GSMA

Accelerating Rural Connectivity:

Insights from the GSMA Innovation Fund for Rural Connectivity

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GSMA

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The Connected Society programme works with the mobile industry, technology companies, the development community and governments to increase access to and adoption of mobile internet, focusing on underserved population groups in developing markets.

For more information, please visit www.gsma.com/connected-society

To get in touch with the Connected Society team, please email connectedsociety@gsma.com

UKaid from the British people

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Introduction

More than half of the world's population rely on mobile network operators (MNOs) to access the internet. In low- and middle-income countries (LMICs), mobile broadband accounts for 87 per cent of internet connections, remaining the primary and often only way many people access the internet.[1] Mobile connectivity delivers significant socio-economic benefits, from improving well-being[2] to driving economic growth[3], reducing poverty[4] and providing access to information and services that not only assist people in their daily lives, but would also have not been available to them otherwise.[5]

Despite significant progress over the past several years, 3.6 billion people are still unconnected, excluded from the benefits of mobile internet.[6] They are disproportionately poorer, less educated, female, persons with disabilities and rural. While most – 3.2 billion – live in areas with mobile broadband coverage, 400 million do not. Although mobile internet coverage is expanding, Sub-Saharan Africa remains the region with the widest coverage gap, at 17 per cent.[7]

The lack of mobile internet coverage in remote and rural areas is primarily an economic challenge – costs can be prohibitive, revenues lower and logistics complex. Those without coverage tend to live in sparsely populated rural areas with difficult terrain and where high investment costs and low return on investment (ROI) are major barriers for mobile internet providers. It can cost up to two times as much to deploy new base stations in rural areas and can be three times more expensive to operate than in urban areas, while revenues can be up to 10 times less.[8] This means there are areas today where it is simply not commercially viable to expand mobile broadband infrastructure. The challenge is not only to bring mobile internet coverage to these rural areas, but to do so sustainably.

Commercially sustainable connectivity in rural areas requires:

- Lowering the capital expenditure (CAPEX) and operating expenditure (OPEX) for cell sites and infrastructure to increase the ROI of individual sites;
- Reducing the risks of investing in mobile infrastructure and
- Enhancing demand for mobile services to unlock revenue opportunities that increase profits and make these investments more attractive.

In recognition of these challenges and the potential solutions to address them, the GSMA Connected Society programme launched the Innovation Fund for Rural Connectivity with funding from the UK Foreign, Commonwealth & Development Office (FCDO).

This report looks at the solutions proposed as part of this grant, the performance of these sites and the key insights from this project.

1. ITU. (2020). World Telecommunication/ICT Indicators (WTI) Database 2019.
2. GSMA. (2022). Mobile Internet Use, Well-being and Gender: Understanding the Links; GSMA. (2019). The Impact of Mobile and Internet Technology on Women's Wellbeing Around the World.
3. ITU. (2020). How broadband, digitization and ICT regulation impact the global economy; GSMA. (2019). The Mobile Gender Gap Report 2019.
4. Bahia, K. et al. (2021). Mobile Broadband Internet, Poverty and Labor Outcomes in Tanzania. World Bank Group; GSMA. (2019). The poverty reduction effects of mobile broadband in Africa: Evidence from Nigeria
5. GSMA. (2020). The Mobile Gender Gap Report 2020.
6. GSMA. (2022). State of Mobile Connectivity Report 2022.
7. Ibid.
8. GSMA. (2018). Enabling Rural Coverage: Regulatory and policy recommendations to foster mobile broadband coverage in developing countries.

The Innovation Fund and grantees: Solutions and performance

In 2018, the GSMA Innovation Fund for Rural Connectivity was launched to test ways to deploy commercially sustainable mobile broadband networks in rural areas and help identify potential approaches that could be scaled and replicated in similar environments.

Working in partnership with Vodafone Ghana and MTN Uganda, grants were awarded to NuRAN Wireless and iSAT Africa in 2020. Each grantee was awarded up to £330,000 and provided 30 per cent of match funding to test their mobile connectivity solutions for unconnected rural communities.

Funded projects were expected to provide turnkey solutions, including equipment, deployment and operation. iSAT Africa and NuRAN Wireless formed consortiums with strategic partners to deliver the projects. They and their partners received advice and guidance from the GSMA, including analytical support to identify commercially viable sites for deployment.

It is worth noting that the onset of the COVID-19 pandemic in early 2020 had a significant impact on both grantees. For instance, lockdowns and travel restrictions affected equipment delivery and deployment of expert personnel to oversee the building, installation and commissioning of sites. This resulted in both delays and the need to change some of the equipment suppliers and partners. In addition, severe flooding in Karaga, Ghana, delayed site installation for several months.

iSAT Africa

In partnership with MTN Uganda, iSAT Africa deployed five mobile network sites in the Karenga district of northeastern Uganda that were not previously connected, providing connectivity to almost 30,000 people in the communities of Kadepo, Kawalakol, Moriuta, Lomanok and Lobeluna. The main site, Kadepo, was almost 30 kilometres (km) away from the nearest mobile network at the start of the grant.

Implemented solution

iSAT Africa's project implemented an innovative solution that used concreteless towers, solar power and an open radio access network (RAN) to provide 2G and 3G connectivity. iSAT also installed two smart poles in the town centres that provide solar street lighting, charging ports for mobile devices and Wi-Fi.

iSAT used the GSMA Connected Society mobile coverage map for Uganda[9] to estimate the link distance between villages, to design the point-to-multipoint (PMP) terrestrial network with a near-line-of-sight (NLoS) solution and very small aperture terminal (VSAT) connectivity, and to determine the tower height for each location. Depending on village size and concentration, tower heights of 10, 15 and 30 metres (m) were selected. These concreteless towers can be easily moved to different sites as required.

iSAT Africa deployed a combination of satellite and terrestrial links to backhaul the traffic to the MTN Uganda Data Centre. A licensed microwave link was installed to connect the main site (Kadepo), where there were more than 3,500 people, to the existing MTN tower 30 km away. From Kadepo, iSAT Africa used wireless PMP equipment with ISM band frequency to connect two more remote sites (Lomonak and Kawalakol). The remaining two sites (Lobeluna and Moriuta), where there were around 2,500 people, were connected with VSAT backhaul.

iSAT Africa used local partners and contractors for all the activities and ensured their contractors employed local community members to help build the sites so that the community would benefit from the project and have a sense of ownership. They also held outreach sessions to raise awareness of the benefits of mobile, how to use mobile and mobile internet services and the types of information that can be accessed via mobile internet that would be relevant to their lives (e.g. to support farming activities and connect with friends and family).

9. See: https://www.mobilecoveragemaps.com/

Table 1: **iSAT Africa solution**

Key area	Technical solution	Partner or vendor
Passive equipment	— Three tower specifications were used: 30m, 15m and 10m based on population — Concreteless foundations — Two smart poles in town centres providing solar lighting, mobile phone charging stations and public Wi-Fi	Camusat
Active equipment	— Open RAN solution, 2G and 3G in a single box	Parallel Wireless
Backhaul	— Different backhaul solutions deployed based on population: satellite, microwave and PTM ISM band	iSAT
Power	— Full solar power with three days autonomy	Camusat
Business model	— Full turnkey solution for MNOs — Demand-enhancing initiatives (user awareness and handset promotions)	Consortium: iSAT and Camusat

Performance and impact

As soon as the sites at Kapedo and Kawalakol went live they immediately became congested due to very high levels of traffic.[10] At the other sites, traffic progressively increased over time. As a result of the unexpectedly high levels of traffic, iSAT had to immediately upgrade the Kapedo and Kawalakol sites while other sites were upgraded at a later stage.

