Project Loon,* INSIGHT: 10 RIVIER ACAD. J. 5 (2014), https://www2.rivier.edu/journal/ROAJ-Fall-2014/J855-Katikala_Project-Loon.pdf [https://perma.cc/7CPH-FAMH].

[139] *See Free Basics Platform*, FACEBOOK FOR DEVELOPERS, https://developers.facebook.com/docs/Internet-org/ [https://perma.cc/54VK-VEAW].

[140] The Aquila project conducted two public test flights of a prototype in 2016, and one of the flights resulted in serious damage to the aircraft during landing. Martin Luis Gomez & Andrew Cox, *Flying Aquila: Early Lessons from the First Full-Scale Test Flight and the Path Ahead*, FACEBOOK ENGINEERING (July 21, 2016), https://code.fb.com/connectivity/flying-aquila-early-lessons-from-the-first-full-scale-test-flight-and-the-path-ahead/ [https://perma.cc/2H9H-PXNS]; Nick Statt, *Facebook Abandons Quest to Build Its Own Internet Drones*, VERGE (June 26, 2018), https://www.theverge.com/2018/6/26/17507826/facebook-aquila-Internet-drone-project-shut-down [https://perma.cc/F2RZ-6P6Z].

[141] In the past, Facebook has lobbied to open up the global regulatory environment with regards to aviation and spectrum policy to high altitude solutions. One engineer has noted that Facebook still plans to "actively participat[e] in a number of aviation advisory boards and rule-making committees in the U.S. and internationally." Statt, *supra* note 140.

a. Loon's Connectivity Project and the Regulatory Framework

Loon's envisioned broadband infrastructure primarily concerns two regulatory spheres, overflight and spectrum. To obtain overflight permissions, Loon has approached international regulatory agencies such as the International Civil Aviation Organization, Civil Air Navigation Service Organization, among others. Loon has also approached international and national public agencies to obtain spectrum licenses. But given the high cost of spectrum licenses, Loon's efforts have focused on partnering with existing licensed telecom companies. Both regulatory spheres, in the context of Loon's already emerging partnerships, are discussed below.

Floating at an altitude of 60,000 feet, Loon's balloons require permission from several countries in the balloons' flight path to fly over their territories and reach the desired coverage area. A basic tenet of international law is that every state has complete and exclusive sovereignty over the airspace above its territory.[142] The Paris Convention of 1919 sided with the "sovereignty of the air" school (as opposed to the "freedom of the air" school), emphasizing that each nation has absolute sovereignty over the airspace covering its territories and waters.[143] The Convention on International Civil Aviation of 1944, also known as the Chicago Convention, with 191 signatories, re-codified this principle of sovereignty over airspace.[144] Article 6 of the Chicago Convention further states that "[n]o scheduled international air service may be operated over or into the territory of a contracting State, except with the special permission or other authorization of that State."[145] To that end, the International Air Services Transit Agreement of 1944 (with 130 signatories) grants certain freedoms of the air, such as flying across signatory states' territory, for *scheduled* international air services.[146] Article 5 of the Convention, concerning *non-scheduled* air services, still requires compliance

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[142] *See* William W. Bishop, Jr., INTERNATIONAL LAW: CASE AND MATERIALS 422–23 (Little Brown & Co. Law & Business eds., 1953); John Cobb Cooper, *The Chicago Convention After—Twenty Years*, 19 U. MIAMI L. REV. 333, 334–35 (1965).

[143] Jae Woon Lee, *Revisiting Freedom of Overflight in International Air Law: Minimum Multilateralism in International Air Transport,* 38 AIR & SPACE L. 351 (2013) (the Paris Convention (1919) embraced sovereignty of the air principle, while the Chicago Convention (1944) embraced an extreme version of the principle).

[144] *Id.* at 360–61. The limits of the sovereignty of the air principle and the definition of "airspace" will be discussed in the context of satellite mega-constellations. *See infra* Section III.1.A.2.a.

[145] *See* Convention on International Civil Aviation, *supra* note 128, at art. 6.

[146] ICAO, *Information Paper on Revisiting the International Air Services Revisiting the International Air Services Transit Agreement of 1944* (ICAO Information Paper No. LC/36- IP/2), (Nov. 25, 2015), https://www.icao.int/Meetings/LC36/Working%20Papers/LC%2036%20-%20IP%202.en.pdf [https://perma.cc/333V-V7UP].

with state regulations, otherwise the state may require landing as a condition of flying over its territory.[147] As a non-scheduled international flight under this framework, Loon must work with individual state aviation agencies to obtain and maintain permissions to fly over and land in certain countries.

To facilitate overflight permissions, Loon has already begun meeting with international public aviation agencies and industry groups. Loon has approached the International Civil Aviation Organization (ICAO), a UN specialized agency and global aviation forum established by the Chicago Convention. Many of ICAO's standards are the basis for member states' aviation regulations, allowing for standardization of operating procedures among ICAO countries.[148] ICAO provides a forum for states to discuss global aviation topics, including overland flight agreements. Ultimately, this forum facilitates and accelerates the process to obtain necessary permits from national civil aviation authorities.[149] In 2016, Loon went before ICAO for its triennial assembly to ask the 191 member states for airspace access. Loon specifically asked for standardized overflight agreements to allow it to expand its global and regional testing.[150] The ICAO General Assembly endorsed Loon, noting the balloons comply with ICAO standards and go beyond the safety requirements.[151] When presenting to ICAO, Loon noted its intent to support SDGs 9 and 17 with its proposed infrastructure.[152] Various ICAO

[147] *See* Lee, *supra* note 142, at 360; Cooper, *supra* note 142, at 339–40 (explaining ambiguities in Articles 5 and 6 of the Chicago Convention).

[148] States that signed the Chicago Convention are responsible for implementation of Standards and Recommended Practices (SARPs) through civil aviation authorities. *See* Convention on International Civil Aviation, *supra* note 128, at art. 37–38.

[149] *See* OPSGroup, *World Permit Map*, FLIGHT SERV. BEUREAU, http://www.fsbureau.org/permitmap [https://perma.cc/W4BK-TF84].

[150] *Google Asks for Airspace Access for Internet Balloons*, PHYS.ORG (Sept. 30, 2016), https://phys.org/news/2016-09-google-airspace-access-Internet-balloons.html#jCp [https://perma.cc/5CPQ-PHLR]; *Seventh Meeting of the North American, Central American and Caribbean Directors of Civil Aviation* 3 (ICAO Working Paper No. NACC/DCA/07–WP/16, July 31, 2017) [hereinafter *Seventh Meeting*], https://www.icao.int/NACC/Documents/Meetings/2017/NACCDCA7/NACCDCA7WP16.pdf [https://perma.cc/LH4B-T4X3].

[151] *Seventh Meeting*, *supra* note 150, at 2.

[152] Loon maintained that the Internet-carrying balloons directly support the UN's SDGs, particularly goals 9 and 17, targets 9.2, 17.6, and 17.8, and indicators 17.6.2 ("Fixed Internet broadband subscriptions, by speed"); 17.8.1 ("Proportion of individuals using the Internet"); and 9.c.3 ("Percentage of population covered by a mobile network, by technology"). *See* ICAO, REPORT OF THE TWENTY-FIRST MEETING OF THE AFRICA-INDIAN OCEAN PLANNING AND IMPLEMENTATION REGIONAL GROUP (APIRG/21) 33 (Feb. 9, 2018), https://www.icao.int/ESAF/Documents/APIRG/APIRG%2021/Final%20Report%20and%20Appendices/Final%20Report/APIRG%2021%20Report%20-%20FINAL.pdf [https://perma.cc/D2NP-F3XT].

committees have acknowledged Loon's intent to support the SDGs.[153] In a letter to member states, ICAO's Secretary-General recommended that states finalize operational letters of agreement with Loon "to provide trans-global Internet access."[154] Some countries signed overflight agreements during the ICAO Assembly.[155] Desiring more multilateral agreements to secure necessary authorizations and partnerships for ease of operations and direct "float" paths, Loon held a briefing workshop for the Eastern African Community (EAC) and its member states.[156] To date, Loon has not announced the total amount of procured overflight agreements formed.

Besides working with governmental civil aviation agencies, Loon has also joined the Civil Air Navigation Service Organization (CANSO) as a way to work in partnership with Air Navigation Service Providers (ANSPs).[157] CANSO is a representative body of companies that provide air traffic control services and represents the interests of ANSPs. Air traffic control issues are integral to Loon's operations. Loon must coordinate directly with local air traffic control when balloons are launched, throughout their flight, and upon descent. Each balloon is equipped with a transponder that constantly transmits its position and altitude to air traffic control.

In addition to partnering with various aviation organizations and agencies, Loon balloons must comply with telecommunications regulations. To extend connectivity, the Loon balloon network relies on radio waves, which are fundamental to many telecommunications services and technologies. Rules and guidelines ensure the orderly allocation and use of radio frequencies, or "electromagnetic spectrum," at the international and

[153] "The Committee noted that [Loon] directly supports SDGs 9 and 17 and encouraged the Assembly to endorse the spirit of paper extending its coverage to all aviation solutions that are compliant with SARPs that assist in the achievement of the SDGs related to bringing the Internet to underserved parts of the world." CANSO, *Project Loon–Floating Cell Phone Towers in the Sky* 2 (ICAO DG Conference Africa) (document undated), https://www.icao.int/WACAF/Documents/DGCA/DGCA-6/WP%2010.2%20-%20Africa%20DG%20Conf%20-%20Project%20Loon%20(CANSO).pdf [https://perma.cc/V86G-GY76].

[154] *Seventh Meeting*, *supra* note 150, at 4 (referencing ICAO State Letter (Ref. AN13/22.1-16/42, June 17, 2016, *High Altitude Operations of Unmanned Free Balloon*).

[155] Kenya and Nigeria signed agreements for overflight during the ICAO Assembly. *See Project Loon – Floating Cell Phone Towers in The Sky*, *supra* note 153, at 2.

[156] ICAO, *Seventh Meeting of the Directors General of Civil Aviation Administration of the AFI Region*, (AFI-DGCA/7–WP/18, July 20, 2018); Civil Aviation Safety and Security Oversight Agency (CASSOA), *Project Loon – Aviation Powered Internet* CASSOA.ORG (June 26, 2018), http://www.cassoa.org/cassoa/?p=1713 [https://perma.cc/6KFY-RYYK].

[157] *CANSO Members: Project Loon*, CIVIL AIR NAVIGATION SERVS. ORG., https://www.canso.org/sites/default/files/Article%20-%20Project%20Loon.pdf [https://perma.cc/Z72Q-R26Q]; *Project Loon: Managing Balloon Technology in Airspace*, 4 AIRSPACE 26–27 (2016).

national levels of governance. At the international level, the ITU has long regulated the global community's use of wired and wireless communications mediums.[158] The ITU specifically regulates radio frequencies, working to prevent interference across borders and ensure efficient use of the finite natural resource.[159] With a long history of international coordination, the UN specialized agency brings together 193 member states, more than 700 private entities, and 150 academic institutions to weigh in on a complex frequency allocation plan.[160] The ITU regularly holds World Radio Conferences to establish regulations and allocation plans for the global use of radio spectrum. At the conferences, the latest versions of the Radio Regulations, the main body of ITU laws which have treaty status, are adopted.[161] Each country has its own frequency allocation plan based on the ITU plan.[162] With the right to exclude certain frequency allocations within national borders and with three different allocation plans divided by regions, countries' frequency allocation charts differ. Even so, there is much overlap for most allocations.[163] Beyond complying with regional and international allocations, spectrum licenses ultimately depend on national regulations and local availability.[164]

The nature of this regulatory framework has led Loon to begin partnering with various telecommunications companies. Loon employees have done outreach with the ITU, but no significant lobbying efforts exist at the

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158 *See generally* INT'L TELECOMM. UNION, THE INTERNATIONAL TELECOMMUNICATION UNION: AN OVERVIEW (2002), https://www.itu.int/itudoc/gs/promo/gs/81150.pdf [https://perma.cc/9GDT-GMX3]; s*ee also* SCOTT MADRY ET AL., INNOVATIVE DESIGN, MANUFACTURING AND TESTING OF SMALL SATELLITES 92 (2018) ("The ITU addresses and agrees on global transmission standards for all types of media and transmission services whether via wire, coaxial cable, optical transmission systems, radio frequency and infrared transmission, or wireless mobile telecommunications systems of all types including cellular telephone, radio communications services (including specialized commercial, medical, and emergency services), satellite services of all types, and even links to UAVs and High-Altitude Platforms.").

159 Veronique Wavre, *Universal Service Obligation (USO) and Spectrum Management*, *in* POLICY DIFFUSION AND TELECOMMUNICATIONS REGULATION 7374 (2018).

160 OECD, INTERNATIONAL TELECOMMUNICATION UNION (ITU) PROFILE, 1 (2016), https://www.oecd.org/gov/regulatory-policy/ITU%20profile.pdf [https://perma.cc/7XJV-WWPT]; MADRY ET AL., *supra* note 158, at 92.

161 *See* NAT'L AERONAUTICS AND SPACE ADMIN., SPECTRUM 101: AN INTRODUCTION TO NATIONAL AERONAUTICS AND SPACE ADMINISTRATION SPECTRUM MANAGEMENT, at iv, 18 (2016), https://www.nasa.gov/sites/default/files/atoms/files/spectrum_101.pdf [https://perma.cc/3Y2Q-T6XG]; François Rancy, *ITU Radio Regulations – 110 Years of Success*, ITU NEWS MAGAZINE, 15 (May 2016) https://www.itu.int/en/itunews/Documents/2016-05/2016_ITUNews05-en.pdf [https://perma.cc/4Y3M-FC4E].

162 MADRY ET AL., *supra* note 158, at 93.

163 *Id.*

164 KERRETTS, *supra* note 36, at 53.

international level with regards to spectrum given the role of national telecommunications agencies in regulating spectrum use.[165] Moreover, instead of procuring spectrum licenses or utilizing the already crowded unlicensed spectrum, Loon's market strategy is to partner with existing telecom providers.[166] Initially, Loon leaders wanted to lease spectrum, but another vision prevailed—lease the balloons to wireless carriers to expand their network coverage. This saves Loon spectrum license expenses and ensures that telecom companies are partners, not competitors.[167] In that regard, Loon is not an Internet service provider; individuals can only access the balloon network through their mobile network operator. Therefore, Loon now must not only gain support from national and occasionally international regulators, but also private actors, adding an additional layer of complexity.

In fact, Loon has worked with national regulatory agencies and existing telecom providers to conduct tests in various countries, signaling that the company is ready to enter into commercial deals with network operators around the globe. Prior to 2017, the Loon team completed beta tests in New Zealand, Brazil, Nevada, and Central California—typically using unlicensed spectrum.[168] In 2017, Loon partnered with the Peruvian government and Telefonica to deliver Internet access to flooded areas around Lima.[169] That same year, the FCC awarded Loon an experimental license to help connect

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[165] Olivia Hatalsky et al., PowerPoint Presentation, ITU Outreach-Project Loon, (Sept. 14, 2017), https://www.itu.int/en/ITU-R/seminars/rrs/RRS-17-Americas/Documents/Forum/3_Google%20Olivia%20Hatalsky.pdf [https://perma.cc/GNA7-P556].

[166] The radio waves used in Loon's New Zealand launch operated on unlicensed spectrum in the 2.4GHz and 5.8GHz bands used in wi-fi. *See* Liam Tung, *Google Trials LTE in Project Loon's Balloons over Brazil*, ZDNET (June 17, 2014), https://www.zdnet.com/article/google-trials-lte-in-project-loons-balloons-over-brazil/ [https://perma.cc/Q82M-AJGD].

[167] *See* Simonite, *supra* note 134.

[168] The Loon team has conducted tests with a few telecom companies that have spectrum and infrastructure in place to market the service to customers: Vodafone in New Zealand, Telstra in Australia, and Telefonica in Latin America. The Loon team has conducted research flights in California's Central Valley to test the strength of the balloon-powered Internet connection and small-scale field trials in rural areas of New Zealand. Loon successfully connected a local school in an isolated area of northeastern Brazil to the Internet for the first time. In 2016, the Indian government was approached about a pilot project with Loon, and in the summer of 2017, Kenya. *See* Simonite, *supra* note 134. *See also* FCC, Experimental Radio Station Construction Permit and License, File No. 0251-EX-CR-2017*,* https://apps.fcc.gov/els/GetAtt.html?id=192339&x= [https://perma.cc/5SVZ-Y6ZJ].

