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BUSINESS MODELS FOR THE LAST BILLION:

MARKET APPROACHES TO
INCREASING INTERNET
CONNECTIVITY



 **SSG ADVISORS**

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BUSINESS MODELS FOR THE LAST BILLION: MARKET APPROACHES TO INCREASING INTERNET CONNECTIVITY

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AUTHORS:

Steve Schmida, Isaac Williams, Caitlin Lovegrove

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Agency for International Development or the
United States Government.



1 Mill Street, Suite 201, Burlington, VT 05401

and

2000 P Street, N.W. Suite 410, Washington, DC 20036

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EXECUTIVE SUMMARY

In a little more than two decades, the Internet has transformed from a communications network used primarily by universities to an integral part of the global economy that generates more than \$4 trillion in value annually and with the potential to address a variety of social challenges.

Study after study has demonstrated that increasing Internet access improves economic growth while also creating new opportunities in education, gender empowerment, and transparent governance. Recognizing the value that digital inclusion brings, the newly adopted United Nations Sustainable Development Goals (SDGs) set universal Internet access as an explicit target (#9c) and highlight the need to strengthen the use of information and communications technologies for women's empowerment (#5b).

Unfortunately, the dividends of the digital economy have not been equitably distributed; more than four billion people do not access the Internet around the world. The so-called digital divide is particularly acute in rural areas in the least developed countries (LDCs), where low household incomes and high infrastructure investment costs conspire to deter investment in network connectivity, leaving communities and local economies cut off.

This report describes the emergence of innovative, low-cost business models that can enable the world's lowest income consumers to participate in the emerging digital economy. In preparing it, SSG

Advisors sought the input of over 100 industry and technology leaders, entrepreneurs, investors, government officials and development practitioners, using a combination of interviews and highly interactive small-group sessions held in five global locations.

To frame the conversation, SSG asked these Internet connectivity leaders to consider how a member of the world's poorest billion, able to spend only an average of \$2.25/month on connectivity, might be able to afford Internet access and what business models and technology solutions could make this happen. By focusing on the most extreme use case, this assessment sought out technologies and business models that were competitive enough to serve even the most challenging markets.

The input participants provided both surprised and inspired this report's authors: there is an enormous potential market, a range of novel uses of existing technologies, and a host of new innovative business models, all of which create great potential for connecting the most challenging markets sustainably and profitably.

KEY FINDINGS

- **Current approaches to providing Internet connectivity have their limits.** Network operator-driven business models that rely primarily on subscriber revenue have brought the first 3 billion people online and will continue to grow, but the assessment uncovered wide consensus that most of these actors do not see rural, low-income markets as commercially viable. This disconnect risks leaving several billion people without access to the Internet.
- **But technology is not the problem.** The technologies exist that could provide universal connectivity. The challenge lies in deploying and scaling business models that can sustainably provide connectivity to low-income consumers.
- **Innovative business solutions that reach the most challenging markets already exist.** There are practicable, market-based approaches to providing Internet connectivity to low-income populations. Rather than stretching the viability of traditional business models, these new approaches rely on innovative strategies to supplement customer revenue and drive down costs. There are a number of barriers, however, that have limited these models' ability to be deployed at sufficient scale.
- **These business models tend to keep costs low, have a local presence, and diversify revenue streams.** Though each is unique, many successful models share certain characteristics. They lower costs by using commoditized technologies, renewable energy, local switching, and content servers, among other cost-saving elements. They rely on local entrepreneurs as agents and advocates and drive income through content and value-added services while developing alternative revenue streams from both consumers and third parties.
- **Existing models have succeeded at a relatively small scale but face a lack of early-stage financing, limited partnership opportunities, and unfamiliar or restrictive regulations.** Due to the perceived high risk of so-called base of the pyramid (BoP) markets and the relative lack of focus by key stakeholders on connectivity for low-income populations, entrepreneurs and existing ventures face challenges scaling successful models.
- **Scaling these solutions will require innovative, cross-sector partnerships that bring together the large set of diverse organizations with an interest in universal connectivity.** By offering early-stage blended finance and incubation services to emerging connectivity business models, public and private partners can work together to bring high-impact, viable ventures to scale. This approach to scaling a connectivity ecosystem for the world's poorest requires focus, leadership, and collaboration, not new money.

ACKNOWLEDGMENTS

This report advocates a collaborative approach to address Internet connectivity gaps for remote and low-income populations. In preparing it, the authors were the beneficiaries of just such a generous partnership from colleagues throughout industry, government, and the financial community. This report would not have been possible without the support of the United States Agency for International Development (USAID), the Mobile Solutions, Technical Assistance, and Research (mSTAR) project, and FHI 360. Particular thanks to Troy Etulain and Hannah Skelly from the mSTAR project for support, guidance, and invaluable feedback throughout.

The small-group, white boarding sessions hosted in Silicon Valley, Washington D.C., Manila, Nairobi, and New Delhi were instrumental in helping the authors develop a more nuanced picture of the challenges and opportunities relating to Internet connectivity provision around the world. SSG wishes to offer particular thanks to Shannon Lucas and Joanna Dillon at Vodafone's Innovation Studio for generously hosting the Silicon Valley white boarding session. We are grateful to both Jim Forster and Darrell Owen, who volunteered significant time and shared insights from their wealth of experience.

Thanks also to FHI 360's Washington, D.C., team for hosting our Washington white boarding session; Evah Kimani, Polycarp Ngoje, and Charles Kimani from SSG's Nairobi team for expertly hosting and facilitating the white boarding session there; Lawrence Ang, Celina Agaton, Terence Lok, and Lorenzo Cordova for planning and facilitating the Manila session, and Louis Casambre and the Government of the Philippines DOST-ICT team for hosting the session; Sandipan Chattopadhyay, from Xelpmoc in Bangalore, for leading the New Delhi white boarding event, and Sharad Malholtra, Anand Raman, and the entire FHI 360 New Delhi team for hosting.

The great majority of the ideas and insights in this report have their origin in consultations over the past several months with over 100 industry leaders, entrepreneurs, investors, government staff, and development practitioners worldwide. Their enthusiasm about the future of Internet connectivity for un- and under-connected populations and their commitment to increasing connectivity inspired and motivated this work.

Finally, while this report benefited from the input of so many, its final form reflects the views of SSG Advisors and the authors alone.

INTRODUCTION

SCOPE AND METHODOLOGY

This report summarizes the findings of a several-month outreach and analysis effort focused on the future of Internet connectivity for marginalized populations: those who, due to their location or income level, do not yet have Internet connectivity. This assignment was undertaken by SSG Advisors on behalf of FHI 360's Mobile Solutions Technical Assistance and Research (mSTAR) project, supported by USAID. It aimed to identify business models and/or new applications of communication technologies that could support connectivity for these low-income or otherwise disadvantaged populations and provide recommendations for activities or initiatives that could help test, accelerate, or further develop these new solutions. This assessment was grounded in an awareness of the substantial benefits of Internet connectivity, including its positive impact on social indicators,¹ including health,² gender equity,³ and environmental conservation,⁴ as well as its role in increasing transparency in politics, improving access to governmental services,⁵ providing lifesaving services in disaster situations, and contributing to economic growth and increased GDP.⁶

In pursuit of insights on business approaches to expanding Internet connectivity from both industry and leading practitioners, SSG Advisors conducted a multi-faceted landscape assessment. This included individual interviews with key informants; a review of the past several years of published material, and all-day workshops, termed "white boarding sessions," with key industry, government, and development leaders. In total, over 100 executives and practitioners

from government, industry, startups, and the development community shared their perspectives on the future of Internet connectivity for low-income populations and discussed what emerging business models and solutions hold the most promise. For a full list of organizations that generously provided input to this assessment, please see Appendix I.

Central to the assessment's outreach strategy were five white boarding sessions, held in various global centers for connectivity and digital inclusion: Silicon Valley, Washington D.C., Manila, New Delhi, and Nairobi. Each of these intimate day-long events brought together approximately 15 key individuals to represent diverse interests and perspectives from investors, leading technology companies, service providers, development agencies, and government. Using a human-centered, participatory facilitation strategy, SSG designed the sessions to solicit reflection and create collaborative brainstorming on business models that have the potential to drive the expansion of Internet connectivity to low-income populations. In addition to reflecting on opportunities and challenges in their own sectors, each attendee also participated in cross-sector break-out groups to brainstorm emerging solutions and discuss areas for potential collaboration. One of the unexpected values of the white boarding sessions, frequently stated by participants, was the opportunity for diverse stakeholders with an interest in increasing connectivity for the world's low-income, base of the pyramid (BoP) consumers to be in the same room and have a conversation about common challenges and promising opportunities.



The white boarding sessions were complemented by individual interviews with key informants from a variety of backgrounds, including industry, investment, development, and policy. Each interview lasted 45-60 minutes and was based on an interview guide that aimed to gather specific insights from the interviewee's experience and identify success factors and challenges of emerging business models. Interviews were targeted towards individuals that could provide critical insights but were unable to attend white boarding sessions, key informants for specific business models, and experts who could provide further insight on topics and solutions identified during white boarding sessions.

Finally, the entire outreach and interview effort was grounded in a review of published material relating to digital inclusion and connectivity for low-income populations. In order to ensure relevancy in a rapidly shifting industry, the review focused on material primarily published within the previous three years that encompassed a wide range of material including academic papers, industry white papers, and development sector reports, as well as a variety of blog posts and journalistic pieces. Within these, SSG focused its review on the present state, key challenges, and consensus solutions in digital inclusion and access, with a strong emphasis on Internet connectivity. This review of recent published material gave the assessment team a robust basis for the conversations and white boarding sessions that followed, and helped differentiate between solutions that were new and emerging and those that were already widely recognized.

APPROACH AND STRUCTURE

Over half of the world's population, approximately four billion people, are not connected to the Internet today. While geography, culture, language, gender, and livelihoods all offer rich approaches to consider the ways that the unconnected interact with technology and the reasons they are not online, given its focus on business models and market viability, this report takes spending power and, more generally, income as its primary lens.

More specifically, this assessment focused on the lowest-income population without Internet connectivity, the "last billion" out of the world's 7.4 billion people. The last billion have a monthly average income of \$45 and, according to the International Telecommunications Union (ITU) and other analyses, a potential affordable communications expenditure of \$2.25 per month (as show in the table to the right). The majority of people in this group live in Sub-Saharan Africa and the Indian subcontinent.⁷ Approximately 75% live in rural regions and depend largely on agriculture for their livelihoods.⁸ An estimated 20-40% live out of reach of even the most basic mobile networks.^{9 10 11}

Segmenting the world's unconnected by income level and lowest-income market sets a clear benchmark that business models must meet in order to approach feasibility for this population. Further, if business models can succeed with this market, it stands to reason that they have a good chance of prospering at higher price points.¹²

Given this focus and the tremendous amount of work that has already been invested in presenting individual technologies and network structures for Internet connectivity from a technical and systems-level perspective, this assessment focuses on identifying and describing business models and business model elements that make connectivity for this most challenging of markets a realistic proposition. The average consumer does not necessarily care about the technology behind how he or she accesses the Internet, as long as it works and is affordable. In other words, a woman in rural Uganda is not concerned whether her device is using 3G or Wi-Fi via a TV Whitespace spectrum network, or whether backhaul is provided by fiber, microwave, or satellite.

