Data Collection and Evaluation

For Universal Service Funds

A Systems Thinking Approach to Universal Service

Universal Service Agency Missions

Tanzania

Universal Communications Service Access Fund

"To **facilitate** access to communication services in underserved areas through project planning, subsidy provision and partnership with sector players in achieving social economic development."

https://www.ucsaf.go.tz/pages/mission-and-vission

Malawi

Universal Service Fund

"to **promote** the availability of services in areas that are marginalised in service provisioning, underserved and unserved communities"

https://usf.mw/about/

Botswana

Universal Access and Service Fund

"to **promote** and ensure universal access to communication services in Botswana."

https://www.uasf.org.bw/about-uasf/

Angola

Fundo de Apoio ao Desenvolvimento das Comunicações

"a) Contribuir para a promoção do acesso das populações rurais aos serviços de comunicações;..."

"a) To **help promote** access to communications services for rural populations;..."

https://www.fadcom.gov.ao/definição

South Africa

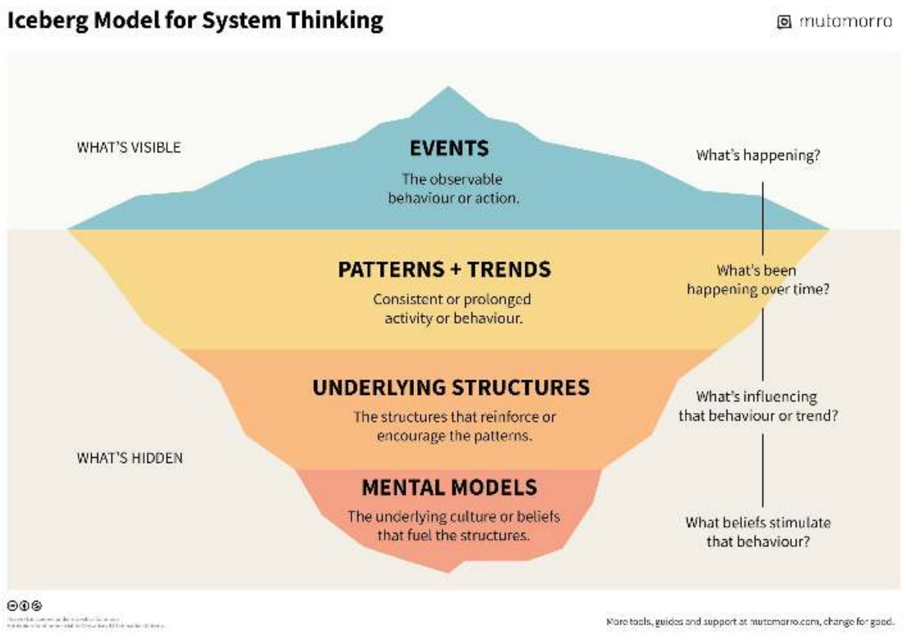
Universal Service and Access Agency

"To **facilitate** the rollout of adequate Information and Communication Technology (ICT) infrastructure to enable universal access to under-serviced areas in South Africa..."

http://www.usaasa.org.za/about/strategic-overview.html

Systems Thinking

Systems thinking is a way of making sense of the complexity of the world by looking at it in terms of wholes and relationships rather than by splitting it down into its parts.



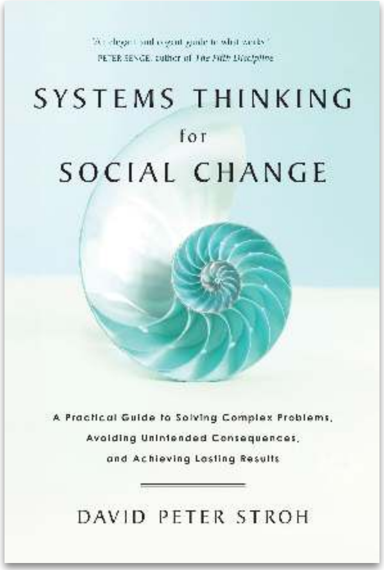
https://en.wikipedia.org/wiki/Systems_thinking

https://mutomorro.com/iceberg-model/

Systems Thinking for Social Change

The ***Systems Thinking for Social Change*** approach embraces a four stage change process:

- Building a foundation for change which focuses on including key stakeholders, establishing common ground and building collaborative capacity;
- Building understanding through systems mapping which invites practitioners in undertaking systems interviews, organizing systems information, developing a preliminary systems analysis and balancing both the complexity of the system while also embracing its simplicity;
- Building support by bringing the system to life involves engaging people in their own analysis of the system, surfacing mental models and creating catalytic conversations; and,
- Making an explicit choice to move forward including understanding the payoffs of the existing system, defining and contrasting the case for change and the case for the status quo, creating both/and solutions, and making a choice or choices to influence the system.



https://bookshop.org/p/books/systems-thinking-for-social-change-a-practical-guide-to-solving-complex-problems-avoiding-unintended-consequences-and-achieving-lasting-results-david-/8758661

Unintended consequences - examples

Systems thinking can reduce the chances of unintended consequences

Subsidies for tower construction that don't end up being operationalized due to:

- High OPEX cost;
- Lack of complementary infrastructure;
- Lack of customer ability to pay;
- Digital literacy issues

Rural wireless initiatives limited by:

- High microwave fees for spectrum;
- Rights of way for wireless AP deployments;
- Vandalism

Public WiFi initiatives:

- Conflicting with commercial Wireless ISPs
- Facing high rights of way costs
- Reduced usage due to lack of social acceptance
- Gender disparities

1. Define the System and Scope

Identify the boundaries and components of the system:

- **Key Stakeholders**: Governments, regulatory bodies, telecom providers, consumers, non-profits, and international organizations.
- **Components**: Infrastructure, regulatory frameworks, funding mechanisms, service providers, technology, and consumers.
- **Geographical Scope**: Local, regional, national, and global contexts.

2. Understand Interconnections & Relationships

Map out the relationships between different components:

- **Regulatory Frameworks and Policies**: How government policies influence telecom providers and funding mechanisms.
- **Funding Mechanisms**: How USFs are collected, managed, and disbursed. Sources of funding, allocation criteria, and distribution channels.
- **Infrastructure and Technology**: The impact of technological advancements on infrastructure development and service delivery.
- **Service Providers**: Their role in implementing services and reaching underserved areas.
- **Consumers**: Their access to and affordability of services, usage patterns, and feedback loops.

3. Identify Leverage Points

Determine where interventions can have the most significant impact:

- **Policy and Regulation**: Advocating for policies that support sustainable and equitable funding models.
- **Operators Types and Size**: Can different business models and / or operator size and scale deliver more affordable access solutions?
- **Innovation and Technology**: Investing in technologies that reduce costs and expand reach.
- **Capacity Building**: Training and support for local communities and service providers to enhance service delivery and adoption.
- **Partnerships**: Explore partnerships with not just the private sector but municipalities, non-profits, other sectoral organisations.

4. Analyse Feedback Loops

Understand positive and negative feedback loops:

- **Positive Feedback**: Increased funding leading to better infrastructure, which improves access and affordability, attracting more users and justifying further investments.
- **Negative Feedback**: Poor management of funds leading to inefficient use of resources, resulting in limited access, higher costs, and dissatisfaction among consumers.

Collecting Data

Identifying Digitally Unconnected Communities

Step 1b: Select a Top-Down and/or Bottom -Up mapping approach

There are two main approaches to begin geographically mapping network infrastructure and access, depending on the geographic scope of the exercise.

The first is **top-down** and involves mapping a large geographic area by accessing secondary data sources and identifying gaps in infrastructure service. This differs from the more granular and localized **bottom-up** approach, which starts with an ex-ante selection of a specific locality and builds an understanding of current conditions through a direct census of residences and physical survey of network assets. Both approaches overlay infrastructure assets and coverage against population density. The figure below differentiates between the two, but a given mapping exercise may take elements from both approaches, accessing secondary mapping of network assets, population density and other relevant infrastructure, and combining it with an on-the-ground survey and census.

Figure 13: Differentiating between two different approaches to mapping unconnected and underserved populations

Top-down approach:

Large geographic areas (national or sub-national) are mapped by accessing secondary mapping data in order to identify infrastructure coverage gaps.
Additional characteristics:

- Data gathered from secondary sources such as national government agencies or third-party aggregators (e.g. satellite data, operator infrastructure, etc.)
- Tends to cover large geographic areas
- May develop a multipronged approach to connectivity interventions beyond a single site/location

Bottom-up approach:

Starts with the specific, targeted locality, mapping local data and testing for different aspects of network infrastructure availability.
Additional characteristics:

- Local mapping (testing network infrastructure available in the vicinity)
- Adding socio-demographic attributes at the local level collected via census
- Includes relevant geographic and environmental conditions

Step 1b: Select a Top-Down and/or Bottom-Up mapping approach

In addition to the two main approaches, there are at least four different types of connectivity maps covering different elements and aspects of connectivity service. Those are Demand Mapping, Infrastructure Mapping, Investment Mapping and Service Mapping and their components are highlighted in the table below.

Table 2: Core mapping content of different types of connectivity maps

Demand mapping	Infrastructure mapping	Investment mapping	Service mapping
• Demand for bandwidth • Quality of service • Willingness to pay • Required services	• Telecommunication structure • Other relevant infrastructure (utilities) • Construction works (roads, buildings)	• Segmenting infrastructure by investment sources • Private / funded • Planned / realized	• Bandwidth & Access Technology (level of service availability) • Provider • Data volume usage, take-up • Price

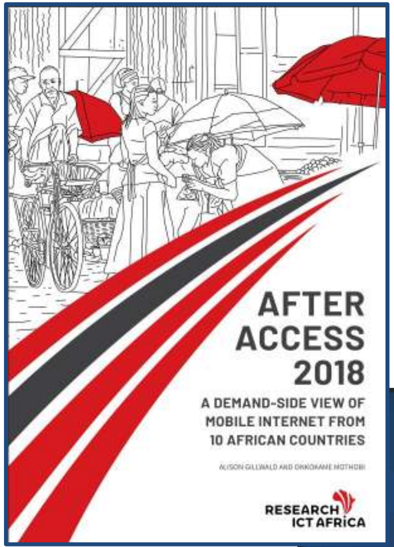
A standard process of map developing can incorporate three stages: 1) Data Collection; 2) Data Processing; and 3) Data Publication. Data collection spans the identification of relevant sources and the appropriate data series to be collected. Data processing involves combining data series and robust quality checks. Data publication encompasses the sharing of data for appropriate audiences at relevant levels.

