May 2024

Connectivity in Crisis

The Humanitarian Mobile Coverage Gap

Understanding differences in humanitarian connectivity and exploring solutions

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GSMA Mobile for Humanitarian Innovation

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This initiative has been funded by UK International Development from the UK government and is supported by the GSMA and its members.

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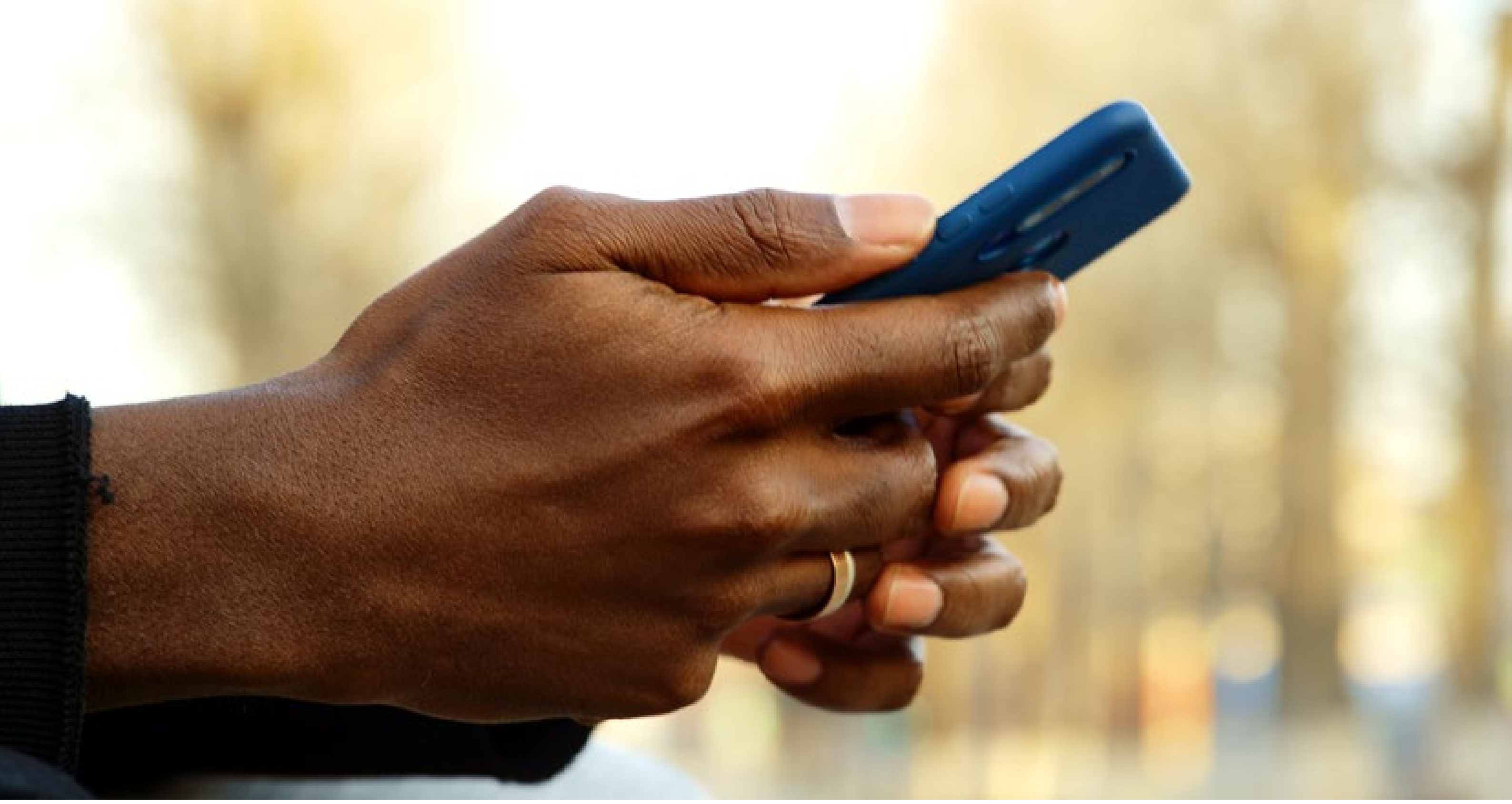


Introduction

Connectivity is a fundamental requirement in crisis settings, both for the people affected by crisis and the delivery of a modern humanitarian response. While the connectivity needs of humanitarian responders tend to be met in a crisis, the corresponding needs of crisis-affected communities are often poorly understood, underappreciated and under supported. Its absence and loss can have profound humanitarian implications.

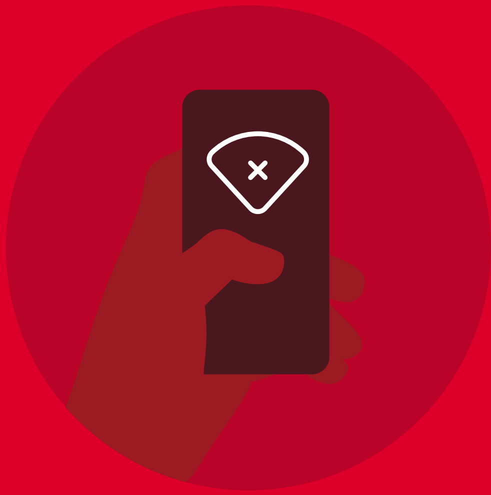
Expanding and upgrading mobile networks for crisis-affected communities requires effective, evidence-backed approaches to understand coverage gaps. While data suggests that crisis-affected communities disproportionately live in areas outside mobile network coverage,[1] and some studies have explored this in detail,[2] this type of analysis is not widely available. Where it is available, the data is not standardised or sufficiently granular to support decision-making.

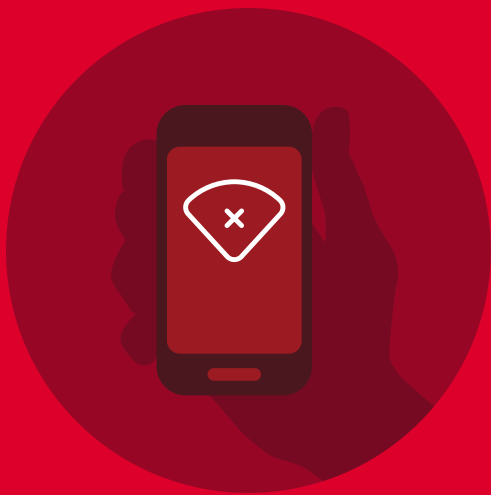
There is growing recognition across a range of sectors that closing humanitarian mobile coverage gaps is important, and recent technological advances have fostered collective enthusiasm about potential step changes in mobile coverage. However, a variety of challenges have made long-term, meaningful progress difficult.

The GSMA aims to galvanise cross-sector action to meet the connectivity needs of crisis-affected communities around the world. This report presents the results of a recent analytical pilot study that measured differences in mobile coverage for crisis-affected groups in Burkina Faso, the Democratic Republic of the Congo (DRC) and Nigeria. It also examines two areas with transformational potential to bring coverage to crisis-affected areas: aerial connectivity and direct partnerships between mobile network operators (MNOs) and humanitarian and development actors.

1 Downer, M. and Hamilton, Z. (2024). Connectivity in Crisis: The Humanitarian Implications of Connectivity for Crisis-Affected Communities. GSMA.
2 UNHCR. (2016). Connecting Refugees: How Internet and Mobile Connectivity can Improve Refugee Well-Being and Transform Humanitarian Action.

01 Measuring differences in humanitarian mobile coverage





Connectivity is a vital need for people affected by crisis. However, data on the availability of mobile coverage in crisis settings is often inadequate, inconsistent, or unreliable. This prompted the GSMA to develop a new approach to measuring differences in mobile coverage for crisis-affected groups. By blending existing datasets, many of which are publicly available, we can estimate the difference in coverage between national populations and people affected by crisis. Our pilot study produced estimates for Burkina Faso, DRC and Nigeria. As much as possible, these estimates are disaggregated by technology and different populations in need of humanitarian assistance.

The results of the pilot suggest that **despite some data limitations, it is feasible to develop reliable estimates of differences in mobile coverage for crisis-affected groups in other humanitarian contexts.** These should be a useful starting point when advocating for, and implementing, practical solutions to reduce these gaps. When calculated at scale, estimates of these differences on a global level should also be possible.

We invite input and reflection from colleagues across sectors on this analysis, especially as we seek to replicate analyses in other contexts. We hope that these outputs prove useful and informative to stakeholders implanting solutions, as well as to global advocates for humanitarian connectivity.