While data uptake on 2G and 3G was remarkable, averaging about 250 GB across all sites every month, it still only accounted for 2 per cent of what people used their devices for. Most used their handsets for voice calls (45 per cent of device use) and mobile money (45 per cent of device use).

In terms of backhaul availability, both the terrestrial and VSAT sites were available more than 95 per cent of the time over the course of the pilot. Despite power autonomy declining from 72 hours to 36 hours to account for the site upgrades, no sites went down due to a lack of solar power. The solar power solution successfully provided power to all sites 99 per cent of the time.

iSAT Africa encountered a number of other challenges during implementation that had an impact on initial uptake and use of mobile services in the communities, including:

— **Agent availability:** A substantial number of people had old SIM cards that no longer worked and could not be used to access the network. Agents who could provide new SIM cards and support with registration were located quite far from the villages (approximately 70 km away), which created delays in people using the service. Agents were also not available in the communities to sell airtime vouchers or conduct mobile money transactions. To address this challenge, MTN dispatched their marketing team to the villages, which boosted SIM card and service subscriptions, and MTN also recruited and trained agents in the villages, which further increased the sale of SIM cards and mobile money transactions. As a result of these actions, overall revenue from the sites increased dramatically.

— **Knowledge and skills:** Very few people in the villages knew how to use mobile phones and how to take advantage of mobile internet. To address this challenge, iSAT Africa offered a programme that trained people in the community on the advantages of using mobile phones and mobile internet and how the internet can assist them in their daily lives. Local NGOs and school staff were also given seminars on how to use mobile internet to meet their needs. These activities helped to increase revenue.

— **Affordability:** For many, the affordability of handsets and services (particularly the mobile money transaction fees) was a challenge.

The 18-month pilot found that the combination of backhaul using different technologies proved to be successful in connecting the five sites, which generated around $9,000 per month in total revenue. MTN Uganda subsequently contracted iSAT Africa to continue managing and operating the sites on a commercial basis.

10. These were slightly larger villages than the others and also had trading centres.

Table 2 outlines the total cost of ownership (TCO) projection for iSAT's solution compared to a traditional macro site and an rural site such as Huawei's Rural Star solution. The TCO is competitive and would decline further with economies of scale, making this a viable option for operators to complement their offer. Also of note is the added cost of running two technologies (2G and 3G) at each site, which increases CAPEX and operating licence costs.

Table 2: **TCO of pilot compared to other scaled models**

		TCO of pilot vs. other scaled models (indicative)				
		iSAT 10–15 m	**iSAT 15 m**	**iSAT 30 m**	**Huawei Rural Star 3G**	**Traditional macro site 3G**
Site specifications	Tower height (m)	10 m	15 m	30 m	12–18 m	60 m
	Radius claimed (km)	2 km	5 km	10 km	1–5 km	12 km
Financials per site	**5-year TCO**	**£77,386**	**£78,106**	**£84,138**	**£57,203**	**£154,828**

* Note: The traditional macro 3G sites and Huawei Rural Star sites are based on scaled deployments, whereas the TCO for the iSAT Africa solution is based on a pilot with five sites.

NuRAN Wireless

In partnership with Vodafone Ghana, and with support from the Ghana Investment Fund for Electronic Communications (GIFEC), NuRAN provided connectivity at seven sites in northeast Ghana, reaching more than 15,000 people. The selected region for this project was located near Karaga, approximately 17 hours' drive from Accra and three hours from Tamale, the largest nearby city.

Implemented solution

The solution used specialised low-cost RAN equipment – a software-defined RAN that provides a lower power all-in-one solution in a single box – as well as TV White Space (TVWS) for backhaul and microwave for longer links. The sites were powered using renewable solar energy. NuRAN also provided power charging stations at each site. A 2G-only site with limited power was deployed in communities of less than 1,000 inhabitants (three sites – Mamprugu, Napoligu and Jankpinhi) and a larger 2G/3G site was deployed in communities of more than 2,500 inhabitants (four sites – Tunni, Bagli, Kpalugu and Manie).

Two radio access units were used for the project: OC-2G/LC-2G and Vanu's NodeB. The former is a small footprint, 2G-only unit designed to connect the most remote rural communities. The latter is a next-generation unit capable of operating different 3GPP technologies with significantly wider coverage. These technologies can be enabled, disabled or configured remotely in line with an MNO's needs.

All sites were interconnected using TVWS terrestrial backhaul links in a star topology aggregating the traffic at a central node in Bagli. The length of the TVWS links ranged from 7 km up to 16 km. The central node is connected to the nearest Vodafone point of presence at Karaga via microwave 32 km away. TVWS is an attractive backhauling prospect as it operates on a lower frequency band (450–700 MHz) with better radio frequency (RF) propagation compared to higher frequencies, therefore offering a larger coverage footprint. Another benefit is the NLoS nature of TVWS, which allows links to operate even if the path between the transmitter and receiver is not completely unobstructed. Some drawbacks to the technology are the need to carry out site and RF surveys to validate the feasibility of using TVWS, and the need for two field teams to install and align the antennae on either side of the link. There is also the need for government to coordinate and manage the use of TVWS spectrum across the country to address the risk of sharing spectrum with very high-powered transmitters that can flood signal reception and make it an unviable option.

Two tower heights (18 m and 12 m) with the same design and specifications were chosen for the project. Modular and scalable solar power systems were used with remote monitoring and configuration to ensure site loads and power consumption were sufficiently managed in line with weather conditions.

NuRAN also deployed charging stations at each site to provide "free energy" and reduce mobile phone costs for subscribers. The charging station cabinets were installed on the outside of the site fence and were fed from the site power system. In addition, Vodafone was active in the area and provided marketing and customer support activities to help community members use their phones and the available services.

Table 3: **NuRAN Wireless solution**

Key area	Technical solution	Partner
Passive equipment	— Two tower specifications were used: 12m and 18m based on population	NASCO
Active equipment	— 2G-only RAN solution (OC-2G/LC-2G) — 3G NodeB RAN solution — All optimised to reduce power consumption	NuRAN, Vanu
Backhaul	— Use of TVWS — Microwave radios	Redline
Power	— Solar off-grid power with remote performance monitoring to reduce site visits	Clearblue
Business model	— Low-cost CAPEX and OPEX network — Charging stations provided to enable subscribers to stay online	

Performance and impact

2G-only sites were live for the first year, at which point four of the sites were upgraded to 2G/3G. Subscriber adoption at the sites was higher than expected with approximately 60 per cent of the population subscribing to 2G services by the end of the first year. This is likely due to the fact that this is an area of high commercial activity with visitors coming from surrounding villages.

Daily data usage of 2G services peaked at 100 MB per site, which is reasonable given it is a 2G only data service with limited users. The two sites with the highest data usage were Tunni and Jankpinhi, which were also the sites generating the least amount of voice traffic. 3G was added to Tunni in December 2021, which immediately increased monthly data usage at the site 11-fold to approximately 1.1 GB.

2G site availability over the year varied between between 72% and 90%, with the three smaller sites performing best. Backhaul was the main cause of site outages throughout the year. Manie, being the furthest away from the central aggregation point, was the worst performing site. COVID-19 travel restrictions also affected site availability since site equipment was installed without the necessary supervision and verification checks from partners, which led to issues at the sites once they were in service. 3G sites were available 97 per cent of the time, on average, since going live in the four sites where it was deployed. Power availability for 2G and 3G is now stabilised at more than 98 per cent, on average.