[169] After working with O3B networks, Level 3 and Ecologistica Peru to set up ground stations (which connect the balloons to the backbone of the Internet) and integrating the balloon-powered Internet into Telefonica's network, the balloon network transmitted more than 160 GB worth of data over the span of seven weeks, or about 2 million emails worth of data. Alastair Westgarth, *Helping out in Peru*, MEDIUM (May 17, 2017), https://medium.com/loon-for-all/helping-out-in-peru-9e5a84839fd2 [https://perma.cc/AT2V-Q4VN].

people in Puerto Rico after Hurricane Maria.[170] To this day, Loon maintains its relationship with FCC, for example by recently encouraging the agency to "clarify that [USF] resources can be used by mobile carriers to support Loon and other new solutions that expand the preparedness and resilience of the communications networks."[171] Alphabet recently announced Loon's first commercial contract with Telkom Kenya, a partially state-owned enterprise, to provide coverage to remote areas of Kenya in 2019.[172]

Ultimately, the company is navigating multi-jurisdictional regulatory issues in light of its transnational infrastructure solution. In doing so, it is following the UN's advice regarding multi-stakeholder partnerships for infrastructure development—a consequence of the current regulatory landscape concerning public goods such as spectrum and airspace.

2. *Outer Space Connectivity: The Global Broadband Space Race*

Alphabet is not alone in its mission to connect the globe; over the past several years, there has been renewed interest in satellite Internet. Remarkably, this revival has emerged despite satellite Internet companies' troubled history,

[170] Loon obtained consent agreements to use land mobile radio spectrum in the 900 MHz band from existing carriers operating within Puerto Rico. By collaborating with the FCC, the FAA, FEMA, AT&T, T-Mobile, and many others, Loon was able to provide connectivity to 200,000 Puerto Ricans after Hurricane Maria. *See* Press Release, FCC, *FCC Grants Experimental License for Project Loon to Operate in Puerto Rico* (Oct. 7, 2017), https://www.fcc.gov/document/fcc-grants-experimental-license-project-loon-puerto-rico/. [https://perma.cc/29ZD-KXHY].

[171] In the aftermath of Hurricane Marina, eligible telecommunications companies leveraged innovative technologies to reconnect their subscriber base, ranging from cells-on-wheels, to cells-on-UAVs, to Loon balloons. Loon called for project costs to be reimbursable for eligible telecommunications carriers from the High Cost Fund. *See* In the Matter of The Uniendo a Puerto Rico Fund and the Connect USVI Fund, Comments of Loon LLC, FCC, (July 26, 2018), https://ecfsapi.fcc.gov/file/107261684001853/2018-07-26%20Loon%20Comments%20(WC%2018-143).pdf [https://perma.cc/8U5D-SBEW]; Monica Avellen, *Loon Highlights Value Of Mobile Carrier Partnerships in Puerto Rico*, FIERCEWIRELESS (July 30, 2018), https://www.fiercewireless.com/wireless/loon-highlights-value-mobile-carrier-partnerships-puerto-rico [https://perma.cc/6T8Y-8EDF].

[172] Safaricom Kenya Limited controls 71.2% of the total subscription followed by Airtel Kenya with 17.6% with Telkom Kenya and Finserve East Africa (Equitel) controlling a market share of 7.4% and 3.8% respectively. *See* Alfred Kipyegon Bett et al., *Analysis of Information Systems Capabilities and Performance of Firms in Telecommunications Industry, Kenya,* 6 INT'L J. SCI. RES. & MGMT. 319, 320 (2018); Jamal Carnette, *Is Alphabet's Craziest Moonshot Starting to Pay Off?,* MOTLEY FOOL (July 26, 2018), https://www.fool.com/investing/2018/07/26/is-alphabets-craziest-moonshot-starting-to-pay-off.aspx [https://perma.cc/YNW6-ZNKL].

marked by bankruptcies in the 1990s.[173] A handful of satellite companies, including OneWeb, SpaceX, and O3b (or "Other 3 Billion"), are developing fleets of smaller satellites to circumscribe Earth and provide truly global Internet service. The mega-constellations that they propose are on a mission to bridge the digital divide. In 2017, executives of these companies spoke to the United States Senate Committee on Commerce, Science, and Transportation about the future of the commercial satellite industry and discussed regulations that could aid in their efforts to bridge the divide and enhance social and economic development.[174] So far, none of the companies have deployed their full constellations to space, setting off a global broadband space race to see who will obtain first mover advantage.

The innovators at SpaceX, OneWeb, and O3b are working to change the cost structure and quality of satellite service. Satellite Internet has been an option for people living in rural areas (especially in developed countries) for decades—albeit an expensive alternative, often providing patchy, low-quality service. By launching thousands of smaller satellites in lower orbits, next-generation satellite service providers expect to see less latency. Traditionally, satellite communications systems "hover" in geosynchronous orbit, about 22,000 miles above the Earth, whereas satellites in LEO float roughly 100 to 1,250 miles above Earth and are not aligned with Earth's rotational period.[175]

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[173] The trend to launch commercial small satellite constellations began in the early 1990s. As a result of insufficient market demand and technical issues, the companies Iridium and Globalstar went through bankruptcy proceedings. Iridium in fact went bankrupt one year after deployment. *See* RAM S. JAKHU & JOSEPH N. PELTON, GLOBAL SPACE GOVERNANCE: AN INTERNATIONAL STUDY 358-61, 370 (2017). Since the 1990s, projected costs of satellite operations have decreased by two orders of magnitude. *See* BHAVYA LAL ET AL., INST. FOR DEF. ANALYSES, GLOBAL TRENDS IN SMALL SATELLITES 284 (2017), https://www.ida.org/-/media/feature/publications/g/gl/global-trends-in-small-satellites/p-8638.ashx [https://perma.cc/WS8R-L8WE].

[174] The Commercial Satellite Industry: What's Up and What's on the Horizon: Hearing Before the S. Comm. on Commerce, Sci., and Transp., 115th Cong. (2017). Recent scholarship indeed argues that companies specializing in satellite and space technology can positively contribute to the global development agenda. See JAKHU & PELTON, supra note 173, at 520–23, 529–36; Small Satellites and the U.N. Sustainable Development Goals, in MADRY ET AL., *supra* note 158, at 65; European Space Agency, *Sustainable Development With A Little Help From Space*, ESA.INT, (May 31, 2016), http://www.esa.int/Our_Activities/Preparing_for_the_Future/Space_for_Earth/Sustainable_development_with_a_little_help_from_space/ [https://perma.cc/X4ZP-BS5L]; EUROCONSULT EC, PROSPECTS FOR THE SMALL SATELLITE MARKET, (2018), http://www.euroconsult-ec.com/research/smallsats-2018-brochure.pdf [https://perma.cc/B8VL-5P7N].

[175] *See* Klint Finley, *Can These Small Satellites Solve The Riddle Of Internet From Space?*, WIRED (March 1, 2018), https://www.wired.com/story/can-these-small-satellites-solve-the-riddle-of-internet-from-space/ [https://perma.cc/R7PB-Z4KV]. In geostationary orbit, a

In higher orbits, connections can lag quite a bit, making real-time connections impracticable. Yet geostationary satellites provide more geographic coverage on Earth with fewer satellites, whereas a LEO network requires thousands of smaller satellites to achieve the same amount of geographic coverage.[176] For instance, SpaceX's constellation will have nearly 12,000 satellites.[177] Although smaller LEO satellites are a fraction of the cost of traditional ones, launching thousands of them could still result in significant total project costs.[178] Consequently, many companies are working to reduce the costs of launching satellites into space.[179] Some companies are also considering smaller fleets that will operate in middle Earth orbits.[180]

Like Loon, satellite companies are also on mission to address the problem of the global last mile. For example, OneWeb's mission is to bridge the global digital divide by 2027, and the company frequently uses the term "global" to market its ambitions: OneWeb is "building a new *global* knowledge infrastructure accessible to all" and "can address the most

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satellite "hovers" over one spot because the satellite's orbital period aligns with Earth's rotational period.

[176] *See* Lawrence D. Roberts, *A Lost Connection: Geostationary Satellite Networks and the International Telecommunication Union*, 15 BERKELEY TECH. L.J. 1095, 1099–100 (2000); Stewart Sanders, *The New Space Race is All About Satellites: Pros and Cons of Each Orbit*, THENEXTWEB (Nov. 3, 2018), https://thenextweb.com/contributors/2018/11/03/the-new-space-race-is-all-about-satellites-pros-and-cons-of-each-orbit/ [https://perma.cc/E3QX-EKEP].

[177] *See* Finley, *supra* note 175. Recently, OneWeb received FCC approval to serve U.S. customers with a constellation of 720 satellites, far from the thousands envisioned by some LEO networks. FCC FACT SHEET, *OneWeb Market Access Grant*, Order and Declaratory Ruling - IBFS File No. SAT-LOI-20160428-00041, https://transition.fcc.gov/Daily_Releases/Daily_Business/2017/db0601/DOC-345159A1.pdf [https://perma.cc/X8D4-XZEM].

[178] Small satellites are less massive, which substantially reduces launch costs. Also, the designing, manufacturing and launching stages can be completed in less than two years, lowering mission costs. *See* JAKHU & PELTON, *supra* note 173, at 366. In 2015, OneWeb's goal was to build satellites at $500,000 per satellite or less. The total estimated cost of building, launching and operating the constellation is $3.5 billion. *See* Caleb Henry & Brian Berger, *Amid Concerns, OneWeb Gets Vague About Constellation's Cost*, SPACENEWS (Sept. 12, 2018), https://spacenews.com/amid-concerns-oneweb-gets-vague-about-constellations-cost/ [https://perma.cc/TCF7-YBZK]. Recently, OneWeb refused to affirm satellite unit costs or total program costs, disclosing only that each satellite cost less than $1 million to produce. Caleb Henry, *OneWeb Vouches for High Reliability of Its Deorbit System*, SPACENEWS (July 10, 2017), https://spacenews.com/oneweb-vouches-for-high-reliability-of-its-deorbit-system/ [https://perma.cc/2PYC-X9GT].

[179] *See* Finley, *supra* note 175.

[180] Satellites in middle Earth orbit still provide lower latency connections than satellites in geostationary orbit, but the total number of satellites needed to provide complete coverage would also decrease. *See* Finley, *supra* note 175.

demanding *global* connectivity challenges. . . ."[181] In many respects, its mission is similar to Loon's. For instance, the goal is not only to provide rural areas with Internet access, but to "assure *global* communications" by bringing areas back online after natural disasters. Aspiring to be a global infrastructure solution, companies like OneWeb and O3b are also creating go-to-market strategies that opt for Loon's approach, planning to partner with other operators who have already leased spectrum to extend current networks. In other words, some companies plan on selling bandwidth to Internet service providers or mobile providers, rather than directly to end-users.[182]

Next-generation satellite companies' next steps include planning viable commercial deployments and gaining regulatory approvals. To successfully bring global infrastructure to market, companies will have to work with international and national public agencies regulating space and spectrum to gain necessary approvals. However, companies planning large-scale satellite deployments could face legal and regulatory issues because current international and national space regulations do not fully address large-scale satellite constellations.[183] Companies will have to work with an outdated and complex regulatory framework, potentially undermining the ability of satellite broadband infrastructure to bridge the global digital divide.

a. Connectivity via Mega-Constellations and the Regulatory Framework

Plans to launch next-generation satellites will trigger the application of national and international air and space laws. As explained above, states have "complete and exclusive sovereignty over the airspace above [their] territory" in accordance with Article 1 of the Chicago Convention.[184] However, the concept of complete and exclusive sovereignty over the airspace above a state's territory has evolved in the last century. The concept of *usque ad coelum*, whereby sovereignty extended "to the heavens," was modified by the Outer Space Treaty of 1967. The treaty "set vertical limits to a [s]tate's sovereignty over airspace."[185] While the boundary between airspace and outer space is not clear, states admit that their sovereignty over airspace is no longer

[181] ONEWEB, http://www.oneweb.world/ [https://perma.cc/4S9G-3CH7]. Even the web address has a ".world" domain name.
[182] *See id.*; *Seamlessly Scaling our O3b Fleet to Meet Exponential Demand for Connectivity*, SES (Feb. 26, 2018), https://www.ses.com/newsroom/seamlessly-scaling-our-o3b-fleet-meet-exponential-demand-connectivity [https://perma.cc/32RC-L9AU]; Finley, *supra* note 175.
[183] *The Commercial Satellite Industry: What's Up and What's on the Horizon: Hearing Before the S. Comm. on Commerce, Sci., and Transp.*, 115th Cong. (2017).
[184] Convention on International Civil Aviation, *supra* note 128, at art. 1.
[185] Legal Committee, ICAO, *Revisiting the International Air Services Revisiting the International Air Services Transit Agreement Of 1944*, at 2 (No. LC/36-IP/2 2015).

infinite and ends where outer space begins.[186] Launched satellites transiting through a state's airspace must therefore accord international and national civil aviation regimes. Upon reaching the undefined vertical limits of national airspace and entering outer space, however, a different regulatory framework applies.[187]

The legal framework for outer space activities consists of five international treaties which were adopted between 1967 and 1979, including the Outer Space Treaty, the Liability Convention, and the Registration Convention. Many terms in the treaties have been adopted by national space legislation. With 107 signatories, the Outer Space Treaty—which contains basic principles for space activities—is considered to contain principles of customary international law.[188] One such principle is that outer space and celestial bodies are global commons, not subject to national sovereignty and jurisdiction.[189] According to the Outer Space Treaty and the Liability Convention, a launching state (i.e., a state that launches or procures the launching of a space object or from whose territory or facility an object is launched) is internationally liable for damage caused by its space object.[190] Determining the launching state can be complex with regard to multinational launches because more than one state may be implicated, and the international

[186] There is no international agreement that defines the altitude that is considered outer space, nor the demarcation between airspace and outer space. *See* JAKHU & PELTON, *supra* note 173, at 653–54.

[187] *See id.* at 311.

[188] The Outer Space Treaty is considered to contain principles of customary international law, binding signatories and non-signatories alike. The customary principles can be found in Articles I–IV, VI, VII, VIII and arguably also Art. IX. *See* Rada Popova & Volker Schaus, *The Legal Framework for Space Debris Remediation as a Tool for Sustainability in Outer Space*, 5 AEROSPACE 1, 4 (2018), https://www.mdpi.com/2226-4310/5/2/55 [https://perma.cc/GYV3-YST9].

[189] This is stated in the first paragraph of Article 1 in the Outer Space Treaty, "according to which the use and exploration and use [sic.] of outer space should be regarded as the 'province of all mankind.'" Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, art. 1, Jan. 27, 1967 (hereinafter "Outer Space Treaty"); *see also* Popova & Schaus, *supra* note 189, at 4.

[190] Convention on International Liability for Damage Caused by Space Objects, art. I(c), II, III, Nov. 29, 1971; Outer Space Treaty, *supra* note 189, at art. VII. *See also* CHRISTOPHER D. JOHNSON, SECURE WORLD FOUND., LEGAL AND REGULATORY CONSIDERATIONS OF SMALL SATELLITE PROJECTS 8, https://swfound.org/media/188605/small_satellite_program_guide_-_chapter_5_-_legal_and_regulatory_considerations_by_chris_johnson.pdf (noting four potential categories of launching states: (1) the state that launches; (2) the state that procures the launch; (3) the state from whose territory an object is launched; and (4) the state from whose facility an object is launched) [https://perma.cc/R2QH-5MM4].

rights and obligations of the launching states may differ.[191] Depending on treaty obligations, each launching state may be internationally responsible and potentially liable under international space law—prompting governments to regulate, supervise, license and oversee satellite projects.[192] This authorization requirement extends to small satellite constellations, which are legally considered "space objects," independent of their size.[193] Moreover, if a state is a signatory to the Registration Convention, it is required to register launched space objects nationally and internationally with the UN.[194] Even if there is more than one launching state, there is only one state of international registry for each satellite.[195]

The launching of communications satellites also triggers the application of national and international spectrum laws. Each country has its own frequency allocation plan, which mostly overlaps with the frequency allocation plan put forth by ITU members for satellite services and communications.[196] Electromagnetic spectrum for radio communications between satellites and ground stations is limited, requiring responsible use and sharing of the finite natural resource.[197] The process of obtaining a license to operate a satellite in a certain market normally involves filing an application for the intended frequency with the national telecommunications agency in the country where the satellite will provide connectivity.[198] Under the ITU Radio

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[191] *See* JOHNSON, *supra* note 190, at 10 ("Once the launching states question is answered, it is wise to investigate what international space treaties these states are party to. . . . Determining the launching states will show which ones have what international responsibilities under international space law, including registration with the UN.").