Table 3: Common process for all types of broadband mapping

Data collection	Data processing	Data publication
Choice of - Data sources; - Information to be collected; - Spatial level of data collection; - Data supply process/frequency	- Quality checks (additional manual checks/ user feedback); - Data conversion; - Additional data spatial integration	Choice of - Data access level; - Spatial level of publication; - Publication format

Source: World Bank, Juan Navas-Sabater

Demand-side Research



Demand-side research into affordable access is arguably the most effectively way to fully understand access challenges but they are also comparatively expensive to undertake.

https://www.zicta.zm/2022_report.pdf

https://researchictafrica.net/publication/after-access-2018-a-demand-side-view-of-mobile-internet-from-10-african-countries/

Step 1b: Select a Top-Down and/or Bottom-Up mapping approach

Once a review of the two overall approaches (top-down and bottom-up) has been conducted, a decision can be made on which approach to pursue, or which elements from both approaches to combine. As the Solutions Guide has been drafted from the perspective of individual communities that are not yet served by accessible and affordable telecommunication services, it will focus on the elements needed in the bottom-up approach. There are, however, many firms and resources (as noted in the description of the top-down approach) that can be contacted for comprehensive support for a top-down approach. The bottom-up approach tends to be more user- and locality-driven. The table below summarizes the pros and cons of both approaches.

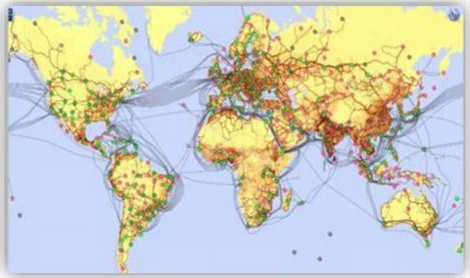
Table 4: The top-down versus the bottom-up approach: pros and cons

	Top-down approach	Bottom-up approach
Pros	• Comprehensive view across a large geographic region • Can identify multiple communities in need of connectivity service support • Can fulfil multiple objectives in robust data gathering and monitoring (service obligations, electrification issues, etc.)	• Able to focus in depth on developing a very granular picture of connectivity for a specific locality that would not necessarily be possible for a large region or many communities • Can be conducted and completed more effectively with fewer resources
Cons	• Resource intensive: time, labour, capital, skills and processing power • May require regulatory intervention to obtain certain datasets • Requires commitment to ensure data validity and accuracy (updating) • May bias intervention approach if the datasets are incomplete (e.g. focusing only on cellular options vs all wireless technologies)	• Reduces the geographic focus to a single or a few communities • Affects only the locality in view, not a country or region • Can also be time- and labour-intensive in the drive to collect as much relevant data as possible

Step 1b: Top-Down Infrastructure Mapping Examples

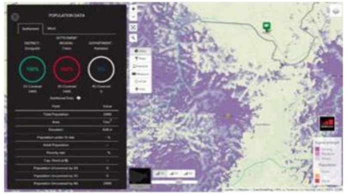
Figure: Top-Down Infrastructure Mapping Examples

The ITU Broadband Map -
https://itu.int/go/Maps



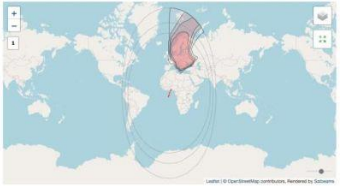
The African Terrestrial Fibre Optic Cable Mapping Project (AfTerFibre) -
https://afterfibre.nsrc.org/

GSMA Mobile Coverage Maps
http://www.mobilecoveragemaps.com/



The Connected Pacific -
https://connectedpacific.org

Satbeams –
https://www.satbeams.com/footprints



Step 1b: Top-Down Infrastructure Mapping Examples

Table 5: Top-down infrastructure mapping: examples

Map name	Geographic coverage	Network type	Publicly available or commercial service	Data downloadable to the public	URL
ITU Broadband Maps	Global	Terrestrial fibre, microwave and undersea fibre	Public	Limited access	https://itu.int/go/Maps
Telegeography Submarine Cable Map	Global	Undersea fibre	Public	Yes	https://www.submarinecablemap.com/ and https://github.com/telegeography/www.submarinecablemap.com
African Terrestrial Fibre Optic Cable Mapping Project (AfTerFibre)	Africa	Terrestrial fibre and undersea fibre	Public	Yes	https://afterfibre.nsrc.org/
The Connected Pacific	East Asia and the Pacific	Undersea fibre	Public	Yes	https://connectedpacific.org
Satbeams	Global	Satellite	Public	Some	https://www.satbeams.com/
GSMA Mobile Coverage Maps	Africa (8 countries)	Terrestrial cellular	Public	No	http://www.mobilecoveragemaps.com/
Masae Analytics	Global	Terrestrial networks and undersea	Commercial	No	https://www.masae-analytics.com/
InfraNav	Global	Terrestrial networks and undersea	Commercial	No	https://www.infranav.com/
Fraym	Africa	Terrestrial networks and undersea	Commercial	No	https://fraym.io/
Towersource (infrastructure)	Global	Terrestrial networks	Commercial	No	https://www.towersource.com/
mapELEMENTS (coverage)	Global	Terrestrial mobile coverage	Commercial	No	https://www.mapelements.com/
OpenSignal	Global	Terrestrial cellular coverage	Commercial	No	https://www.opensignal.com/

Step 1b: Top-Down Infrastructure Mapping Examples - Countries

Table 6: Top-down country mapping: examples

Country	Department	Map type	Open data	URL
Poland	Office of Electronic Communications	Infrastructure	Yes	https://wyszukiwarka.uke.gov.pl/
United Kingdom	Office of Communications (Ofcom)	Mobile service coverage	No	https://checker.ofcom.org.uk/
Ireland	Commission for Communications Regulation (Comreg)	Mobile service coverage	No	https://coveragemap.comreg.ie
European Union	European Commission Directorate General for Communications Networks, Content & Technology (DG CNECT)	Broadband service coverage	Yes	https://www.broadband-mapping.eu/

Step 1c: Mapping Key Elements – Other Network Infrastructure

Table 7: Sources of network infrastructure data

Infrastructure type	Rationale for mapping	Potential sources
Fibre-optic cable routes and PoPs	Signals backhaul availability for high-capacity, lower-cost bandwidth	Fibre backhaul providers, national regulator, ITU Broadband Transmission Maps
Cellular network (coverage and towers)	Signals potential backhaul (fibre- or microwave-to-the-tower) and existing access network availability	MNO coverage maps, national regulator, crowd-sourced data (e.g.: OpenSignal, OpenCellID)
Satellite coverage maps	Identifies whether satellite services cover the area, and what type of service is available	SatBeams: https://www.satbeams.com/; LyngSat Maps: http://www.lyngsat-maps.com/ (see Annex 2 for additional satellite map references)
Wi-Fi hotspots	Signals potential backhaul (fibre- or microwave-to-the-premise) and existing access network availability	Mozilla Location Services and Facebook App
Spectrum rights	Can determine if spectrum bands allocated to given services are already assigned to providers. If yes, then confirmation is obtained that obligations are being met; if no, then potential arises for legally leveraging unassigned (or unused) spectrum.	National regulator, crowd-sourced open telecommunication data tracking (for Africa: https://opentelecomdata.org/spectrum-chart/)

Step 1c: Mapping Key Elements – Socio-Demographic Data

Table 8: Socio-demographic data needed to estimate potential demand for different services

Socio-economic data type	Rationale	Potential sources
Population size	To construct potential base of individual subscribers of connectivity services	Direct survey/census; government datasets; satellite Earth observation data on population density (for example: JRC's Global Human Settlement Layer population, WorldPop – University of Southampton, Landscan – Oak Ridge, CIESIN's Gridded Population of the World (GPW), CIESIN / Facebook High Resolution Settlement Layer (HRSL) Map)
Geographic area for service	The total service area has to be estimated to select viable access technologies	GIS mapping
Per capita income estimates	Signals potential ARPU estimates required for net revenue and financial viability of different services	Direct survey/census; government datasets
Potential customers (anchor tenants: government, enterprise, commercial)	Factors into estimates required for net revenue and financial viability of different services	Direct survey/census
Other revenue sources (e.g. government subsidy or donor funding)	Factors into estimates required for net revenue and financial viability of different services	Direct survey/census

Step 1c: Mapping Key Elements – Constraints on Technology Options

Other geographic elements and infrastructure assets are useful to incorporate in order to capture a more complete picture of opportunities and constraints.

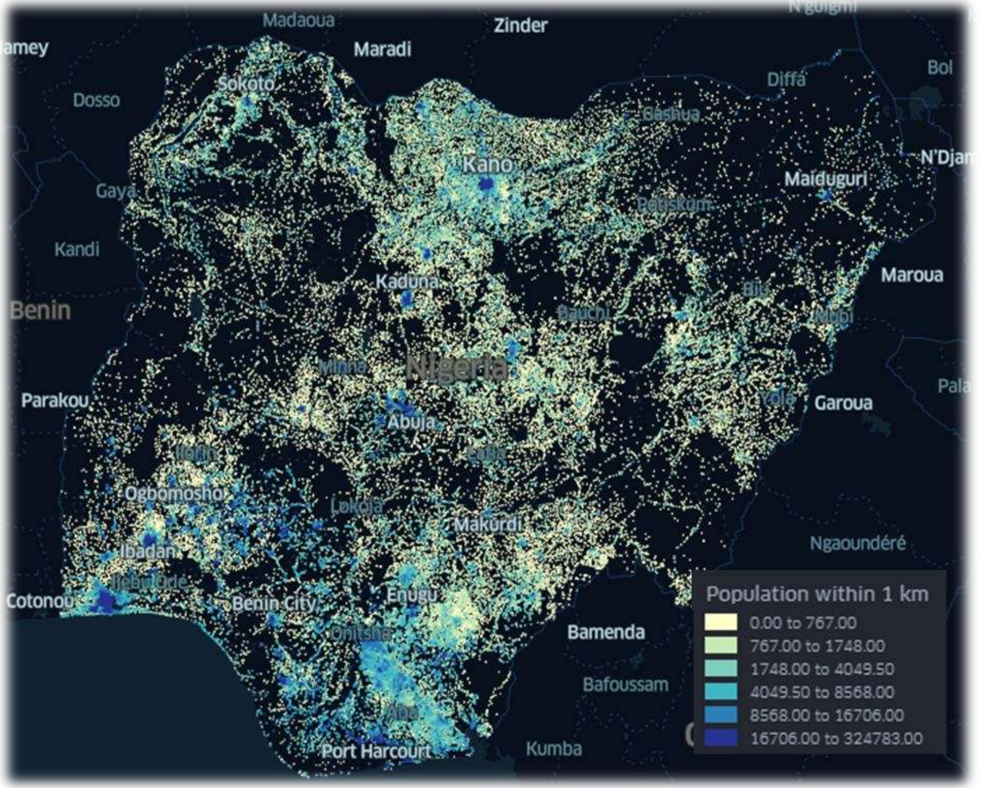
Table 9: Other geographic elements and infrastructure assets to incorporate in order to obtain a more complete picture of opportunities and constraints