Technical details this new approach can be found in Annex 1.

Note on terminology

The analysis in this report presents net differences in coverage between various groups. The quantitative analysis avoids using the term ‘gap’, for which the analytical convention is to present as a proportional difference.

Burkina Faso

Humanitarian need, 2023[3]

People in need of assistance

4.65m

Internally Displaced People

2.06m[4]

Refugees

35,657

Most pressing needs

Food security

3.5m

Protection

3.1m

Health

2.8m

National mobile statistics, Q4 2023[5]

Unique mobile subscribers

8.8m

38% Penetration

Unique mobile internet subscribers

4.3m

18% Penetration

MNOs

Moov Africa, Orange, SKYNET, Telecel

Using coverage data from the GSMA's Mobile Coverage Maps, our analysis found persistent differences in 4G coverage across all crisis-affected communities. A small difference in 3G coverage was found for people in need of assistance (PiN), but the analysis suggests that internally displaced people (IDPs) are more likely to be covered by 3G in Burkina Faso than the overall population. This may be because many IDPs reside in urban areas, which are more likely to have mobile network coverage.

The relatively small number of refugees in Burkina Faso seem to have notably better mobile network coverage. This is likely due to the fact that most refugees live in only a few areas, such as Dori, which are well covered.

It is encouraging that, despite different sources of connectivity data producing different estimates, they all had the same overall narrative in terms of coverage disparities between population groups (see discussion in Annex 1).

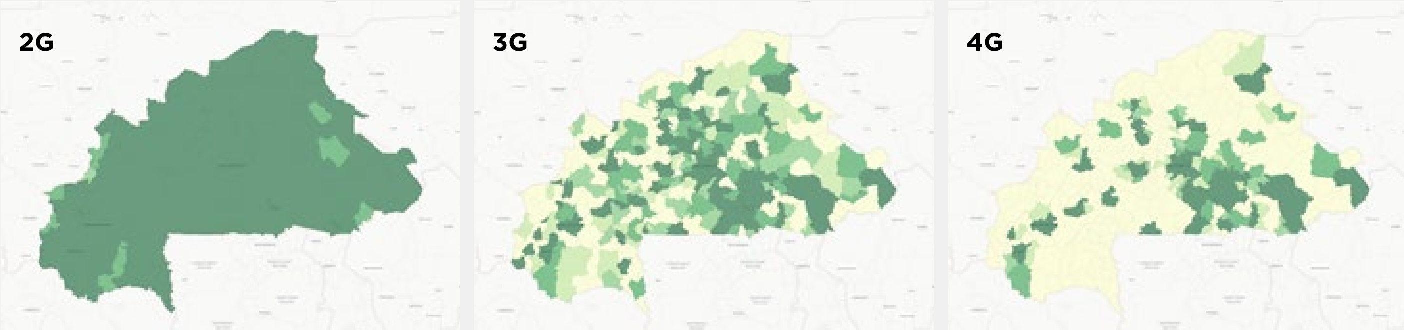
Table 1
Humanitarian mobile coverage in Burkina Faso

		Coverage			Difference with total population		
	Total population	IDPs	PiN	Refugees	IDPs	PiN	Refugees
2G	98%	99%	98%	99%	0%	0%	+1%
3G	64%	71%	60%	83%	+7%	-4%	+19%
4G	46%	40%	34%	62%	-6%	-12%	+16%

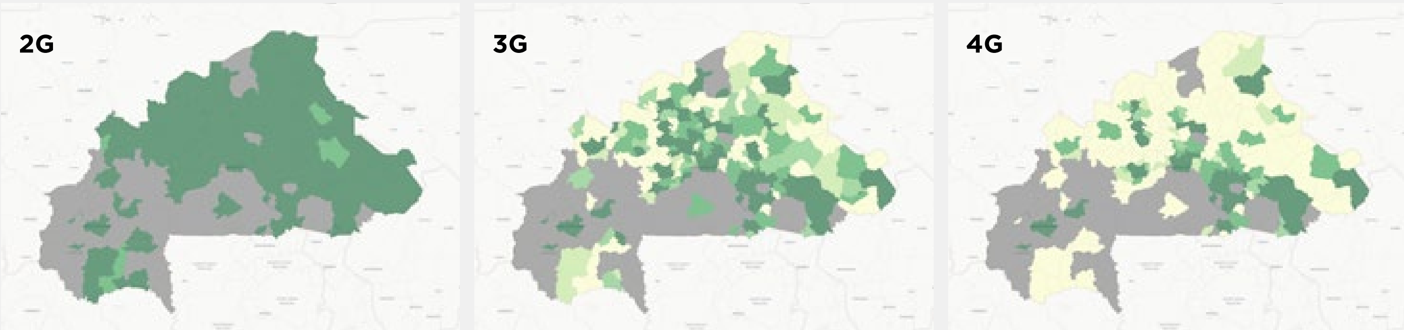
3 OCHA. (2023). Burkina Faso: Aperçu des Besoins Humanitaires 2023 (mars 2023); Conseil National de Secours d'Urgence et de Réhabilitation. (31 March 2023). Enregistrement des Personnes Deplacees Internes du Burkina Faso.
4 Only 1.57 million IDPs were included in the UN Humanitarian Response Plan (HRP), indicating that roughly 500,000 IDPs, largely in the south and southwest of the country, were not categorised as needing humanitarian assistance.
5 GSMA Intelligence data (accessed 6 March 2023).

Figure 1
Network coverage in Burkina Faso, by technology generation and population type

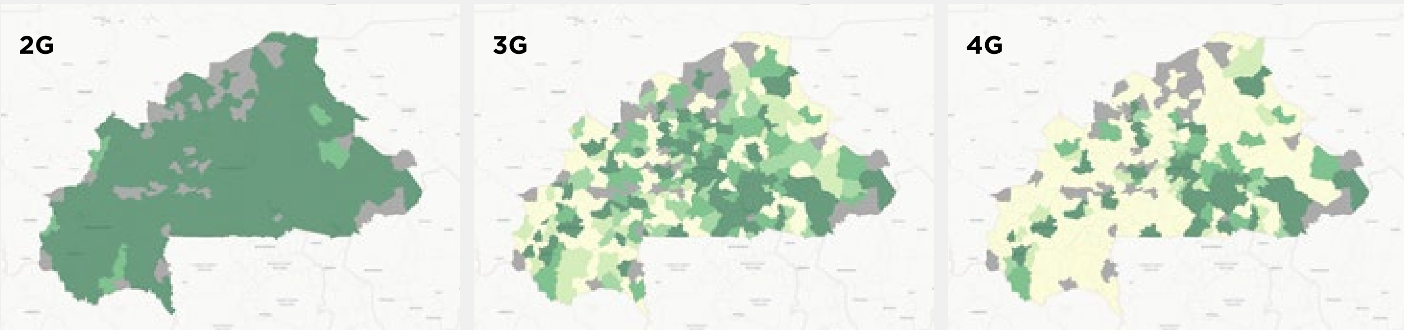
Total population



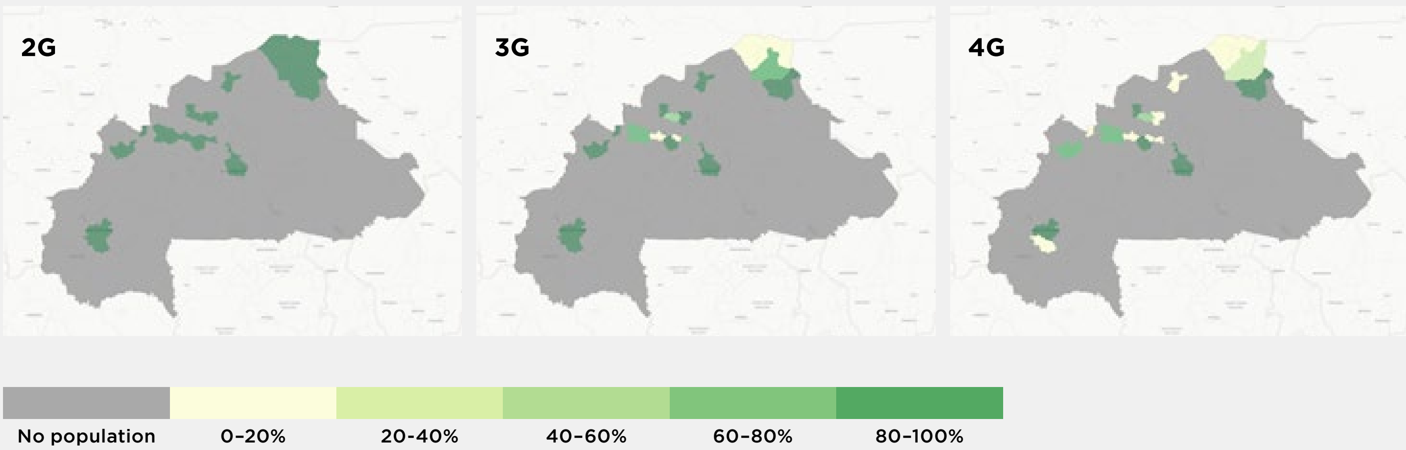
People in need of humanitarian assistance