[192] States bear international responsibility for national activities in outer space, no matter if the activities are performed by governmental or commercial organizations. Thus, under the various treaties states are required to authorize and license national space activities and ensure continuous supervision and control. *See* Outer Space Treaty, *supra* note 189, at art. VI; JOHNSON, *supra* note 190, at 10. Some satellite constellations require additional authorizations and permits from government authorities. *See* JAKHU & PELTON, *supra* note 173, at 371.

[193] *See* JAKHU & PELTON, *supra* note 173, at 371.

[194] International space law encourages and sometimes mandates states to register their space objects in the international registry in order to notify other states of their space activities. The United Nations Office for Outer Space Affairs (UNOOSA) keeps the space object registry. Some of the information is voluntarily supplied to UNOOSA by states, whereas registration is mandatory for states party to the 1975 Registration Convention. *See* JAKHU & PELTON, *supra* note 173, at 371; JOHNSON, *supra* note 190, at 10.

[195] JOHNSON, *supra* note 190, at 14.

[196] MADRY ET AL., *supra* note 158, at 93.

[197] *See* JOHNSON, *supra* note 190, at 3.

[198] Entities may file a petition for a declaratory ruling to access the U.S. market using a non-U.S.-licensed space station. *See* 47 C.F.R. § 25.137 (2019); In the Matter of Streamlining Licensing Procedures for Small Satellites, FCC 18-44, April 17, 2018, para. 23 https://transition.fcc.gov/Daily_Releases/Daily_Business/2018/db0417/FCC-18-44A1.pdf [https://perma.cc/UGL4-G8JN]. If a satellite company wants to reach a certain national

Regulations, satellites may not be operated without a license "by or on behalf of the government of the country to which the station in question is subject."[199] For example, under the U.S. Communications Act of 1934, satellite operators must be issued a license allowing communications to and from the United States or from any U.S. satellite.[200] Moreover, the same Act grants the FCC authority to implement the ITU's Radio Regulations.[201] Upon meeting the filing requirements of the national licensing agency, which may take years, the national administration, as a member of the ITU, then notifies the ITU and enters the satellite's frequency on the master chart of internationally used frequencies.[202] The filings with the ITU must detail the "specific frequency bands that are to be utilized as well as the specific orbits and orbital patterns to be used by the intended system."[203] Filing initiates the publication stage of the ITU process, whereby the ITU checks the submitted information for completeness and publishes the filing for members to review and comment.[204] This stage does not confer rights or any priority on the filing administration. The next stage of the process, called "coordination," entails negotiations between affected countries and the notifying administration.[205] The last stage

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market, it must apply for a spectrum license with the relevant telecommunications agency. For example, recently Canada-based Telesat and Space Norway, with constellations authorized by other administrations, applied for U.S. market access with the FCC. The FCC declined Telesat's request that its constellation should have spectrum priority based on its filing date with the ITU facilitated by the Canadian administration. *See* In the Matter of Telesat Canada, FCC 17-147 (Nov. 3. 2017) https://www.fcc.gov/document/telesat-ngso-market-access-grant [https://perma.cc/6YJM-RKGX]; Caleb Henry, *FCC Grants Telesat LEO Market Access Despite Viasat Protests*, SPACENEWS (Nov. 6, 2017), https://spacenews.com/fcc-grants-telesat-leo-market-access-despite-viasat-protests/ [https://perma.cc/D9DJ-W532].

[199] ITU Radio Regulations, No. 18.1 (2016), http://search.itu.int/history/HistoryDigitalCollectionDocLibrary/1.43.48.en.101.pdf [https://perma.cc/V6PS-UBZX].

[200] 47 U.S.C. § 301(d), (f) (2018).

[201] 47 U.S.C. § 303(r) (2018).

[202] *See* JOHNSON, *supra* note 190, at 4.

[203] States that are party to the Outer Space Treaty and Registration Convention enact national laws embodying international standards, which require detailed information to issue a license. The information to be filed typically includes, "the number and size of the satellites and many details of their technical characteristics, plus business plans for the services to be provided, the builder of the satellite and related contractual details, the financial details as to financing, contractors to build and launch the satellite, specific details as to mitigation procedures to lessen the possibility of creating orbital debris. . ." MADRY ET AL., *supra* note 158, at 94-95.

[204] Int'l Telecomm. Union, *How Satellites are Brought into Service: A Brief Account of the Regulatory Steps for Satellites Using Frequency Bands Falling Under the "Coordination Procedures,"* WORLD RADIO CONFERENCE 2000 https://www.itu.int/newsarchive/wrc2000/presskit/how-sat.html [https://perma.cc/QDB4-GY4D].

[205] *Id.*

is notification.

With LEO mega-constellations several steps ahead of regulation, scholars point to several issues requiring international cooperation and intersystem coordination: namely, the ITU's "first come, first served" principle, inadequate processes for orbital congestion and spectrum interference, and ineffective space debris mitigation requirements.

First, although the ITU's "first come, first served" principle aims to provide equitable access to spectrum resources, some have noted the tendency of countries to abuse the system by filing "paper satellites."[206] Today, the worry is that companies launching in LEO might go "regulation shopping" to a "government of convenience," which might require fulfillment of fewer national requirements and deployment deadlines before filing applications to the ITU for large constellations.[207] Some question whether the ITU's approval process for frequencies and orbital allocation for mega-LEO constellations "represents a reasonable economic, regulatory, and safety assessment model to follow."[208]

Second, scholars note the inadequate processes to mitigate orbital congestion and spectrum interference. Present-day national and international regulatory procedures do not address the question of "how many new mega-LEO systems can be plausibly deployed. . . ."[209] With so many companies competing in the global broadband space race, absent international coordination, future orbital congestion and harmful spectrum inference are a given.[210] To tackle this issue, international cooperation would need to address which frequency plans and constellation orbital deployment locations are "reasonable in terms of approving these systems for launch."[211] Currently, regulation on orbital allocation only specifies that geostationary satellites have

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206 *See* MADRY ET AL., *supra* note 158, at 95 ("Some countries have in the past accelerated (and abused) the national review process to file so-called "paper satellites" with certain technical characteristics with the ITU simply to take advantage of the ITU's "first come, first served" principle. Needless to say, such practices undermine the principle of equitable access to spectrum resources. The ITU now has created charges for satellite filing and other milestone procedures to limit such 'paper filings.'").

207 JAKHU & PELTON, *supra* note 173, at 360. The FCC imposes deployment deadlines to prevent companies from "warehousing" spectrum, laying claim to frequencies and barring them from use by other companies. *See* Caleb Henry, *Oneweb Asks FCC to Authorize 1,200 More Satellites*, SPACENEWS (Mar. 20, 2018), https://spacenews.com/oneweb-asks-fcc-to-authorize-1200-more-satellites/ [https://perma.cc/MK6W-QUCY].

208 JAKHU & PELTON, *supra* note 173, at 360.

209 MADRY ET AL., *supra* note 158, at 96.

210 JAKHU & PELTON, *supra* note 173, at 5, 373. Scholars have commented on possible interference by LEO satellites with geosynchronous satellites. *See* MADRY ET AL., *supra* note 158, at 89.

211 MADRY ET AL., *supra* note 158, at 96.

protected status against non-geostationary satellites.[212] No procedures or guidelines at the ITU or national level exist that detail the priority of orbital allocations for LEO constellations.[213] As more companies are applying for licenses for their constellations, some propose instituting a moratorium on deploying LEO satellites, at least until a reasonable global decision-making process is established to equitably prioritize mega-LEO deployments internationally.[214]

Third, large-scale LEO satellite deployments could potentially lead to the aggravation of orbital space debris. Since the 1950s, when space missions commenced, it is estimated that more than 621,000 human-made objects that are greater than one centimeter in diameter have come to reside in orbit.[215] With the addition of potentially 15,000 small communications satellites in LEO, ten times the amount currently in orbit, some worry that, absent properly allocated altitudes for constellations, there will be more collisions of space objects, leading to more space debris.[216] The ever-increasing number of satellites and human-made objects colliding in space could quickly reach the tipping point for runaway debris, also called the Kessler syndrome, jeopardizing sustainable use of space.[217] Although there are some international guidelines in place,[218] voluntary orbital cleanup projects underway,[219] and

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[212] *See id.* at 95, 100 ("The filing process is different in the case of [geostationary] satellite networks. This is because it is necessary to seek specific orbital locations in the GEO belt and to identify slots that might be available that are not occupied by existing satellite networks.").

[213] *Id.* at 96.

[214] *Id.*

[215] There are currently in orbit about 21,000 man-made objects that are more than 10 centimeters; about 600,000 objects measuring between 1 and 10 centimeters; and hundreds of millions of objects less than 1 centimeter. *See* Ram S. Jakhu et al., *Regulatory Framework and Organization for Space Debris Removal and On Orbit Servicing of Satellites*, 4 J. SPACE SAFETY ENG'G 129 (2017), https://www.sciencedirect.com/science/article/pii/S2468896717300836 [https://perma.cc/3GFH-RSDF].

[216] MADRY ET AL., *supra* note 158, at 82.

[217] *Id.* at 96.

[218] The Inter-Agency Space Debris Committee has published Space Debris Mitigation guidelines, urging removal of satellites from orbit within twenty-five years of when their mission ends. *See id.* at 81; Popova & Schaus, *supra* note 188, at 3, 10–11. Some companies have committed to deorbiting out-of-use satellites within five years of the mission's end date. *See* Caleb Henry, *OneWeb Vouches for High Reliability of Its Deorbit System*, SPACENEWS (July 10, 2017), https://spacenews.com/oneweb-vouches-for-high-reliability-of-its-deorbit-system/ [https://perma.cc/H7U9-JFQT].

[219] Some cleanup efforts are currently underway, but there is no international agreement on the obligations of countries or companies to clean up orbital debris. Many actors are developing projects to capture and de-orbit small satellites, including Swiss-based CleanSpace One, the U.S. Defense Advanced Research Projects Agency, and the German space agency. *See* MADRY ET AL., *supra* note 158, at 86. Cooperation between industry, government, and

national mechanisms requiring companies to detail space debris mitigation plans,[220] most national and international legal frameworks for space activities do not impose legal obligations for debris removal.[221] This deficiency has caused some scholars to advocate for modernized global space governance to address the risk of runaway debris,[222] such as establishing an international regulatory framework and intergovernmental organization with an active debris removal (ADR) space debris mandate,[223] and amending the Liability Convention to include ADR obligations.[224]

In sum, like Loon, satellite companies will also have to navigate multi-jurisdictional regulatory issues in light of the envisioned global infrastructure. In doing so, they will have to rely on various partnerships to not only operate under existing spectrum licenses, but, more importantly, address regulatory gaps concerning international space activities and mega-constellations.

B. Disruptive Potential of the Innovations: Changing the Economics of Broadband Access?

Internet service relies on telecommunications infrastructure as the medium through which data flows, including cables (copper wires or optical fiber) and electromagnetic waves (for satellite, wireless, mobile networks). The projects identified in the previous Section aim to globally transmit Internet

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academia is also common. *See* Tereza Pultarova, *This Space Junk Removal Experiment Will Harpoon & Net Debris in Orbit*, SPACE (Apr. 6, 2018), https://www.space.com/40221-space-junk-debris-sweeper-experiment.html [perma.cc link unavailable].

220 National regulations usually require companies to at least specify their orbital debris mitigation procedures. In France, national laws allow for enforcement of space debris removal guidelines, and companies are penalized if they have not timely deorbited. MADRY ET AL., *supra* note 158, at 82, 95. In contrast, the FCC and other U.S. federal agencies require companies to submit plans during the licensing process that ensure compliance with the space debris mitigation guidelines—specifically, they must show that the spacecraft will deorbit within twenty-five years of the mission's end. *See* TED WACKLER, WHITE HOUSE OFFICE OF SCI. AND TECH. POL'Y, ORBITAL DEBRIS REPORT 3 (2017), https://www.whitehouse.gov/wp-content/uploads/2017/12/08-14-17-OSTP-Orbital-Debris-Report.pdf [https://perma.cc/M246-38RP].

221 *See* Popova & Schaus, *supra* note 188, at 1.

222 MADRY ET AL., *supra* note 158, at 90.

223 Jakhu et al., *supra* note 215, at 129 ("[M]itigation efforts must be accompanied by active debris removal (ADR) of *existing* pieces of debris from space in order to effectively protect the space environment . . . . [which] cannot be effectively undertaken due to the existing complex legal problems, primarily at international level.").

224 *See* MADRY ET AL., *supra* note 158, at 86 (noting that launching states are already liable for collisions in space). *See also* Popova & Schaus, *supra* note 188, at 10 (noting "no agreement on whether space debris should be considered to be space objects, as per the definition of 'space object' of Art. I . . . of the Liability Convention"); Jakhu et al., *supra* note 215, at 131 (arguing a piece of space debris is a space object).

connectivity with non-terrestrial infrastructure—circumventing the need to dig trenches, install cables, and determine property rights. Loon's balloon deployments, the new LEO mega-constellations, and Facebook's drones are possible *wireless* solutions to the last mile problem, relying on overcrowded radio waves. This Section explores how these projects could potentially do more than bridge the access gap—including disrupting the telecommunications industry and changing the economics of broadband access.

The analysis below contemplates the disruptive potential of Loon's balloons and mega-constellations, the two projects that are furthest along. Upon briefly examining the theory of disruptive innovation, the Section proceeds to compare the projects to other wireless and wireline solutions, as well as to each other. First, the Section considers how both projects directly compete with incumbent wireless providers in their respective sectors: Internet balloons via non-terrestrial "floating" cell towers could potentially challenge mobile operators, while LEO satellite mega-constellations may challenge the dominance of geostationary satellites. Second, the Section considers whether the two infrastructure projects might also disrupt the customer base of wireline Internet service providers. The Section ends by considering whether, between the two wireless infrastructure solutions, one project has more disruptive potential.

Relying on the theory of disruptive innovation to assess the two wireless projects' disruptive potential, it is unclear whether either project will prove to be disruptive. Not all innovations are considered disruptive, in the sense that they alter or transform established markets and incumbent players. Scholars argue that an innovative technology is disruptive when it alters the status quo and creates a new market, rapidly.[225] One theory of disruptive innovation, articulated by Clayton Christensen in the *Innovator's Dilemma*, explains how new technologies may cause incumbents to fail.[226] First, the disruption begins when a smaller company with fewer resources gains a foothold in a market that an incumbent has overlooked. This process usually means creating a market where none previously existed by offering a lower cost, inferior product—in essence, converting non-consumers into consumers.[227] Typically, incumbents' customers initially ignore the new entrant because they believe the offered service is inferior. The new entrant begins to improve the quality of its service over time—enough so that

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[225] JAKHU & PELTON, *supra* note 173, at 363–64.

[226] *See generally* CLAYTON CHRISTENSEN, THE INNOVATOR'S DILEMMA: WHEN NEW TECHNOLOGIES CAUSE GREAT FIRMS TO FAIL (1997).

[227] JAKHU & PELTON, *supra* note 173, at 366–67; Clayton M. Christensen et al., *What is Disruptive Innovation?*, HARV. BUS. REV. (Dec. 2015) at 5, http://pedrotrillo.com/wp-content/uploads/2016/01/Whatisdisruptiveinnovation.pdf [https://perma.cc/M4QC-LTG8].

incumbents' customers begin to notice. Only when incumbents' customers switch to the new entrant's product has disruption occurred. To summarize, the three key characteristics of disruptive innovation include (1) adoption by an underserved market, (2) initially inferior performance at a lower cost, and (3) greater market capture as quality improves.[228]

Applying the first factor to mega-constellations and Loon's balloons, there are signs that disruption could occur as both infrastructure projects target underserved markets. First, by seeking to connect the unconnected, both projects attempt to turn non-consumers into consumers. Positioning itself to be a wireless Internet provider to unconnected markets, Loon's balloons could directly compete with existing providers, such as mobile network operators, although the company has chosen not to.[229] Likewise, LEO satellite companies may directly compete with incumbent geostationary satellite telecommunications operators for underserved markets.