Other relevant data	Rationale	Potential sources
Electrification	The extent of available electrical grid infrastructure will determine if additional costs will be incurred for capital (for adding power-generation systems) and operating expenses.	World Bank, World Resources Institute and Facebook have released a new predictive model for accurate electrical grid mapping: https://engineering.fb.com/connectivity/electrical-grid-mapping
Roads	This will help to gauge the locality's accessibility and the sites where infrastructure may need to be constructed.	Open Street Maps (https://www.openstreetmap.org/) or national government transportation agencies
Topography	Important for determining radio frequency propagation. Estimates of network service coverage can be dramatically different when topography and radio frequency propagation are taken into consideration.	A commonly used open-source tool for mapping radio frequency propagation against topographical data is SPLAT (Signal Propagation, Loss and Terrain: http://www.qsl.net/kd2bd/splat.html) Other commercial software exists.
Other risk factors	The community concerned may face above-average risks. For example, for communities in locations that are prone to seasonal hurricanes or monsoons, it may be useful to identify the path usually taken by such extreme weather across the region.	Case-by-case

Is there a demand?

Unconnected population number might serve as a measure of market attractiveness for the ISPs.

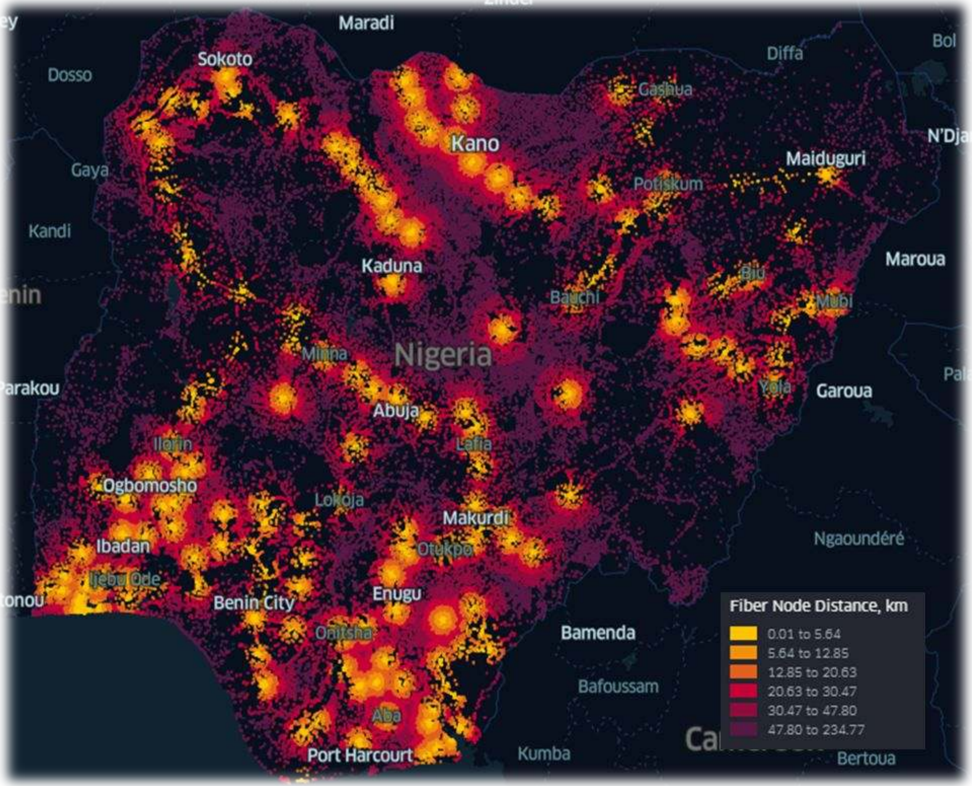
School data: https://africaopendata.org/
DSSGx ITU: [mapping the offline population]()
Population: [WorldPop]()



Schools by population within 1 km around

The state of backbone fiber

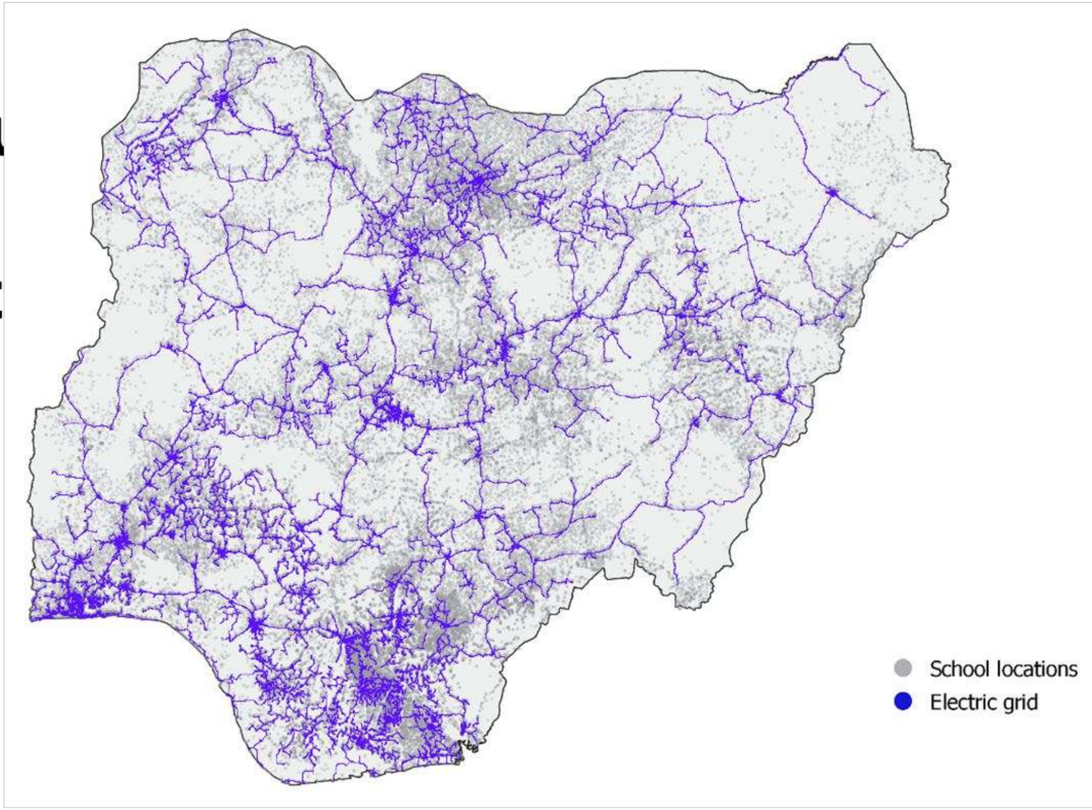
Availability of fiber backbone infrastructure might indicate capability to transmit larger volumes of traffic.



Distances from schools to fiber nodes

Fiber backbone: https://bbmaps.itu.int

The state of electricity, as enabling infrastructu e in school and community connectivit