Internally displaced people



Refugees



Democratic Republic of the Congo

Humanitarian need, 2023[6]

People in need of assistance

26.4m

Internally Displaced People

6.1m[7]

Refugees

531,000

Most pressing needs

Food security

36.4m

Protection

9.8m

Health

7.4m

National mobile statistics, Q4 2023[8]

Unique mobile subscribers

27.7m — **27%** Penetration

Unique mobile internet subscribers

14.3m — **14%** Penetration

MNOs

Africell, Airtel, Orange, Smile, Supercell, Tatem Telecom, Vodacom

Due to gaps in population data, it was not possible to estimate humanitarian differences in mobile coverage for refugees in DRC. However, using coverage data from the GSMA's Mobile Coverage Maps, the analysis produced estimates of differences in coverage for PiN and IDPs. The analysis found differences for both 3G and 4G networks. However, the 4G difference for IDPs was negligible (just one percentage point less) and should be considered at parity with the national population. PiN also had a seven percentage point difference for 2G coverage, indicating systemic exclusion from connectivity.

Again, it is encouraging that despite different sources of connectivity data producing different estimates, each provided the same overall narrative in terms of disparities between population groups (see discussion in Annex 1).

Table 2
Humanitarian mobile coverage in DRC

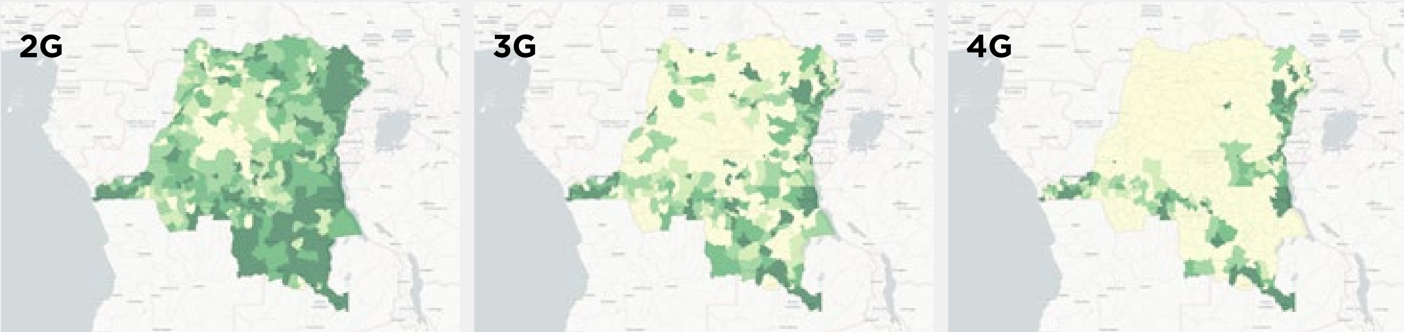
		Coverage		Difference with total population	
	Total population	IDPs	PiN	IDPs	PiN
2G	81%	81%	74%	0%	-7%
3G	63%	56%	52%	-7%	-11%
4G	48%	47%	38%	-1%	-10%

6 OCHA. (2023). Burkina Faso: Aperçu des Besoins Humanitaires 2023 (mars 2023); Conseil National de Secours d'Urgence et de Réhabilitation. (31 March 2023). Enregistrement des Personnes Deplacees Internes du Burkina Faso.
7 Only 1.9 million IDPs were included in the UN HRP, indicating that roughly 400,000 IDPs were not categorised as needing humanitarian assistance.
8 GSMA Intelligence data (accessed 6 March 2023).

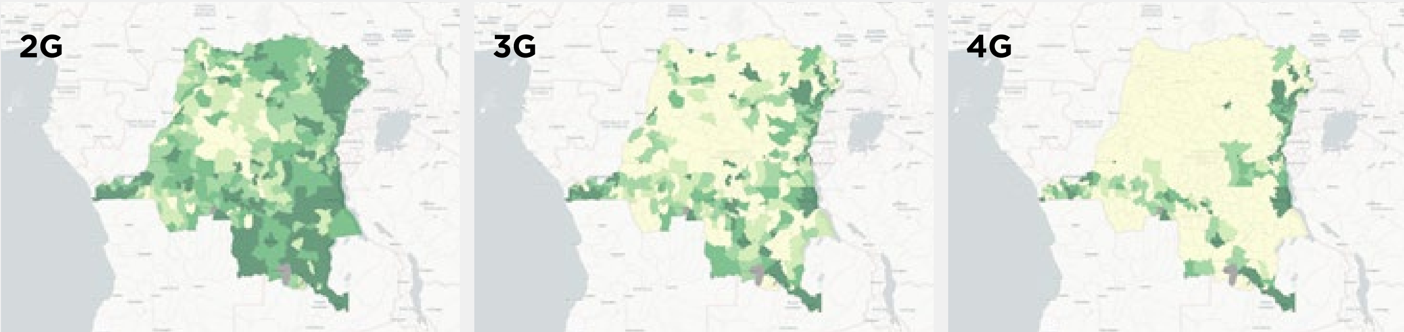
Figure 2

Network coverage in DRC, by technology generation and population type

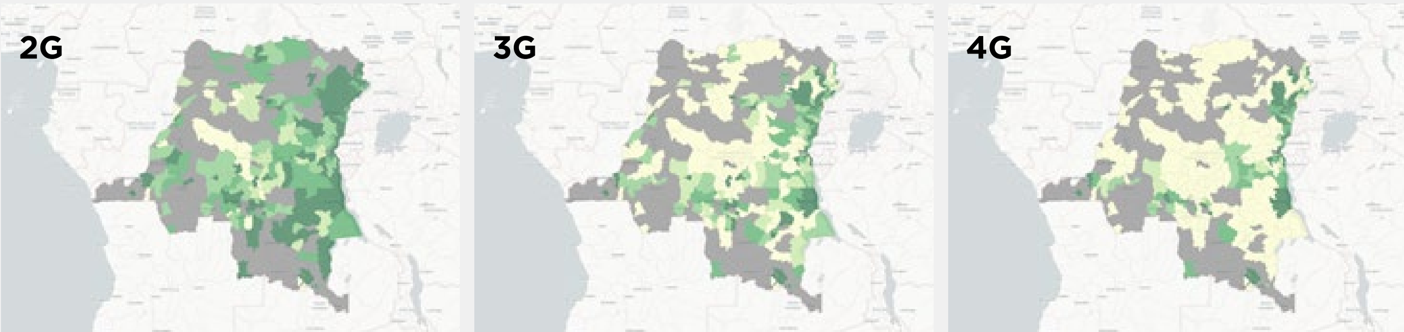
Total population

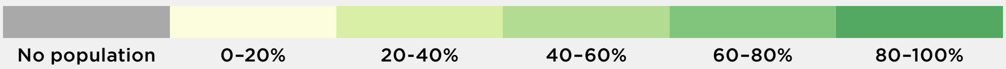


People in need of humanitarian assistance



Internally displaced people





Nigeria

Humanitarian need in Borno, Adamawa and Yobe (BAY) states, 2023[9]

People in need of assistance

8.3m

Internally Displaced People

2.4m[10]

Returnees

1.5m

Most pressing needs

Health

5.8m

Water, sanitation and hygiene (WASH)

5.1m

Protection

4.6m

National mobile statistics, Q4 2023[11]

Unique mobile subscribers

109.8m — **49%** Penetration

Unique mobile internet subscribers

66.6m — **29%** Penetration

MNOs

9mobile, Airtel, Glo Mobile, InterC Network, MTN, ntel, Smile, Swift Networks

Due to data gaps, it was only possible to estimate differences in mobile network coverage for IDPs in Nigeria. Using network coverage data from the GSMA/Collins Bartholomew, the analysis found sizeable differences across 2G, 3G and 4G networks, both at the national level and in BAY states where most IDPs reside. However, the difference in the BAY states is notably less, which means that a large proportion of the difference at a national level is explained by the fact that coverage is more limited in the BAY states, where IDPs are disproportionately located.