The second characteristic of disruptive innovation, inferior performance at lower costs, is pertinent to analyzing the disruptive potential of LEO satellites. The rationale driving mega-constellations is the use of lower orbits to improve latency. Absent more satellite deployments and testing at LEO, it is difficult to ascertain the possible service quality. A number of factors could negatively impact service quality, including weather, availability of spectrum, and potential interference with other satellites' signals. But the potential unreliability has also been dealt with by design through redundancy in the form of larger constellations, a potentially key driver affecting the economics of access.[230] Even with the uncertainty regarding quality, some argue that LEO satellites will nevertheless be disruptive vis-à-vis geostationary satellites—offering at least equal or superior performance at

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[228] JAKHU & PELTON, *supra* note 173, at 364.

[229] From the outset Loon has chosen to partner with, instead of compete with, incumbent wireless carriers. In considering Loon balloons' disruptive potential vis-à-vis mobile providers, the decision to supply network capacity to local mobile network operators renders the disruptive innovation analysis inapplicable. *See* Tung, *supra* note 166 and accompanying text; SIMONITE, *supra* note 134; *supra* text accompanying note 167.

[230] *See* JAKHU & PELTON, *supra* note 173, at 367; Caleb Henry, *LEO and MEO Broadband Constellations Mega Source of Consternation,* SPACENEWS (Mar. 13, 2018), https://spacenews.com/divining-what-the-stars-hold-in-store-for-broadband-megaconstellations/ ("[The industry is] recognizing that the megaconstellation approach to capacity expansion represents a sea-change in the economics of the satellite industry. . .We see this recognition across the traditional value chain, from manufacturing and launch through operators and service providers, as well as customers . . . Manufacturers are angling for constellation construction contracts by promoting new smallsat platforms. Launch providers are designing adapters and deployers for constellations, or building new rockets specifically sized for dedicated smallsat missions. And operators of ground-based satellite gateways are installing new antennas around the world to provide turn-key solutions for constellation operators.") [https://perma.cc/Q39F-PXFU].

lower costs.[231] Over time, this may result in incumbent satellite providers' customers switching service providers, signaling the arrival of a disruptive innovation.

It is not enough to consider whether either project is capable of effectively competing with companies in their respective sectors. For example, many have wondered if satellite Internet service providers can effectively compete with traditional broadband, such as cable Internet.[232] Whether either project will disrupt the business models of traditional wireline service providers greatly depends on the targeted location for service provision. The two wireless solutions aim to serve unconnected markets, where there is limited availability of wireline services, or as identified in Part II, *supra*, the last mile portions of infrastructure that incumbent wireline providers find difficult and uneconomical to develop. In areas where wireline development is uneconomical, the infrastructure projects cannot "disrupt" certain markets because there is already limited or nonexistent competition.

One of the two wireless solutions may prove disruptive in urban markets in developing countries. Even if these areas receive more attention by incumbent wireline providers, the speed of mobile broadband or satellite Internet could be greater than what is currently available with wireline services or roughly equal at lower costs of access. Notwithstanding the increase in high-speed fixed-broadband subscriptions globally, the lack of high-speed wireline connections in developing countries is notable: the penetration rate is 6 percent (1.6 percent excluding China), compared with 24 percent in developed countries.[233] In developing countries, mobile broadband is more affordable than fixed broadband, resulting in Internet access being increasingly mobile.[234]

In contrast, it is unlikely that either of the two wireless solutions will prove disruptive in urban markets in developed countries, where fixed broadband connections are more common. Given that mobile and satellite broadband have not yet reached the speeds of wireline services, it is unlikely that the inferior performance of Loon or LEO satellite Internet will result in great uptake by incumbents' customers in developed countries. Although satellite Internet connection speeds are sky-rocketing, latency remains an issue. Both mobile broadband and satellite broadband speeds are still

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[231] The next-generation satellites have been coined "NewSpace" ventures and are predicted to challenge the economic models for existing satellites in a "disruptive way" with low cost technology and improved designs. Some wonder if mega-constellations will "lead to the obsolescence of existing operators' economic models." JAKHU & PELTON, *supra* note 173, at 360, 362.

[232] *See* Finley, *supra* note 175.

[233] *See* INT'L TELECOMM. UNION, *supra* note 5, at 6.

[234] *Id.* at 4–5.

considered slow compared to speeds available through a wireline connection. Connection reliability and quality are important to users in developed countries, who expect less latency to conduct real-time activities such as videoconferencing. Most customers of incumbent carriers would consider the quality of wireless services to be inferior to wireline services, and they would not subscribe to a low-cost wireless service unless quality significantly improves. However, switchover to wireless-based Internet providers might be conceivable in the future with greater advancements in 5G and alleviation of spectrum congestion by governments.[235]

Nevertheless, in last mile areas where limited competition currently exists, Loon and LEO companies eventually may have to compete with wireline providers. At low price points, former noncustomers may begin subscribing to lower performance Internet service, such as mobile broadband. In these areas, individuals may initially find slow or unreliable Internet adequate to suit their needs, but over time the increased adoption and market demand may spark the need for and interest in higher reliability connections and, thus, wireline development.[236] Such was the case in India, which moved from the bottom of the list for "mobile broadband penetration to the world's largest mobile data-consuming nation."[237] As a result of increased adoption and greater demand, telecom companies in India are responding by installing more wireline infrastructure in the form of optical fiber.

Given that the two infrastructure solutions posed by Loon balloons and LEO satellites are both in the wireless space and are high altitude projects, it is worth asking whether one solution is more likely to be disruptive than the other in developing countries. Applying the key characteristics of disruptive innovation, determining which project has more disruptive potential requires predicting how much demand each wireless solution will generate. Demand will depend on the cost of access, an important driver for adoption in developing countries,[238] and the regulatory landscape.

If the mission is to connect the unconnected, Loon may have greater success because of the relatively low cost of its proposed infrastructure. First, Loon balloons were designed from the outset to be inexpensive, requiring limited amounts of expensive hardware. The balloons utilize solar energy, an

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[235] Recent wireless broadband and mobile communications technology has increased the demand for radio frequencies and requires governments to find a solution to optimize spectrum use. *See* JOVAN KURBALIJA, AN INTRODUCTION TO INTERNET GOVERNANCE, 39 (2016).

[236] According to survey data, many Nigerians perceive broadband as expensive relative to its quality, and are willing to pay, on average, an extra 166% per month for more reliable and faster broadband. *Willingness to Pay for Broadband in Nigeria*, *supra* note 63, at 428.

[237] Luke Beirne, *How Long Are We Going to Need that City?*, TRADE ARABIA (Sept. 12, 2018), http://www.tradearabia.com/news/REAL_345017.html [https://perma.cc/CZD8-4U9N].

[238] *See infra* notes 329–331 and accompanying text.

inexpensive energy source when compared to the cost of fuel required to move satellites to their orbital positions in space. Moreover, the decision to complement the capabilities of mobile operators translates into savings on spectrum licenses for Loon. With the ability to provide between twenty to thirty times broader coverage than cell towers, savings for mobile operators from balloon "cell towers" may result in lower costs of access in some markets.[239] Additionally, launching Loon balloons, although far from a simple task, is rather mechanical, does not necessarily rely on third parties, and is far less expensive than rocket launches. In contrast, satellite companies must rely on the launch industry, such that the availability and costs of launch vehicles could potentially "undermine the whole economic advantage" of small satellites.[240] In sum, Internet access via Loon balloons is arguably more cost-effective. As satellite companies experiment with variables affecting cost — such as the orbit height, satellite size, and launch vehicle availability—they will inevitably have to consider whether their business model offers access at rates that subscribers can afford.

A less onerous regulatory framework may also reduce Loon's costs. Regulatory burdens tend to translate into higher project costs that could affect a project's success.[241] Loon balloons fly in national airspace, for which the transnational regulatory framework is more stable because it is similar to the current regulatory framework for international civil aviation.[242] In contrast, given how outdated and underdeveloped international outer space law is, the regulatory framework for LEO satellites may be less stable in the future as

[239] The Loon System includes the "most essential components of a cell tower and redesigned them to be light and durable enough to be carried by a balloon twenty km up, on the edge of space." *The Loon System*, LOON, https://loon.co/technology [https://perma.cc/RHR4-WFRA]. In theory, the service should "reach more people for less money than it would take to install base stations or fiber optic cables in those areas." Amy Nordrum, *How Project Loon Built the Navigation System That Kept Its Balloons Over Puerto Rico*, IEEE SPECTRUM (Mar. 8, 2018), https://spectrum.ieee.org/tech-talk/telecom/Internet/how-project-loon-built-the-navigation-system-that-kept-its-balloons-over-puerto-rico [perma.cc link unavailble].
[240] JAKHU & PELTON, *supra* note 173, at 368.
[241] One author aptly notes "a problematic and persistent behavior in the space industry is thinking of engineering as the first step, and potential commercial markets and economic and regulatory consequences as a second step." JAKHU & PELTON, *supra* note 173, at 370. This applies to space industry projects and tech solutions.
[242] Although the regulatory framework is more stable, this does not render the commercialization of Loon balloons straightforward. Loon will have to obtain permission from many states to fly over their territories—at least many more states than would be required to register a satellite.

greater international cooperation is required to address space innovation.[243] The lack of international cooperation to develop an updated regulatory framework may translate to greater costs for satellite companies. Some other points of differentiation include difficulties securing spectrum allocated to satellites,[244] as well as greater state involvement due to state responsibility for liabilities caused by space objects under international law.[245]

Ultimately the global last mile problem may require many solution providers and may not be such a "space race" after all. In fact, news reports signal that Loon and satellite companies are even collaborating with regards to the same challenge: the routing of data packets through constantly moving balloons and satellites.[246] Moreover, although it remains unclear how much disruptive potential each project has at this stage, it *is* clear that the cost of access will be a key driver in generating demand in low-end markets. An important factor for adoption in developing countries will be whether Internet service is affordable, which partly depends on the sufficiency of backhaul infrastructure.

C. Leapfrogging Stages of Development?

Connecting users to broadband without having to build new terrestrial infrastructure would, potentially, overcome a significant obstacle to bringing Internet access to under-served markets worldwide. As such, many wonder whether wireless broadband infrastructure solutions such as balloons and mega-constellations will enable developing countries to "leapfrog" expensive

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[243] Many new regulations are needed at the national and international level to address challenges, such as the burst in ITU filings for spectrum priority; issues with orbital space debris, orbital congestion, and limited orbit control capabilities; shortage of radio frequencies; and potential interference to satellite systems. *See* JAKHU & PELTON, *supra* note 173, at 362–72. Cooperation in international forums is especially crucial with regards to these challenges as "the existing international space governance system is insufficient, inadequate, and inappropriate for facilitating the rapid introduction of small satellites as well as regulating their negative implications." *Id.* at 371.

[244] *See* JAKHU & PELTON, *supra* note 173, at 149 (discussing accommodating radio frequency spectrum allocations as a governance challenge, especially as "demand for terrestrial wireless broadband continues to expand sharply (i.e., nearly 40% per annum).").

[245] Because states bear international responsibility for activities in outer space, no matter if the activities are performed by governmental or commercial organizations, launching or registering states may ultimately be liable for any damage caused by their space objects under the various treaties. *See* Johnson, *supra* note 190, at 7–8, 10. As a result, greater costs from increased state involvement in the satellite industry are foreseeable given the potential for greater harm stemming from collisions, and thus liabilities.

[246] *See* Salvatore Candido, *The Connectivity Brain Behind Loon's Network*, MEDIUM (Jan. 31, 2019), https://medium.com/loon-for-all/the-connectivity-brain-behind-loons-network-f26c2b0b4288 [https://perma.cc/JRV2-CBAF].

underground cables, just as fiber enabled them to leapfrog over cable and DSL.[247] As many consider the wireless infrastructure projects' potential to accelerate telecommunications development in developing countries, the importance of backhaul network infrastructure has played a central role in the debate. This Section views skeptically the claim that wireless telecommunications innovations will help countries leapfrog stages of infrastructure development. Instead, it argues that wireless solutions complement, rather than compete with, wireline broadband and, in fact, rely on wired backhaul networks to decrease the cost of access and increase reliability.

Wireless solutions depend on spectrum, which is already quite limited and overcrowded, and these "spectrum limitations have a significant impact on the broadband delivery capabilities of a wireless service."[248] Wireless technology is not considered a comprehensive solution but an "intermediary" one because it cannot serve large areas given the physical limits of radio spectrum; this limits the number of devices that can be connected at any given time.[249] One key advantage of wireline broadband is that because the service does not rely on spectrum, greater speed and capacity are available. Moreover, fewer factors could weaken the signal, such as proximity to cell towers and weather.

Experts mostly agree on the advantages of wireline broadband, but still highlight that both wireless and wireline broadband services are needed and that one will not displace the other.[250] They note that wireless services will remain complementary because wireless service depends on the speed and quality of wireline connections. For wireless networks, data traffic travels over the air for only a short distance and then requires a high-capacity wired connection.[251] For instance, Loon balloons rely on backhaul networks to

[247] *See* INT'L TELECOMM. UNION, *supra* note 5, at 6.

[248] *See* Larry Thompson et al., *Comparing Wired and Wireless Broadband,* BROADBAND COMMUNITIES, 86 (2015) (noting that spectrum scarcity "significantly constrains the amount of broadband that can be provided").

[249] KURBALIJA, *supra* note 235, at 179.

[250] *See* Thompson et al., *supra* note 248, at 92 (noting that because wireline technologies are not plagued by issues of scarce spectrum, they provide better service compared to wireless technologies in terms of speed, latency, capacity, and reliability). Whereas wireless services are mainly used to meeting customers' mobile needs, high-quality wireline services are necessary for activities such as videoconferencing and streaming. *See id.*

[251] *See id.* ("Wireless service depends on the speed and quality of wireline connections. Wireless towers require high-capacity connections, typically using Ethernet delivered over a landline carrier's fiber network."); OECD, FIXED BROADBAND NETWORKS, *supra* note 21, at 5 (noting that the growth of Wi-Fi and other mechanisms for offloading mobile traffic is expected to place greater demands on wired networks).

extend connectivity.[252] Without a nearby ground station with a backhaul connection, some might be unable to access Loon Internet. Until more advances are made in laser communications systems to address the shortcomings of radio waves,[253] it is prudent to continue with both terrestrial and wireless Internet broadband networks.

Although leapfrogging stages of development could lower access prices, so would ample provision of backbone infrastructure. Internet access in developing countries is as much a last mile issue as it is a backbone issue. Backhaul networks—whether international connectivity via submarine cables or satellites, regional backbone, or domestic backbone—are key for carrying

[252] When data is sent wirelessly to a balloon, the floating cell tower then transmits the data wirelessly to a ground station that is connected to the wired backbone Internet. *See* Salvatore Candido, *1 Connection, 7 Balloons, 1,000 Kilometers*, MEDIUM (Sept. 11, 2018), https://medium.com/loon-for-all/1-connection-7-balloons-1-000-kilometers-74da60b9e283 ("[A] backhaul connection must pass from a ground access point to a balloon—a big jump that ultimately has some constraints.") [https://perma.cc/GR62-8KSM]; Taylor Hatmaker, *These Google X Moonshots Will Radically Change the World,* KERNEL MAG (Mar. 8, 2015), https://kernelmag.dailydot.com/issue-sections/features-issue-sections/12083/google-x-project-loon-titan-makani/ (data "travel[ing] through the balloon network is ultimately relayed to [Google's] local telecommunications partners' ground stations, where it connects to pre-existing Internet infrastructure.") [https://perma.cc/E9C2-LQXP]. In contrast, fixed cell towers transmit the data via fixed connectivity to the main network. *See* HALL ET AL., THE FUTURE OF NATIONAL INFRASTRUCTURE, *supra* note 10, at 185. Although Loon balloons are designed to expand coverage areas, there are still "people who live outside the reach of one of [the] balloons operating adjacent to a backhaul connection on the ground." Candido, *supra* note 246.