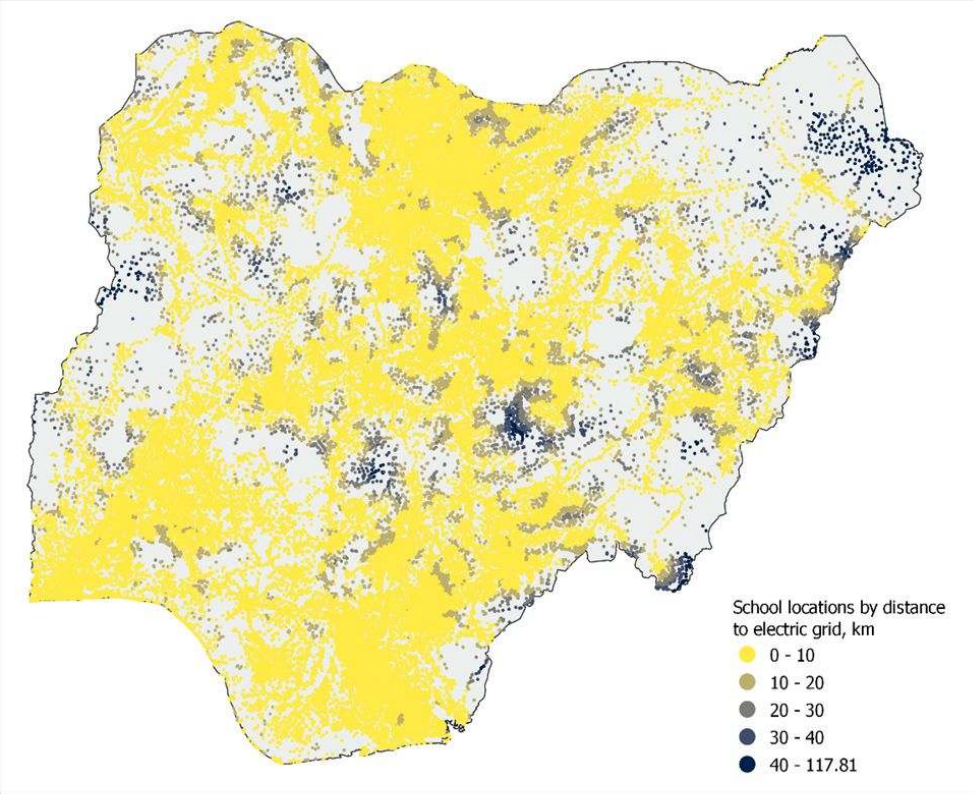
Medium-voltage electric grid

Electric grid: Meta Data for good

The state of electric grid

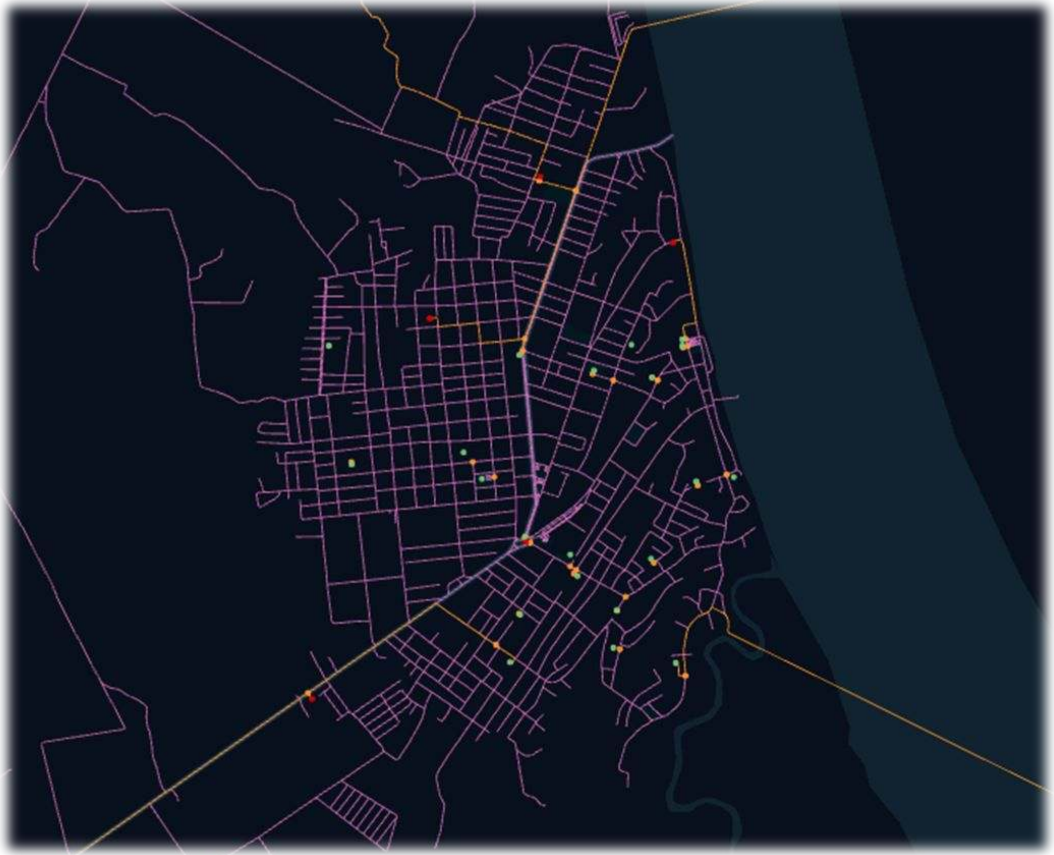
Electrification is a necessary condition for providing connectivity.

Electric grid: Meta [Data for good]



Distances from schools to medium-voltage electric grid

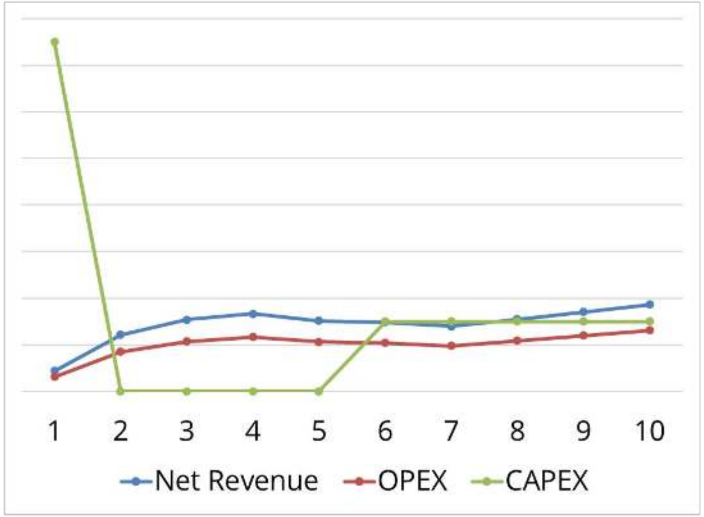
Fiber path model



Road network is used for fiber network planning. It helps us to identify deployment paths and costs.

Business planning.
How much would it cost to close the gap?

- How much is the CapEx?
- How much is the OpEx?
- How much is the potential revenue?



Evolution of Revenues, OPEX and CAPEX (example)

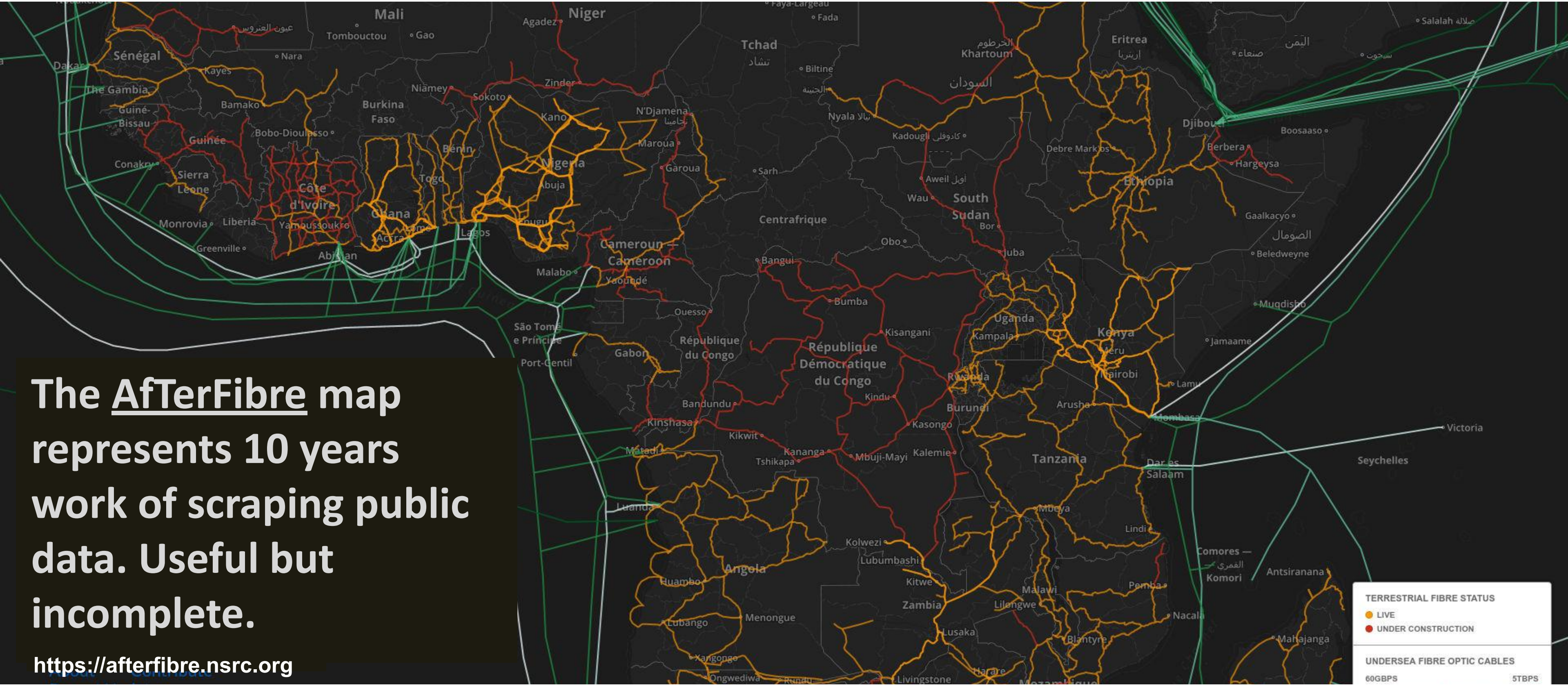
ICT infrastructure business planning toolkit

Open Data and Telecoms

In order to bridge this divide, we need more accurate information about the true extent of connectivity and services. This begins with better information about the infrastructure of access itself. Priority areas include:

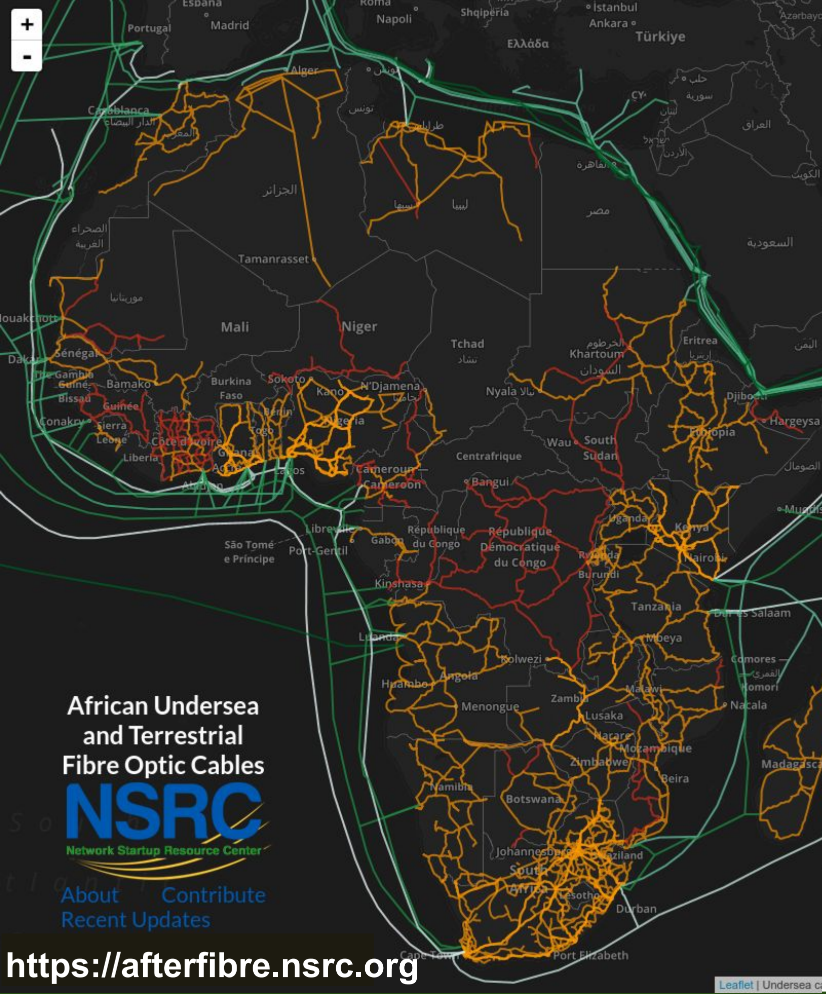
- Fibre Deployments
- Tower Locations
- Spectrum Assignments
- Backhaul Rate Cards