In the second half of 2021, the seven 2G sites were generating total revenue of around $3,000 per month. It should be noted that this figure only considers revenue from subscribers who spent most of their time at the site and not those who visit the area, so it very likely underestimates the total revenue generated by the site.

Table 4 summarises the TCO of NuRAN's solution over a five-year period for the seven sites in rural Ghana compared to a traditional macro site and an rural site, such as Huawei's Rural Star solution. In comparison to Huawei Rural Star, NuRAN's costs are higher for sites running 2G and 3G (with the added cost of running two technologies), but lower for a 2G-only site. These costs would drop further with economies of scale. The sites can be classified into three deployment categories:

- **2G/3G hub:** A central site that aggregates the traffic of the six surrounding sites over TVWS. All traffic is transferred over microwave to Vodafone's nearest point of presence, from where it is routed to the core network. A higher number of backhaul radios (five in total), a larger power system to support the active equipment and a more robust tower to support the load, increases the TCO of the site.
- **2G/3G site:** A standard site consisting of 2G and 3G radio equipment backhauled over a single TVWS link to the central site. The main cost reductions are the simpler, less robust structure and the smaller power system to support less active equipment.
- **2G site:** A very small, single technology site designed to cover very small rural settlements. The significantly lower cost is due to a small tower (12 m instead of 18 m), a low-power base station (i.e. 630 mW) and a smaller power system.

Table 4: **TCO of pilot compared to other scaled models**

		TCO of pilot vs. other scaled models (indicative)				
		NuRAN 2G/3G hub	**NuRAN 2G/3G hite**	**NuRAN 2G- only**	**Huawei Rural Star 3G**	**Traditional macro site 3G**
Site specifications	Tower height (m)	18 m	12 m	12 m	12–18 m	60 m
	Radius claimed (km)	1-5 km	1-5 km	1-5 km	1–5 km	12 km
Financials per site	**5-year TCO**	**£98,594.39**	**£70,781.32**	**£40,385.28**	**£57,203**	**£154,828**

* Note: The traditional macro 3G sites and Huawei Rural Star sites are based on scaled deployments, whereas the TCO for the NuRAN solution is based on a pilot with seven sites.

Network-as-a-Service (NaaS)

Following the Innovation Fund project, NuRAN opted to change their business model to provide better value to MNOs looking to invest in rural connectivity. With the new model, they aim to build and operate scalable 2G, 3G and 4G networks in remote and rural areas. This model differs from the previous one in which they acted as an equipment vendor, providing their proprietary 3GPP RAN solutions at a cost.

Under the new model, NuRAN's geomarketing team works together with the MNO to identify unserved sites within a target ARPU. NuRAN covers the costs of building, commissioning and operating the sites within a revenue-share agreement. At the end of the contract, the sites can be transferred to the MNO at a cost (based on revenue). This model allows MNOs to expand their coverage in rural areas with minimal risk. For NuRAN, using capital raised from development finance institutions (DFIs) allows them to shift from being equipment vendors to deploying large-scale turnkey projects.

> "For NuRAN, using capital raised from development finance institutions (DFIs) allows them to shift from being equipment vendors to deploying large-scale turnkey projects."

Key lessons

This section looks at the impact of different technological parts of the solutions on TCO and the role of other operational factors. It also explores key factors in scaling rural connectivity solutions.

Factors affecting the TCO

Scale is a key factor affecting the TCO. As the number of sites increase within and across countries, it becomes possible to consolidate operational and support teams which reduces resource mobilisation costs. Larger volumes of equipment and infrastructure also allow better pricing to be obtained from suppliers which helps to spread fixed project costs across more sites. As the number of projects increases, so does market confidence in the proposed solution and business model. This improves the ability of providers to get financing while also lowering the cost of financing.

Other key factors that had an impact on the TCO for the grantee solutions are outlined below.

Technology

There are three main areas in which infrastructure costs can be prohibitive:

- The passive infrastructure and site build;
- The backhaul that connects base stations to the core network; and
- The energy (both supply and storage) that enables both these components to function.

These elements account for a major share of the TCO for each network deployment, including operators' CAPEX and OPEX. The grantees sought to reduce TCO across these different areas with the following solutions:

- **Radio Access Network (RAN):** The cost of a network site is affected by the RAN. From a CAPEX standpoint, the three biggest costs are the power system, tower structure and site build. From an operational point of view, site visits for maintenance and troubleshooting and satellite backhaul (in the absence of terrestrial connectivity) are the more onerous costs.
- **iSAT Africa:** Through their vendor, Parallel Wireless, iSAT Africa used open RAN with both 2G and 3G technology in a single box to bring down the total cost of RAN. The technology deployed for 2G and 3G is based on a modular approach, which enables capacity to be upgraded. The base transceiver station (BTS) can therefore be configured up to four transceivers (TRX), which means it does not require another BTS or hardware upgrade to increase capacity. This was important because the sites generated higher traffic than expected and had to be upgraded. This solution also uses optimised transmit power to lower both the cost and overall power consumption.
- **NuRAN Wireless:** NuRAN Wireless focused on delivering a solution with a small form factor, minimal field visits once deployed, low power consumption and optimised backhaul. A smaller unit reduces shipping and transportation costs and has a direct impact on the required tower specifications and cost of the structure. Ensuring that most issues could be resolved remotely was also important in keeping operational and maintenance costs to a minimum. To reduce costs, they also sought to provide a unit that was resilient to environmental conditions and would not require protective measures, such as special enclosures, high temperature protection or frequent maintenance. However, deploying more than one technology at the site increases the overall site TCO, and using two vendors to provide 2G and 3G increased the cost for NuRAN Wireless.

— **Backhaul:** Satellite is often used for rural connectivity, but the higher capacity costs and monthly fees affect the TCO. Both grantees implemented more cost-effective approaches.

  iSAT Africa used a portfolio of different connectivity solutions, including cost-effective licensed microwave links that work well with NLoS and PMP links in the ISM band (unlicensed frequency).

  NuRAN Wireless used a central site that aggregates the traffic of the six surrounding sites over TVWS, a more cost-effective solution than satellite from a TCO perspective over several years. All traffic is transferred over microwave to Vodafone's nearest point of presence, from where it is routed to the core network. By comparison, having a higher number of backhaul radios, a larger power system to support the active equipment and a more robust tower to support the load, increases the TCO of the site.

— **Towers:** By working with Camusat, iSAT Africa was able to build concreteless sites, which reduced their initial building costs and will allow them to relocate the sites if needed. This resulted in significant cost savings in materials (they did not need to purchase cement, sand, stones, etc.), the transport of materials to the sites and the engineers required to build the sites. For rural sites where tower height is less than 30 m, concreteless towers are cost-effective and have the advantage of being able to be moved to another location without the need for any new civil work.

— **Power:** The use of solar power by both grantees reduced the TCO as they have much lower operational costs than grid- or generator-powered sites. Grid power is often not available or unreliable in rural locations and costs are incurred from using it. Generator power has high operating costs because of daily fuel consumption, refuelling costs, generator service costs and theft of fuel. By comparison, solar has proved to be reliable and has low maintenance costs.

Operational factors

Beyond the technology, there were several operational factors that had an impact on the TCO.