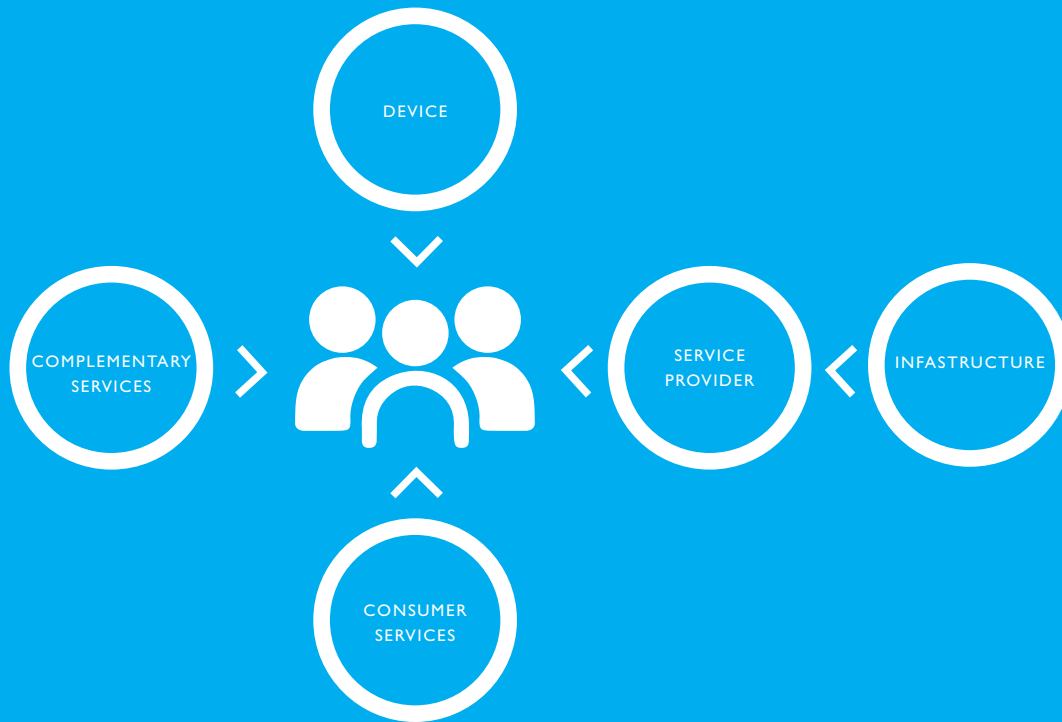
MONTHLY COMMUNICATIONS SPEND FOR THE WORLD'S POPULATION

BILLIONS OF PEOPLE	AVERAGE ANNUAL INCOME	AFFORDABLE MONTHLY COMMUNICATIONS SPEND	TOTAL ATTAINABLE MARKET (BILLIONS)
1ST BILLION	\$29,206	\$205	\$2,460
2ND BILLION	\$12,722	\$53	\$636
3RD BILLION	\$5,540	\$23	\$276
4TH BILLION	\$2,987	\$12	\$144
5TH BILLION	\$1,771	\$7	\$84
6TH BILLION	\$1,065	\$4.40	\$53
7TH BILLION	\$540	\$2.25	\$27

DATA: ITU AND UN DATA; ANALYSIS: RICHARD THANKI, UNIVERSITY OF SOUTHAMPTON.

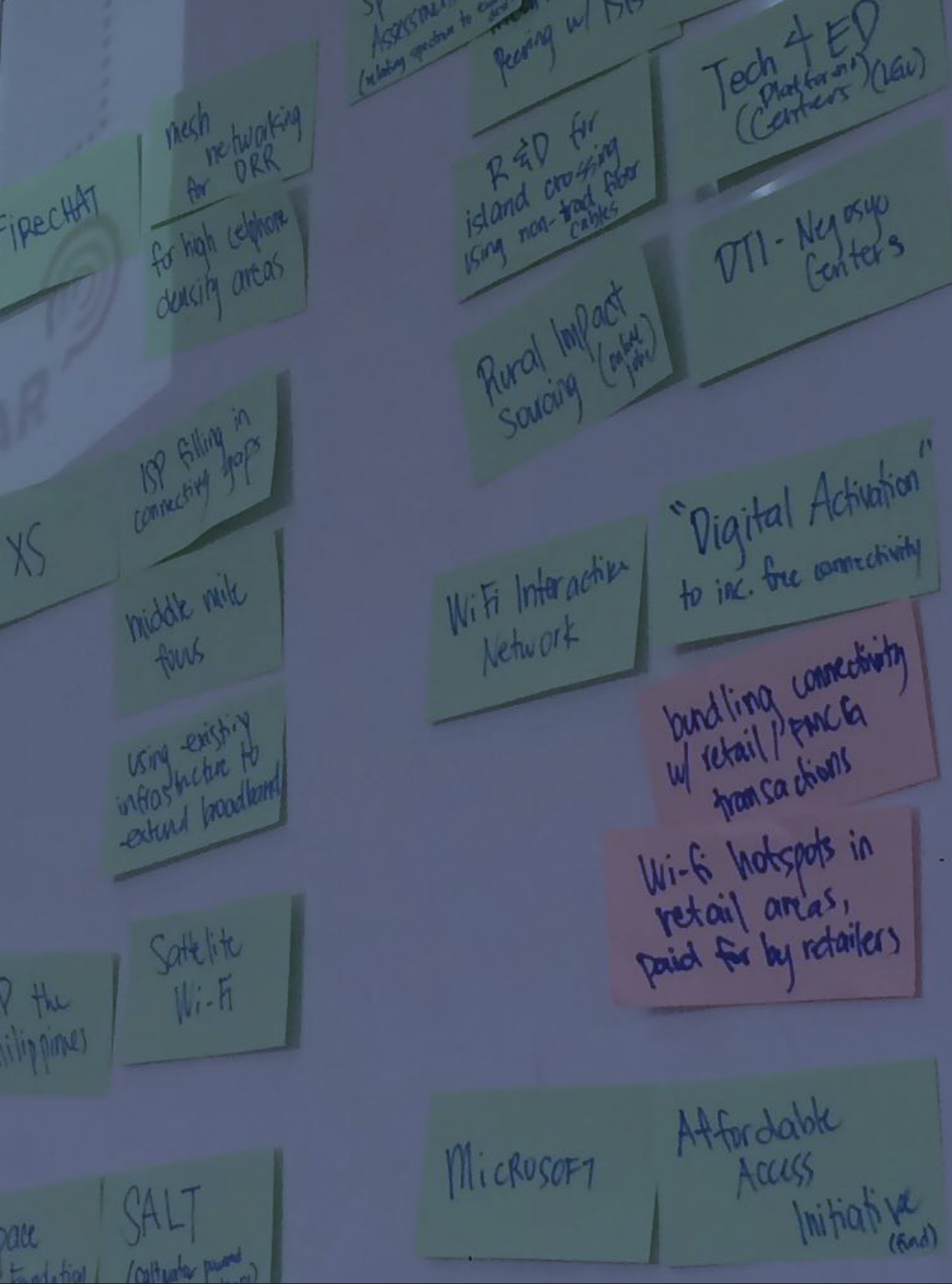
To emphasize this approach in considering connectivity solutions, SSG structured discussions during the white boarding sessions and interviews around a framework that presented key connectivity elements as an ecosystem with the consumer at the center. This helped to ensure dialogue was focused on the impact of solutions and business models on the end-consumer as well as their relationship with other ecosystem elements. Several white boarding sessions emphasized the point further by structuring the conversation around a composite, representative consumer. In Silicon Valley and D.C., participants discussed the challenges facing a 40-year-old fisherman on a remote island in Indonesia, and what solutions might address his connectivity needs.

EMERGING SOLUTIONS: ANALYSIS WITHIN THE CONNECTIVITY ECOSYSTEM



Building on the insights gathered through the interviews and white boarding sessions, this report is broken into three principal sections that both capture the major inputs from assessment participants and use these insights as a basis for analysis of the opportunities, challenges, and potential ways forward for connectivity business models for the last billion. The first section details some major developments and trends shaping the market environment for connectivity ventures, as described by industry, investors, and other

experts. The next section discusses distinct emerging solutions that enable last billion business models, as highlighted by assessment participants, illustrated by five case studies of specific ventures that are effectively deploying these solutions. The report then turns to a brief review of the particular challenges identified by assessment participants to scaling innovative connectivity business models. The report closes with a succinct set of recommendations.



MAJOR DEVELOPMENTS AND TRENDS IN CONNECTIVITY

MARKET ENVIRONMENT FOR LAST BILLION CONNECTIVITY

At the outset of the assessment, it became clear that the industry-wide dynamics that were shaping mainstream Internet connectivity and ICT also had consequences for the viability and competitiveness of business models operating in even the most difficult last billion markets. In a rapidly evolving market, the challenges and opportunities facing mobile network operators (MNOs) and Internet service providers (ISPs) more broadly are directly linked to their willingness and ability to reach new, low-income consumers in remote areas. The increasing use of mobile devices by all income levels as the primary Internet access tool completely redefines the market for over-the-top services and multimedia content. Perhaps most importantly, the consensus among major corporations about the need for ubiquitous Internet access has created an invaluable new group of champions of innovative approaches to the most difficult connectivity challenges.

The white boarding sessions and interviews continued to surface these systems-level observations. Specifically, participants noted the important but constrained growth potential of MNOs and other traditional network providers, the shifting industry dynamics driven by increasing reliance on data and higher-capacity digital devices, the strong incentives present in many companies, from technology firms to consumer goods multinationals, to help connect the entire world to the Internet, and the widespread availability of the technology needed to achieve full connectivity.

TRADITIONAL CONNECTIVITY MODELS STILL STRONG BUT FACE LIMITS

Assessment participants underscored the necessity of recognizing that approaches to connectivity focused on MNOs and large ISPs were still the dominant business model for connectivity provision but were unlikely to reach many people in low income rural areas. One expert in African telecoms noted that network operators operating within this bilateral, provider-consumer model have chosen to focus the great majority of their investments in urban and high- to middle-income markets, winning new customers and working to sustain average revenue per user (ARPU) through premium and add-on services. This organic growth of the subscriber base for existing networks in urban and peri-urban areas will likely continue to bring significant numbers of people online, particularly those with higher affordable communications expenditures of \$7-12/month and often

“As an incubator there is very little external push to focus specifically on last-mile solutions.”

- Director of a Startup Incubator in Manila

living in and around cities and major towns in the developing world.¹³
¹⁴ One participant at the D.C. white boarding session asserted, “Over the next 5 years, [we can] expect 1 billion people to already come online primarily because of market activity.”

That said, assessment participants at times vociferously argued that this organic growth would only go so far. Already, noted one expert, MNOs in many countries in Sub-Saharan Africa were beginning to saturate what they perceived to be commercially viable markets. “Mobile operators have reached the edge of their addressable markets. [Anything beyond] will be very tough and may require additional capital and subsidy,” he explained. “It’s just the choices you make if you are accountable to shareholders.” Low-income, low-density areas often impose higher capital and operating expenses while offering lower revenue – clearly not a compelling business proposition. Another participant argued, “The market will go so far, and then there’s that frontier, at which point you need some public investment.”

This perception regarding the commercial viability of low-income markets matters, not least because it affects investment decisions up and down the connectivity value chain. A leading device and network equipment manufacturer noted, “Honestly, we don’t invest much in [low-income, rural connectivity solutions] – we’re primarily focused on improving service for high-revenue, urban markets. But if we had a customer asking for these types of hardware we would have no problem investing.”

DECLINING ARPU AMIDST INCREASING CONSUMER CHOICE

Interviewees and white boarding session participants noted that traditional customer ARPU for network operators has been in steady decline over the last several years due to increased competition. Several interviewees highlighted that this trend is grounded in a strong shift of mobile users at all income levels to smartphones, resulting in traditional voice and text-driven revenue being further eroded by

data-based applications such as Viber, Skype, and WhatsApp. While industry reports for Sub-Saharan Africa seem to confirm this drop in ARPU due to the shift to data, some interviewees argued that this was not the case everywhere: India was specifically cited as an exception.¹⁵

In other cases, participants noted the challenges that MNOs face due to the proliferation of Wi-Fi connections as alternatives to mobile networks. In India, informants went so far as to wonder whether the increasing prevalence of Wi-Fi-enabled devices and service providers represented an industry shift that might undermine MNO business models. Finally, numerous participants noted that this smartphone and Wi-Fi-based uptake was driving changes in user experience and uses for connectivity (for more, see Devices on page 17 and Consumer Services on page 19).

Generally, these changes were noted simply as market shifts that business models in connectivity must adjust to, whether they come from dominant MNOs or the small rural connectivity startup. Interviewees said that, to some extent, network operators have been able to maintain margins by offsetting declining ARPU with decreasing capital and operating costs. One expert observed that densely populated urban and peri-urban areas allow operators to acquire and provide service to new customers at lower incremental costs.

For last billion business models, the proliferation of data as a service and numerous network technology options offers opportunities to lower costs and increase consumer choice.

MAJOR COMPANIES SEE HIGH VALUE IN UBIQUITOUS INTERNET

Major corporations generously provided input to this assessment, both through participation in the white boarding sessions and in-depth interviews. Throughout these conversations, one common theme emerged very strongly: almost all of the participants described a strong, commercial interest in ubiquitous Internet connectivity. "In our ideal world, Internet connectivity would be universally available for free," said a representative of one of the largest technology companies.

For companies driven by advertising revenue, new users represent new advertising opportunities and better understanding of new markets. For software companies such as Microsoft, increasing affordable bandwidth represents an opportunity to sell software and cloud services more effectively. As these companies reach market saturation in developed countries, they are recognizing the need to find new markets to sustain growth. Yet many potential new markets first require an Internet connection, pushing these companies to both advocate and, more importantly, invest in the push for "ubiquitous Internet." Interviewees and white boarding session participants highlighted four principal dynamics that are driving this market push for Internet for all:

- **Advertising and Big Data.** Assessment participants made clear that there is high value in advertising and market information that many private and public sector organizations stand to gain from a growing Internet user base. Predictive analytics and other so-called big data approaches can provide information on the habits, interests, income, needs, and profile of new Internet users. Tech companies, social media platforms, consumer goods companies, and even public sector organizations stand to benefit in a range of ways. Among others, advertising, even in BoP markets, can drive significant revenue growth for companies such as Facebook and Google.¹⁶ And while the donor community has understandably focused its efforts on big data for use in public sector initiatives, market forces will likely accelerate the big data and predictive analytics in BoP markets, particularly as it relates to consumer products, agriculture, index-based financial services, and logistics.
- **The Emergence of SaaS and Decline of Licensed Software.** Technology company interviewees argued that the emergence of Software as a Service (SaaS) across multiple market segments and the corresponding decline of the licensed software model had shifted the conversation about Internet access since, as a business model, SaaS requires constant, reliable Internet access. Further, SaaS (and associated freemium models) lower up-front end-user costs, meaning that for the first time, lower-income consumers may be a viable customer segment.