Fibre: crowdsourced map



The [AfTerFibre](https://afterfibre.nsrc.org) map represents 10 years work of scraping public data. Useful but incomplete.

https://afterfibre.nsrc.org



Crowd sourced fibre map

Map compiled via official maps (from some operators), shareholder reports, World Bank studies, and other ‘informal’ sources over 10 years

Probably about 70% complete and many networks require updating

Still useful though

“The Arrival of Fast Internet and Employment in Africa”

2019, Hjort and Poulsen

https://www.aeaweb.org/articles?id=10.1257/aer.20161385

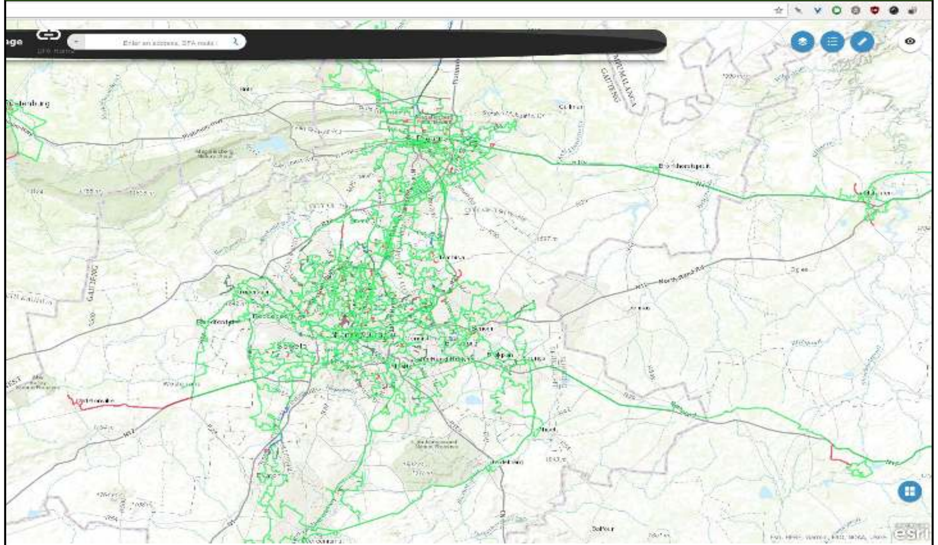
Untapped potential from Open Data

We have only scraped the surface of potential insights from open data in the telecom sector:

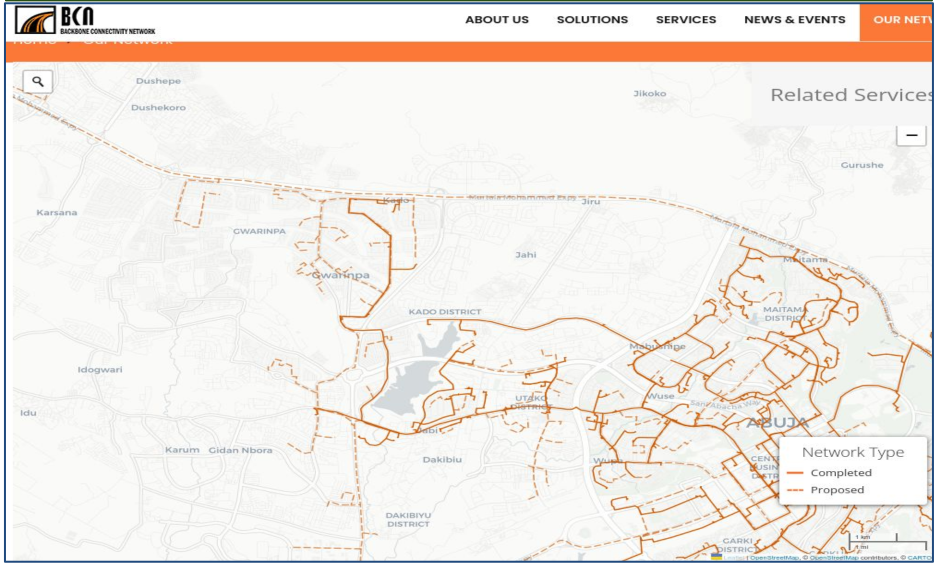
- Poverty indicators
- Climate change
- Redundancy and resilience
- Education outcomes
- Health sector effectiveness

Good practice exists

South Africa: Dark Fibre Africa



Nigeria: Backbone Connectivity Networks



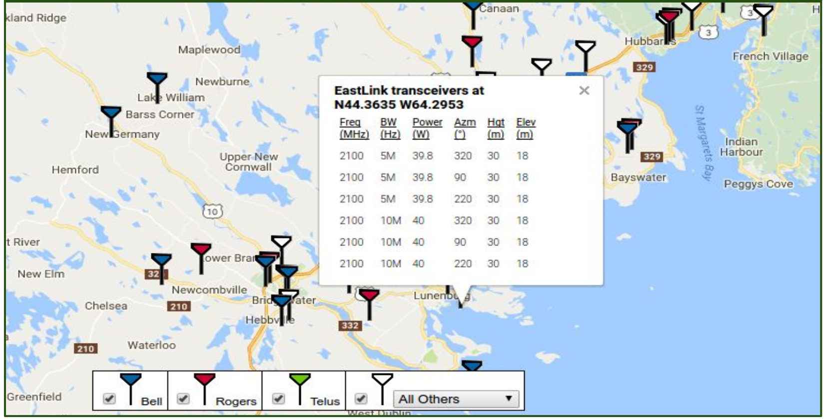
Both Dark Fibre Africa in South Africa and Backbone Connectivity Networks (BCN) in Nigeria publish detailed maps of their fibre networks.

https://www.dfafrica.co.za/network/coverage/

https://bcnnigeria.net//index.php/our-network/

Radio Towers - Governments

Canada

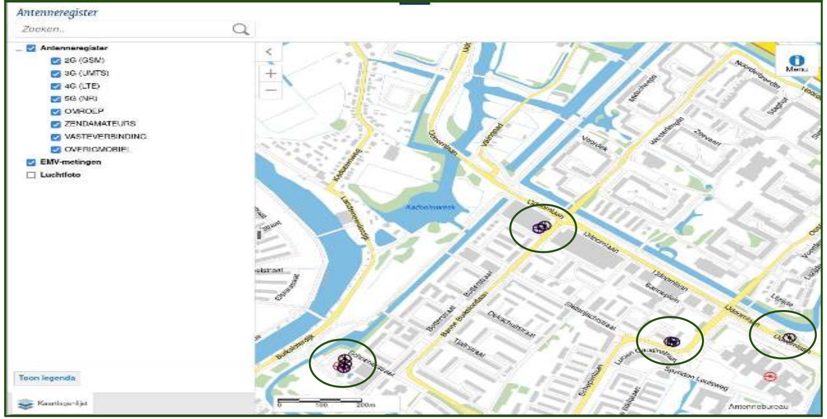


Based on data freely available in CSV format on the Canadian spectrum regulator website. Tower data is available by:

- Operator
- Location
- Frequency
- Tower height
- Antenna Orientation
- Power

http://sms-sgs.ic.gc.ca/eic/site/sms-sgs-prod.nsf/eng/h_00010.html

Netherlands

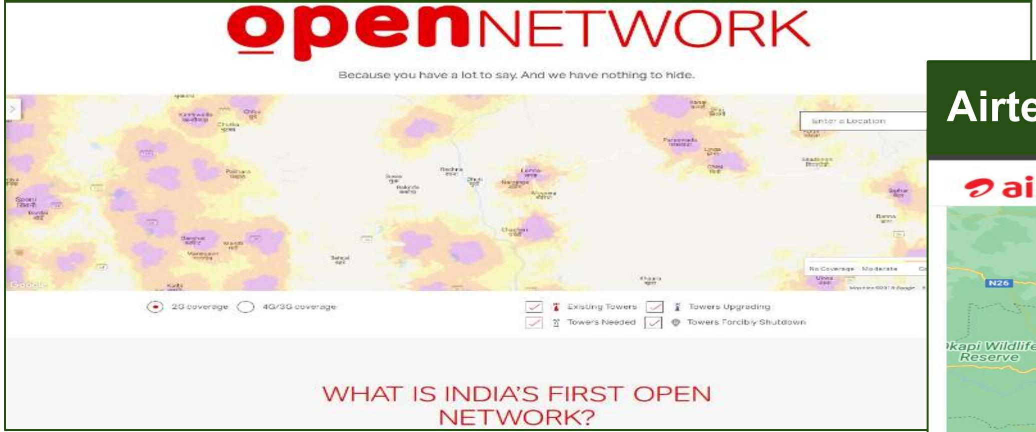


Dutch regulations mandate that any permanently installed antenna installations with a transmitting power greater than 10 decibels Watt (dBW) must be documented in a **public data resource.**

https://www.antenneregister.nl/Html5Viewer/Index.html and https://wetten.overheid.nl/BWBR0027031/2013-03-15