The following factors increased the TCO:

- **COVID-19 pandemic:** There were significant delays and challenges in obtaining the materials ordered from abroad as a result of the COVID-19 pandemic, and alternatives had to be sourced locally and elsewhere at a higher cost. For NuRAN Wireless, not having their experts in country to assist, oversee and train local personnel due to travel restrictions resulted in some installation issues, particularly with newer technologies that personnel were not familiar with or had limited knowledge of the solution. These issues gradually surfaced once the sites were in service, and significant time was spent troubleshooting and many trips were needed to address the issues, which increased costs.
- **Higher maintenance costs:** Maintaining and replacing equipment in rural sites is more expensive due to a range of factors, including the distance and the difficulty of reaching them. One grantee determined that they could have significantly reduced maintenance costs with more careful logistics planning, well-defined procedures and detailed checklists. This would have enabled them to better control and manage project costs by ensuring field activities were performed correctly the first time and costly site visits could be reduced.
- **Equipment availability:** The lack of locally available equipment also meant that some equipment for the pilots had to be shipped from overseas, which increased costs. One of the grantees' local partners lost some equipment and damaged others, which meant replacement equipment had to be shipped from overseas with significant lead times and associated costs.
- **Partner onboarding costs:** Implementing unfamiliar technologies with new partners increases the overhead costs as time is required to ensure partners are correctly implementing and standardising deployment procedures.

The following factors reduced the TCO:

- **Government support:** Originally, only six sites were planned by NuRAN Wireless, but the savings from the support provided by GIFEC made it possible to reinvest in an additional site. GIFEC provided the following assistance:
  - Supported the import of equipment into Ghana and waived 96 per cent of the taxes and duties;
  - Performed the site acquisition and covered the costs to acquire or lease the land;
  - Helped expedite the type approval process for RF, MW and TVWS equipment; and
  - Coordinated with other government entities to the benefit of the project.

  Without the assistance of GIFEC, the time and cost to deploy sites would have increased significantly.
- **Site design:** To simplify the roll-out process and ensure speedy returns, the grantees deployed rural sites based on predefined configuration types that could be upgraded for capacity and technology. This avoided time-consuming and costly site designs since they selected the best fit for each settlement based on population size, settlement footprint and proximity to urban areas.
- **Stimulating demand:** Activities that support the adoption of mobile help to drive uptake of services and increase revenue. iSAT Africa conducted outreach sessions with the community on how to use mobile for voice and mobile internet, as well as the social and economic benefits of mobile internet (e.g. updates on weather, news and COVID-19 protocols, and connecting with family and friends). Vodafone Ghana supported the NuRAN pilot by providing marketing and customer support activities in the area.
- **Community engagement:** iSAT Africa employed local people to help build, operate and maintain the sites, which not only provided jobs for the community, but also lowered the set-up and maintenance costs. They also engaged the village chief from the start of the project and led community outreach activities to raise awareness of the benefits of mobile and strengthen a sense of community ownership. The smart poles added additional value for the community by providing access to light at night and mobile phone charging, and helped ensure that the community protected the infrastructure from theft or vandalism. For example, two smart poles deployed by iSAT Africa do not have any security guards and there has been no vandalism to date.

Pathway to scale

Key insights and lessons from these rural connectivity projects highlighted a number of important factors for reaching scale, including:

- Ensuring an enabling policy and regulatory environment is in place that supports investment in, and deployment of, rural coverage and stimulates demand for mobile internet.
- Minimising the complexity of rural sites by implementing simple, repeatable and predictable site deployments; standardising the necessary equipment where relevant; and streamlining deployment processes, all of which help to reduce the cost and time of site deployment while also ensuring the quality of construction and installation is consistent.
- Deploying solutions that can be easily upgraded and maintained, reducing the need for expert support and minimising costly site visits. This can include ensuring that sites can be upgraded and issues resolved remotely, as well as deploying in clusters since relative proximity between rural sites allows field activities to be carried out in succession, and general maintenance to be scheduled on site visits to repair faults.
- Creating partnerships with different stakeholders, since connecting rural settlements is a collaborative effort and not the sole responsibility of any single industry player or organisation.
- Focusing not just on the supply of necessary infrastructure, but also stimulating demand and ensuring citizens can use the available services, as this will maximise the ROI of each rural site deployment. This includes raising awareness of mobile internet and its benefits, providing community members with the digital skills to use the services and meet their needs, ensuring an agent network is in place to sell SIM cards and airtime and exploring options for providing affordable internet-enabled handsets.

Recommendations and conclusions

Connecting rural areas is a collaborative effort requiring the participation of all stakeholders to make it successful and scalable, including MNOs, governments, service providers and investors. Managed service providers, such as those supported through the GSMA Innovation Fund for Rural Connectivity, can successfully bring together different innovations. If scaled, they have the potential to reduce the TCO of providing connectivity in rural areas and to expand rural connectivity.

Key recommendations:

Bring together innovative technologies that can reduce the TCO across different infrastructure cost areas. It will be important to bring together innovations in RAN, power, backhaul and passive infrastructure that reduce both CAPEX and OPEX across different cost areas to reduce the overall TCO. Newer mobile technologies make mobile data more affordable, while a new generation of lower-cost base stations that can exploit evolving backhaul options help to extend networks, including into rural areas in LMICs. Similarly, the declining cost of renewable energy sources and energy-efficient mobile equipment can also help in areas where consistent energy supplies are not available.[11]

Establish business models that incentivise investment from different players. The current trend is for service providers to assume the risk of deploying rural sites by taking on the CAPEX and OPEX and venturing into revenue-share arrangements. It will be important to explore business models that incentivise investment from different players, such as the model where service providers take on the CAPEX and enter a revenue sharing agreement or where CAPEX investment for rural infrastructure is shared among partners.

Develop partnerships and put processes in place to manage and support them effectively. Expanding rural connectivity requires partners working together, but managing different partners can be complex and, if not done correctly, can increase costs significantly. Having agreements with each partner that clearly define the scope, objectives and responsibilities, and manage interaction and collaboration between partners through clear communication and good information exchange, are critical. Training is also key for onboarding new partners and local staff to ensure technology is deployed correctly, avoiding costly mistakes. This should be complemented with easy-to-follow user guides, manuals and process flows. Having a qualified engineer early in the process to train engineers, as well as review, oversee and check the installation of the sites helps ensure installation quality.

Ensure an enabling policy and regulatory environment. Expanding the reach of commercially sustainable networks requires an enabling policy and regulatory environment, including pro-investment and pro-innovation policies and regulations that reduce the costs and uncertainty of spectrum assignment, remove obstacles to network deployment and promote best practices on tax policy.[12] For instance, lack of flexibility or clarity on licence requirements to provide NaaS infrastructure can inhibit deployment, but simplifying and streamlining the planning approval process for new base stations can incentivise and speed up deployments.

Establish policy measures focused specifically on rural and remote mobile coverage. This could include, for instance, targeted exemptions on import duties for last-mile connectivity equipment and the provision of land to build sites.

11.1GSMA. (2020). Driving the digital revolution with improved mobile coverage.
12. Ibid.

Address the demand-related barriers that prevent people from being able to use mobile to meet their needs. Measures to drive mobile internet use are vital, as increased demand strengthens the business model for rural connectivity and makes rural base stations more economically viable. This requires taking measures to address the key barriers to mobile internet use, including raising awareness of mobile internet and its benefits, as well as improving digital skills and the affordability of mobile internet-enabled handsets.

Ensure sites can be upgraded cost-effectively. These pilots demonstrated that many rural sites have the potential to generate a lot of traffic. From a technology perspective, it is important to ensure the technologies that are deployed enable sites to be upgraded cost-effectively to cope with increased demand. This includes, for instance, deploying sites with RAN that can be easily upgraded without changing any hardware at the site, and planning for extra power if the increase in capacity demands it.