Like the other two pilot countries, different sources of connectivity data produced different headline coverage estimates, but each provided a similar narrative on the disparity between the overall population and IDPs in Nigeria (see discussion in Annex 1).

Table 3
Humanitarian mobile coverage in Nigeria

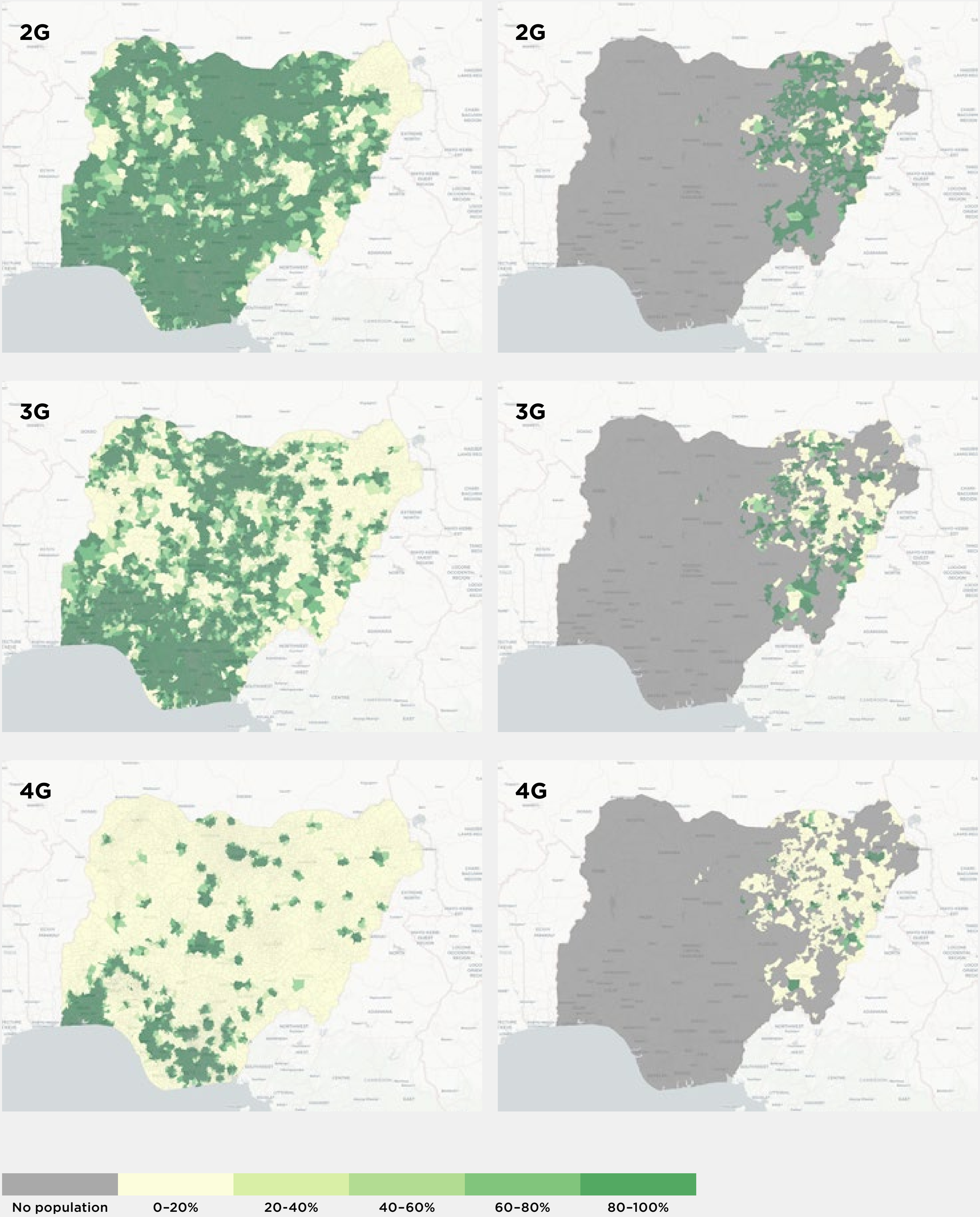
	Nationwide			BAY states		
	Total population	IDPs	Difference	Total population	IDPs	Difference
2G	93%	54%	-39%	61%	51%	-10%
3G	85%	48%	-37%	55%	45%	-10%
4G	78%	42%	-36%	45%	41%	-4%

9 UN OCHA. (2023). Nigeria Humanitarian Needs Overview 2023 (February 2023).
10 As IDPs outside of BAY States are not included in the caseload, only 1.5 million IDPs are included within the number of people in need of humanitarian assistance.
11 GSMA Intelligence data (accessed 6 March 2023).

Figure 3

Network coverage in Nigeria, by technology generation and population type

Total population | **Internally displaced people**



02
Bridging differences in mobile coverage for crisis-affected groups

Connecting crisis-affected, underserved and last-mile communities around the world is a challenge for a broad range of actors and sectors. While efforts to bridge differences in mobile coverage for crisis-affected groups have been relatively limited to date, the development community has used a range of approaches to connect other underserved groups to mobile networks. Investment by the mobile industry, alongside innovative applications of various technology, partnership and financial models have meant that, as of 2023, 95% of the world's population live in an area covered by at least a 3G network.[12]

In 2023, GSMA Intelligence conducted an internal landscaping study of approaches that have been used to provide mobile network coverage to crisis-affected groups. This was done to gauge which approach might be most appropriate for humanitarian actors or in crisis settings.[13] They looked at 18 different approaches, from light tower technology and network as a service (NaaS) partnership models to government universal service funds (USFs). Most models have notable challenges that make them less suitable to network expansion in humanitarian settings, especially if commercial return on investment (RoI) is likely to be low. However, several may offer exciting opportunities when adapted to crisis settings:

- **Technology: Non-terrestrial networks (NTN)**
  Non-terrestrial solutions that leverage high-altitude base stations or satellite technologies to extend the coverage of ground-based communications networks.
- **Technology: Light towers**
  Innovative base station solutions that provide low-cost towers, often powered by renewable energy solutions.
- **Financing: Public-private partnerships (PPPs)**
  Governments, development finance institutions (DFIs) and the private sector each provide funding. This is a well-established financing model to extend connectivity when conventional approaches fail to meet the necessary requirements.
- **Financing: Blended financing**
  Project financing with funding from a mix of sources with different but compatible interests. This can include strategic investors, development agencies, angel investors, private companies and corporate social responsibility (CSR) funds and grants.
- **Partnership: NaaS**
  A model in which MNOs outsource the management of an entire network, including both active and passive network components. This encourages infrastructure sharing and third-party investment in rural connectivity.
- **Partnership:** Cooperation between MNOs and humanitarian or development actors.
  Direct partnerships which leverage the respective strengths, operating models and access to finance to expand or upgrade connectivity.

The remainder of this report examines two key areas with transformational potential to provide mobile network coverage to crisis-affected groups:

- Aerial connectivity, including satellite technology
- Partnerships between MNOs and humanitarian or development actors, including adapting PPPs and blended financing models to involve humanitarian stakeholders