[253] Radio waves are a weak form of light and have many limitations. Optical communications systems seek to address the limitations of radio frequency communications. Although laser is already used in cables, experts are experimenting with using laser through air and space. NASA and other space agencies are studying laser communications systems, which can transfer data ten to one hundred times better than those of radio systems and maintain better signal strength across long distances. Many note that the future, of space communications at least, is optical. *See* Rebecca Boyle, *Space Communications Are Stuck In The Dial-Up Age. Which Means It's Time For More Lasers.*, FIVETHIRTYEIGHT (Apr. 18, 2018, 9:41 AM), https://fivethirtyeight.com/features/space-communications-are-stuck-in-the-dial-up-age-which-means-its-time-for-more-lasers/ [https://perma.cc/9GQV-HAGH]; Nat'l Aeronautics and Space Admin., *Benefits of Optical Communications*, NASA.GOV (May 6, 2014), https://www.nasa.gov/directorates/heo/scan/engineering/technology/txt_opticalcomm_benefits.html [https://perma.cc/58VK-GDHL]; Adam Hadhazy, *How It Works: NASA's Experimental Laser Communication System*, POPULAR MECHANICS (Sept. 6, 2011), https://www.popularmechanics.com/space/a7194/how-it-works-nasas-experimental-laser-communication-system/ [https://perma.cc/WU6L-LRFD].

traffic.[254] One estimate is that fiber backhaul of a 4G LTE network constitutes seventy to eighty percent of a network's total cost.[255] For the cost of access to wireless services to decrease and reliability to increase, more regional backhaul infrastructure is required.[256] Regional connectivity depends on Internet Exchange Points (IXPs), physical infrastructure that allows local Internet Service Providers (ISPs) to exchange local traffic. Called the core of the Internet, IXPs contribute to better performance and lower costs by keeping Internet traffic local.[257] The lack of IXPs in developing countries has meant that data is not routed locally, but as long-distance international traffic via the backbone networks of developed countries. This phenomenon is called boomerang or indirect routing, it increases costs, and decreases speed due to the multiple network hops required to route traffic.[258] For example, intra-African data from one African Internet user to another is often passed outside of the region and is exchanged by ISPs in Europe or North America.[259] The high costs of international traffic routing of intra-regional data result in higher costs of access. In countries where there has been increased regional backbone infrastructure development, Internet services became more affordable and reliable.[260]

Additionally, developing countries aiming to leapfrog stages of telecom development should consider whether they would be leapfrogging into greater dependence on foreign companies. Following the era of

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[254] *See* MARK D. J. WILLIAMS, REBECCA MAYER & MICHAEL MINGES, WORLD BANK, AFRICA'S ICT INFRASTRUCTURE: BUILDING ON THE MOBILE REVOLUTION, 84 (2011); KURBALIJA, *supra* note 235, at 178. More than ninety percent of all global Internet traffic flows through submarine cables. The Digital Silk Road is planning terrestrial cable investment, shifting traffic from the seabed to land. *Id.* at 38.

[255] *See* OECD, FIXED BROADBAND NETWORKS, *supra* note 21, at 12.

[256] *See* Mike Jensen, *Promoting the Use of Internet Exchange Points: A Guide to Policy, Management, and Technical Issues*, INTERNET SOCIETY REPORTS 5 (2009) ("[E]stablishing a local IXP decreases Internet access prices to the end user and provides faster response times from local web sites and other local interactive services").

[257] Carolyn D. Marsan, *Experts Say Economics and Politics Hamper Efficient Routing of Internet Data*, IETF JOURNAL (Nov. 1, 2014), https://www.ietfjournal.org/experts-say-economics-and-politics-hamper-efficient-routing-of-internet-data/ [https://perma.cc/JRV2-CBAF].

[258] KURBALIJA, *supra* note 235, at 178; Jensen, *supra* note 256, at 4 (noting telecommunication and management costs and impacts on speed depending on the number of network hops required to reach another local network).

[259] WILLIAMS, MAYER, & MINGES, *supra* note 254, at 64.

[260] Improvements in Internet performance and economics from IXP installations have been noted in Argentina, Brazil, Ecuador, and Kenya. In Ecuador, local traffic became $1 per megabit per second, much cheaper than when international transit was $100 per megabit per second. In Kenya, latency reductions went from 200 to 600 milliseconds down to a range of 2 to 10 milliseconds, and local mobile operators saved $1.5 million per year on international transit. *See* Marsan, *supra* note 257.

liberalization of the telecommunications sector, many countries have generally welcomed foreign investment. However, some countries have continued to maintain foreign ownership restrictions in sensitive sectors like telecom, seeing the value in retaining a grip on infrastructure that is considered a critical input for economic development.[261] One related issue for developing countries is that dependence on foreign companies for technological solutions does not always translate into the development of tech expertise and stimulation of the local tech industry. This issue is only exacerbated in the satellite context: only about a dozen states possess launch capabilities, and the issue of foreign dependence is especially prominent for non-spacefaring nations who rely on satellite services.[262] In the context of Loon's first commercial deal with Kenya, local experts expressed concerns about "building a reliance on commercial, foreign technology for something as critical as connectivity" and "the potential for dependency on a single foreign company."[263] Some propose additional backbone infrastructure in the form of IXPs to help countries become more self-sufficient with regards to technological development. Developing countries are already heavily burdened when financing access to backbones based in developed countries, and from a public policy standpoint, more IXPs would decrease foreign dependence.[264]Although there are barriers to overcome, such as lack of tech expertise,[265] IXPs would ensure large capital outflows are not paid to foreign ISPs.[266]

In sum, though the envisioned broadband infrastructure solutions

[261] *See* Margit Molnar, *Different Regulations, Different Impacts: What Regulations Affect Trade in Telecommunications Services?*, OECD Experts Meeting on Telecommunication Services 10 (2008), https://fdocuments.us/document/different-regulations-different-impacts-what-.html [https://perma.cc/X3GJ-C7EQ].

[262] *See* JAKHU & PELTON, *supra* note 173, at 366–67.

[263] *Google's Loon Brings Internet-by-Balloon to Kenya*, BBC NEWS (July 19, 2018), https://www.bbc.com/news/technology-44886803 ("Once these networks are in place, and dependency has reached a critical level, users are at the mercy of changes in business strategy, pricing, terms and conditions and so on.") [https://perma.cc/SSK9-P229]; Nathan Mattise, *Project Loon Signs its First Deal for Internet-delivering Balloons—in Kenya*, ARS TECHNICA (July 29, 2018), https://arstechnica.com/gadgets/2018/07/project-loon-signs-its-first-deal-for-Internet-delivering-balloons-in-kenya/ [https://perma.cc/YM9T-FPE4]. *See also* Alex Davies, *Inside X, The Moonshot Factory Racing to Build the Next Google*, WIRED (July 11, 2018), https://www.wired.com/story/alphabet-google-x-innovation-loon-wing-graduation/ ("Critics already call Google a monopoly. Now imagine its dominion extending . . . into how we connect to the Internet at all.") [https://perma.cc/9BPU-9D5H].

[264] *See* KURBALIJA, *supra* note 235, at 174; Jensen, *supra* note 256, at 2.

[265] *See* Jensen, *supra* note 256, at 3 ("The barriers to establishing IXPs in countries where they do not yet exist are largely non-financial. . . [L]imited technical skills and a lack of open competitive markets in telecommunication and Internet services make it more difficult to establish an IXP.").

[266] *See* Jensen, *supra* note 256, at 2.

appear to be convenient alternatives to investing in wireline infrastructure, they do not address the issue of adequate access to backbone infrastructure and are at best intermediary or complementary. However, the popularity of national broadband plans and universal service obligations across countries points to a genuine demand for any infrastructure that may bridge the last mile by reaching poor and rural communities. These imperfect solutions may help some countries to at least provide provisional Internet access to rural areas that are decades away from being profitable for wireline investment. The technology might, after all, be disruptive in reaching unconnected communities years ahead of schedule, prompting demand for services and future wireline infrastructure development.

Nevertheless, the financial and social constraints of the developing world will be important factors driving adoption in underserved markets. Skeptics criticize companies such as Loon for assuming that demand for broadband Internet exists in developing countries.[267] They explain that the people these companies want to provide with Internet service might not actually want it, emphasizing obstacles such as lack of disposable income and unmet basic needs. Questioning whether many of the world's unconnected people "want all this Internet," skeptics urge tech companies interested in connectivity to fully consider the needs of people in the developing world.[268] As such, the financial and social constraints of the developing world are explored next, in the context of a theoretical framework that aims to assess the potential development impacts of broadband infrastructure: via the capability approach.

IV. EVALUATING THE POTENTIAL IMPACT OF BROADBAND INFRASTRUCTURE USING THE CAPABILITY APPROACH

Parts II and III above addressed some of the regulatory frameworks that companies interested in nontraditional broadband infrastructure must pay attention to—universal service policies and regulations concerning airspace, outer space, and spectrum—and evaluated the disruptive potential of high-altitude broadband infrastructure. However, a greater question is posed by the infrastructure projects described above: besides the promise of new markets and additional profits, what is the ethos or purpose behind the infrastructure provision? Moreover, if the connectivity projects purport to solve a need—

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[267] *See* Finley, *supra* note 175 ("We hear many times from satellite operators—especially those launching massive constellations—the pitch of 'connecting the other half of the population. . . But the truth is that, of the total global unconnected population, two-thirds is not connected because they choose not to be connected.")

[268] *See id.* (noting that what a remote village may want from the Internet is going to differ from what a person in Menlo Park wants).

namely the lack of worldwide connectivity and loss of associated benefits—how should the impact of these projects be measured?

As will be discussed below, socioeconomic development is typically the goal for most infrastructure provision. Infrastructure resources are not built for their own sake, but for a purpose; usually they are seen as development inputs that help generate productive downstream activities. This view has long been held by the World Bank, well versed in traditional infrastructure assets, and is articulated in the UN SDGs, which aim to strengthen social, economic, and environmental development.[269] The executives at Alphabet and some satellite companies have also articulated a similar vision whereby they expect nontraditional connectivity infrastructure to benefit recipients socioeconomically. By extending Internet access to billions in rural and remotes areas of the world, those affiliated with Loon believe connectivity will lead to a number of positive developments, including access to online learning, better access to medical information and doctors, enhanced employment opportunities, and increased political participation.[270] The goal of socioeconomic development also aligns with views articulated by the satellite company O3b, whose founders believe that ubiquitous connectivity will be an enabler "of industry productivity, economic growth, and social opportunity."[271]

Instead of assuming that development will be a natural byproduct of broadband infrastructure deployment globally, this article cautions against a "build it and they will come approach," often employed naively by technology enthusiasts. Entering into emerging markets, private actors have not always engaged with development studies literature and may be unaware of the

[269] UN, *Social Development for Sustainable Development*, https://www.un.org/development/desa/dspd/2030agenda-sdgs.html [https://perma.cc/F29A-26G7].

[270] *See* SCHMIDT & COHEN, *supra* note 13, at 13 (where the chairman of Google and a former U.S. State Department official (who is now the president of Jigsaw (previously Google Ideas)) predict that five billion people will join the virtual world and that the "boom in digital connectivity will bring gains in productivity, health, education, quality of life and myriad other avenues in the physical world.").

[271] Simon Gatty Saunt, *Accelerating a Pan-Africa Broadband Revolution*, SES, (Nov. 22, 2018), https://www.ses.com/blog/accelerating-pan-africa-broadband-revolution [https://perma.cc/WNX3-RWJ9]. O3B is now owned by "SES."

"unique challenges of implementing technology" in developing countries.[272] There are limitations to technocratic approaches and solutions to development. Moreover, this article recommends employing Amartya Sen's capability approach to anticipate and measure the potential development impact of newly available connectivity infrastructure. Sen's capability approach sharpens the focus from macro- to micro-level considerations when implementing infrastructure solutions to anticipate how newly available technology may positively and negatively impact individuals' lives and substantive freedom.

The first Section will evaluate the alleged direct relationship between infrastructure resources and socioeconomic development. The second Section briefly summarizes and applies the capability approach as an alternative to evaluating project outcomes in the aggregate and broadly in terms of "socioeconomic development." The Section also addresses macro- and micro-level barriers that prevent the development of capabilities and examines the potential impact technology might have once introduced on existing and newly acquired capabilities. The second Section ends with an appraisal of community-led approaches to development to ensure that access to technology does not become harmfully disruptive—rather, it should respect the autonomy of individuals and communities.

A. Exploring the Relationship Between Infrastructure and Socioeconomic Development

Infrastructure resources are not built for their own sake, but for a purpose—usually, to enhance development. Definitions of infrastructure typically highlight the role such resources play in enabling development. One definition notes that infrastructure resources are "*shared means to many ends*."[273] As such, the value of the infrastructure resource is not generated primarily from consuming the resource for its own sake, but from

[272] *See* Jean-Yves Hamel, UNDP, *ICT4D and the Human Development and Capabilities Approach: The Potentials of Information and Communication Technology*, 57 (Human Development Research Paper, no. 37, 2010) ("A fundamental problem in the application of ICTs is apparently the domination of the field by technologists approaching the implementation of the tools and techniques in purely technological terms, with insufficient attention to local capacities and the diversity encountered in the field, which can make it or break it in developing countries."); Mark Thompson, *ICT and Development Studies: Towards Development 2.0*, 3 (Working Paper Series 27, 2007).

[273] FRISCHMANN, INFRASTRUCTURE, *supra* note 9, at 4; OECD, 2 INFRASTRUCTURE TO 2030: MAPPING POLICY FOR ELECTRICITY, WATER AND TRANSPORT, 20 (2007) ("Infrastructures are not an end in themselves. Rather, they are a means for ensuring the delivery of goods and services that promote prosperity and growth and contribute to quality of life, including the social well-being, health and safety of citizens, and the quality of their environments.").

"downstream productive activity that requires the resource as an input."[274] Even if there is a direct, immediate benefit from consuming an infrastructure resource, the value for most lies in their "intermediate production capacity."[275]

More specifically, telecommunications infrastructure is widely recognized as a vital development input.[276] Scholars note that telecommunications benefits go beyond connecting people—calling the infrastructure a "link in the chain of the development process itself" and as important as water and electricity.[277] Besides the term "telecommunications" infrastructure, scholars use interchangeably terms such as broadband or ICT infrastructure, the definition of which is commonly believed to encompass the Internet.[278] Many scholars use words like essential, basic, or fundamental when describing the Internet as an infrastructure resource,[279] and underscore that it is a "public and social infrastructure that is transforming our society."[280] Aside from the commercial activities it enables, the Internet is believed to be socially valuable because of the downstream activities it facilitates, for example via platforms which enable the exchanging of ideas and goods and social interactions.[281]

As "shared means to many ends," it is important to ask what the end goals of broadband infrastructure projects are. Scholars regularly emphasize the economic and social benefits of infrastructure and its role in economic and

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[274] *See* Frischmann, *Economic Theory of Infrastructure*, *supra* note 18, at 956–58 (explaining why a road system may provide directly realizable consumptive benefits, but the social benefits accrue from "activities it facilitates at the ends, including, for example, commerce, labor, communications, and recreation").

[275] *See* HALL ET AL., THE FUTURE OF NATIONAL INFRASTRUCTURE, *supra* note 10, at 32.

[276] Jayakar & Liub, *supra* note 34, at 186.

[277] Frieden, *supra* note 99, at 453–54.

[278] *See* Hamel, *supra* note 272, at 1 (The World Bank defines ICTs as "tools or techniques that allow recording, storing, using, diffusing and accessing electronic information," and others say ICTs "facilitate communication and the processing and transmission of information and the sharing of knowledge by electronic means").

[279] WILLIAM H. LEHR & LORENZO MARIA PUPILLO, INTERNET POLICY AND ECONOMICS: CHALLENGES AND PERSPECTIVES 3 (2d ed. 2009) ("The Internet is now widely regarded as *essential* infrastructure for our global economy and society."); *id.* at 6 ("As *basic* infrastructure, the Internet supports the production and consumption of both market and nonmarket goods."); *see also* OECD, *Internet Governance*, http://www.oecd.org/Internet/Internet-governance.htm ("The Internet is a *fundamental* infrastructure with a still largely untapped potential to address a wide array of economic and social challenges.") [https://perma.cc/L683-P645].

[280] PRESIDENT'S INFO. TECH. ADVISORY COMM., INFORMATION TECHNOLOGY RESEARCH: INVESTING IN OUR FUTURE 11–20 (1999), http://www.itrd.gov/pitac/report/pitac_report.pdf [https://perma.cc/558L-ML6U].

[281] FRISCHMANN, INFRASTRUCTURE, *supra* note 9, at 217. *See* Frischmann, *Economic Theory of Infrastructure*, *supra* note 18, at 957 n.43 (explaining how platforms are enabling technologies that other firms use to build more innovative products).

social development.[282] Along that vein, scholars increasingly perceive broadband as an essential service to foster economic growth and social development.[283] This view is shared by traditional development actors, such as the World Bank, the OECD, and the UN, but also by Alphabet executives, who believe in the power of connectivity to generate socioeconomic progress.[284] However, even though the term is invoked by many, socioeconomic development is not clearly defined, and the concept lacks a general framework, much less an agreed-upon methodology for measuring impact.[285] The term development usually alludes to macro-level progress, change, or growth, and the modifier "socioeconomic" relates development to social and economic factors.[286] To better understand the aims of broadband infrastructure provision, the two factors are briefly examined separately.