Appendix:
Site performance and use

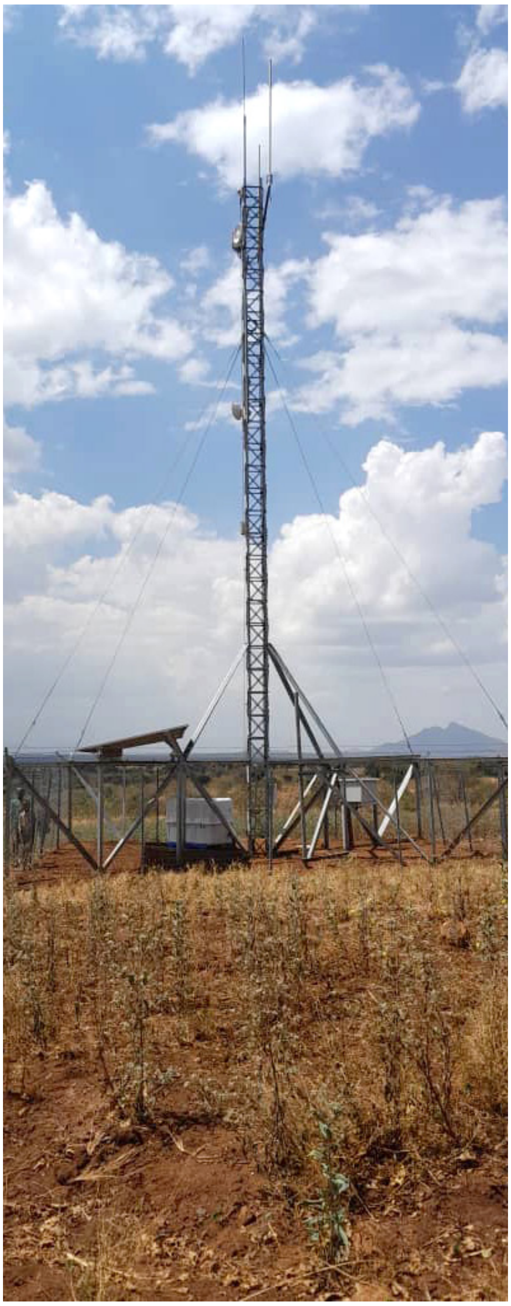
The following are additional details on site performance during the pilots.

iSAT Africa

Site availability:

Table 5: **12-month site availability**

Sites	Availability
Kadepo	98%
Lomanok	96%
Kawalakol	99%
Lobeluna	95%
Moriuta	96%



Call set-up success rate across all sites:

Table 6: **12-month call set-up success rate (CSSR)**

Sites	CSSR
Kadepo	89%
Lomanok	98%
Kawalakol	96%
Lobeluna	99%
Moriuta	99%

Note: The Kadepo site had a lower call set-up success rate because it became congested as soon as it went live. Once it was upgraded the success rate improved. Table 7 shows the average traffic channel (TCH) and stand-alone dedicated control channel (SDCCH) congestion rates throughout the year.

Table 7: **12-month congestion rate**

Sites	TCH congestion rate	SDCCH congestion rate
Kadepo	2%	1%
Lomanok	0%	0%
Kawalakol	1%	1%
Lobeluna	0%	0%
Moriuta	0%	0%

Daily average unique subscribers

Table 8 shows the daily average unique subscribers for the 2G and 3G service for the second six months of service.

Table 8: **Daily average unique subscribers for 2G and 3G**

(May to October 2021)

Sites	Population	Unique subscriber counts (daily average)						
		May 2021	Jun 2021	Jul 2021	Aug 2021	Sep 2021	Oct 2021	Average
Kadepo	3,075	560	741	723	699	738	733	699
Lomanok	2,249	452	658	659	636	607	636	608
Kawalakol	561	263	273	244	220	237	239	246
Lobeluna	1,500	77	161	149	134	128	114	127
Moriuta	1,800	210	170	191	159	112	123	161
Network subs	9,185	1,562	2,003	1,966	1,848	1,822	1,845	1,841
Network penetration rate		17%	22%	21%	20%	20%	20%	20%

Figure 1: **Average monthly data usage (MB) at 2G sites** *(November 2020 to October 2021)*

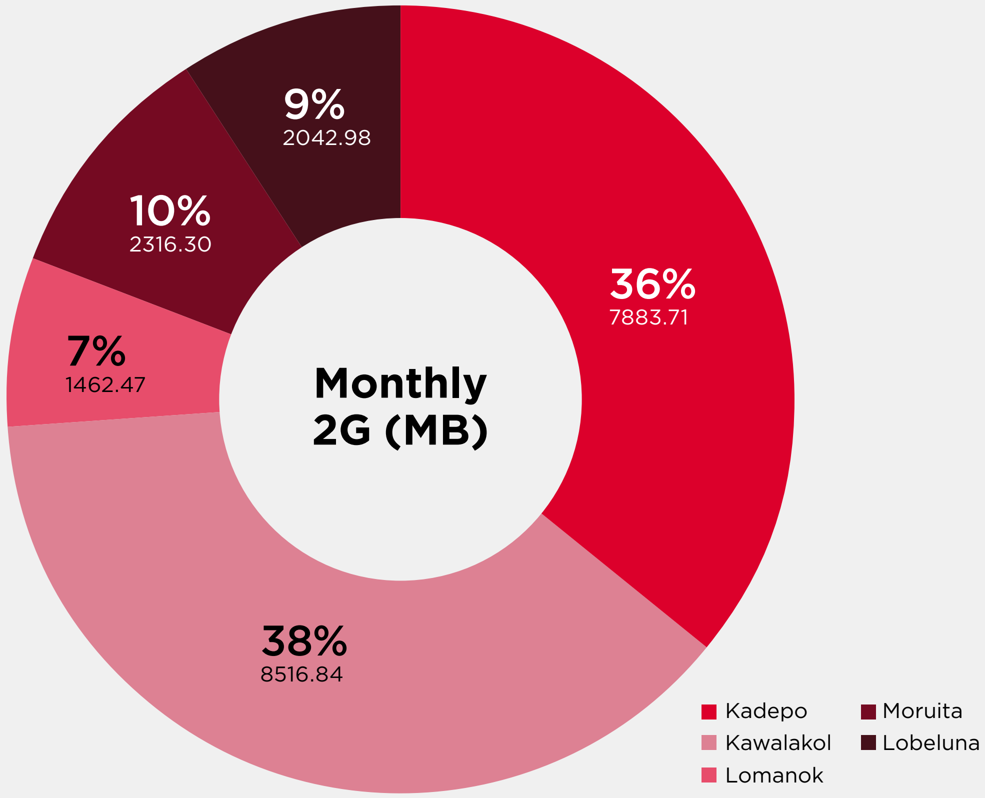
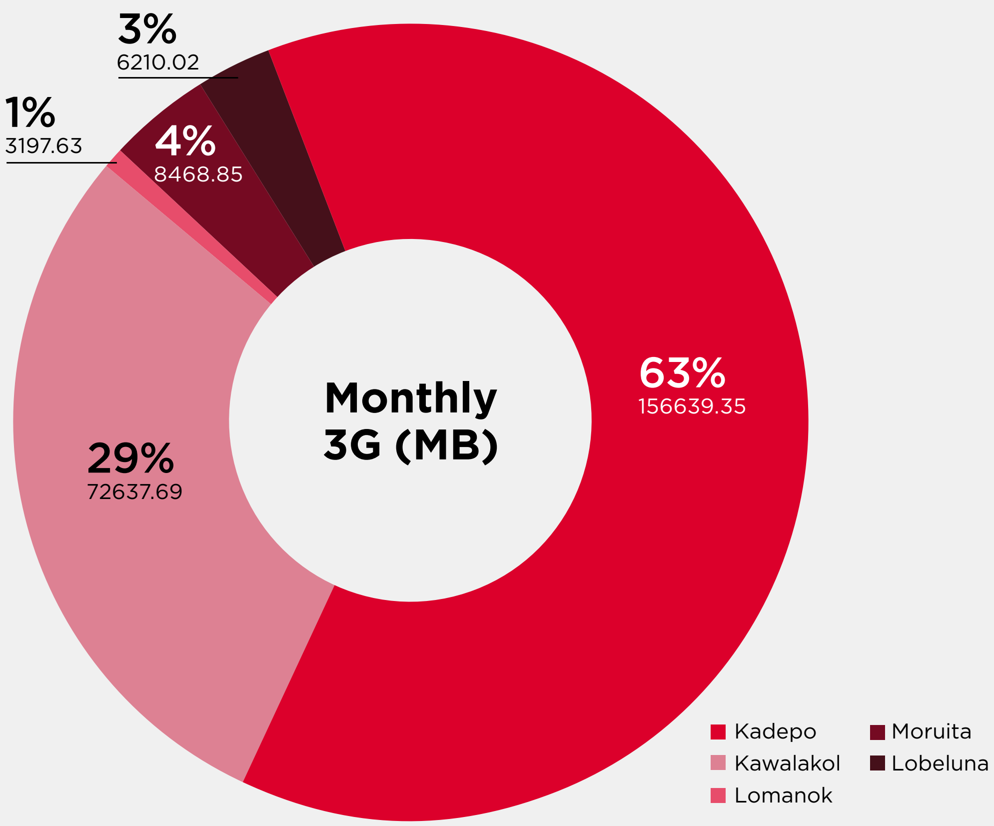