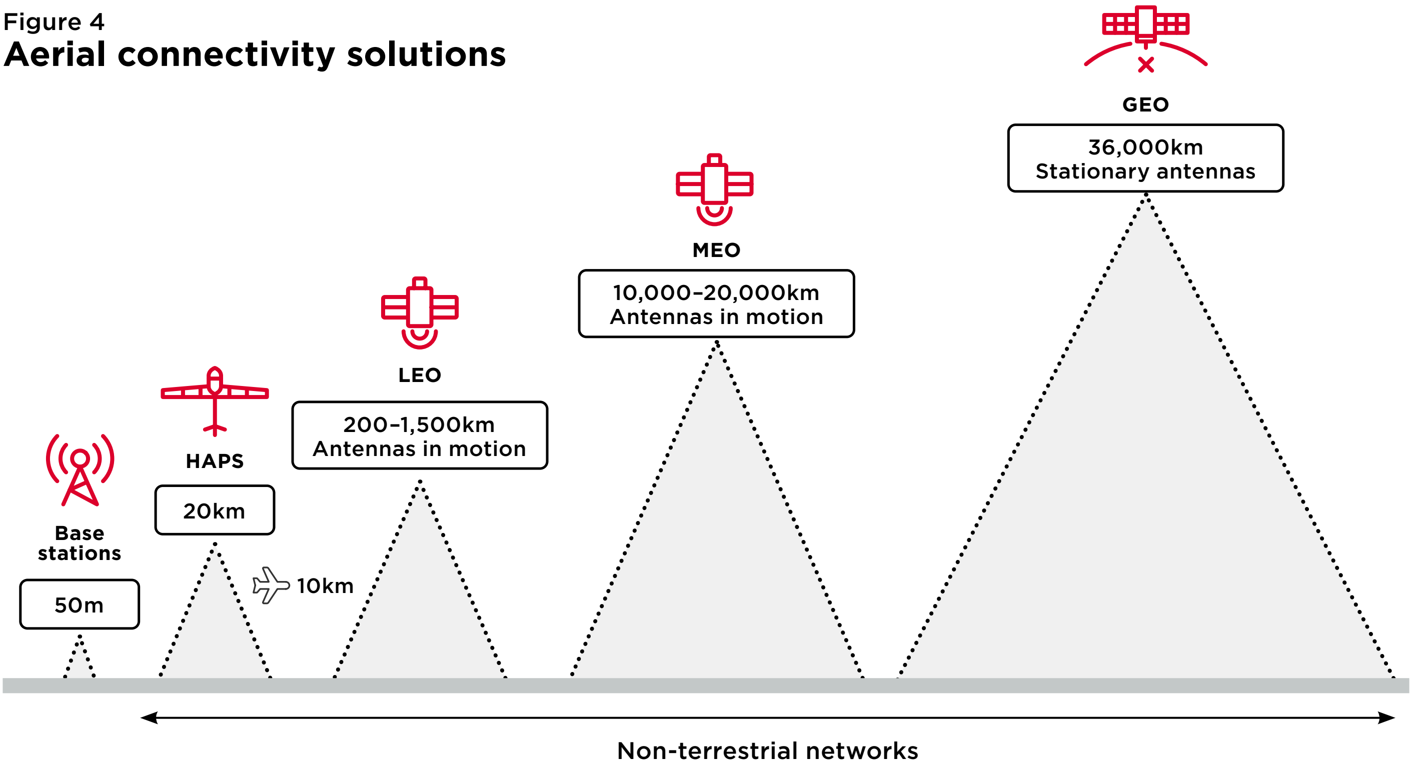
12 GSMA. (2023). The State of Mobile Internet Connectivity 2023.
13 Importantly, this analysis does not include sensitivities related to active conflict settings where security concerns and the potential for infrastructure to be deliberately damaged can complicate these models further.

Aerial connectivity

Aerial connectivity refers to any non-terrestrial (non-Earth-based) solution that extends the coverage of ground-based communications networks. It is a useful umbrella term for satellites – low-Earth orbit (LEO), medium-Earth orbit (MEO) and geostationary orbit (GEO) – and high-altitude platform stations (HAPS). These technologies have different levels of maturity, deployment models and commercial timelines.

Iterations of aerial connectivity technology have been available for decades. However, recent technological advances are generating enthusiasm in many sectors, including the humanitarian sector, about a potential step change in global connectivity.

Figure 4
Aerial connectivity solutions



Adapted from: SoftBank, GSMA Intelligence

Satellites

Satellite connectivity has been available for decades. While there a range of technological options, the key trade-offs continue to be cost, altitude, coverage and connection strength. As altitude increases, ground coverage is boosted but with a resultant increase in latency. For example, LEO satellites are nearest to Earth, circumnavigate the globe around 16 times per day and their lower altitude means it takes less time for signals to make a round trip from satellite to Earth. By comparison, GEO satellites are farthest away, offering much wider coverage per satellite and have an altitude that perfectly matches the Earth's 24-hour rotation and keeps them "stationary". Their latency can be up to 60 times greater than LEO satellites.

Newer LEO satellite constellations are rapidly creating opportunities for satellite-based, mass-market connectivity. Their rise is underpinned by lower launch and operational costs, as well as higher performance capability relative to legacy higher altitude satellites. LEO providers such as OneWeb and Starlink provide worldwide coverage. Starlink has already launched D2C while OneWeb provides wholesale backhaul.

There are currently four main routes through which satellite operations can enable consumer connectivity and close humanitarian mobile coverage gaps:

- The provision of wholesale backhaul in partnership with MNOs
- The provision of D2C services via satellite dishes or ground terminals
- The provision of direct-to-device (D2D) service in partnership with device manufacturers and chipset vendors, and separately with MNOs

Satellite backhaul

Backhaul is the part of the network that provides connectivity from access networks (the part of the network to which phones connect) to the core network (where data from access networks gets processed and directed to its intended recipient). Satellite backhaul partnerships are both symbiotic and pragmatic for satellite providers and MNOs. Satellite providers help extend mobile networks to unconnected areas while receiving wholesale revenue. MNOs are then able to reach new customers through traditional terrestrial base stations, potentially far from existing network infrastructure. For example, Intelsat and AMN are using satellite backhaul and solar-powered base stations to connect hundreds of thousands of rural residents in Madagascar.[14]

Due to prohibitive costs, satellite backhaul is used when there is no economic case for using fibre or fixed wireless. Primarily in remote areas, especially where mountainous. However, high-capacity and low-latency LEO constellations open the possibility to deploy satellite backhaul in more locations.[15] As satellite pricing declines (as predicted), higher capacity satellites and associated ground segment[16] is developed, satellite backhaul is likely to become more competitive.

For humanitarians, this means crisis-affected areas that have not been viable to connect could now be connected. Additionally, satellite backhaul could provide network resilience, redundancy and recovery in the face of shocks. For example, in January 2024, Japanese MNO KDDI worked with Starlink to switch 159 base stations to satellite backhaul after a 7.6 magnitude earthquake on the Noto Peninsula damaged the existing fibre backhaul. KDDI had an existing relationship with Starlink, having used satellite backhaul for remote locations since 2022.[17] Similarly, Digicel Pacific has a partnership with SES to leverage their MEO constellations to provide shock-resilient connectivity across Papua New Guinea.[18]

However, while the initial cost of connecting a crisis-affected area to an existing satellite network is low compared to other backhaul technologies, the ongoing operational expenditure (OpEx) of pay-per-use traffic fees can be up to 20 times higher. One potential way to mitigate this is to "pool" backhaul capacity across several cell sites. There may be an opportunity for humanitarian and development partners to support OpEx costs in areas where they see a humanitarian need for deployments.

Despite challenges, improved satellite backhaul capacity enabled by new satellite constellations has potential to close humanitarian mobile coverage gaps.

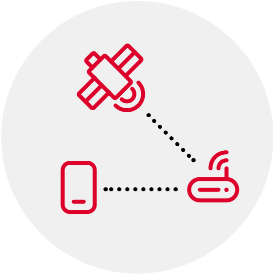
14 Gillet, J.P. (26 February 2024). "Come Hell or High Water: Connectivity Beats the Odds". Intelsat.

15 For example: Eutelsat OneWeb. (1 March 2023). "VEON and OneWeb Partner to deliver seamless communication and digital services"; Africa Mobile Networks Group. (14 July 2023). "AMN announces backhaul agreement with Starlink to connect millions across Africa".

16 The ground segment is comprised of gateway antennas and UT antennas, which are used to transmit and receive satellite signals. Unlike a traditional GEO satellite, where a simple, fixed, Earth-based antenna looks at a fixed point in the sky, what makes the ground segment particularly challenging with LEO constellations is that the antennas are in constant motion, tracking the satellites 24/7 as they move across the sky. Recent advancements in antenna-tracking hardware and software have helped make LEO satellite broadband possible.

17 KDDI. (2022). スペースXの「Starlink」をau通信網で利用開始.

18 Lipscombe, P. (3 November 2022). "Digicel Pacific partners with SES to bolster PNG coverage". *Data Centre Dynamics* (accessed 14 March 2023).



Direct-to-consumer services

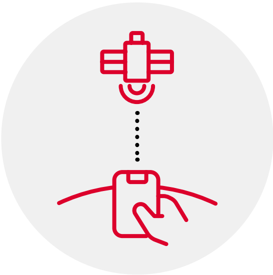
D2C satellite connectivity is somewhat analogous to fixed-line broadband. It is not considered a mobile connectivity solution as it relies on relaying a signal to end users through short-range hops, such as via Wi-Fi. This requires the purchase and installation of user equipment in addition to a connectivity cost, usually in the form of a set monthly subscription fee. Users need to be near the equipment to receive a signal.