Radio Towers - Commercial Maps

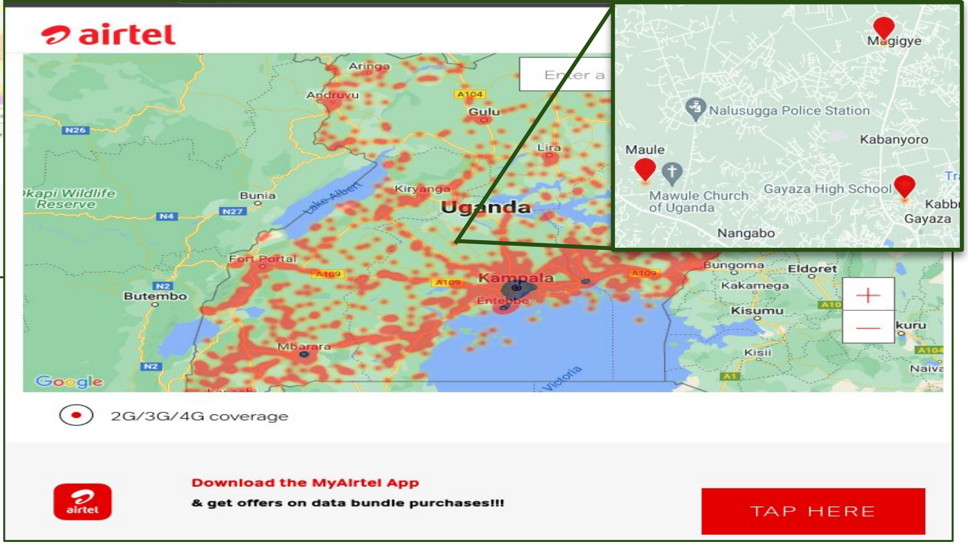
Airtel India



Some commercial operators also publish tower locations. Airtel's motto is "*Because you have a lot to say. And we have nothing to hide.*"

https://www.airtel.in/opennetwork/

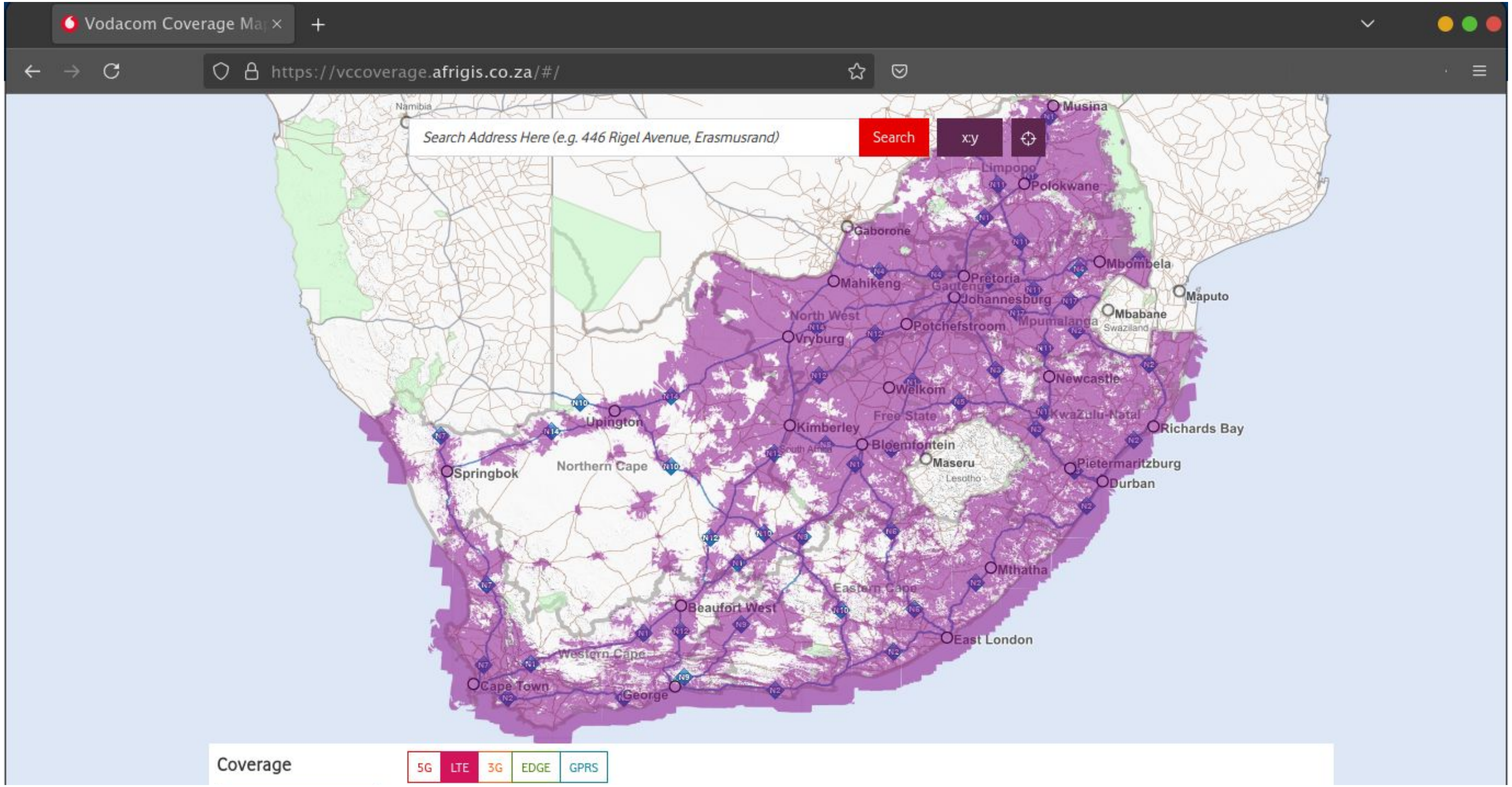
Airtel Uganda



https://www.airtel.co.ug/openNetworks

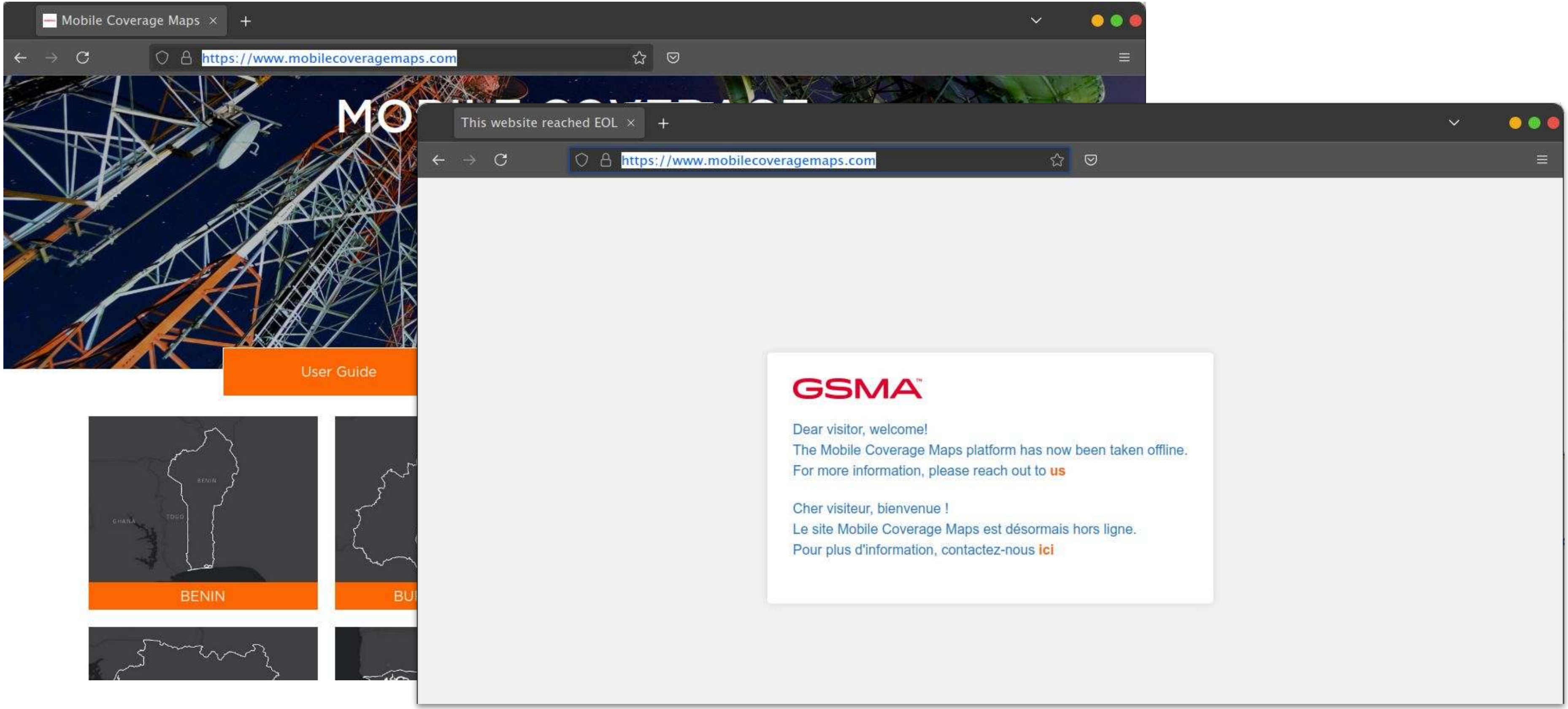
Mobile Coverage - Commercial Maps

vodacom
South Africa



https://vccoverage.afrigis.co.za/

Mobile Coverage - GSMA



Spectrum Assignments

https://ncc.gov.ng/technical-regulation/spectrum/frequency

NCC | About The Commission | Licensing & Regulation | Technical Regulation | Stat & Re

Technical Regulation > Spectrum Administration > Frequency Assignment Tables

Frequency Assignment Tables

For the purpose of frequency allocation, the world is divided into three regions. Nigeria falls within Region 1. Article 5 of the Radio Regulations deal with these frequency allocations which have been made from 8.3KHz to 300GHz. After each World Radiocommunication Conference, reviews to the table are made to reflect additions and modifications resulting from these conferences. It is mandatory for all administrations to adhere to these allocations.

The National Frequency Table of Allocations is a compendium of frequency allocations to services applicable to Nigeria as well as a depiction of frequency usage in Nigeria. The table has been developed and periodically reviewed in conformity with the international regulations governing radio spectrum and the international/ regional agreements acceded to by the Federal Republic of Nigeria in the capacity of the National Frequency Management Council. It conveys the nation's compendium prior to the World Radiocommunication Conference of 2015. The objective of developing and sustaining a National Table of Frequency Allocation is to promote spectrum discipline, increase efficiency and usage.