Figure 1 shows 2G monthly average usage across the sites for a 12-month period.

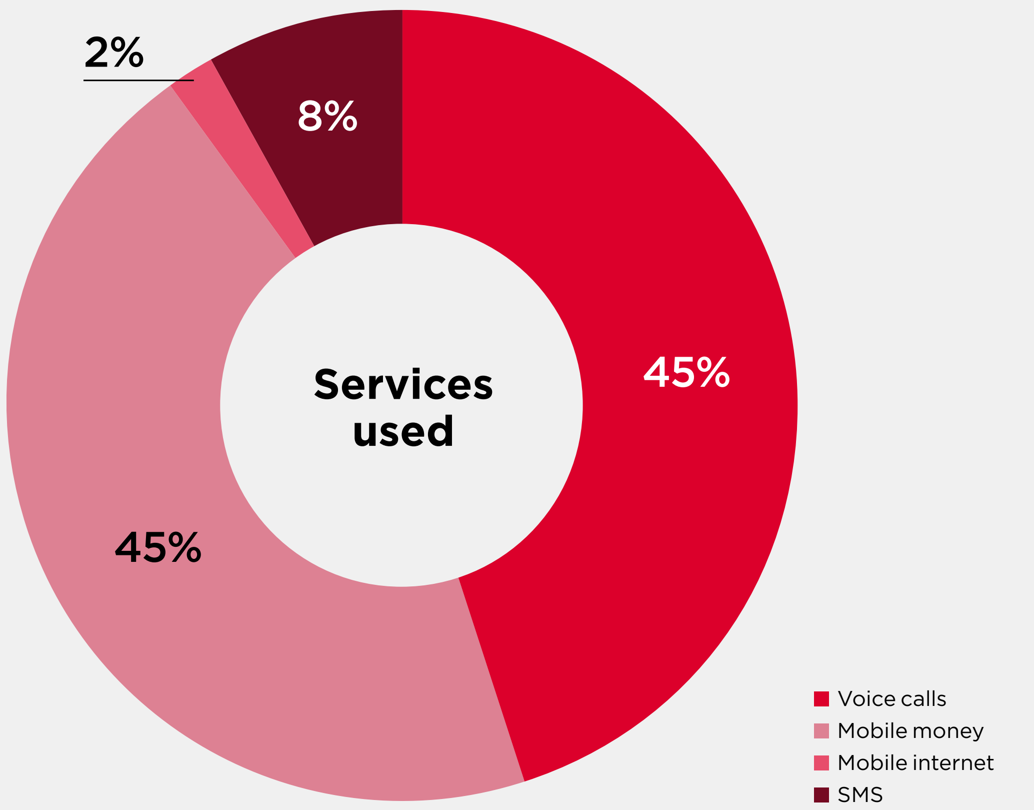
Data use in Kadepo far exceeded all other sites as it was an aggregator site and the largest of all five sites. This data usage is particularly impressive given that these sites did not previously have any 2G coverage and the population began adopting and using data services within a short timeframe.

Figure 2: **Average monthly data usage (MB) at 3G sites** *(November 2020 to October 2021)*



3G data usage was good across the five sites, averaging 247.2 GB per month. Demand-side initiatives are important for getting more people online.

Figure 3: **Services used across the five new sites in North-East Uganda**



While data use was impressive, most people lacked suitable devices, the skills or the ability to afford data services. This resulted in most people using their devices for voice calls and mobile money.

NuRAN Wireless

Figure 4: **Site availability of 2G services for the first 12 months across the seven sites**