"Microsoft has made the transition to a company who sells services from the cloud, so we are hugely motivated to have cheaper and more affordable bandwidth."

- Director at Microsoft

- **The Internet of Things (IoT).** Various estimates forecast that by 2020, between 24 and 26 billion objects (vehicles, machines, appliances, etc.) will be connected to the Internet.¹⁷ While not yet a present reality, the IoT could conceivably create a strong drive for further network build out in rural and other low-density geographies. At the Washington D.C. white boarding session, participants discussed at length the potential for the IoT to drive demand for connectivity even for low-income populations. At the Nairobi session, participants highlighted the work of m-KOPA in using connected devices (solar panels and other household electronics) as core to the viability of its business model and central to its consumer interface. Several participants pointed out, however, that interoperability and privacy/security concerns may limit the growth and utility of the IoT as a driver for universal connectivity.

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- **Market Information and Sales Platforms for Consumer Goods.** Numerous interviews during the assessment showed that companies, including consumer goods producers, agricultural service providers, and financial services firms, recognize the value of the market at the BoP and see Internet connectivity as a means of both understanding and reaching this market segment. It can provide them access to valuable market data but also allows them to channel information about their products and services directly to the last billion and other BoP consumers, a population that is otherwise often difficult to reach. (For more, see the WiN case study on page 20.)

LOW-COST NETWORKS CAN BE BUILT WITH EXISTING TECHNOLOGY

The white boarding sessions and interviews revealed a remarkable consensus that technologies already exist to provide network connectivity for all. When explicitly asked about new technologies that are emerging for BoP markets, participants repeatedly spoke instead of how current technologies could be deployed in new ways or used more effectively. Even when they were pressed to offer an opinion on emerging solutions such as Google Loon's balloon-based systems, interviewees often returned to that fact that these so-called moonshot solutions would ultimately need to depend upon and work with existing technologies to create solutions that would actually work in last billion markets.

Among many examples, participants highlighted that fully mature technologies such as Wi-Fi and 3G/4G, when combined with ultra-low-cost Base Transceiver Stations (BTS), as well as emerging technologies such as TV White Space-enabled equipment, are able to deliver a quality user experiences in even rural BoP markets. On the content side, local servers and switching can help reduce bandwidth costs by keeping content local, routing traffic efficiently, and optimizing download/upload times. For electricity, the huge decline in solar panel prices makes powering equipment and charging devices a viable proposition in off-grid environments. Advances in fiber optic technology such as dense wave division multiplexing (DWDM) are ready to effectively make upstream bandwidth a non-issue in many settings. Other consumer-facing digital innovations such as mobile banking and mobile payments provide game-changing consumer information and payment systems solutions for connectivity businesses. Despite this broad optimism among assessment participants about the adequacy of existing technological solutions for connectivity, some interviewees from large tech firms argued for the important potential contributions of innovative (usually airborne) technologies that position network equipment in hard-to-reach places, particularly referencing drone, balloon, and micro-satellite solutions.

ED RESOURCES
DUCE
PEX

DEREGULARIZATION
OF OTT USAGE
WAS THE TOP
C WARE APP, etc

LONG LASTING
BATTERIES /
ENERGY EFFICIENT
DEVICES

TRY BEFORE
U BUY!
(WITH RELEVANT
CONTENT)
Free data

Afford
Devices
and.

EXPLOIT ALT.
CONNECTIVITY
METHODS
(Low P2P, etc)

DRIVE MOBILE
COVERAGE by
government owning
tower infrastructure

HUB & SPOK
BUSINESS
MODEL
- Aggregate
Business

SPONSORED
CONTENT
- End user
does not pay
Advertiser

SOLUTIONS AND CHALLENGES

EMERGING SOLUTIONS FOR LAST BILLION CONNECTIVITY

While many traditional provider-consumer models for Internet connectivity may not be viable for low-income users living in lower-density areas, innovative solutions and business models are emerging that allow proven technologies to be deployed in ways that provide both a high-quality user experience and competitive returns to investors and entrepreneurs alike. Interviews and white boarding sessions consistently uncovered innovative approaches to serving the challenging last billion market, ranging from a wholesale rural network operator in Nigeria to a free Wi-Fi partnership with major multinationals in the Philippines. Over the course of the assessment, participants also helped to identify the common aspects of successful models.

Most importantly, each of these models is characterized by an ecosystem approach to connectivity. In this framework, the end user is not the sole source of revenue for the network provider; nor is network connectivity the only service being provided to the user. Rather, the end user sits in the center of a series of transactions that are predicated on – but not limited to – connectivity, and which together create a viable business model. Ecosystem models combine alternative revenue sources with low-cost network technologies and see the Internet less as a network and more as a suite of services. This new, collaborative approach to Internet provision is thus able to offer connectivity to even the very poorest users – those able to spend an average of \$2.25/month on such services.

In order to be viable, these pioneering models have developed unique approaches to reducing risk and increasing returns by building partnerships with a wide range of stakeholders that find value in connectivity for the last billion, including government, development actors, network operators, service providers, consumer goods companies, and the local communities themselves. In the new model, capital and operating expenses become a shared burden because partners recognize that the value generated is a shared benefit. Governments subsidize or invest because they recognize the value of Internet connectivity for their country's development; tech companies build out networks because they want additional users; advertisers and service providers subsidize operating costs because they see value in reaching last billion consumers, and development actors join in because of the benefit to economic development and other social indicators.

The viability of these models is premised on new or re-emerging solutions throughout the connectivity ecosystem in infrastructure, network operators, consumer and complementary services, devices, and policy and regulatory frameworks (see page 8 for the consumer-centric

ecosystem framework used in white boarding sessions and interviews).

NETWORK INFRASTRUCTURE: INVESTING IN BACKHAUL

Various solutions are exploring ways of driving down the costs of deploying and operating network infrastructure. In some form or another, international backbone and other backhaul networks remain the critical first step for all the business models encountered during this assessment. As such, the emerging solutions that lower costs or improve the performance of upstream networks such as these have a direct impact on the viability of downstream and last mile business models.

- **Innovative airborne network infrastructure.** Interviewees from leading tech and satellite companies were keen to highlight approaches that innovate on the traditional, sequential value chain of international backbone, backhaul/middle mile, and last-mile networks. Airborne and direct-to-consumer models promise to skip backbone and, in some cases, backhaul network infrastructure entirely, going directly from international networks to middle mile networks and potentially even user devices, often via platforms such as satellites. Google Loon and Facebook Aquila, (as well as some of the innovations in satellites described below) are particularly prominent in this regard.¹⁸ However, other assessment participants cast doubt on these solutions from the perspective of cost effectiveness and relevancy. One said, "It's not clear to me how these proposals actually impact network deployment for remote areas. You still need some kind of ground-based infrastructure."
- **Fiber optic cables as mainstay.** With the mixed skepticism and excitement for mold-breaking airborne initiatives, the assessment resoundingly confirmed that fiber optic cables continue to be the mainstay of network connectivity. Participants generally believed that the majority of networks would continue to depend on fiber optic solutions to a great extent due to their unparalleled reliability and cost effectiveness for large volumes of traffic, though other solutions will continue to supplement or replace them in specific settings. Furthermore, fiber optic links between population centers are increasingly recognized as an opportunity for connecting low-density areas in between those centers. The impact of fiber on last billion connectivity, however, will depend on how well competition can keep prices low on upstream

networks. Participants at the D.C. white boarding session noted that fiber backbone or backhaul can serve as a foundation for secondary networks using lower-cost equipment that can easily serve last billion populations at a very small incremental cost to the fiber network operator: Interviewees highlighted that the installation of fiber backbones (usually subsidized through government investment) in a growing number of countries presents a key opportunity by providing a fiber point of presence (POP) within range of point-to-point Wi-Fi links that can reach neighboring rural communities.

- **Potential viability of satellites.** Though satellite solutions did not figure prominently in participant input, several individuals noted that lower prices and higher quality of satellite connectivity mean that in certain settings (particularly remote, landlocked, or island

regions) High Throughput Satellites (HTSs) can offer price-competitive alternatives to traditional cable-based broadband both to ISPs and directly to consumers. For example, Timor Telecom is currently using the O3B medium-earth orbit HTS network to provide faster broadband speeds to its customers in East Timor.¹⁹ Other applications highlighted during the assessment include the potential for satellite backhaul as the basis for low-cost Wi-Fi-based networks in remote areas. For example, ViRural's entire financial and operational models are based on an assumption of satellite backhaul. Some participants, however, are still skeptical. One expert noted: "We've been working on satellite for a long time and no one has ever been able to make it cheaper than land-based solutions for most applications, particularly when you factor in the required ground-based infrastructure such as receivers."

CASE STUDY COOPERATIVE PPPS (MACMILLAN KECK/BRIDGESPAN VENTURES)

Prior to 2012, the telecommunications sector in The Gambia had received international data connectivity over a terrestrial fiber optic cable from Senegal. With no competition, the cable owner was able to demand \$2,000 per Mbps per month for wholesale connectivity, driving up rates for the consumer as well.

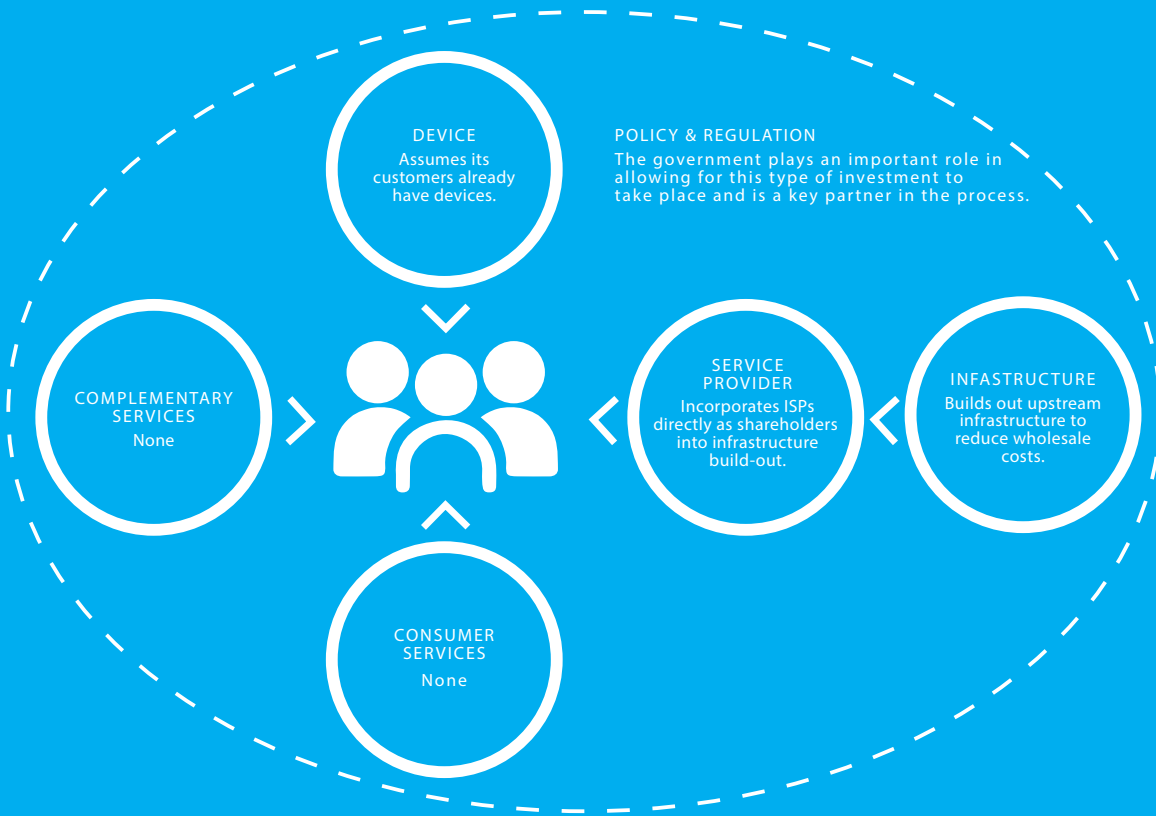
In The Gambia, advisors from MacMillan Keck/Bridgespan Ventures helped a number of telecom and government parties structure the cable management organization as a cooperative public-private partnership (PPP). Launched in December 2012, the cooperative structure managed The Gambia's access to the Africa Coast to Europe (ACE) submarine cable system. With a total of seven retail telecom operators participating, no operator owned

more than 20% of the PPP and was allocated capacity in amounts corresponding to ownership share. After the launch, prices for wholesale capacity dropped to \$500 per Mbps per month, 25% of original prices. The assumed follow-on decrease in consumer pricing allows for creative delivery of end-user connectivity to BoP markets.