Humanitarian organisations have been using D2C satellite connectivity for their own connectivity needs for a while. For example, Inmarsat's Broadband Global Access Network (BGAN) has long been a mainstay of humanitarian communication in hard-to-reach locations. Today, this system enables simultaneous voice and data communications globally from small and lightweight satellite terminals.[19]

There have been several relatively new entrants to this space, leveraging LEO constellations and shifting the ways in which D2C models could help close some humanitarian coverage gaps. For example, there are stories emerging of Starlink terminals, where they can be accessed, being used to bridge connectivity gaps in conflict-affected areas of Sudan.[20] OneWeb has also showcased how their two mobile user terminals can bring connectivity on the move during emergency situations.[21]

While these models continue to be valuable for connecting responders and providing hot spot-style connections for crisis-affected communities, their suitability for providing humanitarian coverage at scale remains in doubt. As each connection to a household requires the purchase and installation of user equipment, alongside monthly subscription fees, it remains a costly solution.

19 Inmarsat. (2021). *German Red Cross: Emergency Exercise Case Study*.
20 Rawh N. (4 March 2024). "'We are on the edge': Communication blackout thwarts mutual aid efforts in besieged Khartoum". The New Humanitarian.
21 Eutelsat/OneWeb. (2023). "OneWeb demonstrates low-Earth-orbit offering and global connectivity solution to humanitarian community in Geneva".



Direct-to-device services

Satellite D2D services provide connectivity direct to a mobile phone, eliminating the need for receivers or additional access network equipment (such as a traditional base station). At the time of publication D2D only exists in the US as a trial service, however several MNOs and satellite groups are working in partnership to deploy D2D services in the future. In Sub-Saharan Africa, for example, AST SpaceMobile has deals in place with Vodafone and Orange.

D2D solutions are not new. Handsets capable of satellite communication have been in use since the late 1990s, commonly referred to as “satellite phones”. However, their cost, limited functionality and subscription service models have generally limited their use to specific and specialised applications, such as by humanitarian organisations in remote rural locations.

Recently, there has been a wave of interest in satellite D2D solutions using mobile satellite services (MSS) spectrum. This was made widely available by Apple, in partnership with Globalstar, with the launch of the iPhone 14 in 2022. Other smartphone makers are likely to follow suit. These devices are currently limited to emergency SOS functions and two-way messaging, excluding voice and data services.

MSS Spectrum only works with specific handsets, which means it will be limited to the premium segment of the smartphone market for at least the next few years. This makes it largely unsuitable for providing mobile coverage in locations where communities may only have access to more basic handsets.

The next wave of innovation in D2D technology will include solutions using MNO spectrum. This means that satellite connectivity will be able to be integrated in existing networks provided by terrestrial base stations. With future mobile standards releases, any new mobile phone or 3GPP device will be able to connect directly to satellite connectivity without modification. This also means that even those with the most basic handsets will be able to use the network. However, it may take time for this innovation to trickle down to lower priced handsets.

Moreover, specific satellite capacity in appropriate spectrum bands will be required while deployments will also need to overcome regulatory hurdles related to the approved use of MNO spectrum assigned for terrestrial networks.

Commercial services could become available in the US and other advanced markets as early as late 2024, though as with MSS spectrum, these services will be limited to SOS and two-way messaging. The growing number of LEO satellite constellations could enable a wider range of voice and data services by the end of the decade.

The main issue with current D2D services is the need to develop satellite networks in specific spectrum bands, and their current low-bandwidth (SOS / SMS) offering. If D2D satellite capacity develops, it will be able to bring connectivity not just to humanitarian responders but, increasingly, to crisis-affected communities themselves. Depending on global LEO coverage, connectivity could technically become available to all communities on Earth, however it will remain more expensive than traditional terrestrial networks.

High-altitude platform stations and unmanned aerial vehicles

With high-altitude platform stations (HAPS), an airborne vehicle provides connectivity from high in the Earth's atmosphere, whether from an unmanned aerial vehicle (UAV), a balloon or an airship. The altitude of the platform can vary from a few hundred metres to several kilometres. HAPS can offer a good combination of high download speeds, strong upload speeds and low latency. They also have a narrower coverage area than satellites, which can be useful for targeted deployments, such as specific villages or settlements.

HAPS are a more nascent technology than other connectivity innovations in this report, with commercially viable technologies and operating models still in development. Alphabet's now-defunct Project Loon was probably the most famous HAPS project. Loon conducted trials with various MNOs, but only one, Telekom Kenya, was converted to a commercial partnership. Loon's troubles reducing operational costs or forging sustainable MNO partnerships[22] have not deterred several other companies from trying to develop viable HAPS solutions.

Spectrum for high-altitude platforms, both for providing mobile backhaul and also direct access to mobile handsets, has been expanded and harmonised internationally at the past two World Radiocommunication Conferences (WRCs). Local application of these guidelines will allow for the telecommunications element (although the aviation element is regulated separately) of these platforms to operate and coexist safely. Commercial HAPS networks are yet to be developed at scale but are the subject of significant interest from some network operators.

Alongside HAPS, UAVs or drones at a lower altitude acting as temporary mobile base stations can also provide connectivity in crisis-affected areas.

Given that UAVs and their payload need to stay in approximately the same location relative to the ground to provide consistent coverage, bad weather can hamper their effectiveness. Solutions also need to maintain a high level of safety and compliance with air traffic control and regulatory body requirements to operate in many different air spaces.

In 2023, GSMA Foundry supported World Mobile to pilot the use of a tethered aerostat to provide connectivity in rural Mozambique via Vodacom's network. Flying at an altitude of 300 metres, the 25 metre-long aerostat was tethered with a cable to a ground station and provided 2G and 4G connectivity. It was able to provide coverage to an area more than 12 times that of a traditional base station.[23]

The use of UAVs for emergency connectivity is not new. For example, between 2018 and 2020, the GSMA supported Nokia and the Philippine Red Cross to deploy UAVs to provide emergency 4G connectivity.[24] As deployments mature, their ability to provide geographically specific coverage, perhaps to recently displaced communities in a new settlement, could be hugely impactful. However, this will depend on technological innovations, such as improved flying time.

22 Hatt, T. (2021). The end of Project Loon: money talks. GSMA Intelligence.
23 GSMA Foundry. (2023). New Coverage Takes to the Skies. Case Study December 2023.
24 GSMA. (2022). Nokia Saving Lives: Grant Project Lessons and Outcomes.

Partnerships between MNOs and humanitarian or development actors

While technological advances offer significant promise to bridge differences in mobile network coverage for crisis-affected groups, innovative partnerships and financing arrangements between industry and humanitarian or development actors can also unlock progress. These partnerships can be set up in a variety of ways. This report highlights three catalytic, often overlapping, areas these partnerships could focus on: collective positioning; demand creation and aggregation; and innovative de-risking financing.

Collaborative evidence

In humanitarian connectivity discussions, it is often bemoaned that service providers do not recognise the business case of connecting unserved crisis-affected communities. Where they believe there is sufficient demand, humanitarian and development actors can work directly with MNOs to articulate the business case for expanding network footprints to include crisis-affected groups.

One model, which UNHCR calls the “expansion model”, highlights viable opportunities for MNOs to connect communities using their standard technologies and approaches.[25] This may be as simple as communicating the size of a population to an MNO or conducting research to demonstrate the addressable market in a crisis-affected area.

Additionally, partners can provide catalytic funding (linked closely to ‘De-risking’, as discussed later) to support the development of economically viable business models. For example, between 2021 and 2022, UNDP Sudan provided a mobile, modular solar unit to power temporary base stations in refugee hosting communities in Gedaref State for a fixed period.[26] The intention was to test the value proposition of solar powered base stations in low-revenue, crisis-affected sites to increase digital access and reduce OPEX costs through an alternative, cheaper and more readily available energy source.

Where demand may not be sufficient to cover initial CapEx for infrastructure, partners can consider covering it (see also the ‘De-risking finance’ section). In what UNHCR refers to as the “innovation model”, agencies could provide equipment such as base stations donated by a vendor.[27] For example, between 2011 and 2014, USAID donated four base stations to Vodacom DRC that had notably lower OpEx and were better suited to the crisis context.[28] While donations may overcome cost barriers, it is important to note there can be additional technological hurdles as it is essential for equipment to function on the MNO’s existing network infrastructure.

25 Etulain, T. (2020). Collaboration for Connectivity: Digital Access, Inclusion and Participation. UNHCR.
26 UNDP (2023) UNDP Guidance Note: Private sector recovery and development in crisis and post-crisis settings.
27 Ibid.
28 USAID. (July 2014). “Cell towers strengthen security in DRC”.

Demand creation and aggregation

Humanitarian and development actors often create demand for mobile services through their activities, which can create an environment conducive to additional investment in infrastructure.