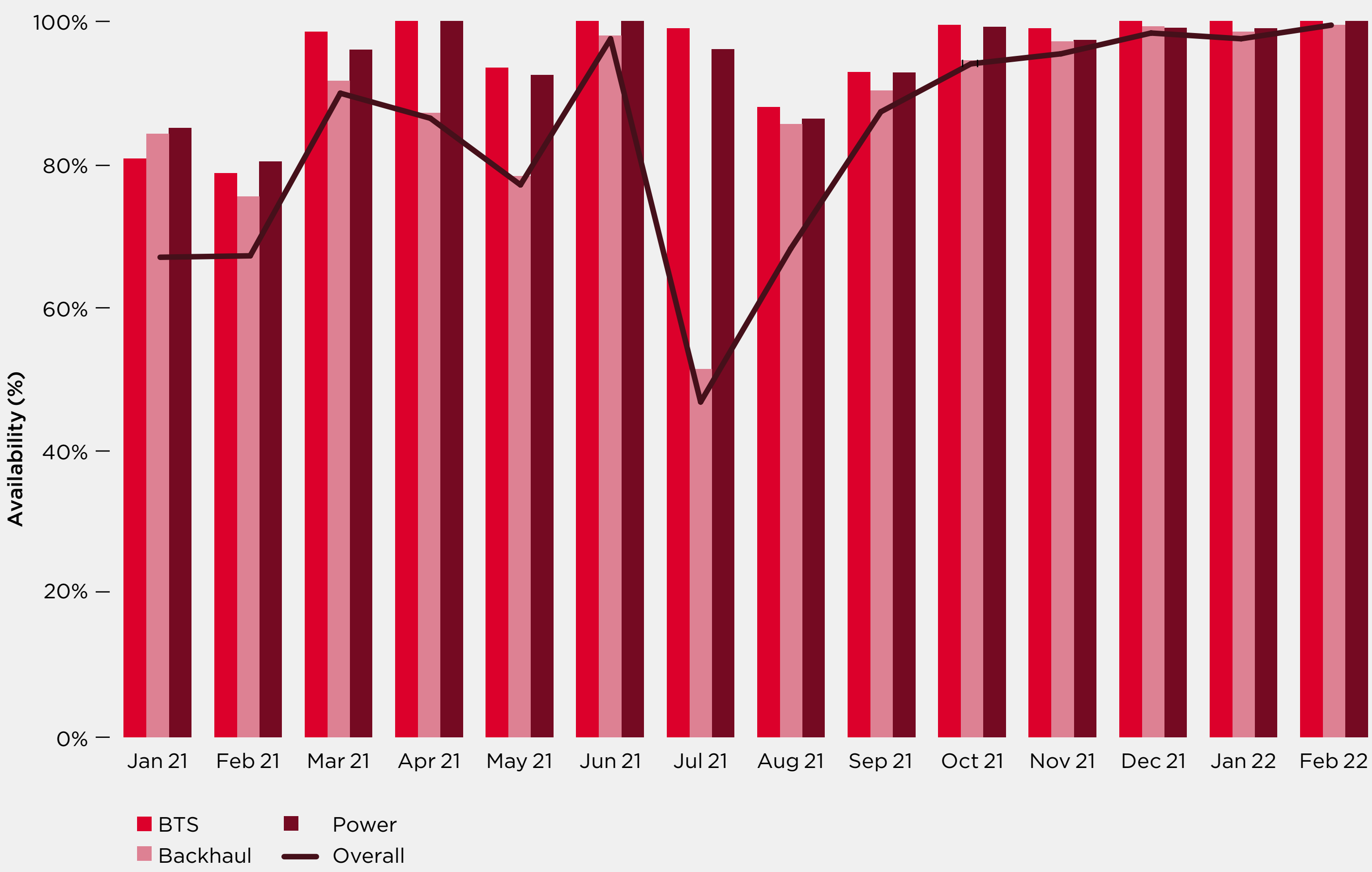


Table 9 shows site availability in terms of backhaul.

Table 9: **Overall site backhaul availability**

(2021)

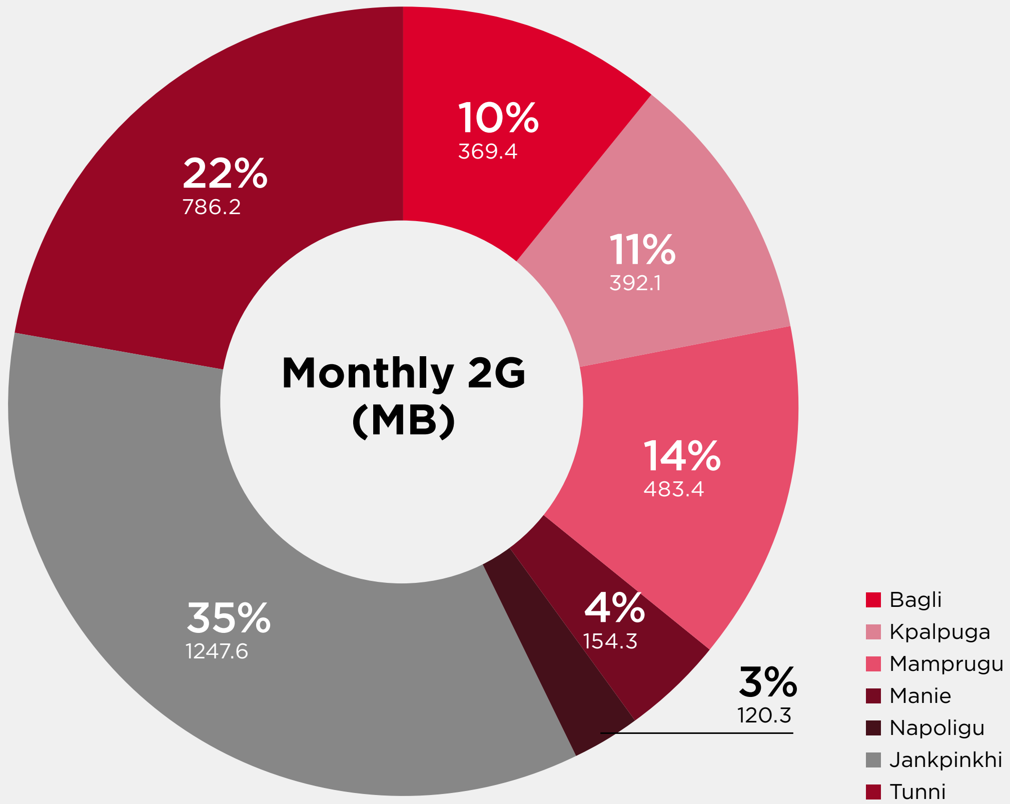
Sites	Availability	Backhaul Distance (km)
Mamprugu	90.1%	7.68
Jankpinhi	87.3%	7.73
Napoligu	86.8%	16.05
Bagli	85.1%	N/A (aggregation point)
Kpalpuga	85.0%	11.13
Tunni	72.6%	10.10
Manie	72.4%	16.77

The three smaller sites (Mamprugu, Jankpinhi, Napoligu) with the lower backhaul and power requirements performed best during the pilot. Of the larger sites, Bagli was the best performer as it is backhauled over microwave instead of TVWS.

Manie was the worst-performing site, likely because it was farthest away from Bagli, the central aggregation point. Backhaul was the main cause of site outages. A combination of missing ancillaries, channel interference and LAN auto-negotiation issues at the sites affected the performance.

Due to the COVID-19 pandemic, the site equipment was installed without the necessary supervision and verification checks, which also resulted in issues arising once they were in service and affected site availability.

Figure 5: **Average monthly data usage (MB) at 2G sites** *(January to December 2021)*



Call set-up success rate across all sites:

Table 10: **12-month call set-up success rate**

Sites	CSSR
Mamprugu	88.7%
Jankpinhi	90.6%
Napoligu	82.0%
Bagli	78.0%
Kpalpuga	55.8%
Tunni	83.3%
Manie	77.2%

Daily average unique subscribers

Table 11 shows the daily average unique subscribers for the 2G service for the second six months of service.

Table 11: **Daily average unique subscribers for 2G**

(July to December 2021)

Sites	Population	Unique subscriber counts (daily average)						
		Jul 2021	Aug 2021	Sep 2021	Oct 2021	Nov 2021	Dec 2021	Site PR
Bagli	3,647	1,216	1,167	1,324	1,336	1,604	1,912	**52%**
Jankpinhi	960	451	404	285	327	529	718	**75%**
Kpalpuga	2,600	2,182	1,957	2,103	2,164	2,540	2,730	**105%**
Manie	3,066	1,466	1,442	1,374	1,513	1,780	2,122	**69%**
Mamprugu	668	368	293	254	312	386	454	**68%**
Napoligu	684	732	604	596	608	760	889	**130%**
Tunni	3,536	346	329	348	443	513	454	**14%**
Network subs	**15,161**	**6,762**	**6,149**	**6,283**	**6,703**	**8,111**	**9,278**	
Network PR		**45%**	**41%**	**41%**	**44%**	**54%**	**54%**	

3G went live in four sites in rural Ghana, Bagli, Kpalugu, Manie and Tunni in December 2021. An immediate congestion in voice traffic was observed, particularly in Bagli. There was also a slight increase in data traffic in the same month. However, due to some technical and environmental issues, some equipment was damaged and replacements had to be shipped in, causing major faults across all sites for a period of almost 3 months. After these were resolved an increase in data traffic was noted across most 3G sites. The sites are now stable with congestion near 0% and site availability averaging above 80% across all sites.