The cooperative PPP model used in The Gambia is an approach to structuring investments that seeks to maximize private sector participation and investment while reducing risks of monopolistic and rent-seeking behavior. In doing so, it creates facilities-based competition on what is ostensibly monopoly infrastructure, increasing the affordability of connectivity in parts of the world where costs are high due to lack of competitive access

to high speed fiber optic cable infrastructure. Additionally, as opposed to a traditional PPP wholesale model, the investors, as both operators and customers of the cable, do not charge a wholesale markup. Instead, they operate the infrastructure at cost, a savings that can be passed on in the form of lower downstream pricing for end users.

Evidence suggests that, by fostering competition and transparency, the cooperative PPP model can reduce wholesale bandwidth prices, in some cases by a factor of 10 or more, and play a major role in reshaping the cost structure for network providers and increasing the viability of lower-revenue markets.



NETWORK OPERATORS AND ISPs: INNOVATING ON COST, CONTENT, AND STRUCTURE

Increasingly, both incumbent network operators and innovative startups are developing approaches to reach the last billion and other BoP consumers based on hybrid models and a redefined relationship between consumer and network operator.

- **Specialized roles to serve last billion market opportunities.** Participant input throughout this assessment has highlighted that new BoP solutions result in shifting roles for MNOs and ISPs. In some cases, network providers were noted as working in the background, leaving consumer-facing roles to new service organizations that often provide and broker a range of additional services beyond connectivity, as in the case of WIN (see case study on page 20). On the other hand, other very interesting business models encountered during the assessment use MNOs' widespread distribution networks, marketing, billing, and other client facing capabilities. ViRural, for example, sells last-mile network access to local MNOs who can better maintain the customer relationship while providing the value-add of a broader network (see case study on page 22). In both cases, traditional network operators see their roles evolve in creative ways in the face of new ventures that are by turns competitors and partners.
- **Third-party network ownership shifting risk and return considerations.** Interviewees highlighted further innovations related to ownership and operation of network infrastructure. In particular, they recognized the presence of third-party network operating firms, a role that has in some cases been played by government. Instead of owning a substantial portion of the network infrastructure, traditional network providers may rent most or all of it from government, brokers, or satellite or other airborne backhaul providers. Tower operating companies, until recently an innovation, are now the norm, allowing for increased availability of 3G and 4G service in locations such as India, Pakistan, and Malaysia. One network technology company executive highlighted the example of Mexico, where the federal government has undertaken the build-out of 4G networks across the country, renting capacity back to network operators.
- **Mesh networks' emergence as a viable network alternative for niche applications.** Several white boarding sessions demonstrated enthusiasm for the potential of mesh networks to shift the cost structure of last mile connectivity. The Manila white boarding session highlighted the potential of models such as Firechat, a communications app that uses Bluetooth and peer-to-peer networking to route messages between users in the absence of other networks. This approach is gaining increasing prominence, particularly for its potential deployment during natural disasters. On the other hand, other participants noted that community-driven mesh networks are heavily dependent on the existence and participation of tech-savvy individuals in every community, something they perceived as unrealistic.
- **Edge computing and local switching can reduce costs and improve performance.** Interviewees highlighted that in contexts where the lack of localized data centers is having a negative effect on the speed and cost of connectivity, edge computing – the ability to push computing power to the edges of a network (i.e. closer to users) thus allowing more localized computing – has helped to mitigate these issues. This is particularly relevant in Africa, where recent tests have shown that the majority of Internet traffic is still routed through data centers outside of the continent.²¹ Similarly, local switching was highlighted by several entrepreneurs as a key element of emerging business models. ViRural, for example, routes local traffic within its own networks in order to help lower backhaul costs.
- **Local content servers lowering cost through caching.** Several business models encountered during this assessment make use of local content servers as a means to offer more value to the end consumer. In combination with mesh and other local network solutions, local content servers that periodically cache a set of content from an Internet connection can provide many of the benefits of connectivity while substantially reducing the network burden and cost. For example, ViRural stores large media content on localized hard drives in each location to push out over a local Wi-Fi network and schools in areas with low connectivity are beginning to store educational content locally for use during the day.²²
- **Limited, free access as a means of driving adoption.** Zero-rating-based approaches, such as Facebook Free Basics, that offer free connectivity for consumers accessing a limited number of websites and services with the possibility to purchase full access, were not a substantial element of participant input during this assessment. They were, however, highlighted tangentially as a means of bringing online significant unconnected populations who were within range of networks. Participants highlighted their potential use in accelerating adoption in cases where connectivity is perceived as unaffordable or where the potential uses of the Internet are simply unfamiliar.

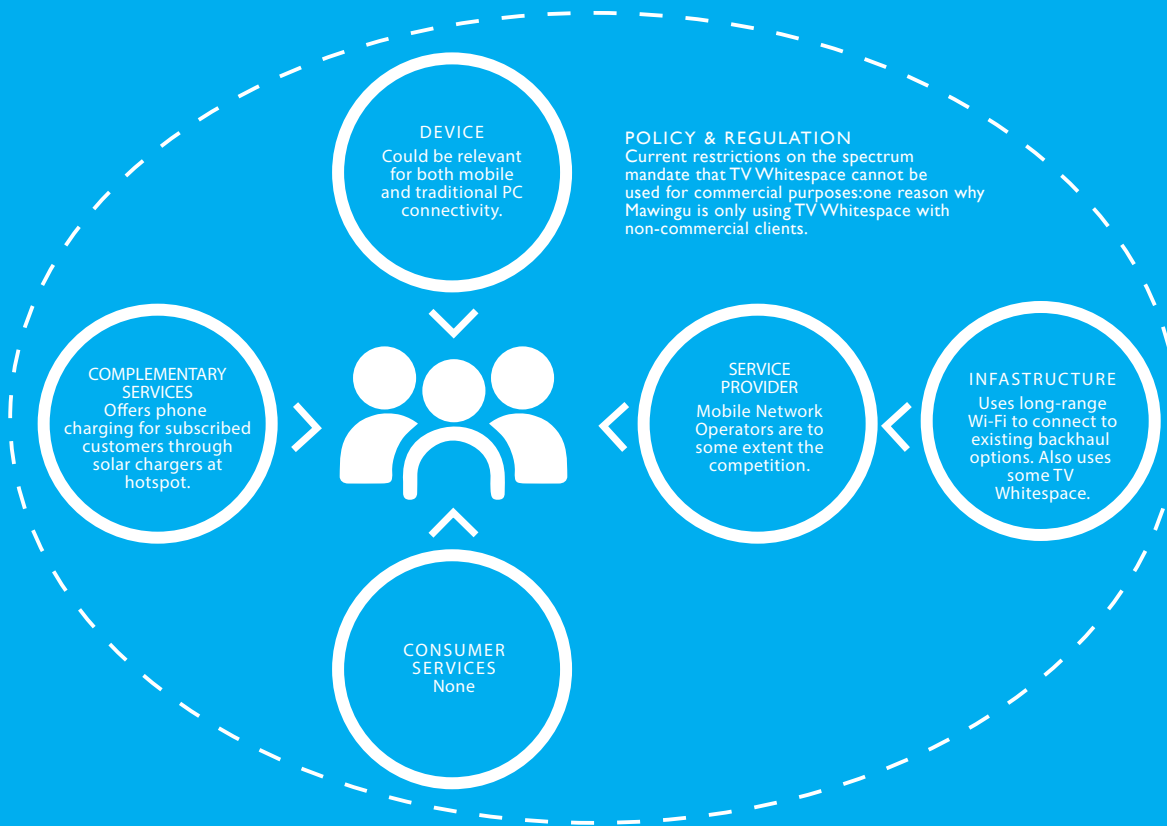
CASE STUDY MAWINGU

Mawingu is a Kenyan startup that operates and sells access to Wi-Fi hotspots in northern Kenya, using a combination of Wi-Fi, microwave relays, TV Whitespace equipment, and renewable energy solutions. It began as a small-scale PPP between USAID and Microsoft under the Global Broadband Initiatives Program. Initially aiming to simply demonstrate the viability of TV Whitespace technology in northern Kenya, it quickly became clear that, combined with Wi-Fi and microwave relays, the technology was not only viable but that consumers in these low-income, rural communities were willing to pay for Internet connectivity. The result was a new business that has now received

venture capital funding and operates over 100 hotspots, with between 50-100 people paying approximately \$2.50 per month at each hotspot.

Hotspots are placed in high traffic locations in rural communities across northern Kenya and connected back to the grid through point-to-multipoint wireless networks. Mawingu sells access to individual hotspots through local sales agents in each village. These sales agents collect cash and receive a 10% commission on sales. Knowing the local area, they have also been instrumental in understanding the needs and desires of Mawingu's customers, and suggesting prime hotspot placement.

Mawingu clearly showcases how different stakeholders can work together to finance and scale a viable business model. Initially supported through blended finance from a development entity and a technology company, Mawingu has now received equity funding from International Network Investments, Vulcan, Inc., and Microsoft, as well as debt financing from OPIC. These unique collaborations exemplify the potential for cross-sector partners to work together to capture new markets and provide high-quality connectivity to low-income consumers.



CASE STUDY AIRJALDI

Airjaldi is an ISP providing broadband services to enterprises and individuals through fixed wireless and Wi-Fi hotspots. It operates 10 networks in six Indian states, specifically targeting rural areas and serving over 70,000 clients. Airjaldi uses Wi-Fi links and relays (many solar-powered) to extend connectivity from existing infrastructure into rural areas that have little or no access to broadband services. Customers choose packages ranging from 1Mbps to dedicated lines of 100Mbps or more.

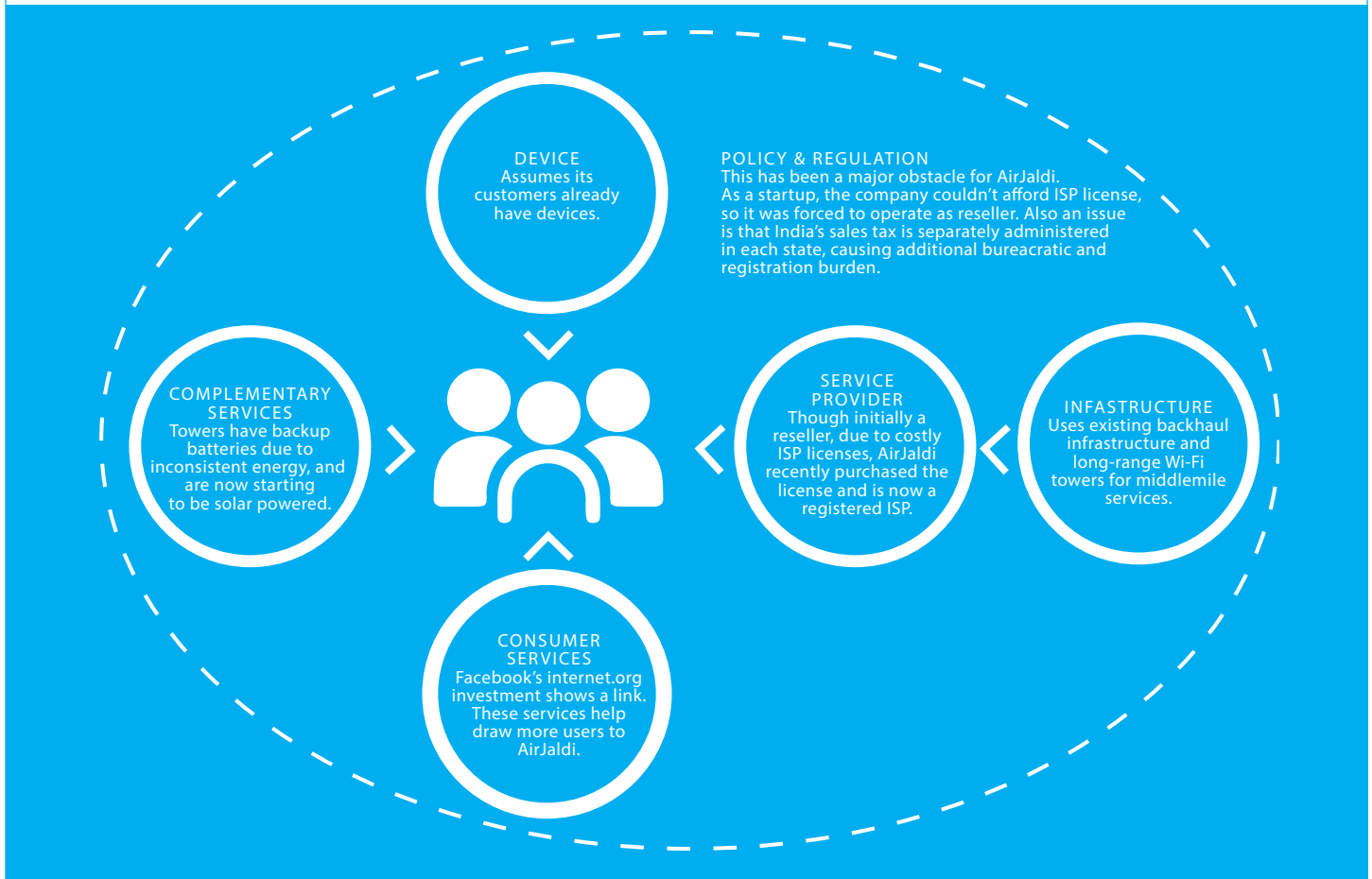
Airjaldi's networks have grown in response to identified demand and opportunities for provision of internet

services, enabling economical scaling of networks. Wide reach, attentive service, high availability and speed, and affordable prices all contribute to high customer loyalty and uptake. Airjaldi's hotspot services are a profitable means of reaching customers at a lower ARPU, and are particularly attractive to the many rural consumers who own smartphones but find mobile Internet offers too expensive.