One model is subsidised services for crisis-affected communities. For example, recipients of humanitarian assistance could be provided with cash or "connectivity coupons" to enable them to use mobile services. Project Isizwe in South Africa, as an example, provides free Wi-Fi in schools and community housing through an innovative model whereby donors cover the costs of a set amount each day, and then tailored tariffs are available when users exceed it. These models address demand-side affordability, but MNOs will likely need longevity guarantees if it is to drive network investment. Beyond connectivity, subsidies from humanitarians can also be used to support the purchase of handsets, which could galvanise demand without the need for prolonged investment.

Humanitarian and development actors could look at models through which they equip recipients of humanitarian assistance with digital skills and knowledge. An understanding of digital services and the ability to use them can create market demand, and humanitarians are often well placed to deliver such programming. For example, a project in northern Uganda that focused on digital skills training alongside the expansion of mobile money agent networks contributed to nearly 12,000 new mobile wallets being opened.[29]

Humanitarian and development actors could also consider how they might aggregate their own organisational spending to support network expansion. For example, as part of a multi-pronged strategy to improve connectivity for refugees in northern Uganda, UNCDF collaborated with MNOs to extend coverage and mobile money services. Through engagement and convening, UNCDF encouraged humanitarian partners to commit to using various mobile money products, both for humanitarian services as well as internal payments such as salaries. This aggregated demand in the target areas, which supported the business case for MNOs to invest in new infrastructure without a requirement for de-risking investments from development partners. Where field offices contract separate communication services, such as D2C satellite, agencies could also consider how they might aggregate these budgets to encourage terrestrial network expansion which would also benefit local communities.

De-risking finance

In situations where commercially viable business models are limited, or where investment is deemed particularly risky, humanitarian and development actors can consider making financial contributions to close humanitarian mobile coverage gaps. Financial contributions can be used to reduce financial risks for MNOs when it is probable that the performance of an investment will be different from expected.

As high-risk investments carry a risk premium, this can directly affect capital costs (i.e. riskier investments are likely to attract higher interest rate payments from lenders). De-risking can therefore be used to reallocate, share or reduce existing or potential risks associated with an investment. While several of the approaches related to demand stimulation and articulation of a business case can be a means of de-risking, in many cases, financial contributions can be incredibly effective.

One way that humanitarian and development actors can financially de-risk a project is to jointly fund initiatives through a blended finance model, using a mix of funding from sources with different, but compatible, interests. A partnership between a humanitarian agency and an MNO could generate commercial returns while also delivering services to the agency's clients. For example, GiveDirectly funded the construction of 10 new base stations in Liberia, enabling them to deliver digital cash (see Box 1).

29 For example: GSMA. (2023). Creating jobs and expanding financial inclusion in refugee settlements: Using an inclusive market systems approach.

Similarly, humanitarian and development actors can offer loss-guarantee schemes. These provide financing in situations where investments fail to deliver certain financial outcomes. In these instances, the guaranteeing entity can agree to cover all or a share of the losses incurred by MNOs when they expand networks that prove to be unviable. Loss-guarantee schemes significantly decrease the risks associated with network expansion and are particularly valuable when the guaranteeing agency has more confidence than the MNO that a new site will become profitable. UNCDF Uganda has on several occasions de-risked MNOs to extend or upgrade networks to cover refugee settlements in the country through last-mile delivery initiatives. This support has catalysed the MNOs to investment in markets they would have otherwise not considered.

Box 1:

GiveDirectly and MTN in Liberia

GiveDirectly launched in Liberia in 2018 with a focus on rolling out mobile money enabled cash transfers,[30] despite some doubts within the local humanitarian sector regarding the viability of mobile money or digitally enabled distribution methods.

The GiveDirectly team is currently focussed on the provision of a three-year basic income (UBI) project in Maryland County, a remote area in the south of the country, in partnership with MTN. The project aims to bring every adult above the extreme poverty line.

GSMA modelling suggests that one quarter of Liberia's population live outside of 3G coverage, with one-in-ten lacking even 2G.[31] In some villages in Maryland County, residents report walking several hours to find reliable connectivity.[32] This posed a challenge to the GiveDirectly team, as they expanded their UBI programme.

Several villages were identified for the UBI programme which were too far from existing cell-towers to allow residents to effectively use mobile money services. It was decided that for the model to work, new towers would need to be built.

Due to the remote and rural nature of these villages, MTN had doubts about the economic viability of new cell-towers if financed purely through a traditional MNO CAPEX model.

Given the necessity of these towers for their project, the transformational potential they had for the villages in question, and to reduce the time individual villagers spent travelling to get coverage, the GiveDirectly team decided to cover the capital costs of building 10 new towers. The towers are now owned by the community, whilst MTN covers the ongoing operational costs of maintaining and servicing them.

In total, GiveDirectly contributed $205,000 to the construction of these towers which brought mobile network coverage to more than 2,400 adults across 21 villages. [33] A cost per person of no more than $85.

A key challenge in this work was the unwillingness of traditional donors to contribute to constructing the cell-sites due to an aversion to using development finance to invest in infrastructure. GiveDirectly was able to leverage their flexible funding – however this will act as a barrier to other organisations who may wish to replicate this model but lack the necessary funding models.

"When I got a gist that GiveDirectly had partnered with the LonestarCell-MTN network and would be in town, I was really happy! I began to imagine how life would be if I could just make calls from my bedroom and no longer worry about who's trying to call me and they aren't getting through"

Maryland UBI programme participant

30 GiveDirectly (2018) GiveDirectly launching in Liberia.
31 GSMA Mobile Connectivity Index, 2022.
32 "The key to #UNI is cell service | GiveDirectly & MTN", 2023.
33 Lukyamuzi, M. (2023) The power of getting a mobile phone. GiveDirectly.li

Conclusion

While the analysis in this report only covers three countries of the many dozens that are currently home to crisis-affected communities, the pilot study data suggests that differences in mobile network coverage for crisis-affected groups is still a problem that must be addressed. While the data needed to broaden this analysis is patchy, it is clear that coverage estimates could be calculated at scale and support local actors to advocate for, extend or upgrade mobile networks.

Over time, technological advances like aerial connectivity solutions will make it easier to close remaining coverage gaps. However, for the foreseeable future, cross-sector cooperation between MNOs and humanitarian and development actors will continue to have a role in ensuring network expansion is equitable for those who need it most.

For our part, the GSMA is committed to continuing gathering this type of evidence for the sector. It will also continue to support stakeholders keen to pursue positive outcomes, under initiatives such as Connectivity for Refugees, as well as directly with partners who may want our support.

Annex:
Technical approach

Calculating differences in mobile network coverage for crisis-affected groups requires generating estimates of network coverage for the total population of a country or region alongside similar estimates for crisis-affected populations. Comparing the two estimates for disparities identifies whether there is a prevailing difference in a location.

Preparing the population data requires creating population "settlements" using georeferenced images with population density data, which for this analysis was sourced from the Global Human Settlement Layer (GHSL).[34] The number of settlements is limited to those with more than 10 people, in part to streamline the analysis but also because extremely small settlements may reflect a degree of measurement error in the population data. Then, along with data related to crisis-affected communities, this data is used to create two population maps: one for the general population and one for crisis-affected populations.

In the second step of data processing, coverage differences are calculated for individual settlements. The approach used to calculate the difference depends on the type of coverage data (see Table 1).

Data sources

This analysis required the GSMA team to identify a range of suitable data sources to generate estimates of network coverage, national population distribution and crisis-affected population distribution.

34 See https://ghsl.jrc.ec.europa.eu/data.php

Mobile coverage data

A key element of the pilot analysis was to compare outputs from a range of coverage data sources (Table 4) to understand their effects on estimates and to identify the minimum data standards necessary for future work. This was primarily because the most reliable data source, the GSMA Mobile Coverage Maps, are not widely available and increasingly out of date.[35]

Table 4
Connectivity data

GSMA Mobile Coverage Maps	This was generally considered to be the most accurate coverage data available, as it is based on MNO-provided cell site locations and applying a consistent radio propagation model. It was available for 17 African countries, though some of the maps are more than three years old at the time of analysis. The maps for the three study countries were sourced based on the following dates: 2022 for Nigeria, 2020 for DRC and 2020 for Burkino Faso.
Ookla Mobile Network Performance Maps[36]	This open data provides an extensive view of network performance from the world's largest source of crowdsourced network tests. As it is based on Ookla users running network performance tests, it may be limited in areas with low smartphone penetration or a limited number of Speedtest users. The maps for the three study countries were sourced based on data extracted in Q3 2023.
Ookla sites from Cell Analytics[37]	This provides estimated LTE cell site locations based on the triangulation of Ookla Speedtest performance, coverage, and signal measurement data. It provides accurate coverage data in locations with Ookla app users, but will be more limited in areas without crowdsourced measurements. The maps for the three study countries were sourced based on data extracted in Q3 2023.
OpenCellID[38]	This data is based on a publicly available community project that crowdsources the GPS positions of 2G, 3G and 4G cell towers. It provides coverage data where there are project contributors, but not in other locations. The maps for the three study countries were sourced based on data extracted in Q3 2023.
GSMA/Collins Bartholomew[39]	This data is based on network coverage maps submitted by MNOs. This data can be more comprehensive than crowdsourced data, but many maps have not been updated for several years and there may be differences in how MNOs calculate and report coverage. The maps for Nigeria were sourced based on data provided in 2022. We did not use coverage maps for Burkina Faso and DRC, as it was several years out of date.
Ookla Coverage Right[40]	This data is sourced from MNOs and third-party data providers. It has similar considerations as those related to the GSMA/Collins Bartholomew network coverage maps. The maps for the three study countries were sourced based on data extracted in Q3 2023.