Figure 6: **Monthly Site availability**

(December 2021 to August 2022)

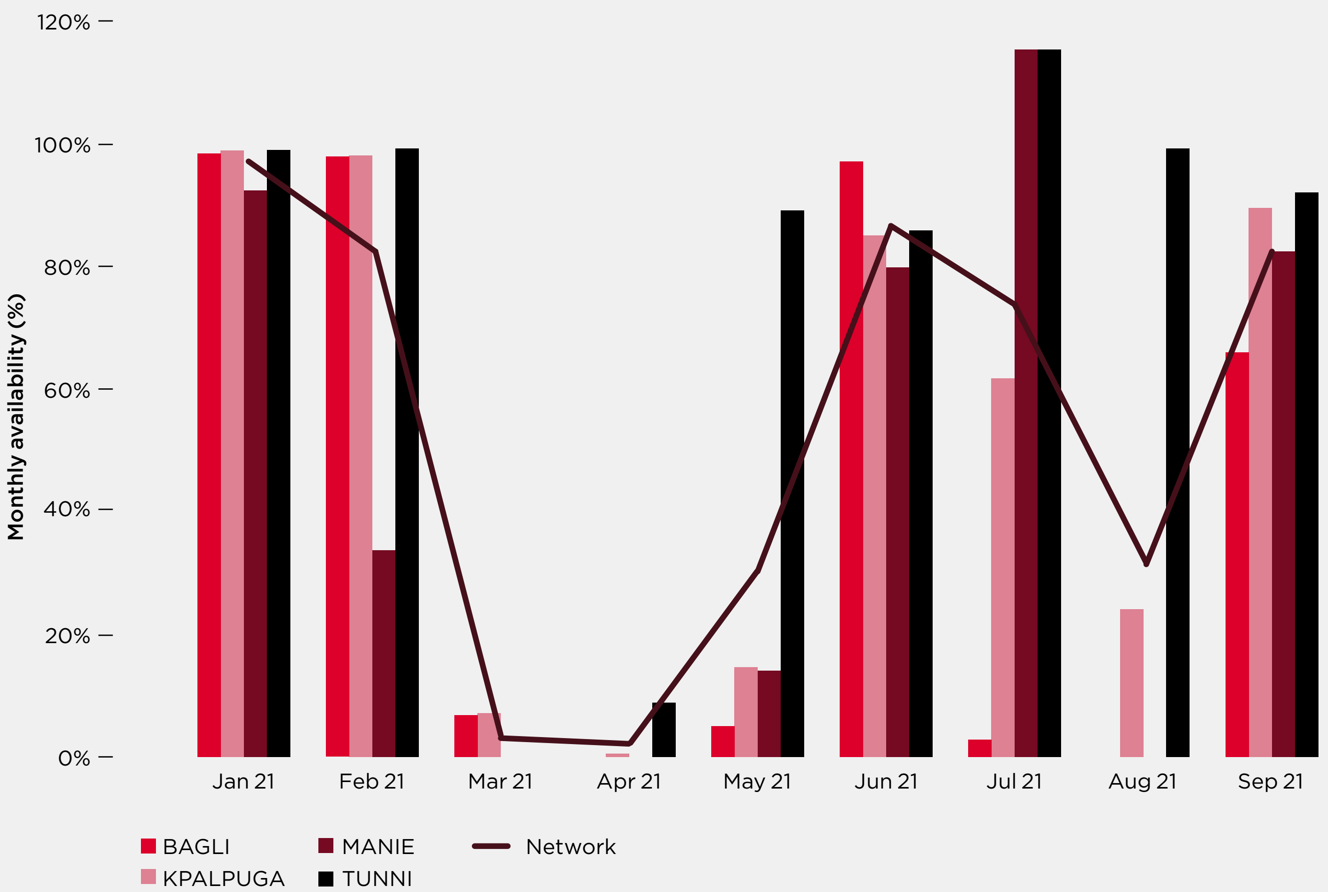
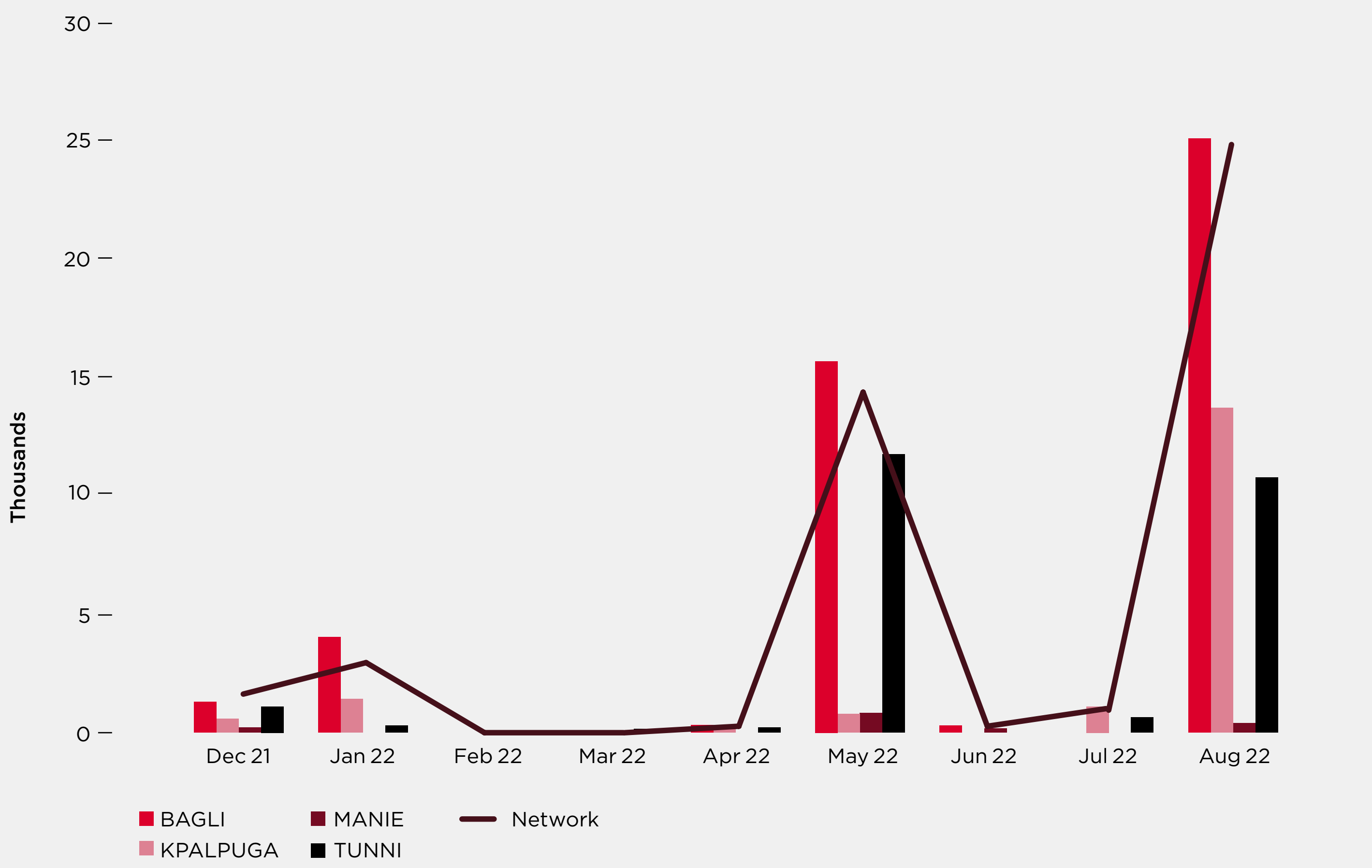


Figure 7: **Monthly data usage (MB)**

(December 2021 to August 2022)



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