Each network is managed by a local team. To address the challenge of workforce recruitment and retention in rural areas, Airjaldi operates training centers where local community members can undergo a six-month training

and internship program, at the end of which they join Airjaldi as network deployment staff. Over 85% of Airjaldi's workforce is a has undergone this training program.

Partnerships with Indian government institutions, philanthropic organizations such as the Ford Foundation, and technology companies such as Microsoft and Facebook have been critical to Airjaldi's success. With this model, Airjaldi has proven that new networks for last billion connectivity can be profitable within 12-18 months. With plans to double its size this year, and growing investor interest, Airjaldi is well placed for continued reaching new markets.



DEVICES: OPTIMIZING THE CONNECTIVITY EXPERIENCE

The last billion business models identified by this assessment all assume that the consumers they target already own devices (such as either feature or smart phones) to access the connectivity they offer. The attention of engineers, developers, and entrepreneurs is now focused less on ensuring the last billion poor have access to a device – that problem is assumed to be solved – but instead, on optimizing the device's usability, affordability, attractiveness, and performance.

- **Smartphones increasingly affordable to all.** Interviewees and white boarding session participants alike argued that smartphones, previously seen as too expensive, were

increasingly the norm even for last billion consumers. For example, a representative from a major equipment manufacturer said, "In one to two years, device cost will not be an issue." Not only are device costs dropping, but MNOs and their partners increasingly break device cost down into many small recurring payments, rather than one large payment up front. This substantially drives uptake for higher-end phones among low-income populations. m-KOPA is using its mobile-based asset financing model to sell smartphones in Kenya: currently a mainstream Huawei smartphone costs a customer approximately 40 cents (in US dollars) per day and the expectation is that this will continue to drop.

“Just because poor people are poor, it doesn’t mean they want a phone that doesn’t work as well.”

- Deputy Director, Alliance for Affordable Internet

- **Accessible but desirable devices aid adoption.** Several interviewees noted that manufacturers have attempted to create extremely affordable devices with little success despite the low price point. For example, the Intel Cloud FX was a \$35 smartphone powered by a Firefox operating system. One expert explained that low-end smartphones seem to fail due to users not wanting to own something that everyone in their community knows is the cheapest, lowest-end product on the market. He noted that, even for the poor, consumer goods are aspirational and status symbols. Another interviewee noted that many last billion and other BoP consumers prefer instead to purchase slightly higher-end smartphones either used or on a payment plan.
- **Richer content on smartphones offering additional customer engagement options.** The increasing use of smartphones also suggests a shift in user expectations with regards to accessing information on the Internet. Interviewees noted that these trends are shaping the focus of application developers and the types of content offered by connectivity ventures. “If I were a developer,” said one, “I would not be bothering [to develop applications] on feature and basic phones.” Participants highlighted the effects this should have on what content the development sector supports: whereas previous efforts aimed at developing apps for feature phones, some suggested that the focus should now turn to creating content optimized for higher-capacity mobile devices. Business models serving the last billion have already made this shift – video entertainment content only accessible on smartphones or similar high-capacity devices is a common element of several of the ventures profiled here – creating opportunities for additional revenue streams to drive business model sustainability.

CONSUMER SERVICES: LOCALLY-RELEVANT AND VALUE-ADDED CONTENT

The assessment highlighted the importance of locally-relevant and value-added content in last billion business models. Both can drive uptake and are key to the feasibility of several of the business models identified in this assessment. Specifically, with MNOs finding their traditional voice/text business under pressure, the role of value-added services (VAS) and content is generating new revenue.²³

- **Locally-relevant (not necessarily locally-created) content matters most.** While much focus in the development community has been placed on local application development ecosystems, some interviewees suggested that relevancy and attractiveness of content in a given context is much more important than whether the application in which it is found is actually locally created or not. In fact, in many cases user-generated content on international platforms has been one of the greatest drivers of demand: anecdotal evidence from the assessment suggests that social networking and communications platforms (e.g. WhatsApp, Facebook) are among the most used at the base of the pyramid. For example, one interviewee spoke of illiterate users in a particular region of India using WhatsApp’s voice message and video sharing functions to communicate in their local language.
- **Content as supplementary revenue source.** Sponsored content allows connectivity providers to generate another revenue stream from companies that are interested in reaching last billion consumers. In addition, interviewees highlighted the potential for entertainment and sports content (tailored to local tastes) to provide additional value for which consumers are willing to pay. In September, mobile operator MTN and sStream launched PockitTV, a mobile entertainment and sports platform that offers a range of local and international content for \$0.06/day. By using a very low per-use pricing model, PockitTV is tailored to the needs of the BoP user in Africa. As connectivity providers derive ever-greater portions of their revenue from content and VAS, they have the potential to offset declining subscriber fees for connectivity itself.
- **Innovative pricing and marketing approaches to content are gaining traction.** Several business models encountered in the assessment make content central to their value proposition and the connectivity product they offer to the last billion consumers. One firm, Tone, uses a bundled package of content and services that is tied to a data package, which can then be offered at a substantially lower price than a data-only subscription due to subsidies from content providers. Tone is specifically targeting the last billion user market through partnerships with network providers, as well as donor agencies looking to connect low-income populations. By bundling both access and content into a single package, models such as the one used by Tone create a product that is readily marketable to last billion and other BoP consumers and appealing to MNOs as well as advertisers.

CASE STUDY WI-FI INTERACTIVE NETWORK (WIN)

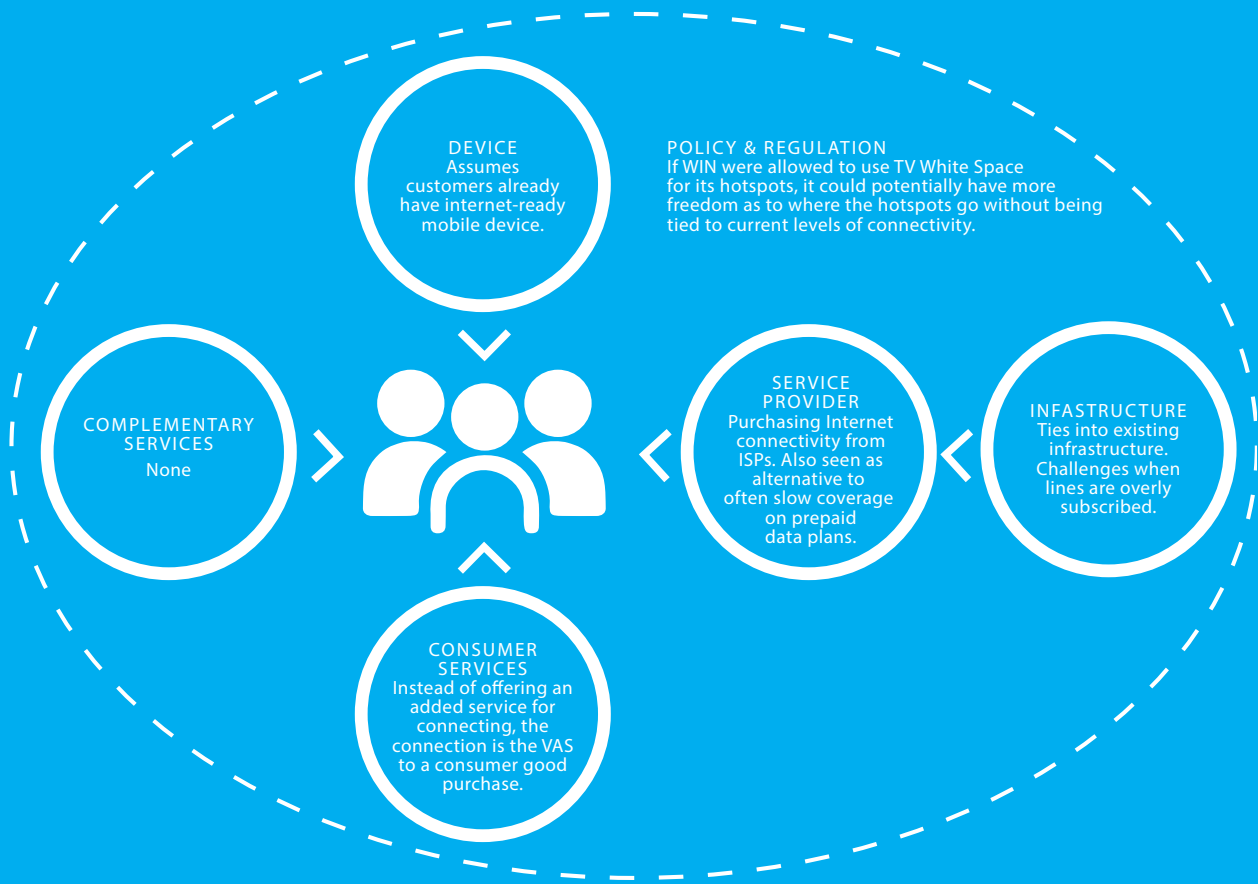
The Wi-Fi Interactive Network (WIN) leverages the power of consumer brands to offer free Wi-Fi to BoP consumers. The company currently is under contract with several global retail brands to offer a limited period of free Wi-Fi on a local network for every consumer product purchased from the partner company. For example, if a family in a small village purchases a sachet of washing powder from the local kiosk, that family would also receive a voucher code for 30 minutes of access to the Wi-Fi network based at the kiosk. The consumer brands cover the cost of installing and operating the Wi-Fi hotspots at

the local kiosks if the shop agrees to maintain a certain level of inventory purchases.

This model has a dual value proposition for these consumer brands. On the one hand, offering free Wi-Fi allows brands to differentiate their products from competitors'. More importantly, however, by entering or scanning vouchers in their local communities, consumer brands are better able to track sales, general customer profiles, and market trends. In the Philippines, many consumer goods are sold through small kiosks that do not have inventory tracking or electronic records of sale.

WIN is already working with several local and international consumer brands and food chains, with the target of having thousands of sponsored hotspots by 2017.

The WIN model is particularly interesting because of its ability to capture the value of Internet connectivity to non-users – in this case, consumer-facing companies. With slight modifications, this model could even be pushed to areas with no connectivity, where costs for network build out could be covered in whole or in part by interested businesses.



COMPLEMENTARY SERVICES: RENEWABLE ENERGY AS KEY ENABLER OF CONNECTIVITY

While connectivity has important relationships with a range of other services, none is more critical than energy provision. Indeed, every business model encountered in this assessment that directly targets consumer connectivity for the last billion is built around and dependent on renewable, off-grid energy solutions.

- **Renewable energy underpinning sustainability of connectivity in rural settings.** With unstable power grids forcing many network operators to rely on generators, a low-cost renewable
- **Symbiotic relationship between rural energy and connectivity.** The Nairobi white boarding session highlighted both the critical importance of reliable, low-cost power solutions for powering

energy solution can be the key to profitability for many networks focused on BoP markets. Interviewees and white boarding session attendees observed that the major advances in renewable energy technology, combined with a roughly 50% drop in the price of solar panels from 2008 to 2013, have shifted the underlying assumptions about the viability of connectivity solutions for rural, low-income markets.²⁴

network equipment and the success of models such as m-KOPA in demonstrating the symbiotic relationship between energy and network connectivity in rural business models. m-KOPA uses embedded GSM combined with mobile payments to help rural customers finance assets such as solar power systems and smartphones.²⁵ Beyond renewable energy, the New Delhi white boarding session participants highlighted the possibilities in using electrical grids as the basis for network connectivity build-out. Participants specifically noted government plans in Andhra Pradesh to build out fiber optic networks using existing electricity poles and sub-station infrastructure.²⁶

- **Energy as part of a bundle of services.** With connectivity infrastructure (towers, repeaters, Wi-Fi nodes) as some of the only powered equipment in many rural communities, many last-billion connectivity business models are keenly aware of the benefits of sharing this electricity with the rural communities where they operate. Mawingu has installed additional solar capacity with each of its Wi-Fi points, allowing customers who purchase Internet access to also charge their phones. ViRural installs community charging stations at each of its rural towers and Wi-Fi points. Customers can charge their devices for a fee, providing a key source of revenue for ViRural.