35 Due to their age, the GSMA Mobile Coverage Maps will be decommissioned in 2024.
36 See https://www.ookla.com/ookla-for-good/open-data
37 https://www.ookla.com/cell-analytics
38 See https://www.opencellid.org
39 See https://www.gsma.com/coverage/
40 See https://www.ookla.com/gis-datasets

Population data

To conduct this type of analysis, granular location data of crisis-affected populations is required.

The team sought to include data on three population types: those determined as "people in need" (PiN) by a UN Humanitarian Response Plan (HRP), internally displaced people (IDPs) and refugees. However, data was not uniformly nor readily available (Table 2).

The data was based on two 'types' or formats:

- 'Administrative' humanitarian data, where the relevant population is counted by administrative area (e.g. by district or region). For this study, we only used such data if it was available at an ADM3 level, as anything higher would not provide sufficient granularity for the location of crisis-affected populations. The population of each administrative area was then distributed proportionately across the underlying settlements in that area, assuming a similar distribution as the wider population. This approach has the advantage to allocate humanitarian population only to places where populations settlements exist (instead of a blanket distribution across the area). However, an error may be introduced by making this allocation across all settlements, instead of only to those where the crisis-affected populations live.
- 'Points' humanitarian data, where the longitude and latitude references are provided for each humanitarian data point (for example a refugee site). The humanitarian data in each point location is assigned to the closest settlement by geographic distance. This approach assumes that the humanitarian population is evenly distributed in the settlement, which is more realistic than a single point in the map. However, this may introduce an error for large settlements where the humanitarian population might be concentrated in smaller parts of the settlement. It is also possible that for some locations, humanitarian populations do not live in (or are not close to) general population settlements, for example refugee camps.

Going forward, the preferred data for crisis-affected populations would be georeferenced across the relevant geographic area, rather than a single 'point'. However, this can be challenging to identify and measure in many countries.

Table 5
Humanitarian population data

	People in need	IDPs	Refugees
Burkina Faso	UN OCHA: 2023 Humanitarian Needs Overview data (via HDX)	CONASUR: Situation des PDI par communes accueil du 31 mars 2023	UN OCHA: 2023 Humanitarian Needs Overview data (via HDX)
DRC	UN OCHA: 2023 Humanitarian Needs Overview data (via HDX)	CMP/IOM/UN OCHA: Displacement - Déplacé - Site Assessment, July 2023 (via HDX)	No suitable, geographically disaggregated data on refugees available
Nigeria	The UN OCHA 2023 Humanitarian Needs Overview data is not suitably geographically disaggregated for use	International Organization for Migration (IOM): DTM Nigeria Baseline Assessment Round 43, July 2023 (via HDX)	No suitable, geographically disaggregated data on refugees available

Geographically disaggregated data available and suitable (green)
Geographically disaggregated data available but not suitable (orange)
Geographically disaggregated data unavailable (red)

Calculating mobile coverage

Burkina Faso

Different coverage data sources produced different estimates of national network coverage (Table 6). The most accurate coverage data available was the 2020 GSMA Mobile Coverage Map data as it was based on MNO-provided cell site locations. This data also produced the highest estimates for each technology generation, suggesting that other sources tended to underestimate coverage, particularly those based on crowdsourced platforms. It's also worth noting that even the Mobile Coverage Maps also underestimate 3G and 4G coverage due to operator deployments in the past three years.[41]

It is encouraging that despite different sources of coverage data producing different estimates in aggregate, they each provided much closer results when comparing the coverage differences between national and crisis-affected populations (Tables 7-9). This suggests that alternative coverage data sources can be used to estimate the overall coverage difference between crisis-affected populations, which is one of the main objectives of the humanitarian coverage mapping exercise.

Table 6
National mobile coverage estimates for Burkina Faso

	Mobile Coverage Maps	Other sources
2G	98%	52% to 97%
3G	64%	40% to 63%
4G	46%	13% to 34%

Table 7
Estimated difference in mobile coverage for IDPs in Burkina Faso

	Mobile Coverage Maps	Other sources
2G	0%	0% to 2%
3G	7%	0% to 5%
4G	-6%	-10% to -4%

Table 8
Estimated difference in mobile coverage for PiN in Burkina Faso

	Mobile Coverage Maps	Other sources
2G	0%	-9% to 0%
3G	-4%	-8% to -10%
4G	-12%	-15% to -12%

Table 9
Estimated difference in mobile coverage for refugees in Burkina Faso

	Mobile Coverage Maps	Other sources
2G	+1%	2% to 15%
3G	+19%	18% to 25%
4G	+16%	-9% to 12%

41 GSMA modelling suggests national 3G coverage may now be closer to 70% and 4G coverage may now be closer to 60%. See: GSMA Mobile Connectivity Index, Burkina Faso.

DRC

Different coverage data sources again produced different estimates of national network coverage (Table 10). As with Burkina Faso, the research team had most confidence in the quality of the 2020 GSMA Mobile Coverage Map data. Whilst it is more than three years old, current modelling estimates indicate it is still broadly accurate due to the lack of coverage expansion in recent years.[42] Similarly to Burkina Faso, despite different sources of coverage date producing different estimates, they each again provided much closer results when comparing the coverage difference between national and crisis-affected populations (Tables 11-12).

Table 10
National mobile coverage estimates for DRC

	Mobile Coverage Maps	Other sources
2G	81%	44 to 76%
3G	63%	37 to 52%
4G	48%	16 to 35%

Table 11
Estimated difference in mobile coverage for IDPs in DRC

	Mobile Coverage Maps	Other sources
2G	0%	1 to 6%
3G	-7%	-10% to -9%
4G	-1%	-11% to -7%

Table 12
Estimated difference in mobile coverage for PiN in DRC

	Mobile Coverage Maps	Other sources
2G	-7%	-10% to -9%
3G	-11%	-11% to -10%
4G	-10%	-11% to -8%

42 See: GSMA Mobile Connectivity Index, DRC. The estimates presented the Mobile Connectivity are slightly different to the national coverage estimates in this study, as they incorporate other national-level data sources.

Nigeria

Due to the recent inclusion of new data on the expansion of 4G sites, the research team had most confidence in the GSMA/Collins Bartholomew data for Nigeria, which incorporated more up-to-date coverage maps from operators. For both 2G and 3G, the estimate from this data is aligned with those of the GSMA Mobile Coverage Maps, and a higher estimate for 4G. As with Burkina Faso and DRC, despite producing different aggregate coverage estimates[43], the other coverage data sources generally produce similar results in terms of the disparity of coverage between IDPs and the broader population (Table 14).

Table 13
National mobile coverage estimates for Nigeria

	Nationwide		BAY states	
	GSMA/ Collins Bartholomew	Other sources	GSMA/ Collins Bartholomew	Other sources
2G	93%	83% to 93%	61%	46% to 65%
3G	85%	69% to 85%	55%	33% to 46%
4G	78%	15% to 55%	45%	24% to 25%

Table 14
Estimated difference in mobile coverage for IDPs in Nigeria

	Nationwide		BAY states	
	GSMA/ Collins Bartholomew	Other sources	GSMA/ Collins Bartholomew	Other sources
2G	-39%	-38% to -32%	-10%	-13% to 3%
3G	-37%	-38% to -31%	-10%	-10% to 4%
4G	-36%	-33% to -12%	-4%	-11% to 12%

43 Though it is worth noting that the overall coverage estimates perform slightly better for other sources in Nigeria compared to DRC and Burkina Faso. This is potentially because crowdsourced platforms are more widely used in Nigeria, which has higher levels of mobile internet and smartphone adoption.

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