One goal of infrastructure investment is economic development,

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[282] *See* FRISCHMANN, INFRASTRUCTURE, *supra* note 9, at 11 (infrastructure resources are essentially "intermediate capital resources that serve as critical foundations for productive behavior within *economic and social systems*."); OECD, INFRASTRUCTURE TO 2030, *supra* note 273, at 20 ("In the past, infrastructures have provided significant social and economic benefits. Looking to the future, they will continue to play a vital role in *economic* and *social* development. . ."); John M. Anderies, et al., *Institutions and the Performance Of Coupled Infrastructure Systems*, 10 INT'L J. OF THE COMMONS 502 (2016) (studying how infrastructure "functions in structuring *social* and *economic* processes").

[283] *See* HOLZNAGEL ET AL., *supra* note 1, at 15 (discussing "socioeconomic impacts of broadband"); LEHR & PUPILLO, *supra* note 279, at 3 (noting the Internet is "essential infrastructure for our global *economy* and *society*"); Gerli et al*., supra* note 32, at 726 ("Superfast broadband is increasingly perceived as an essential service to foster *economic* growth and *social* development"); Harvard Berkman Center for Internet and Society, *Next Generation Connectivity: A Review Of Broadband Internet Transitions And Policy From Around The World*, 129 (2010) ("Broadband access is necessary to participate in the 21st-century economy. It's also good policy as well: Broadband boosts *social* opportunity and *economic* growth."); *id.* at 242 ("The wide *social* and *economic* impact of broadband has given all levels of government an interest in the quality and price of services.").

[284] *See* SCHMIDT & COHEN, *supra* note 13, note 270; WORLD BANK, SOCIO-ECONOMIC ASSESSMENT OF BROADBAND DEVELOPMENT IN EGYPT, (2010), https://openknowledge.worldbank.org/handle/10986/12690 [https://perma.cc/49BZ-XE5F]; OECD, BROADBAND POLICIES FOR LATIN AMERICA AND THE CARIBBEAN: A DIGITAL ECONOMY TOOLKIT, http://www.oecd.org/Internet/broadband/lac-digital-toolkit/Home/toolkit-text-chapter1.htm [https://perma.cc/2ZXB-TPQ3].

[285] Narcyz Roztocki & H. Roland Weistroffer, *Conceptualizing and Researching the Adoption of ICT and the Impact on Socioeconomic Development*, 22 INFO. TECH. FOR DEV., 541–42 (2016).

[286] *Id.*

considered tantamount to economic growth and productivity.[287] On a macro-level, growth related to infrastructure is measured by increases in national income or GDP, and on an individual level, by increases in personal income.[288] Because infrastructure resources are often inputs in productive downstream activity, many believe infrastructure and economic development are at least positively correlated.[289] The same holds for broadband infrastructure: the recent move toward national broadband plans is because policymakers and economists judge that access to broadband provides economic growth opportunities.[290] The World Bank, with many years of experience in traditional infrastructure, deems broadband infrastructure as vital to producing economic development and has found that increased broadband penetration in low and middle-income countries results in economic growth.[291] One recent World Bank report noted that "a 10 percent increase in broadband penetration yields an additional 1.38 percent increase in GDP growth for low to middle-income countries."[292] Despite the apparent strength of the claim, the causal link between infrastructure development and economic growth remains

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[287] *See* FRISCHMANN, INFRASTRUCTURE, *supra* note 9, at 19–20 ("Whether it is the Internet or freeways, infrastructure improves the functioning of an economy. Road building and improvements in telecommunications infrastructure have both been found to have a significant impact on productivity and growth for a wide selection of OECD countries. . . ."); OECD, INFRASTRUCTURE TO 2030, *supra* note 273, at 20 ("[Infrastructures] are a means for ensuring the delivery of goods and services that promote *prosperity and growth*. . .").

[288] *See* Roztocki & Weistroffer, *supra* note 285, at 542.

[289] *See* HALL ET AL., THE FUTURE OF NATIONAL INFRASTRUCTURE, *supra* note 10, at 7 (the relationship is symbiotic).

[290] *See* OECD, *National Broadband Plans*, 6 (OECD Digital Economy Papers No. 181 June 2011). *See also id.* at 10 ("Some economists have found that investment in broadband Internet access directly correlates to growth in GDP and gains in productivity . . . a 'consensus' view was that a 10% increase in household penetration of broadband boosted GDP by 0.1% to 1.3%."); HOLZNAGEL ET AL., *supra* note 1, at 21 (high-speed broadband networks are correlated with GDP, higher employment rates, and increased productivity).

[291] *See* Christine Zhen-Wei Qiang et al., *Economic Impacts of Broadband*, *in* INFORMATION AND COMMUNICATION FOR DEVELOPMENT: EXTENDING REACH AND INCREASING IMPACT 45 (World Bank ed., 2009), https://siteresources.worldbank.org/EXTIC4D/Resources/IC4D_Broadband_35_50.pdf [https://perma.cc/79HW-KP6D].

[292] *Willingness to Pay for Broadband in Nigeria*, *supra* note 63, at 421; Qiang et al., *supra* note 291, at 45. This statistic was cited by a Loon engineer, who also explained that Internet access and associated GDP growth could double the standard of living in many countries around the world. Verge, *Inside Google's Wildly Ambitious Internet Balloon Project*, YOUTUBE, https://www.youtube.com/watch?v=OFGW2sZsUiQ [https://perma.cc/WZD5-7QMQ].

subject to much debate.[293]

Another goal of infrastructure investment is social development, but unlike economic development, it is difficult to quantify or measure. To grasp the social value of infrastructure, some suggest examining downstream uses and interactions to see if they benefit society as a whole.[294] For instance, telecommunications infrastructure benefits society and individuals by "facilitate[ing] all sorts of personal, social, and business interactions as people talk, exchange ideas, make plans, and socialize; develop[ing] business and personal relationships; participat[ing] in political discourse; and so on."[295] Moreover, some downstream uses and interactions which telecom infrastructure facilitates are also known to generate economic growth.[296] Nevertheless, though many policy documents and academic articles use terms like improved *well-being*, *quality of life*, and *social welfare* to measure the social impacts of infrastructure, such terms do not always answer the question of why certain activities are "socially valuable," nor do they address the unintended social consequences of newly available infrastructure.[297]

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[293] *See* HALL ET AL., THE FUTURE OF NATIONAL INFRASTRUCTURE, *supra* note 10, at 8, 31 (citing many scholars for the idea that the link between infrastructure availability, economic growth and productivity is uncertain because the "relationships between infrastructure and the economy are multiple and complex"); BJÖRN-SÖREN GIGLER, WORLD BANK GROUP, DEVELOPMENT AS FREEDOM IN A DIGITAL AGE: EXPERIENCES OF THE RURAL POOR IN BOLIVIA 4–6 (2015) (noting that proponents of the ICT for Development (ICT4D) agenda assume a direct relationship between ICTs and economic growth and social development, but that the claim is not sufficiently supported empirically). Some concede that an output of infrastructure investment—namely, economic growth—is not as clear with telecommunications as with roads, for example, but highlight that there are still notable increases in productivity, positive effects on business activities and transfer of knowledge, as well as indirect effects on empowering the workforce. *See* Emiliani, *supra* note 25, at 1–2.

[294] *See* Frischmann, *Economic Theory of Infrastructure*, *supra* note 18, at 1016–17 (listing social activities the Internet enables: "[individuals] engage in innovation and creation; they speak about anything and everything; they maintain family connections and friendships; they debate, comment, and engage in political and nonpolitical discourse; they meet new people; they search, research, learn, and educate; and they build and sustain communities. These are the types of productive activities that generate *substantial social value*. . ."); *id.* at 1017–18 ("Public participation in such activities results in external benefits that accrue to society as a whole (online and offline) . . .").

[295] FRISCHMANN, INFRASTRUCTURE, *supra* note 9, at 217.

[296] For instance, economic theory posits that technological advancements and social networks have economic outcomes as they "enable creation of trust relationships that in turn facilitate business between various agents" beyond the family. Mdoe & Kinyanjui, *supra* note 45, at 3–4.

[297] *See* FRISCHMANN, INFRASTRUCTURE, *supra* note 9, at 23 (measures of social welfare include "quality of life or living standards"); OECD, INFRASTRUCTURE TO 2030, *supra* note 273, at 20 (Infrastructure "contribute[s] to quality of life, including the social well-being, health and safety of citizens, and the quality of their environments.").

Instead, what constitutes development broadly, and what is socially valuable specifically, should be assessed using Amartya Sen's capability approach to evaluate whether an infrastructure resource enables opportunities that an individual or a community has reason to value.

B. Applying the Capability Approach to Broadband Infrastructure Projects

The Section above explored one commonly recognized end goal for infrastructure investment—socioeconomic development—and reminded that companies such as Loon and O3B show interest in enhancing socioeconomic development with global connectivity projects. Given that public and private actors believe that ICT infrastructure and connectivity will lead to socioeconomic development for the billions without Internet access, the next step is to consider how such connectivity might actually contribute to development. Aspiring to reorient approaches to development away from focusing solely on economic growth and measuring well-being by resources or utility, Sen's capability approach instead offers a different aspiration for development: to improve the "ability of persons to lead a life that they have reason to value."[298] The capability approach (sometimes called the human development approach[299]) is typically applied to development projects in developing nations, yet its use does not have to be restricted in scope.[300] In essence, the capability approach views development as freedom: the expansion of freedom is viewed as both (1) the primary end and (2) the principal means of development.[301] Social benefits derive from a person's

[298] *See* Alexandre Apsan Frediani et al., *Approaching Development Projects from a Human Development and Capability Perspective*, 15 J. HUM. DEV. AND CAPABILITIES, 1 (2014) (The capability approach undertakes to define well-being as going "beyond economic conditions."); Sabina Alkire, *The Capability Approach and Well-Being Measurement for Public Policy*, 1 (OPHI Working Paper No. 94, 2015), https://www.ophi.org.uk/wp-content/uploads/OPHIWP094.pdf [https://perma.cc/9BNJ-7JEH].

[299] Another term used interchangeably with the capability approach is "Human Development," historically associated with an office of the United Nations Development Program (UNDP) that produces annual Human Development Reports. *See* MARTHA C. NUSSBAUM, CREATING CAPABILITIES: THE HUMAN DEVELOPMENT APPROACH 17 (2013). The reports have introduced a people-centered approach for advancing human well-being, centered on "expanding the richness of human life, rather than simply the richness of the economy in which human beings live." *About Human Development*, UNITED NATIONS DEVELOPMENT PROGRAMME, http://hdr.undp.org/en/humandev [https://perma.cc/FEJ6-YJEB]. The Human Development Reports continue to recognize that ICTs, such as mobile phones and Internet use, are tools for expanding people's freedom. *See* Hamel, *supra* note 272, at 1.

[300] *See* Mark Coeckelbergh, *Human Development or Human Enhancement? A Methodological Reflection on Capabilities and the Evaluation of Information Technologies*, 13 ETHICS INFO. TECH. 82 (2011).

[301] AMARTYA SEN, DEVELOPMENT AS FREEDOM 36 (1999).

freedom to act and ability to pursue what he or she believes is valuable.[302] Though the aim of infrastructure investment is typically socioeconomic development, this Section proposes an alternative vision: the end goal of broadband infrastructure development should be to enhance individual and collective "capabilities," defined below.

First, the content below provides an explanation of the capability approach, examining key concepts like "capabilities" encompassed by this alternative view of development. Next, the Section examines how ICTs, such as mobile phones and the Internet, are used to improve development outcomes and deliver services in global development projects—a field known as ICT for Development, or ICT4D.[303] In light of the ICT4D studies' assessments of the actual impacts of ICT infrastructure on human development, the Section casts doubt on the ability of mere infrastructure availability to meaningfully expand capabilities and argues for a comprehensive meaning of access. Examining how ICTs impact the development of capabilities, the Section also briefly assesses how ICTs can work for and against capabilities. The Section ends with an appraisal of community-led approaches to development to ensure that access to technology does not become harmfully disruptive, but rather respects the autonomy of individuals and communities.

1. *Key Concepts*

Sen defines development as "a process of expanding the real freedoms that people enjoy" and emphasizes the need for the "expansion of 'capabilities' of persons to lead the kinds of lives they value—and have reason to value."[304] A person's "capability" refers to the alternative combinations or set of functionings that are feasible for her or him to achieve.[305] Functionings reveal the various things a person may value doing or being.[306] For example, elementary functionings might include "being safe, well-nourished, and literate," while more complex functionings might include campaigning for political office.[307] Realized functionings are a way of describing what a person

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[302] *See* Travis Godwin Good et al., *Investigating Capabilities Associated with ICT Access and Use in Latino Micro-enterprises*, 500 AMCIS PROC. (2010).

[303] ICTs are pervasively utilized in global development projects to enhance outcomes. ICT4D initiatives are in response to the growing digital divide and focus on providing those living on less than $2 a day with access to current technologies. *See* ITU, HARNESSING THE INTERNET OF THINGS FOR GLOBAL DEVELOPMENT 7 (2016); *Henry Tinashe Manara, Factors Affecting Sustainability of ICT4D: A Case Study of Mobile-Cinemas in Rural South Africa* 10 (2015) (unpublished MCom dissertation, University of Pretoria) (on file with author).

[304] SEN, *supra* note 301, at 3, 18.

[305] *Id.* at 75.

[306] *Id.*

[307] *See* Alkire, *supra* note 298, at 3.

actually achieves when deliberately using his or her capabilities, and potential functionings (synonymous with capabilities) represent possible choices available to individuals.[308] These choices are circumscribed by personal, social, and environmental conversion factors (see Figure 1 below).[309]

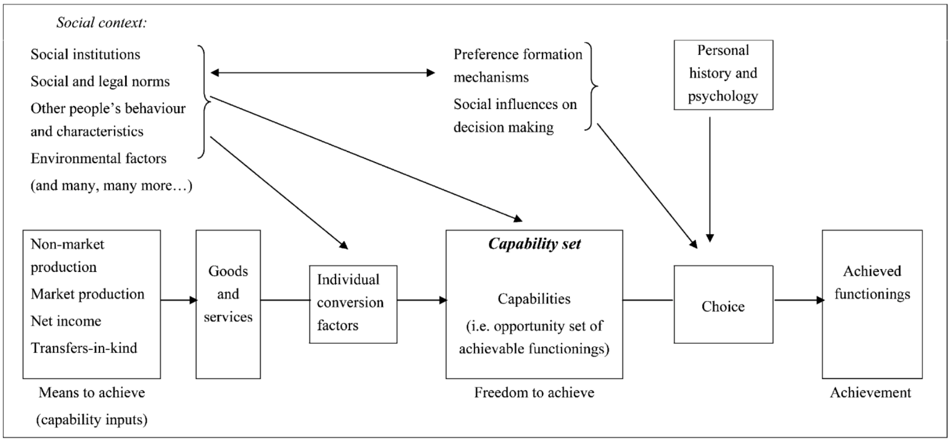

Figure 1: *A person's capability set and his/her social and personal context*[310]

Emphasizing capabilities expansion, the capability approach is about creating real opportunities for people to access and realize functionings that they have reason to value.[311] A person converts capabilities into functionings through agency and choice,[312] and thus the capability approach emphasizes access to valuable functionings without insisting on the achievement of certain functionings.[313] In essence, the approach respects individuals' use of agency so that people are empowered to help themselves and become "actors of their own development."[314] Capability is akin to freedom; it is "the substantive

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[308] Good et al., *supra* note 302, at 3.

[309] *See id.* at 3; Ingrid Robeyns, *The Capability Approach: A Theoretical Survey*, 6 J. HUM. DEV. 98–99 (2005); GIGLER, *supra* note 293, at 15 (noting valued functionings depend on capabilities and also on existing livelihood resources or assets, and the key is to analyze what people are capable of being or doing with available resources).

[310] *See* Robeyns, *supra* note 309, at 98.

[311] *See* Alkire, *supra* note 298, at 4. Some capability expansion examples for an electrification project include promotion of connections with other people and the possibilities of studying in the evening. *See* Frediani et al., *supra* note 298, at 2.

[312] *See* Helena Grunfeld et al., *Challenges in Operationalising the Capability Approach for Evaluating the Contribution of the Cambodian ICT4D Project, iREACH, to Capabilities, Empowerment and Sustainability*, HUMAN DEV. & CAPABILITY ASSN., 3 (2010).