POLICY AND REGULATION

Policy and regulatory approaches are critical to the healthy development of Internet connectivity by creating a fair environment for competition, incentivizing inclusive approaches to investment, managing access to public assets, and creating a stable and predictable environment for doing business. While policy and regulatory approaches were not a focus of this assessment, white boarding sessions and interviews alike made clear their importance to the viability and success of last billion connectivity business models.

- **Pro-growth licensing and spectrum management are central to last billion models.** Some governments have taken innovative approaches to licensing and spectrum management that have helped strengthen the business case for connectivity for low-income populations. One interviewee raised the example of Colombia, where the government offered 4G spectrum licenses on the condition that mobile operators would provide access to low-income families within the license areas. On the other hand, other input during the assessment highlighted the negative role that government can play, often favoring incumbents at the expense of new business models. (For more, see Challenges, below.)

- **Universal Service Funds (USFs) can provide effective support for last billion connectivity.** While recognizing the mixed record of USFs, some participants nevertheless argued that they can be, and have been, effective in supporting network build-out for low-income populations.²⁷ One white boarding session argued that “the problem with USFs has been more with implementation than with the concept. Getting [a fund] set up is not enough, USFs need persistent engagement so that they are actually run in a transparent way.” Interviewees specifically cited examples in Malaysia, where the government used its USF facility to increase broadband penetration among low-income households from 30% to 50% by providing devices and connections to poor students. Senegal was also raised as an example of the potential innovative uses of a USF fund: there a partnership between the World Bank, equipment manufacturers, local operators, and the government USF fund lowered the overall cost of ownership for university students by 75%.

“I see a lot of growing understanding among governments of the importance and impediments of getting broadband to citizens.”

- Director at Intel

- **Government as network builder and/or key client.** Some governments are going beyond their regulatory function to serve as active investors and partners in infrastructure build-out. In Mexico, the government is building out the 4G network to ensure equitable coverage of low-income areas and renting network use back to mobile operators.²⁸ In India, the government’s SMART Villages program makes funding available through the Build Operate Maintain (BOM) model and transitioning networks to local control over five years. Interviews also highlighted cases where governments have helped to extend connectivity into rural areas by bringing government institutions such as schools, clinics, and community centers online. In these situations, government facilities serve as community connectivity hubs: low-cost bases for Wi-Fi or TV White Space deployment. In other instances, the guaranteed demand from government offices has helped ensure the feasibility of commercial rural networks.

CASE STUDY VIRURAL

ViRural is a telecommunications company building out a Wholesale Network for Rural Telephony (WNRT) in remote, rural Nigerian villages that have no grid power, Internet access, or mobile phone coverage. Using a network of what the company has termed “V-Nodes” – 15-meter masts that produce their own solar power, 10 km of GSM voice access, and 3 km of mobile data coverage, – ViRural anticipates an impressive rate of return, thanks in part to its focus of being the infrastructure solution for single or multiple network operators in rural areas. In addition to revenue sharing for “roaming” access on the WNRT which increases the MNOs’ coverage, ViRural sells device charging services at each node. V-Nodes will take advantage of local switching as more are installed in proximity to one another. MNOs can buy access

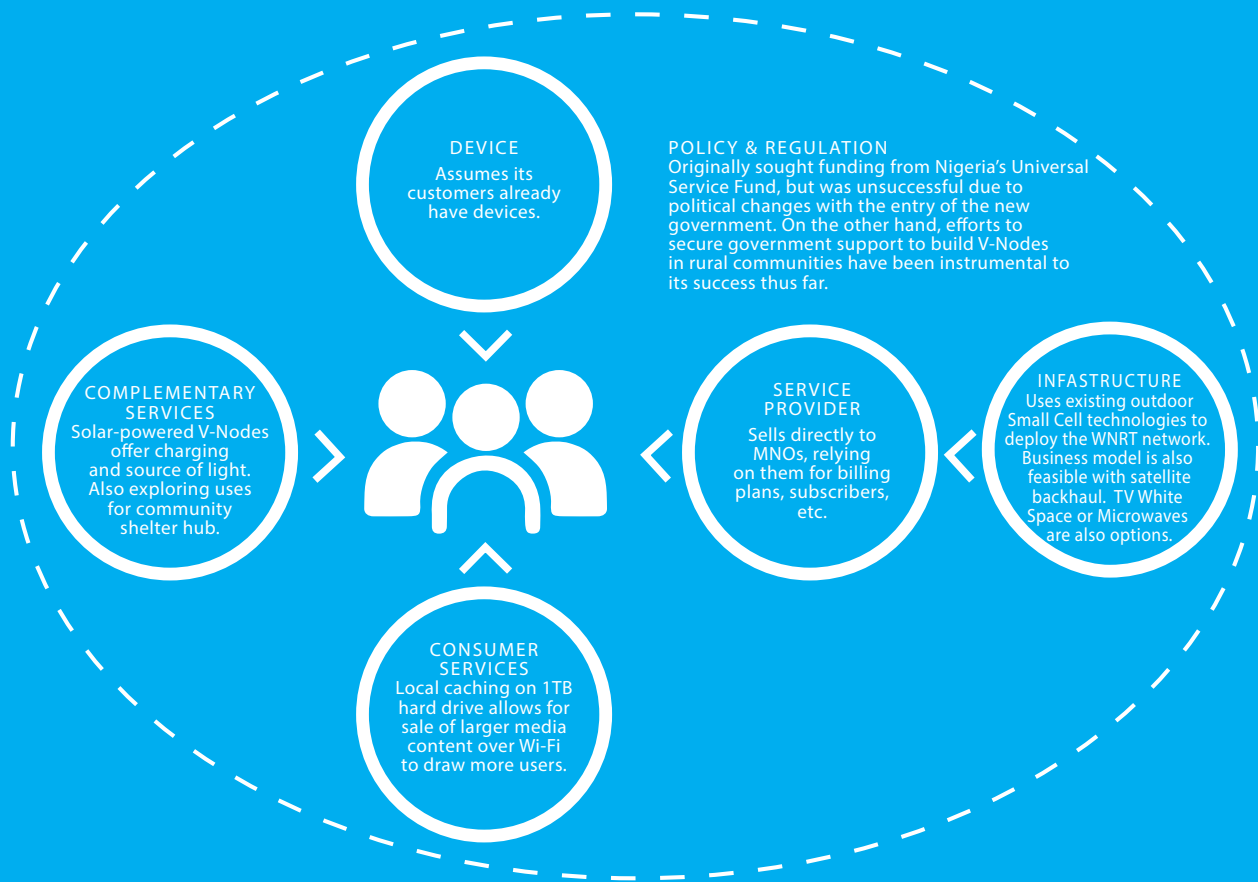
to ViRural’s network, providing them with an off-balance-sheet means to increase network coverage with limited risk.

ViRural is working to close a round of funding for a proof-of-concept with 10 sites deployed by Q4 2016. Assuming the company meets key metrics, it plans to expand to 20,000 villages in rural Nigeria over the next several years.

ViRural’s business strategy to sell network access to MNOs aligns with key industry trends in which MNOs in many markets are shifting ownership of network infrastructure to third party partners. By effectively taking on the infrastructure and operational risk associated with rural network build out, ViRural makes it painless for an MNO to acquire

rural customers with minimum risk and almost no increase in their annual capital expenditures budget.

In an environment of declining MNO ARPU and skepticism of the commercial viability of rural markets, this approach holds great promise for enabling rural network build out as it allows network operators to grow incremental revenue with minimal capital expenditure and, effectively, no operating expenditure (less the revenue share itself). Moreover, with its localized kiosk presence, ViRural enhances its social corporate responsibility by enabling other social service groups to easily expand their service coverage. By integrating well into existing MNO infrastructure and business models, the ViRural model is well positioned to drive substantial growth in rural BoP connectivity.



CHALLENGES TO SCALING LAST BILLION CONNECTIVITY

As the case studies and solutions described in this report demonstrate, the necessary technology exists and the business models seem to be feasible. So why are 4 billion people still unconnected around the world? Why is the digital divide growing?

During the assessment, participants reflected on the challenges facing last billion connectivity solutions. They noted that connectivity solutions for the last billion have generally succeeded only in relatively small-scale deployments. While the reasons for this were diverse and varied somewhat by context – energy access was a major challenge identified in Nairobi, and regulatory impediments figured prominently in discussions in Manila – several major factors emerged over the course of the assessment.

INADEQUATE EARLY-STAGE FINANCING AND INVESTMENT

Financing and investment were uniformly cited as key barriers, particularly at early stages of enterprise development. Startups at the Nairobi white boarding session highlighted the lack of seed stage financing as a major obstacle to their growth. ViRural spent over a year raising capital for even a small pilot deployment.

One of the major challenges with raising capital is the perceived high risk associated with BoP investments and connectivity in particular. Understandably, investors are reluctant to invest in business models they perceive as unproven, serving a market that they do not understand. While donors, foundations, and impact investors have supported BoP connectivity to varying degrees, investments have tended to be one-off decisions rather than a part of any deliberate focus on Internet connectivity solutions specifically for challenging, low-income markets. None have particularly focused on the needs and challenges of the last billion market. Since there is no known coordinating body or organized funding approach specifically targeting the sector, startups at white boarding sessions highlighted that they often did not know where to look for funding. Several tried to approach development actors for support but, lacking knowledge of the sector and the available funding mechanisms, had no success.

Even the models that have been most successful in raising funding (e.g. Mawingu) benefitted from a series of fortunate circumstances and serendipitous alignment of partners. For those businesses

isolated from the impact investment and donor communities, identifying financing for fledgling connectivity ventures in challenging markets, no matter how well designed the business model, becomes near to impossible.

ISOLATED NETWORKS AND LIMITED INFORMATION SHARING

The most successful startups encountered in this assessment were highly networked and relied on relationships to overcome key barriers to scale. They also benefited, to some extent or another, from background in the telecommunications industry which lent them credibility as they pushed the boundaries of traditional models. This is the case in each of the successful all-around connectivity models highlighted here: ViRural, AirJaldi, and Mawingu. In every case, founders and the companies' leadership were extremely well connected to government, industry, and investor communities.

A strong network and industry credibility are, of course, common factors in business success, but they are notable in the last billion connectivity space for their absence. Several participants at white boarding sessions were ready to implement solutions that had many elements common to successful last billion connectivity solutions – low cost structure, diverse and realistic revenue streams, viable markets – but were isolated from networks of investors, advisors, and advocates interested in this market.

Due to this gap, the white boarding sessions convened as a part of this assessment served as much as a platform for collaboration and networking as a forum for brainstorming and information gathering. This feedback was consistent in every white boarding session: the simple act of convening a discussion with a group of diverse stakeholders that all shared an interest in connectivity solutions for

“One of the biggest problems we encounter is access to funds. The investments are too risky for traditional investors and technology is often not a funding priority for NGOs and foundations.”

- Startup Founder in Bangalore

the last billion opened a space for conversations and connections that would not otherwise have occurred and, in some cases, addressed key issues facing participants. One innovative startup at the Manila session was able to overcome a critical regulatory barrier it faced by discussing its needs with a government counterpart who also attended the session.

The business models uncovered in this assessment have clearly demonstrated that an ecosystem approach is critical to the success of last billion connectivity. Due to the challenging nature of these markets, partnerships and creative collaborations between cross-sector actors are a requirement, not a luxury.