The Frequency Assignment Tables for the commercial frequencies assigned by the Nigerian Communications Commission are listed below;

Last Update: August 8, 2022

1. 900MHz Spectrum Assignments | Size: 27.57 KB
2. 800MHz Spectrum Assignments | Size: 189.55 KB
3. 700MHz Spectrum Assignments | Size: 202.86 KB
4. 5.4GHz Spectrum Assignments | Size: 227.2 KB
5. 3.5GHz Spectrum Assignments | Size: 204.61 KB
6. 2.6GHz Spectrum Assignments | Size: 211.28 KB
7. 2.3GHz Spectrum Assignments | Size: 227.5 KB
8. 2.1GHz Spectrum Assignments | Size: 41.25 KB
9. 1800MHz Spectrum Assignments | Size: 24.31 KB
10. 10.5GHz Spectrum Assignments | Size: 411.63 KB

NCC Nigeria exemplifies of good practice in documenting spectrum assignments

800MHz BAND

CDMA Channel No	CH 1	CH 2	CH 3		
Rx MHz	791 - 801	801 - 811	811 - 821		
Tx MHz	832 - 842	842 - 852	852 - 862		
State Of Operation				GUARD BAND	State Of Operation
LAGOS	MTN	MTN	SMILE		LAGOS
OGUN					OGUN
ONDO					ONDO
OSUN					OSUN
EKITI					EKITI
OYO					OYO
KWARA					KWARA
EDO					EDO
DELTA					DELTA
RIVERS					RIVERS
BAYELSA					BAYELSA
AKWA IBOM					AKWA IBOM
CROSS RIVER					CROSS RIVER
EBONYI					EBONYI
ABIA					ABIA
IMO					IMO
ANAMBRA					ANAMBRA
ENUGU					ENUGU
BENUE					BENUE
KOGI					KOGI
NIGER					NIGER
ABUJA, FCT					ABUJA, FCT
NASSARAWA					NASSARAWA
TARABA					TARABA
PLATEAU					PLATEAU
BAUCHI					BAUCHI
GOMBE					GOMBE
ADAMAWA					ADAMAWA
BORNO					BORNO
YOBE					YOBE
JIGAWA					JIGAWA
KANO					KANO
KADUNA					KADUNA
KATSINA					KATSINA
ZAMFARA					ZAMFARA
KEBBI					KEBBI
SOKOTO					SOKOTO

Backhaul Ratecards

Botswana

PUBLIC NOTICE

CORRECTION OF WHOLESALE PRICES

AS AT END SEPTEMBER 2015

BOCRA

The following are BOCRA approved wholesale prices for BOFINET and BTCL. Wholesale prices refer to prices charged by BOFINET and BTCL to other licensed operators. All tariffs are in BWP excluding VAT. Prices show monthly rental charges for No Contract, 1 Year Contracts and Multi Year Contracts where relevant.

BOFINET

Table 1: IPT *(Internet Protocol Transit)*

Capacity (Mbps)	No Contract	1 Year Contract	2 Year Contract	3 Year Contract
10	12 802	12 162	11 905	11 521
20	25 603	24 323	23 811	23 043
30	38 405	36 485	35 716	34 564
40	51 206	48 646	47 622	46 086
50	64 008	60 808	59 527	57 607
100	123 571	117 392	114 921	111 214
200	244 031	231 829	226 948	219 627
500	590 074	560 570	548 769	531 066
775	888 778	844 339	826 563	799 900
1085	1 215 352	1 154 584	1 130 277	1 093 817
2015	2 180 005	2 071 052	2 027 451	1 962 049

Table 2: IPLC Protected

Capacity	Mbps	No Contract	2 Year Contract	3 Year Contract
E1	2	4 801	4 561	4 441
DS3	45	106 813	101 473	98 802
STM 1	155	351 377	333 808	325 024
STM 4	622	1 327 099	1 260 744	1 227 567
STM 16	2 488	4 870 454	4 661 602	4 538 928

Table 3: IPLC Unprotected

Capacity (Mbps)	Mbps	1 Year Contract	2 Year Contract	3 Year Contract
E1	2	3 200	3 040	2 960
DS3	45	71 209	67 648	65 868
STM 1	155	234 252	222 539	216 683
STM 4	622	884 733	840 496	818 378

Table 9: Point To Point Leased Line more than 250km *(Unprotected)*

Capacity	Mbps	No Contract
STM1	155	42,600
STM 2	310	51,120
STM 3	465	63,900
STM 4	622	76,927
1 Gbps	1024	98,500
STM 16	2488	205,136
STM 64	9952	547,035
10 Gbps	10240	562,874
E1	2	596
10 Mbps	10	2 914
DS3	45	12 865
100 Mbps	100	28 031

WI-FI

Wholesale Wi-Fi is charged at P0.06 per megabyte at a minimum wholesale purchase of 5000 megabytes.

BTCL

Table 10: IPLC Product

IPLC Product	No Contract	2 Year Contract
Wholesale-IPLC 64k 0-50km	1918.82	1726.93
Wholesale-IPLC 64k 51-200km	2 038.82	1834.93
Wholesale-IPLC 64k 201-100km	3 659.82	3 293.83
Wholesale-IPLC 64km 400km	4 317.82	3 886.03
Wholesale-IPLC 128k 0-50km	2 552.72	2 297.45

Table 15: Frame Relay

Frame Relay Product	No Contract	2 Year Contract
Wholesale-Frame Relay 64/0kbps	1 437.20	1 293.48
Wholesale-Frame Relay 64/128kbps	1 627.20	1 464.48
Wholesale-Frame Relay 128/0 kbps	1 790.40	1 611.36
Wholesale-Frame Relay 128/192 kbps	2 712.40	2 441.16
Wholesale-Frame Relay 256/320k	3 307.52	2 976.77
Wholesale-Frame Relay 512/640k	4 595.76	4 136.18
Wholesale-Frame Relay 1024/1152k	6 948.96	6 254.06
Wholesale-Frame Relay 1920/0 k	12 639.50	11 375.55

Table 16: Leased Lines

Leased Line Product	No Contract	2 Year Contract
Wholesale leased line 64k 0-50km.	1192.50	1073.25
Wholesale-Leased Line 64k 51-200km	1 465.45	1 318.91
Wholesale-Leased Line 64k 201-400km	2 017.60	1 634.94
Wholesale-Leased Line 64k>400km	2 043.20	1 658.43
Wholesale-Leased Line 128k 0-50km	1 429.50	1 286.55
Wholesale-Leased Line 128k 51-200km	1 823.85	1 641.47
Wholesale-Leased Line 128k 201-400km	2 392.80	1 936.44
Wholesale-Leased Line 128k>400km	2 697.60	2 157.17

https://www.bocra.org.bw/sites/default/files/Tarrif%20Pdf%27s/CORRECTION_OF_WHOLESALE_PRICES_AS_AT_END_SEPTEMBER_2015.pdf

Benin

BENIN TELECOMS

OFFRE D'INTERCONNEXION POUR LES EXPLOITANTS DE RESEAUX ET SERVICES DE COMMUNICATION ELECTRONIQUES OUVERTS AU PUBLIC

2017-2018

1.4.2 Offre de transit IP au niveau des POP

Capacité (Mbps)	Tarif en FCFA/mois/Mbps
100 à 1000	20 000
Plus de 1000	18 000

Frais d'accès : 500 000 FCFA

Les équipements colocalisés concernés doivent avoir au maximum les caractéristiques ci-après :

Volume (V)	$V \leq 1000\ cm^3$
Poids sur Pylône (P)	$P \leq 5kg$
Consommation en énergie (E)	$E \leq 20kwh/mois$

https://arcep.bj/wp-content/uploads/2018/12/BTI-SA-CATALOGUE.pdf

ECOWAS

WEST AFRICAN STATES

DES ETATS DE L'AFRIQUE DE L'OUEST

THIRTY-FIRST SESSION OF THE AUTHORITY OF HEADS OF STATE AND GOVERNMENT

Article 22: **Publication of a reference interconnect offer**

The reference interconnect offers approved by the national regulatory authority shall be made available on the dominant operators' websites and shall be accessible by a web link available on the national regulatory authority's website.

https://map.ppdu.org/en/

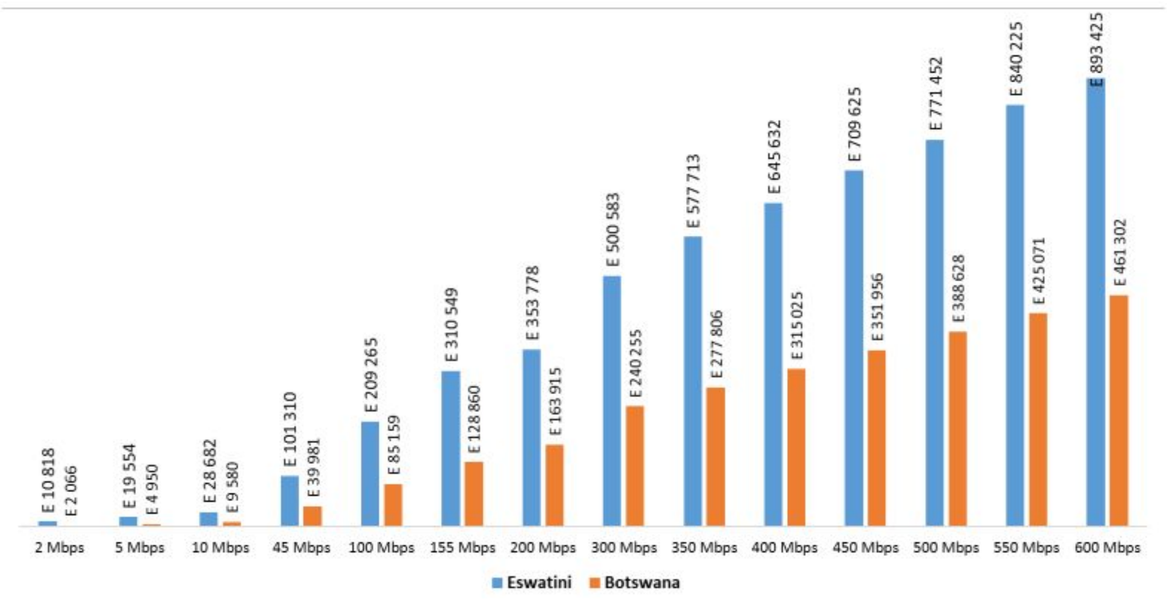
Opportunity for Regional Benchmarking


ESWATINI COMMUNICATIONS COMMISSION

Pricing Benchmark Study

08 September 2020

Figure 27.c : Wholesale Dedicated Internet Monthly Charge



https://www.esccom.org.sz/publications/notices/docs/Pricing%20Benchmark%20Study_Sept%202021.pdf