[313] *See* Frediani et al., *supra* note 298, at 4.

[314] JOSEPH E. STIGLITZ, AMARTYA SEN & JEAN-PAUL FITOUSSI, REPORT BY THE COMMISSION ON THE MEASUREMENT OF ECONOMIC PERFORMANCE AND SOCIAL PROGRESS 151 (2009).

freedom to achieve combinations of alternative potential functionings."[315] The evaluation of well-being is not achieved functionings, or visible states of being. An illustrative example is starving versus fasting: people in both situations do not exercise the functioning of nutrition. However, in the fasting scenario, one has chosen the valued state and still retains the capability of nutrition, while the person who is starving lacks agency.[316] The better evaluative space is thus capabilities, since operationalizing the approach is quite difficult without an agreed upon list of basic capabilities.[317]

2. *From Mere Availability to Genuine Access*

By bringing to market Internet access in countries lacking adequate broadband infrastructure, tech companies are seemingly expanding capability sets for individuals. Indeed, the inadequate broadband infrastructure in developing countries is viewed as "an external macro-level barrier impeding the development of capabilities and their conversion into functionings at the micro-level."[318] Some definitions of infrastructure capture the inherent expansion of opportunities: "[a]n infrastructure service is the *provision of an option for an activity* by operating physical facilities and accompanying human systems to convert, store and transmit resources (physical and virtual)."[319] However, infrastructure provision on its own will not translate into the expansion of capabilities for all; individuals with high capabilities in the first place might quickly capitalize on advantages of newly available technology and infrastructure. Therefore, interventions may be necessary to enhance the capabilities of individuals with already limited capability sets.

Many ICT4D studies find that access to broadband infrastructure or ICTs does not ensure expansion of individual capabilities.[320] By itself, access

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[315] SEN, *supra* note 301, at 75.
[316] *See* Nicholas Garnham, *Amartya Sen's Capabilities Approach to the Evaluation of Welfare: Its Application to Communications*, 4 JAVNOST - THE PUBLIC, at 29 (1997).
[317] *See* Grunfeld et al., *supra* note 312, at 4 ("[A] main difficulty of applying [the capability approach] is its lack of operationalisation . . . Listing basic capabilities could be one way of operationalising the CA, thereby making it more useful to development policy and Nussbaum's . . .tentative list of basic capabilities is one example of this.").
[318] *See* Grunfeld et al., *supra* note 312, at 10.
[319] *See* HALL ET AL., THE FUTURE OF NATIONAL INFRASTRUCTURE, *supra* note 10, at 6.
[320] Many ICT4D initiatives reporting on actual impacts of ICT infrastructure on human development and "lessons learned" consistently convey a clear message: mere access to ICT infrastructure, whether it is computers, mobile phones, and/or the Internet, is not enough to close the digital divide and ensure development outcomes. *See* Grunfeld et al., *supra* note 312, at 4 ("The concept of access must include capabilities, e.g. (computer) literacy, to use the infrastructure, similar to the term 'effective use' . . . to reflect 'the capacity and opportunity to successfully integrate ICTs into the accomplishment of self or collaboratively identified goals.'").

to infrastructure is "not enough to enjoy, for instance, exercising one's capability for affiliation. Instead, what matters is if the person can actually and effectively use the technology."[321] From a capabilities perspective, physical access is a necessary but insufficient condition to expand capabilities; it is only meaningful if it translates into "effective use."[322] This finding is consistent with the message of universal service scholars, who advocate for the reconceptualization of access to include five components: availability, affordability, accessibility, a needs assessment, and awareness.[323] The five components should be more or less present to achieve the goals of universal service, which depend on actual adoption of ICT-based services. Under this view, the digital divide is not a gap between those who have Internet access and those who do not, but rather those who have the skills to use the Internet effectively and those who do not.[324]

Capabilities expansion after the introduction of new infrastructure depends on a number of factors. In addition to physical access to ICTs, effective use of ICTs depends on factors like cost, reliability, cultural acceptability, ease of use, and the relevance of available content.[325] Some capability approach scholars have addressed the issue using different vocabulary, namely the term "conversion factors." They note that resources are converted into functionings differently; differences in personal and socioeconomic factors, as well as the social, institutional and environmental context, affect one's capabilities and functionings.[326] Other scholars use the

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[321] *See* Coeckelbergh, *supra* note 300, at 84.

[322] *See* Grunfeld et al., *supra* note 312, at 4*; see also* GIGLER, *supra* note 293, at 211 ("[T]he findings point to the absence of any statistically significant relationship between these two variables, suggesting that the provision of ICT infrastructure services in rural areas does not have its intended effect and de facto fails to enable people to make meaningful use of the Internet."). Infrastructure provision barely checks the readiness and availability boxes of the ICT development cycle; the next phases interpreting "effective use" are uptake and impact. *Readiness* concerns policies and infrastructure to make ICT availability possible; *Availability* asks how to roll out the program, *Uptake* is about making ICTs useful, and *Impact* looks to maximize ICTs for the greatest development impact. *See* Richard Heeks, *The ICT4D 2.0 Manifesto: Where Next for ICTs and International Development?*, 28–29 (Manchester Centre for Dev. Informatics Working Paper 42, 2009).

[323] *Universal Service Funds in Africa*, *supra* note 31, at 619-20 ("It is important to first ascertain the 'need' of a given community in terms of whether availability, accessibility, affordability, the possession of the right skills to use the available technology or a combination of these elements are the problem . . . [Moreover,] lack of awareness may undermine the rate of adoption.").

[324] *See* Coeckelbergh, *supra* note 300, at 85.

[325] *See* Hamel, *supra* note 272, at 35 (citing TIM UNWIN, ICT4D: INFORMATION AND COMMUNICATION TECHNOLOGY FOR DEVELOPMENT (2009)).

[326] *See* Frediani et al., *supra* note 298, at 4; Alkire, *supra* note 298, at 6 ("physical, social and cultural contexts affect [one's] ability to convert resources into capabilities."). Nussbaum describes the phenomenon in terms of combined and internal capabilities. A person's *internal*

term "barriers" to describe certain social, institutional, and environmental contexts that may impede capabilities development and the conversion of capabilities into functionings.[327] Some of these micro- and macro-level barriers are examined below.

Several micro-level factors may impede the development of capabilities or their conversion into functionings in light of broadband infrastructure availability. An ICT4D study found that Internet non-users provided several reasons for non-use despite having access to public telecenter hubs with satellite Internet, including "lack of awareness, lack of time due to . . . work, home duties, and schoolwork, lack of interest as ICT not considered important, too old, fear of damaging computers, insufficient literacy levels, and living too far away from a hub."[328] Two common micro-level factors, lack of financial resources and digital literacy, are addressed below.

An individual who lacks financial resources may be prevented from learning how to use newly available ICT infrastructure, and in the case she develops the capability, may be prevented from actual use by prohibitive cost. Studies show that in developing countries, pricing ICT services is a very important aspect of demand analysis and is the "strongest determinant of a broadband subscription."[329] For many, access to a mobile device (with Internet access) may already constitute a large portion of one's total income, making consistent Internet usage a luxury. In some developing countries, mobile broadband services cost about 18.8 percent of monthly gross national income per capita for a gigabyte of data and fixed services cost 30.1 percent.[330] This

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capabilities refer to dynamic personal characteristics, while her *combined* capabilities refer to "the totality of the opportunities she has for choice and action in her specific political, social, and economic situation." *See* NUSSBAUM, *supra* note 299, at 21 (Internal capabilities include both innate, as well as trained/developed traits. For example, "personality traits, intellectual and emotional capacities, states of bodily fitness and health, internalized learning, skills of perception and movement").

[327] *See* Grunfeld et al., *supra* note 312, at 10.

[328] *See id.* at 12.

[329] *Willingness to Pay for Broadband in Nigeria*, *supra* note 63, at 423. *See also* Hamel, *supra* note 272, at 49 (noting "higher telecommunications costs inhibits Internet use. . . Sadly, the relationship between costs and usage is most apparent in the poorest countries, where costs are exorbitant and usage rates are lowest."); Grunfeld et al., *supra* note 312, at 11 ("The strong competition in the mobile and ISP markets, with some 37 ISPs, 10 of which were major . . . had not resulted in affordable prices by international standards."); *Willingness to Pay for Broadband in Nigeria*, *supra* note 63, at 422, 430 (noting that the reason for weak demand for both fixed and mobile broadband in Nigeria is due to socioeconomic and demographic characteristics affecting people's willingness to pay for broadband, such as income and level of education).

[330] *Willingness to Pay for Broadband in Nigeria*, *supra* note 63, at 424. In Africa, 1GB of data currently costs an average of eighteen percent of monthly income. *See generally* ALLIANCE FOR AFFORDABLE INTERNET, AFRICA REGIONAL SNAPSHOT: 2017 AFFORDABILITY REPORT (2017).

is exorbitant in light of the UN Broadband Commission's target, which says that entry-level broadband should cost no more than two percent of gross national income per capita for a gigabyte of data.[331] Capability sets may develop or functionings be realized more quickly if access is affordable.

Another micro-level factor that may impede widespread Internet adoption is lack of digital literacy. In developing countries, computer and Internet illiteracy is frequently cited as a factor that contributes to poor Internet penetration and uptake.[332] One study of a telecenter in Vietnam highlights that many rural users were not aware of the benefits of Internet access.[333] Nevertheless, improvement in digital literacy can significantly affect broadband demand and uptake.[334] In response, many governments are combating low network utilization by moving beyond infrastructure provision and instead are focusing on improving citizens' digital literacy skills.[335] In countries such as Kenya and South Africa, universal service policies include the promotion of digital literacy as a target.[336] Government interventions include initiatives to increase digital literacy in schools as well as community sensitization programs to generate awareness.[337] Beyond possessing digital skills to use ICTs, marginalized communities may not use an unfamiliar Internet which "does not speak their local language."[338]

Macro-level social, institutional, and environmental barriers may also affect the development of capabilities and their conversion into functionings in the case of broadband infrastructure provision. Resistance to the Internet

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[331] Press Release, Int'l Telecomm. Union, UN Broadband Commission Sets Global Broadband Targets to Bring Online the World's 3.8 Billion Not Connected to the Internet (Jan. 23, 2018), https://www.itu.int/en/mediacentre/Pages/2018-PR01.aspx [https://perma.cc/7VA3-KTGY].

[332] *See* NYABUGA & BOOKER, *supra* note 45, at 17; Dorothea Kleine, *The Capability Approach and the "Medium of Choice": Steps Towards Conceptualising Information and Communication Technologies for Development*, 13 ETHICS INFO. TECH. 126 (2011) ("[A] certain amount of educational resources (i.e. literacy, IT skills) is needed, as well as health and psychological resources, to make use of the Internet."); Grunfeld et al., supra note 312, at 3 ("For example, having access to and knowing how to use ICT represent capabilities, and converting these capabilities, to send an e-mail would be a functioning."); *id.* at 4 ("The concept of access must include capabilities, e.g. (computer) literacy, to use the infrastructure. . . .").

[333] Many users would visit the center to play games. *See* Thai & Falch, *supra* note 40, at 328. In Mexico, the Connected program has focused on creating community Internet access points, but little information is available whether the personnel are adequately equipped to help develop digital skills to foster adoption of ICTs. *See* Casanueva-Reguart, *supra* note 38, at 2111–12.

[334] *Willingness to Pay for Broadband in Nigeria*, *supra* note 63, at 423–24.

[335] *See* Thai & Falch, *supra* note 40, at 324; NYABUGA & BOOKER, *supra* note 45, at 17.

[336] *Universal Service Funds in Africa*, *supra* note 31, at 627.

[337] *Willingness to Pay for Broadband in Nigeria*, *supra* note 63, at 431.

[338] *See* GIGLER, *supra* note 293, at xxxii (noting how ICTs are mostly designed for affluent people).

and smartphones in some rural areas indicates a social and cultural environment that is hostile to ICT uptake, as technology is perceived as a threat to the traditional ordering of society and beliefs.[339] Such resistance disproportionately affects women. Studies show that in certain areas of the globe, there is a significant gender gap in ICT ownership and usage. In India, men on average are more than twice as likely to own a phone, thirty-six percent more likely to use a bare-bones mobile phone, and sixty-two percent more likely to use the Internet.[340] A study reports that nearly twenty-five percent fewer women than men had access to the Internet across developing countries, and in sub-Saharan Africa, the gender gap was forty-three percent.[341] The same study revealed twenty percent of the Indian women interviewed believed that Internet use was inappropriate for them.[342]

Another macro-level barrier is inadequate access to basic infrastructure services. A study in Bolivia found that low access to basic infrastructure services, like water and electricity, was related to low ICT usage and capabilities.[343] Many have even called the digital divide an electricity divide.[344] About eighty-five percent of the estimated 1.5 billion people without access to electricity live in rural areas of developing countries.[345] For instance, according to Kenya's Rural Electrification Authority, ninety percent of rural Kenya does not have electricity, and only twenty percent of Kenyans generally have access to electricity.[346] This impacts capabilities because individuals in rural areas cannot utilize ICTs absent adequate power sources. Lack of ICT uptake persists due to inadequate electricity despite universal service

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[339] *See* Ellen Barry, *No, Google's Not a Bird: Bringing the Internet to Rural India*, N.Y. TIMES (May 21, 2017), https://www.nytimes.com/2017/05/21/world/asia/internet-in-india.html [https://perma.cc/S8UA-7H3T].

[340] *See id.*; *see also* GSMA, *Women and Mobile in India: Realising the Opportunity*, GSMA.COM (Oct. 24, 2016), https://www.gsma.com/mobilefordevelopment/programme/connected-women/women-and-mobile-in-india-realising-the-opportunity [https://perma.cc/9X4F-YD6H].

[341] *See* Sarah Boettiger, *Tempered Enthusiasm for Digitally Enabled Networks in International Development*, 9 INNOVATIONS: TECH., GOVERNANCE, GLOBALIZATION 132 (2014).

[342] *Id.*

[343] *See also* GIGLER, *supra* note 293, at 234 ("[E]xternal socioeconomic variables are crucial for indigenous peoples' ICT capabilities. . . a structural problem exists—that is, people in the highlands continue to be excluded from many basic infrastructure services, such as electricity, water and sanitation, and ICTs—that can explain the digital inequalities that persist within Bolivia. The geographic region with the highest levels of extreme poverty, highest illiteracy rates, and lowest access to basic infrastructure services also has the lowest ICT use and capabilities.").

[344] *See* GIGLER, *supra* note 293, at 199–200.

[345] *See* Hamel, *supra* note 272, at 11.

[346] NYABUGA & BOOKER, *supra* note 45, at 14. In sub-Saharan Africa, only fifteen percent of rural households have access to electricity. *See* Hamel, *supra* note 272, at 11.

programs to fund telecenters.[347] Even though engineers are attempting to create ICT devices that consume less power, ICT use is still limited in areas lacking adequate power supply.[348]

Finding that the social, institutional and environmental context is not ripe for ICT uptake should not deter broadband infrastructure development in a developing country. Research has shown that the support of the government to ensure basic infrastructure development, along with quality legal frameworks, can lead to improved technology utilization.[349]

3. *How ICTs Impact Capabilities*

Believing there is a relationship between capabilities and technology, many conceive of the Internet and ICTs generally as a means to achieve certain ends and thus inherently a tool for increasing capabilities.[350] Sen has also stated the importance of ICTs, recognizing that "access to the web and the freedom of general communication has become a very important capability."[351] At first glance, tech companies' connectivity agendas appear aligned with human-centered development by anticipating an expansion of individual capabilities resulting from newly available infrastructure. Google executives share the view that the extension of connectivity will lead to positive developments; the states of being educated, healthy, employed, and politically active are no doubt valued functionings of many people in both the developed and developing world.[352] However, as the Section above demonstrated, it should not be taken for granted that the introduction of ICTs ensures capabilities expansion. Moreover, although some ICT4D projects have noted positive effects on individual capabilities, studies also highlight

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347 *See Universal Service Funds in Africa*, *supra* note 31, at 626 ("[A]lthough USF across Africa are used to construct telecentres in disadvantaged areas, more often than not, they are not sustainable as a result of factors such as the relevance of the services offered and the lack of electricity to power computers.").