UNSUPPORTIVE REGULATORY AND POLICY FRAMEWORKS

While this assessment has primarily treated regulatory and policy frameworks as an environmental factor influencing the shape and success of last billion business models and solutions, the importance of regulatory requirements and policy initiatives in

shaping connectivity outcomes around the world cannot be ignored. Regulatory and policy issues were mentioned as key challenges in almost all white boarding sessions and in several interviews. In New Delhi, government and industry participants had vocal exchanges about the role of government policy in connectivity build out, and many startups and industry attendees expressed their view that, despite good intentions, the government at times made matters more challenging. In Nairobi, various participants, both startups and other MNOs, highlighted a perception that government policy favors the largest network operator in the country, Safaricom (also an attendee). The power of governments to regulate technology and standards, control access to spectrum, issue operating licenses, and otherwise shape the competitive environment makes it a critical factor in the viability of the business models identified in this report. Yet it is also one of the most difficult to address given the complex and unique political economy, history, and priorities of each country and region.

under issues
forms
and owning
phones

literacy

RURAL AREAS
- TEACHERS -

HEALTH
WORKERS
at
Facilities

enable user to
securely access
resources without
having to reach the
global internet (in
cost-band)
(country stamp, routing)

Confidence
&/or digital
literacy to
seek out

fragmented
+ complex
customer
engagement
(NGOs, govt,
public sector)

Low level
of user -
English
content

lack of
measurement
of
impact of
VAS

Consumer Services

No locally
relevant
Content

knowledge/
awareness of
available local
Content

Consumer services
are being designed
for internet (data
vs. SMS + voice)

pilot it's

lack of
consolidated
value
add services

and areas partner/
with team of partners
know how, credit history
to design build
and deploy
services

Lack of
Mobile
Money
Agents -
Low Agent
Liquidity

RECOMMENDATIONS

THE WAY FORWARD: TAKING LAST BILLION CONNECTIVITY TO SCALE

As noted in this report, the value that governments, the development community, tech companies, network operators, service providers, and, most importantly, low-income consumers themselves gain from sustainable Internet connectivity cannot be ignored. Yet challenges relating to financing, networking, and regulatory environments continue to stymie the growth of otherwise promising ventures and business models, pointing to the need for new, integrated approaches to supporting the development and growth of last billion connectivity ventures and projects. Existing initiatives such as the Alliance for Affordable Internet (A4AI) focus on broad regulatory and policy advocacy by convening diverse groups of partners ranging from technology companies and industry associations to governments and non-profits. However, to the authors' knowledge, no similar efforts specifically focus on facilitating access to the financing, partnerships, and expertise these businesses require to achieve sustained growth.

The clean energy industry – until recently considered non-viable and now a \$615 billion sector with \$7.3 trillion of forecast investments over the next 25 years – offers a hopeful example of the catalytic potential of coordinated action between government, investors, industry, entrepreneurs, and local communities in an environment of broadly favorable market trends.²⁹ Alongside the robust policy initiatives that helped to change the incentives for market players, a number of highly successful incubators, such as the Energy Excelsior, offer comprehensive support to accelerate the development of clean energy ventures. These can take many forms but generally incorporate elements of early-stage financing, advisory services, technical assistance, knowledge sharing, and matchmaking with investors and other potential partners. The most successful incubators are highly contextualized, purposefully targeting the realities of a specific market.

TOOLS FOR SCALING LAST BILLION BUSINESS MODELS

PIPELINE DEVELOPMENT AND PROJECT PREPARATION

Donors, industry partners, and investors have an interest in supporting last billion business models in connectivity, but often face challenges identifying ventures that have the potential for success. Donors and other concessionary capital providers can help drive investment to the sector by covering some of the up-front costs of identification and screening of viable connectivity investments, reducing cost and risk to capital providers.

GRANTS AND CONCESSIONARY FINANCING

Grants and other concessionary financing can be critical to the development of early stage ventures, particularly those targeting challenging markets where traditional investors

are hesitant to invest without proof of success. These tools, particularly when paired with other support such as technical assistance, incubation, and other forms of business development support, can be critical to taking a venture from concept to pilot.

NEAR COMMERCIAL FINANCING

Even with semi-proven concepts, last billion connectivity ventures and projects face challenges attracting commercial capital. Unfamiliarity with the business models, market risk, political risk, and potentially high up-front capital expenditures are all major impediments. By taking first-loss and junior positions in a business' capital structure, near-commercial financing can provide the critical missing component to making the risk/return profile attractive to other investors. This creative use of philanthropic

and/or impact capital maintains market incentives and some return expectations while giving a business the chance to develop.

DE-RISKING INSTRUMENTS

Businesses providing connectivity services for low-income populations face a wide range of risks – political, market, technology, and currency, to name a few – and many businesses operate in uncharted territory, deploying new models in new settings. Loan guarantees and other de-risking tools help shift the risk/return profile of these businesses, giving investors and lenders greater confidence of repayment due to the backing of a respected third party.

KNOWLEDGE SHARING AND TECHNICAL ASSISTANCE

One of the most frequently expressed concerns among the

ventures encountered in this assessment was the relative lack of cross-fertilization and sharing of expertise among the various connectivity ventures and solutions around the world. Technical assistance – a form of targeted expertise sharing – and knowledge sharing platforms can help ensure that connectivity startups benefit from the lessons learned and shared experience of the substantial international network of those individuals and organizations with a stake in supporting connectivity for the world's poorest. Donors and industry can help catalyze these ecosystems by supporting digital inclusion incubation programs, facilitating periodic convenings that bring together emerging leaders, and creating recognized collaboration platforms (both digital and in-person).

Taking lessons learned from the clean energy space, the many stakeholders in last billion connectivity can create similar ecosystems of finance, information, relationships, and expertise that help move business models and projects to scale. Bringing together the resources of donors, philanthropists, investors, industry, and local communities means that scaling last billion connectivity business models and closing the digital divide does not require substantial new infusions of funds or the creation of entirely new tools. It will, however, require leadership and a commitment to coordinate action and focus specifically on last billion connectivity solutions.

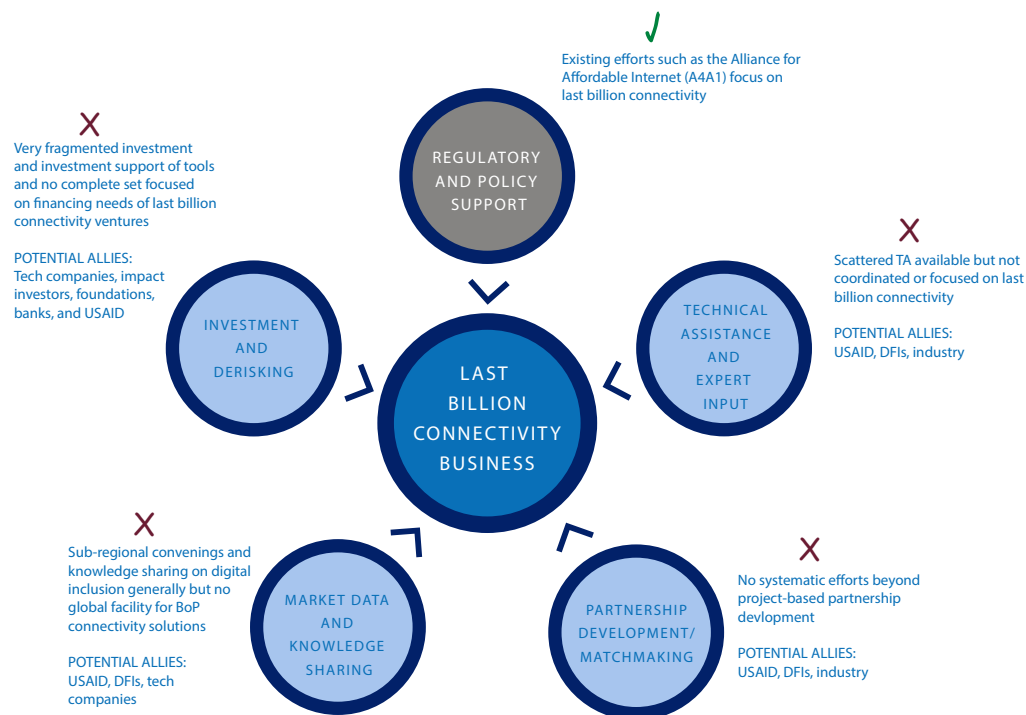
The growth and profitability of Mawingu, the Wi-Fi based hotspot operator profiled in this report (page 17), demonstrates the potential of connectivity models that bring the public and private sector together to expand Internet access to the last billion. In this case, Microsoft and USAID provided the seed funding, networks, and expertise required for Mawingu to prove its business model, begin to grow, and secure follow-on investment. This creative use of philanthropic, patient, and commercial capital, targeted deployment of technical assistance, and credibility provided by major government and commercial partners have now positioned Mawingu for success.

With the majority of the billion unconnected people with average annual incomes of \$540 and monthly communications spend budget of \$2.25 concentrated in two sub-regions, India and Sub-Saharan Africa, connectivity partners must combine global coordination and knowledge sharing with targeted efforts to grow connectivity ventures focused on these markets. For example, a connectivity incubator and financing facility in India could take advantage of the country's dynamic technology sector, large domestic impact-focused capital pool, and an improving regulatory and policy environment. In

East Africa, partners could build on the existing momentum of BoP digital solutions in the region by focusing on connectivity solutions specifically and ensuring that mobile network operators, ISPs, technology companies, and other large commercial companies are better integrated as key partners, investors, and solution providers. In West Africa and Central Africa, connectivity stakeholders can begin to learn from the East African success in building up networks of incubators and financing options for digital solutions to challenging markets while also working to address the many policy and regulatory challenges in the region.

These approaches would use the tools of public sector actors – grants, technical assistance, credit guarantees, risk insurance, direct financing, investment pipeline development, and knowledge sharing among others – in a more coordinated and strategic manner to complement and support private sector investment in last billion connectivity businesses (see “Tools for Scaling Last Billion Business Models” on the preceding page). Rather than the isolated, one-off partnerships that have generated the few successful ventures providing connectivity for the last billion, the many stakeholders in last billion connectivity must take a systematized and focused approach in order to capture this market opportunity at scale. This will require bringing together the tools of donors, Development Financing Institutions (DFI), governments, and industry that already exist: incubators, financing facilities, and knowledge sharing platforms, among others. By working together, focused on this most challenging market, partners can take the mystery out of identifying, supporting, financing, and scaling last billion connectivity solutions. The World Economic Forum calls these types of approaches “blended finance” and highlights their great potential for mobilizing

vast new pools of capital to solve the world's most pressing challenges.³⁰ Blended finance can decrease the risk of a given investment for private investors by focusing on catalyzing private capital investment into last billion connectivity ventures. A blended finance approach could provide more favorable and flexible terms while helping bottom billion and other BoP-focused businesses access the levels of capital they need to pilot and scale promising concepts.



NEXT STEPS

The white boarding sessions and interviews conducted in preparing this report represent an initial foray into the exciting developments that have made connectivity for all seven billion of the world's people a realistic proposition. Yet, throughout this assessment, participants have expressed their interest in and commitment to continuing the conversation. Inevitably, at the end of white boarding sessions – particularly in Nairobi, Manila, and New Delhi, the places where this topic is perhaps most relevant and the promise of these solutions most obvious – participants asked, “What’s next?”

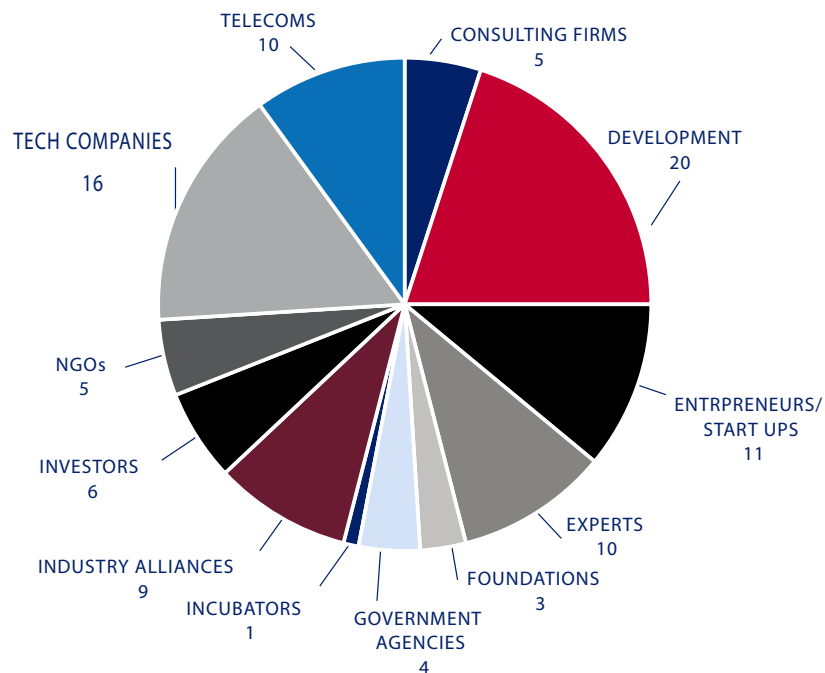
Indeed, what is next? The opportunity is there, the technology exists, the businesses are viable, and the partners are willing. Now is the time to go beyond analysis and conversation and move to action. Government, industry, development, and other partners have the chance to use the tools that are already at their disposal in new, coordinated, and strategic ways to change the landscape of connectivity for the world's poorest.