348 *See* Heeks, *supra* note 322, at 6 (noting three areas for innovation, including "new, low-cost devices for local electricity generation; better ways to store, carry and transmit electricity; and lower power consumption by ICT devices."). In India, a village area network called DakNet is free from dependable power sources by using solar panels or a generator attached to a bicycle wheel. *See* Shivani Harnal & Jasbir Kaur, *Daknet (The Village Area Network),* 6 INT'L J. ADVANCED RES. IN COMPUTER SCI. & SOFTWARE ENGINEERING, 303 (2016).

349 *See* Roztocki & Weistroffer, *supra* note 285, at 543.

350 *See* GIGLER, *supra* note 293, at 3–46; Coeckelbergh, *supra* note 300, at 84–85.

351 *See* Amartya Sen, *Human Rights and Capabilities*, 6 J. HUM. DEV. 160 (2005).

352 *See supra* note 270 and accompanying text.

that ICT use may negatively impact capabilities.[353] This Section briefly examines the potential impact of newly introduced ICTs on existing and newly acquired capabilities by surveying ways that ICTs can work for and against capabilities.

Many ICT4D projects have noted positive effects on individual capabilities in the areas of education, health, and innovation. ICTs are commonly believed to enhance learning, especially in areas where teachers may lack adequate qualifications.[354] Development practitioners also cite examples of ICTs enhancing the capability of innovation in the agricultural context, resulting in better living conditions and higher yields from improved agricultural knowledge.[355] For example, Internet access often results in greater profits if farmers have pricing information for crops in different markets.[356] Scholars commenting on the impact of ICTs on health tend to agree that the use of ICTs in medicine for knowledge management and service delivery can improve health outcomes.[357]

Nevertheless, critiques of the ICT4D agenda call into question the magnitude of positive effects of ICTs on individual capabilities. For instance, some question how much ICTs contribute to learning given that online content is not always available in a local language.[358] Using the language of opportunity costs, scholars also view ICT investments as "tak[ing] away scarce resources from more urgent and direct development priorities, such as improving poor people's access to education, water and sanitation, or health."[359]

Beyond questioning the magnitude of positive effects, others note how ICTs may in fact exacerbate existing inequalities and impede the equitable development of individual capabilities. Sometimes, those who stand to benefit most from ICTs may be left out completely, especially if they lack digital literacy skills. This may perpetuate or exacerbate existing digital divides in

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[353] *See* Grunfeld et al., *supra* note 312, at 13 (noting that in a Cambodian ICT4D project, "[p]articipants had a strong inclination towards viewing ICT skills, the capability of learning in general and about agriculture, health, and education in Khmer, English, and typing, in particular, as the main capabilities to which iREACH had contributed."); *but see* Hamel, *supra* note 272, at 58–59 ("ICT4D therefore only represents a potential for increasing opportunities and capabilities through technology, which can also increase inequality around the world and benefit only those that are able to gain from the new opportunities that ICTs facilitate. . .").

[354] *See* Grunfeld et al., *supra* note 312, at 14.

[355] *See id.* at 16, 20; GIGLER, *supra* note 293, at 3–46.

[356] GIGLER, *supra* note 293, at 8.

[357] *See* Hamel, *supra* note 272, at 27–33.

[358] *See id.* at 36.

[359] GIGLER, *supra* note 293, at 6 (citing Gordon Wilson & Richard Heeks, *Technology, Poverty, and Development*, in POVERTY AND DEVELOPMENT: INTO THE 21ST CENTURY (T. Allen & A. Thomas Eds., OUP 2000).

ICT usage, which may be because of gender, age, or social status.[360] If marginalized groups are excluded from the information society and do not stand to reap the benefits of ICT use, capabilities will only be enhanced for those on the right side of the divide.

ICT usage may also have unintended consequences, including the undermining of individual capabilities. Although Internet access may yield greater profits for those in certain sectors like agriculture, there is also the concern about potential displacement of old workers with new technology, contributing to labor insecurity.[361] Moreover, the role of ICTs in connecting citizens to their government is often viewed as integral to enhancing democracy, promoting good governance via accountability, and boosting rule of law.[362] However, ICT usage by citizens also creates more opportunities for increased government surveillance, may trigger political instability, and can facilitate channels for encouraging violence.[363] For example, the post-election violence in Kenya in 2007, where SMS was used to engage supporters in violence, shows how technology can contribute to both the worst and best of political and societal activism.[364] In sum, ICTs do not always enhance capabilities, but the general belief remains that ICTs are a "crucial enabling infrastructure."[365] Nonetheless, technology is not neutral. It can lead to positive development impacts but may also disrupt communities and existing social and institutional arrangements.

4. *Community-led Development under the Capability Approach*

The importance of community involvement in infrastructure development cannot be understated. As much as communities and the social context can be macro-level barriers to the adoption of ICTs, discussed *supra*, communities can also be key proponents of ICT usage by encouraging uptake and adoption. ICT4D literature reporting on tech development projects notes

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[360] *See* Richard Heeks, *ICT4D 2016: New Priorities for ICT4D Policy, Practice and WSIS in a Post-2015 World*, 26 (Development Informatics, Working Paper Series No. 59, 2014).

[361] *See* Hamel, *supra* note 272, at 8 ("Many studies show that ICTs and the changes that accompany them are 'demonstrably disruptive' for many people in developing countries despite the wealth that they generate.").

[362] *See* GIGLER, *supra* note 293, at 11; Boettiger, *supra* note 341, at 141.

[363] *See generally* NYABUGA & BOOKER, supra note 45, at 7, 41 (discussing post-election violence); Mark I. Wilson and Kenneth E. Corey, *The Role of ICT in Arab Spring Movements*, 26 NETWORKS & COMM. STUD. 343 (2012) (explaining how ICTs played a major role in the Arab Spring as well as the Tunisian uprising); Policy Brief, CIPESA, The Growing Trend of African Governments' Requests for User Information and Content Removal From Internet and Telecom Companies, (July 2017) https://cipesa.org/?wpfb_dl=248 (discussing state surveillance) [https://perma.cc/JV56-38WV].

[364] *See* NYABUGA & BOOKER, supra note 45, at 7.

[365] *See* SEN, *supra* note 301, at xii; Thompson, *supra* note 272, at 1.

that ICT usage and development of capability sets may result from community acceptance. Despite the emphasis by capability scholars on individual variables, some studies indicate that "[c]ommunity-level socioeconomic variables are more important determinants of ICT use than individual-level variables in rural communities in Bolivia."[366] This lends further support for the claim that ICTs need to be locally appropriated to ensure expansion of individual capabilities. In other words, communities need to value ICTs.

For ICTs to be accepted by communities and enhance capabilities, ICT use would need to be deemed a basic capability by the community. Some scholars reason "community capabilities represent all the valuable functionings and opportunities that 'should' be guaranteed for all members of the community" and should be the central focus for analysis and policy planning.[367] Despite the emphasis by Sen on individual capabilities, the capability approach is compatible with group interpretations of well-being and governance processes whereby community priorities are set, which reflect capabilities and functionings that the group has reason to value. Though the capability approach promotes the use of agency by individuals and is "theoretically underspecified" with respect to groups,[368] Sen sees a role for collective action when defining basic capabilities. Instead of defining a list of basic capabilities like Nussbaum, he encourages this list to be determined by public reasoning.[369] Such an evaluative exercise encourages individuals to hold public discussions about their values and needs, as well as the use of democratic processes.

A community-led approach to infrastructure development may also inform the effective design of ICT programs, strengthen political freedom, and fortify the local tech industry. Such an approach would encourage local participation and, in developing countries, ensure projects are designed with the specific resources and demands of poor communities in mind. Bottom-up initiatives may help achieve universal access objectives if the infrastructure is

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[366] GIGLER, *supra* note 293, at xxxii.

[367] Mario Biggeri & Andrea Ferrannini, *Opportunity Gap Analysis: Procedures and Methods for Applying the Capability Approach in Development Initiatives*, 15 J. HUM. DEV. & CAPABILITIES 60, 63 (2014).

[368] Björn-Sören Gigler, *Indigenous Peoples, Human Development and the Capability Approach* 18 (Paper for the 5th International Conference on the Capability Approach ,August 8, 2005), https://ssrn.com/abstract=2924106 [https://perma.cc/8YV3-J3UF].

[369] GIGLER, *supra* note 293, at 24–25, 26 (noting that Sen encourages this list "to be defined by the local context and people's priorities."); Sen, *supra* note 351, at 157.

not only locally appropriated, but also affordable and accessible.[370] More importantly, initiatives that stem from the community give rise to the practice of political freedom if communities are involved in setting priorities with regards to capability development. From a capability perspective, infrastructure projects that simultaneously work to create and strengthen democratic institutions stand to gain more than short-term impacts.[371] A community-led approach to tech infrastructure would also further the long-term objective of creating digital transformation ecosystems in developing countries by strengthening the local tech industry.[372] Beyond using the Internet, the hope is for developing countries to one day enhance their tech capacity in order to invent new technologies, create local content, and innovate technological solutions to their development problems.[373]

Moreover, community-led development is desirable to resolve potential conflicts regarding the use of resources and improve the governance of infrastructure projects. Given that infrastructure resources are intermediate inputs and "shared means to many ends,"[374] community engagement regarding desired infrastructure provision and capabilities expansion is crucial, especially because infrastructure goals often conflict.[375] To resolve these conflicts, effective governance mechanisms are essential. Governance challenges are commonly cited for infrastructure projects: not only do elites and technical experts often make decisions, but the "potential combination of private interests, weak accountability mechanisms, and lack of transparency means that [infrastructure] goals might be implemented without balancing natural environment and wellbeing goals, and in a way that exacerbates

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370 Universal service projects sometimes have been categorized as either top-down or bottom-up. "Top-down projects refer to government-led initiatives, with clearly defined targets in terms of area and service characteristics . . . Bottom-up initiatives are those in which the operators, nongovernmental organizations or other entities propose programs and projects and request funds to cover them based on a business plan." Emiliani, *supra* note 25, at 20, 30.

371 *See* Frediani et al., *supra* note 298, at 10.

372 *See* Nagy K. Hanna, *How Can Developing Countries Make the Most of the Digital Revolution*, WORLD BANK: DIGITAL DEVELOPMENT (March 3, 2017), https://blogs.worldbank.org/digital-development/how-can-developing-countries-make-most-digital-revolution [https://perma.cc/MJ33-LVEE].

373 *See* Meghnad Desai et al., *Measuring the Technology Achievement of Nations and the Capacity to Participate in the Network Age*, 3 J. HUM. DEV. 95, 97 (2002).

374 *See supra* note 273 and accompanying text.

375 Jeff Waage et al., *Governing the UN Sustainable Development Goals: Interactions, Infrastructures, and Institutions*, 3 LANCET 251, 252 (2015) ("Infrastructure goals draw on common natural resources and realising them suggests some conflict with other goals at the same and different levels. For instance, achieving the energy or agriculture goal will have clear benefits for health and education but might be most easily and quickly achieved by actions that undermine biodiversity and climate change goals.").

contemporary and intergenerational inequalities."[376] In fact, the SDGs encourage multi-stakeholder partnerships, which draw on democratically accountable actors, the private sector, and civil society, to resolve "social, economic, and development-related problems and challenges."[377] Engaging the community that the infrastructure projects are aimed to serve, providing avenues for deliberation, and abiding by transparency standards would further combat the skepticism about the "political economy" of ICT4D projects and whose interests such projects truly promote.

One such community-led infrastructure solution that addresses governance concerns is being implemented by a telecommunications nonprofit organization. Rhizomatica serves the state of Oaxaca, Mexico, where many rural villages are ignored by the major telecoms because they are deemed not profitable. Rhizomatica's mission is to enlist direct community involvement and participation to develop decentralized telecommunications infrastructure.[378] With Rhizomatica's help, small indigenous communities in Mexico install, own, and operate base stations built with less expensive software and hardware that was once used by major telecom companies. Not only does the community have complete control over the network, but it also has control over the affordability of access. In one community, subscribers to the community network paid about $2 per month for all local calls and texts, with the town retaining profits after paying electricity and maintenance costs.[379] Such community-led infrastructure development improves acceptance of ICTs and promotes capabilities expansion, especially when a common barrier to access is tackled: cost. Moreover, with community owned and operated networks, the community is actively determining which functionings ought to be guaranteed for all members.[380] Some other positive impacts include local technical knowledge development, decreased dependence on foreign tech solutions, and community-governed technology

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[376] *See id.*

[377] Alice Wanjira Munyua, *Exploring the Multi-Stakeholder Experience in Kenya*, 1 J. CYBER POL'Y 206, 207 (2016) ("There is no universally accepted definition of multi-stakeholder governance. It is considered a vehicle for collaboration and cooperation in the resolution of social, economic, and development-related problems and challenges . . ."). The UN defines partnerships as "voluntary and collaborative relationships between various parties, both state and non-state, in which all participants agree to work together to achieve a common purpose or undertake a specific task and to share risks and responsibilities, resources and benefits." *Id.* (internal quotations and citations omitted).

[378] *About Rhizomatica*, RHIZOMATICA, https://www.rhizomatica.org/about/ (accessed Oct. 27, 2019) [https://perma.cc/DM3Z-DWHY].

[379] Lizzie Wade, *Where Cellular Networks Don't Exist, People Are Building Their Own*, WIRED, Jan. 14, 2015, https://www.wired.com/2015/01/diy-cellular-phone-networks-mexico/ [https://perma.cc/6EUB-WTDD].

[380] Biggeri & Ferrannini, *supra* note 367, at 63.

infrastructure that reinforces the community's values and ways of association.[381]

V. CONCLUSION

After years of significant financing of universal service funds to bridge the digital divide, many universal service missions remain unsolved and have created opportunities for the private sector to step in with innovative last mile solutions.[382] Nevertheless, as companies deploy innovative broadband infrastructure to blanket the globe with high-altitude connectivity, they should not ignore existing policies and institutional arrangements. Given the network structure of telecommunications, public policy will likely continue to play a significant role in telecom infrastructure production and regulation.[383] Accordingly, innovators should work with governments (and their existing infrastructure development plans and universal service agendas), international development actors, and the communities the infrastructure is aimed to serve.[384] As the world steps into a new age of interconnectedness with 5G networks and potentially dramatic societal challenges, such collaboration may help harness the Internet of Things for future global development. Without the support of other actors already on a mission to bridge the global digital divide, the potentially breakthrough infrastructure solutions to the global last mile may deliver unexceptional development outcomes.

There does not exist a template for bringing disruptive technology to market, let alone to rural markets, and many regulatory challenges concerning national airspace, outer space, and spectrum are guaranteed given the

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[381] *What We Do*, RHIZOMATICA, https://www.rhizomatica.org/what-we-do/ [https://perma.cc/N2K7-E46X].

[382] Frieden*, supra* note 99, at 448–49.

[383] *See* Hausman et al., *supra* note 17, at 1.

[384] There has been an uptake of universal service programs in developing countries and a recent surge in national broadband plans, promoting affordable, ubiquitous, and high-speed access, and programs designed specifically to teach ICT skills. *See The Benefits of Applying Universal Service Funds to Support ICT/Broadband Programs*, INTEL (2011), https://www.intel.com/content/dam/www/public/us/en/documents/white-papers/usf-support-ict-broadband-programs-paper.pdf [https://perma.cc/U9KN-H396]; INT'L TELECOMM. UNION, *Universal Access/Service: Assessment Report*, *Harmonization of ICT Policies, Legislation and Regulatory Procedures in the Caribbean* (2013). The World Bank and ITU are keen to connect schools to the Internet and have been contemplating how to utilize national universal service or access funds for an ICT for education initiative. *See* INT'L TELECOMM. UNION, THE UNIVERSAL SERVICE FUND AND DIGITAL INCLUSION FOR ALL STUDY (2013); Michael Trucano*, Universal Service Funds & Connecting Schools to the Internet Around the World,* WORLD BANK: EDUTECH, (Feb. 26, 2015), http://blogs.worldbank.org/edutech/universal-service-funds-connecting-schools-Internet-around-world [https://perma.cc/K7TS-MB3J].

transnational and global nature of the infrastructure. A human-centered approach to commercialization plans for high-altitude connectivity infrastructure may help achieve positive development outcomes. Instead of assuming socioeconomic development in the aggregate will automatically follow the introduction of broadband infrastructure, companies seeking to deploy connectivity infrastructure should consider the real impact the infrastructure will have on individuals and communities, who are the intended beneficiaries of Internet access. This will require thinking beyond the next telecom partnership or deal, and instead will require engaging with the development literature, specifically ICT4D projects that have historically been carried out in many rural communities. Using Sen's capability approach, companies should not take the responsibility lightly to understand how newly introduced broadband infrastructure may or may not deliver "development as freedom."