APPENDICES

APPENDIX I: WHITE BOARDING SESSION PARTICIPANTS AND INTERVIEWEES

- | | | |
|--|--|---|
| A4AI: Alliance for Affordable Internet | Firechat | Saankhya Labs |
| ADEC Innovations | Global VSAT Forum | Safaricom |
| African Technology Foundation | Google Access | Samsung |
| AirJaldi | GSMA | Sema |
| Airtel | Hewlett Packard Enterprise | Smart Communications |
| Asian Development Bank | Huawei | SSG Advisors |
| Balancing Act Africa | Ideaspace Foundation | Startup India Advisory Services |
| Booz Allen Hamilton | Intel | StS Solar Foundation & Hybrid Solar Solutions |
| Bridgespan Ventures | Internet Society of the Philippines | TechChange |
| Chief Information Officers Forum (CIOF) Foundation, Inc. | IXS for All | The X lab |
| Cisco | Jubilee Insurance | Tone |
| CMAI Association of India (Communications Multimedia and Infrastructure) | Ma3Route | Unicef |
| Collaborative Advantage | ManoCap | ViRural |
| Deep Root Strategic Advisors | Map the Philippines | Vodafone Americas Foundation |
| Digital India Foundation | Mawingu | Vodafone Global Enterprise |
| DOST ICT Office | Mezzanine East Africa | VOTO Mobile |
| Eagle Vision | Microsoft | Vulcan Inc |
| Embassy of the United States of America, New Delhi, India | MIT Media Labs | White Space Alliance |
| Every Layer | National Informatics Centre, Govt of India | Wi-Fi Interactive Network (WIN) |
| Facebook/Internet.org | NetHope | World Bank |
| Federation of International Cable T.V. Association of The Philippines (FICTAP) | Next Billion | Worldreader |
| FHI 360 | Open Revolution | Xelpmoc Design and Tech |
| | Open World | |
| | RailTel Corporation of India Ltd. | |
| | Reach | |
| | Research ICT | |

PARTICIPANTS AND INTERVIEWEES BY TYPE



APPENDIX II: RECOMMENDED READING

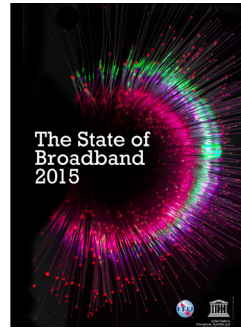


Connecting the Future

Digital Enablement: Bridging the Digital Divide to Connect People and Society

By Huawei | 2015

Provides a very informative framework for addressing the digital divide, moving beyond connectivity to Availability, Affordability, Appetite, and Ability.



The State of Broadband 2015

By ITU and UNESCO | 2015

While not specifically focused on marginalized populations, this report describes extending connectivity into rural areas as a key current challenge for broadband overall.

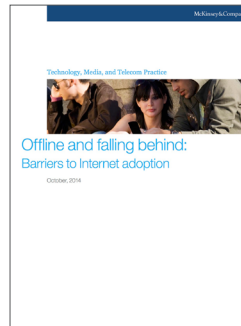


Rural coverage: strategies for sustainability

Country Case studies

By GSMA Intelligence | July 2015

The case studies in this report range from Rwanda to Finland, and highlight a variety of methodologies and stakeholders for increasing Internet connectivity, mostly focusing on broad initiatives with government involvement.



Offline and falling behind:

Barriers to Internet adoption

By McKinsey & Company | October 2014

Includes helpful data to describe some of the current barriers to connectivity. Breaks these barriers down into the following categories: Incentives, Low incomes and affordability, User capability, and Infrastructure.



Women and the Web:

Bridging the Internet gap and creating new global opportunities in low and middle-income countries

By Intel and Dalberg | 2013

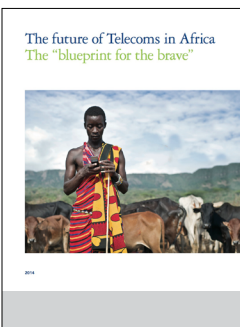
Describes the benefits that more equal online participation would create and the barriers to getting more women online.



Digital Dividends

By World Bank Group | 2016

Showcases a number of findings highlighting the benefits inherent in increased connectivity and lists policy suggestions for increased digital inclusion.



The future of Telecoms in Africa:

The "blueprint for the brave"

By Deloitte | 2014

A comprehensive look at the trends affecting telecoms in Africa, including the challenges they face and potentials for expansion in that market.

APPENDIX III: LIST OF ACRONYMS

A4AI	Alliance for Affordable Internet
ARPU	Average Revenue per User
BOM	Build Operate Maintain
BoP	Base of the Pyramid
BTS	Base Transceiver Stations
DFI	Donor Financial Institution
DVDM	Dense Wave Division Multiplexing
GDP	Gross Domestic Product
GSM	Global System for Mobile Communications
HTS	High Throughput Satellites
ICT	Information and Communications Technology
IoT	Internet of Things
ISP	Internet Service Provider
ITU	International Telecommunication Union
LDC	Least Developed Countries
MNO	Mobile Network Operator
mSTAR	USAID Mobile Solutions, Technical Assistance, and Research project
OPIC	Overseas Private Investment Corporation
POP	Point of Presence
PC	Personal Computer
PPP	Public-Private Partnership
ROI	Return on Investment
SaaS	Software as a Service
SDG	Sustainable Development Goals
USAID	United States Agency for International Development
USF	Universal Service Fund
VAS	Value-Added Services
WIN	Wi-Fi Interactive Network

ENDNOTES

1. For a description of how ICT helped to enable the Millennium Development goals, see page 23 of "The State of Broadband 2012: Achieving Digital Inclusion for All" (Biggs, 2012)
2. UNICEF is using ICT to track medication, increasing its use and distribution: http://www.unicef.org/cbsc/index_66449.html
3. Surveys conducted for the intel and Dalberg report, titled, "Women and the Web" (Kakar, Hausman, Thomas, Denny-Brown, & Bhatia, 2013), found that respondents "reported that Internet access had made their lives easier and more efficient, and that at times—including with online shopping and overseas communication—it provided significant cost-savings."
4. The GSMA report entitled "Mobile's Green Manifesto 2012," describes the impact of mobile technology to enable carbon savings through opportunities in dematerialization, smart transportation and logistics, smart grids and smart meters, and smart manufacturing. (GSMA, 2012)
5. The "World Development Report 2016: Digital Dividends" describes how "e-government tools, such as India's digital identification system, Aadhaar; help expand public services to poor and marginalized populations, promoting their inclusion into the economy and society." (The World Bank, 2016)
6. Estimates from the World Bank find that ICT capital accounted for nearly one-fifth of global growth from 1995 to 2014 and a 10% increase in mobile broadband penetration drives a 1.4% increase in GDP for low-to-middle income countries. (World Development Report 2016 and GSMA Intelligence, ASIA)
7. In 2012, the World Bank estimated that of the 896 million people living on less than \$1.90/day, 309 million live in South Asia and 388.7 million in Sub-Saharan Africa. (<http://www.worldbank.org/en/topic/poverty/overview>)
8. The World Bank, The World Development Report 2013.
9. The World Development Report 2016 states that approximately 400 million people live out of reach of mobile networks. The authors use the 20-40% range due to lack of data as to what proportion of these 400 million people are part of the last billion by income.
10. The 4As of Availability (access and capability), Affordability (value and cost), Appetite (awareness, desire, and fear), and Adoption (digital literacy and individual restrictions) provide a helpful rubric for thinking about some of the reasons that people lack connectivity. This report focuses primarily on business models and solutions that address Availability and Affordability. For more see Huawei's 2015 report, "Digital Enablement: Bridging the Divide to Connect People and Society."
11. Many potential users voluntarily choose not to connect to the Internet though they could afford to do so. Others are well-off and would be profitable customers for connectivity providers but live in remote areas where the physical network infrastructure is still being developed. Still others live in an area with network access but are indeed economically marginalized and cannot presently afford the cost of Internet connectivity. Finally, some are both poor and outside network coverage. Even these distinctions mask further complexities: rural and urban markets are often worlds apart; cultural traditions, political realities, and social norms affect consumer behavior; and even within a given community and culture, men and women may have vastly different levels of access to technology and markets for connectivity.
12. Throughout this report the authors also use the term "base of the pyramid" or BoP to refer to low-income markets, generally, and "last billion" to refer to the lowest income target group, specifically. Business models and solutions discussed in this report clearly have relevancy beyond the last billion – hence the use of the term "base of the pyramid" to refer to the larger group of low-income consumers. The interviewees and white boarding session participants at times referred to them as the "last mile", though the authors generally avoid this term outside of direct quotes due to possible confusion with network typologies (backbone, backhaul, middle mile, last mile). Finally, given our business model approach, we also prefer to view individuals as consumers rather than beneficiaries and the group as a whole as a "market" rather than a "target group" in order to reemphasize the market-driven approach taken by this assessment and the power of consumers (at any income level) to shape market outcomes.
13. In both Africa and the Middle East, mobile subscription is still increasing rapidly (at a CAGR of 21% between 2009 and 2011 in Africa), according to Deloitte. (2014). The Future of Telecoms in Africa. Deloitte. https://www2.deloitte.com/content/dam/Deloitte/fpc/Documents/secteurs/technologies-medias-et-telecommunications/deloitte_the-future-of-telecoms-in-africa_2014.pdf
14. The 2013 GSMA Mobile Economy report found that SIM Penetration is expected to be over 100% in all regions of the world except Africa (where it will reach 97%) by 2017.
15. A 2014 GSMA Report on the mobile economy in Sub-Saharan Africa found that "Average revenue per subscriber (ARPU) in SSA has been falling sharply over the last five years, declining at a CAGR of minus 9% per annum."
16. A recent Stanford study estimated that Google revenues increase by \$24 for each new unique user acquired – meaning the company could increase its revenue by a billion dollars for every 42 million new Internet users. While the \$24 figure is undoubtedly substantially lower for BoP consumers in LDCs, even with a 20-fold lower figure to reflect the lower spending power of BoP consumers, the service attainable BoP market for Google alone is almost \$5 billion. (Google's Plan for Ubiquitous Internet: Strategy and Impact, John Schmidt, Antja Chambers, Paul Schatz, Stanford University, USA: http://web.stanford.edu/class/msande238/projects/2014/G_Internet.pdf)
17. CISCO and ITU: Harnessing the Internet of Things for Global Development <http://www.itu.int/en/action/broadband/Documents/Harnessing-LoT-Global-Development.pdf>
18. Google is developing balloons, controlled through movement in the Stratosphere's wind patterns, that will extend backhaul by 100km from the nearest tower. The company plans to work directly with MNOs to capitalize on this extension. Slightly further behind in development is Facebook's Aquila program, in which solar-powered drones will be launched via balloon into the stratosphere, and Internet signal, beamed between drones via lasers, extends an Internet backhaul. The signal is then received on the ground with small cellular towers and dishes. Facebook is planning to partner with local ISPs to offer this Internet.
19. Timor Telecom Story, O3b Networks: <http://www.o3bnetworks.com/timor-telecom/>
20. Why your internet connection is slow wherever you are in Africa, by Uri Bram: <http://qz.com/472028/why-your-internet-connection-is-slow-wherever-you-are-in-africa/>
21. Mildly technical post about Internet in emerging markets, by David E. Weekly <https://www.facebook.com/dweekly/posts/10101729307500703>
22. Nordhausen, B. (2015, December 15). Overcoming Connectivity Challenges in Rural Schools with Content Servers. Retrieved from Discover ISIF Asia: <http://discoverisifasia.com/2015/12/overcoming-connectivity-challenges-in-rural-schools-with-content-servers/>
23. Deloitte. (2014). The Future of Telecoms in Africa. Deloitte. https://www2.deloitte.com/content/dam/Deloitte/fpc/Documents/secteurs/technologies-medias-et-telecommunications/deloitte_the-future-of-telecoms-in-africa_2014.pdf
24. Tracking the Sun VII, by Galen Barbose, Samantha Weaver, Naim Darghouth: https://emp.lbl.gov/sites/all/files/Tracking%20the%20Sun%20VII_Report_0.pdf page 43
25. The Solar Company Making a Profit on Poor Africans, by Stephan Faris: www.bloomberg.com/features/2015-mkopa-solar-in-africa/
26. For more, see: "Broadband: State nod for Rs. 333-cr fibre grid project," by M. L. Melly Maitreyi: <http://www.thehindu.com/news/national/andhra-pradesh/broadband-state-nod-for-rs-333cr-fibre-grid-project/article7588647.ece>
27. GSMA Asia report notes that a "survey of 64 USFs in 2012 revealed that more than \$11 billion was tied up between them and not yet spent on any rollout projects."
28. Telecommunications Reform in Mexico, Mónica Aspe Bernal Undersecretary for Communications, May 25, 2015
29. <http://www.theclimategroup.org/what-we-do/news-and-blogs/bloombergs-new-energy-outlook-2015-report-predicts-phenomenal-renewable-energy-growth/>; [http://www.marketsandmarkets.com/PressReleases/renewable-energy-market-worth-\\$615-billion-by-2015.asp](http://www.marketsandmarkets.com/PressReleases/renewable-energy-market-worth-$615-billion-by-2015.asp)
30. Blended Finance is not a new concept. WEF estimates that there are currently more than \$25 billion in various facilities and funds around the world focused on areas such as climate resilience, financial services, healthcare and infrastructure: http://www3.weforum.org/docs/WEF_Blended_Finance_A_Primer_Development_Finance_Philanthropic_Funders.pdf