Impact

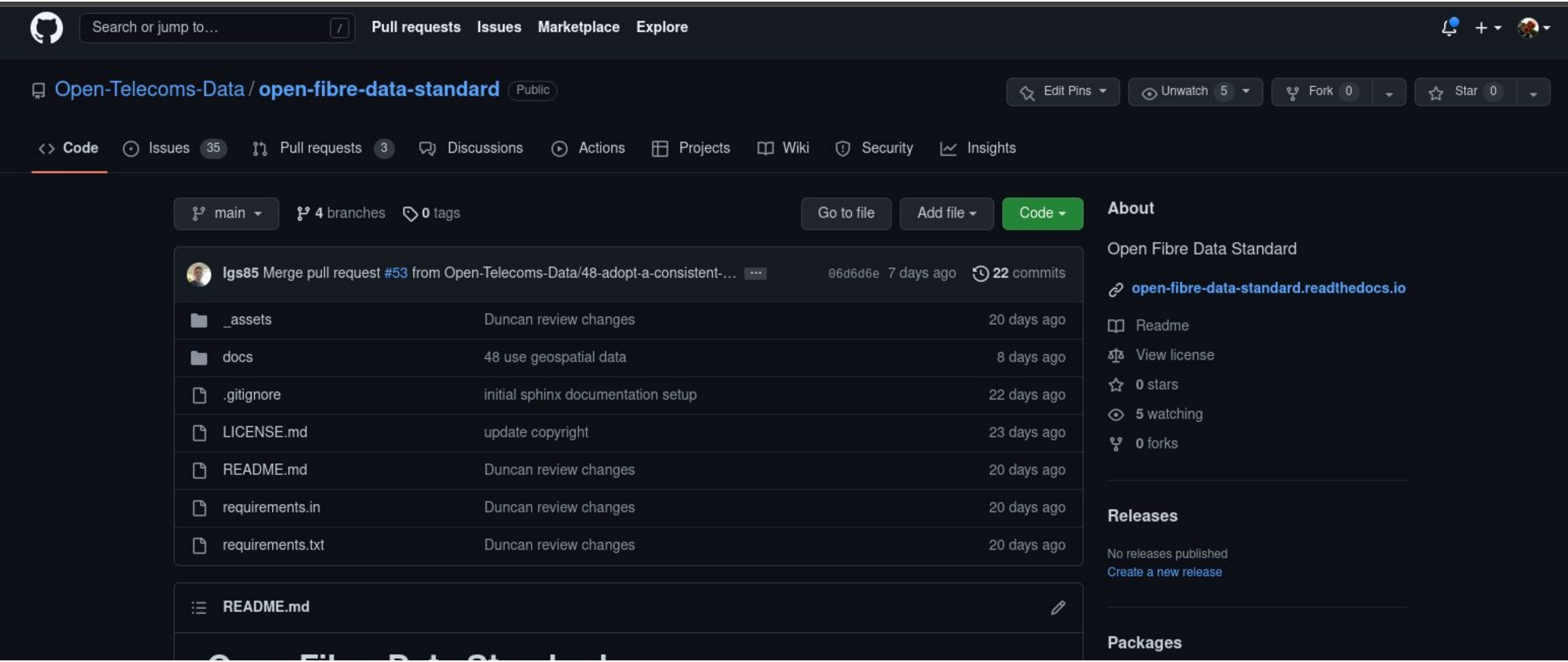
Open Data in the telecom sector will lead to:

- More effective network investments by accurately targeting the unserved. Less duplication of infrastructure investment.
- More coordination across infrastructure sectors: road, electricity, rail, oil & gas.
- Reduction of physical network interruption and destruction.
- Opportunities for small ISPs, rural operators in particular.
- National and regional Benchmarking
- Better coordination with other stakeholders

Multistakeholder initiative

The World Bank, the International Telecommunications Union (ITU), Mozilla Corporation, the Internet Society (ISOC), Liquid Intelligent Technologies, CSquared, and Digital Council Africa are partnering to promote the collaborative development of open data standards for describing telecommunications infrastructure. The first challenge we have taken on is that of terrestrial fibre optic infrastructure.

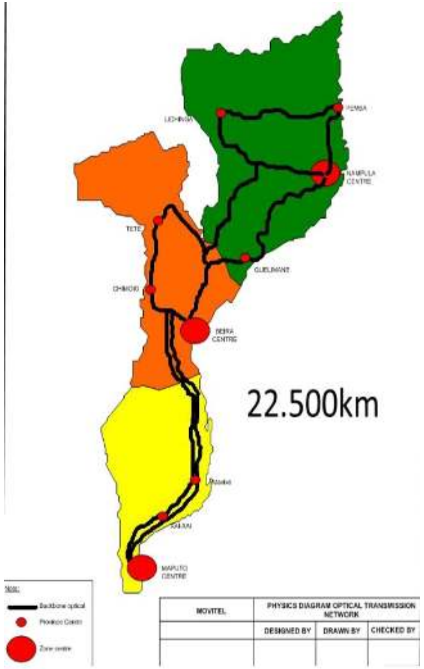
Open Fibre Data Standard



https://github.com/Open-Telecoms-Data/open-fibre-data-standard

National Fibre Optic Backbones

Mozambique

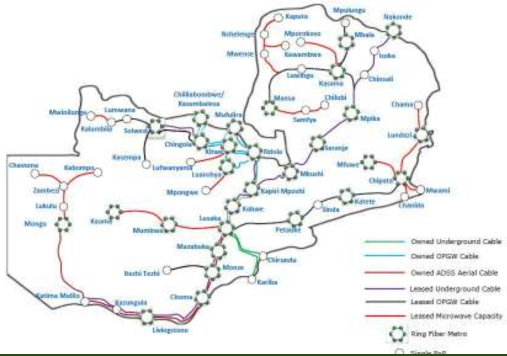


TDM | Movitel | Vodacom

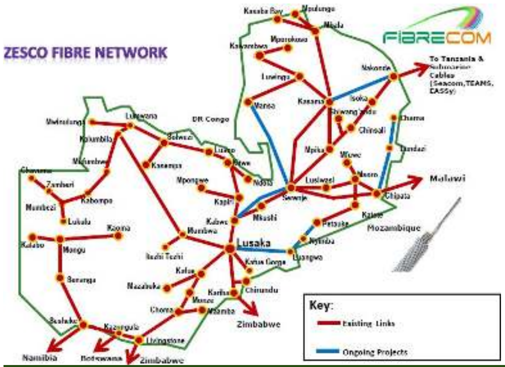
Source: Ministério da Ciência e Tecnologia, Ensino Superior e Técnico Profissional, 2016

National Fibre Optic Backbones

Zambia



Liquid Telecom



ZESCO

Zamtel

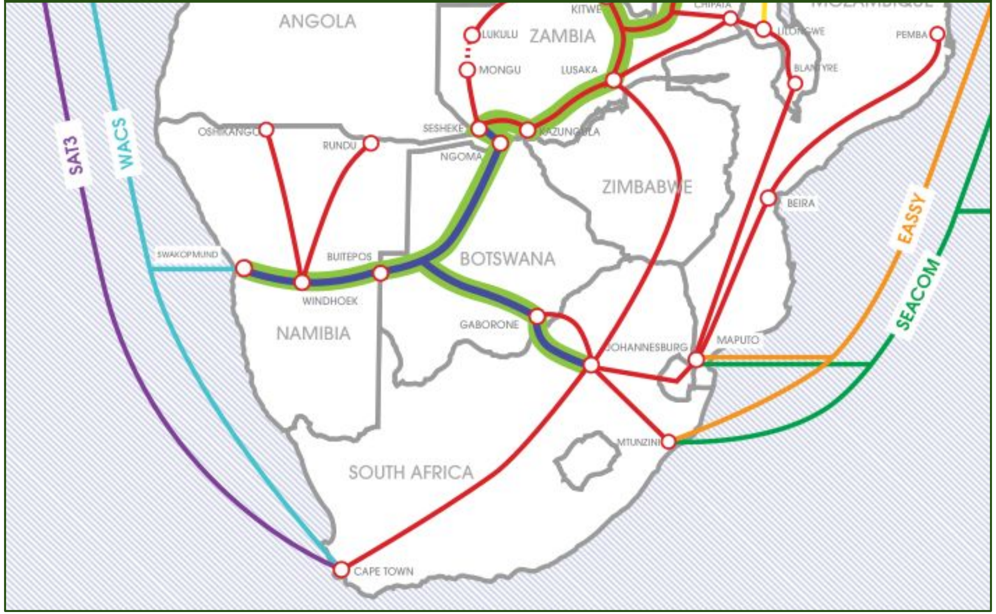
MTN

Airtel

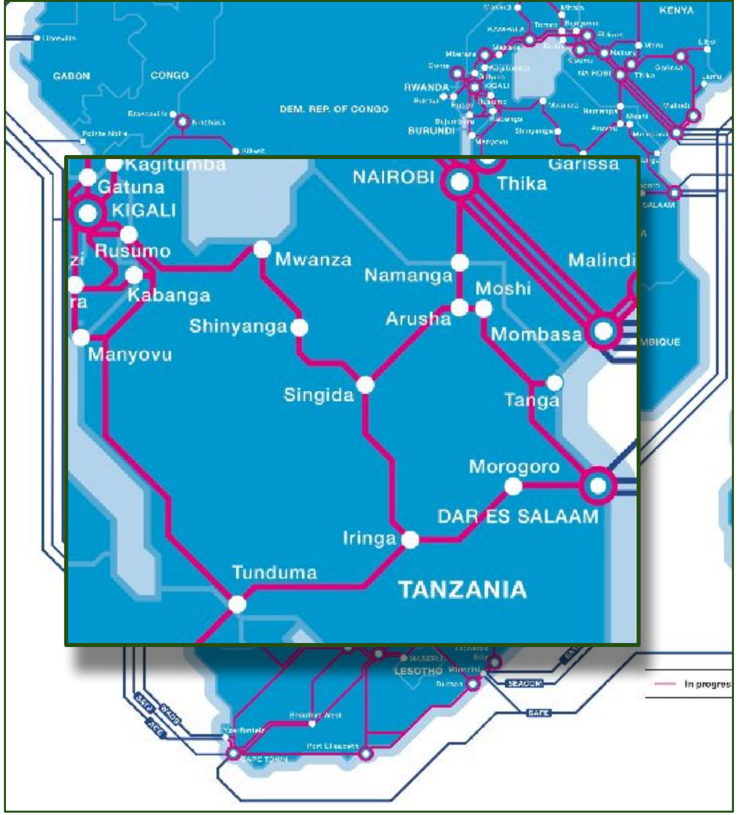
Source: ZICTA Annual Report 2022

Regional Operators

Paratus - TransKalahari Network



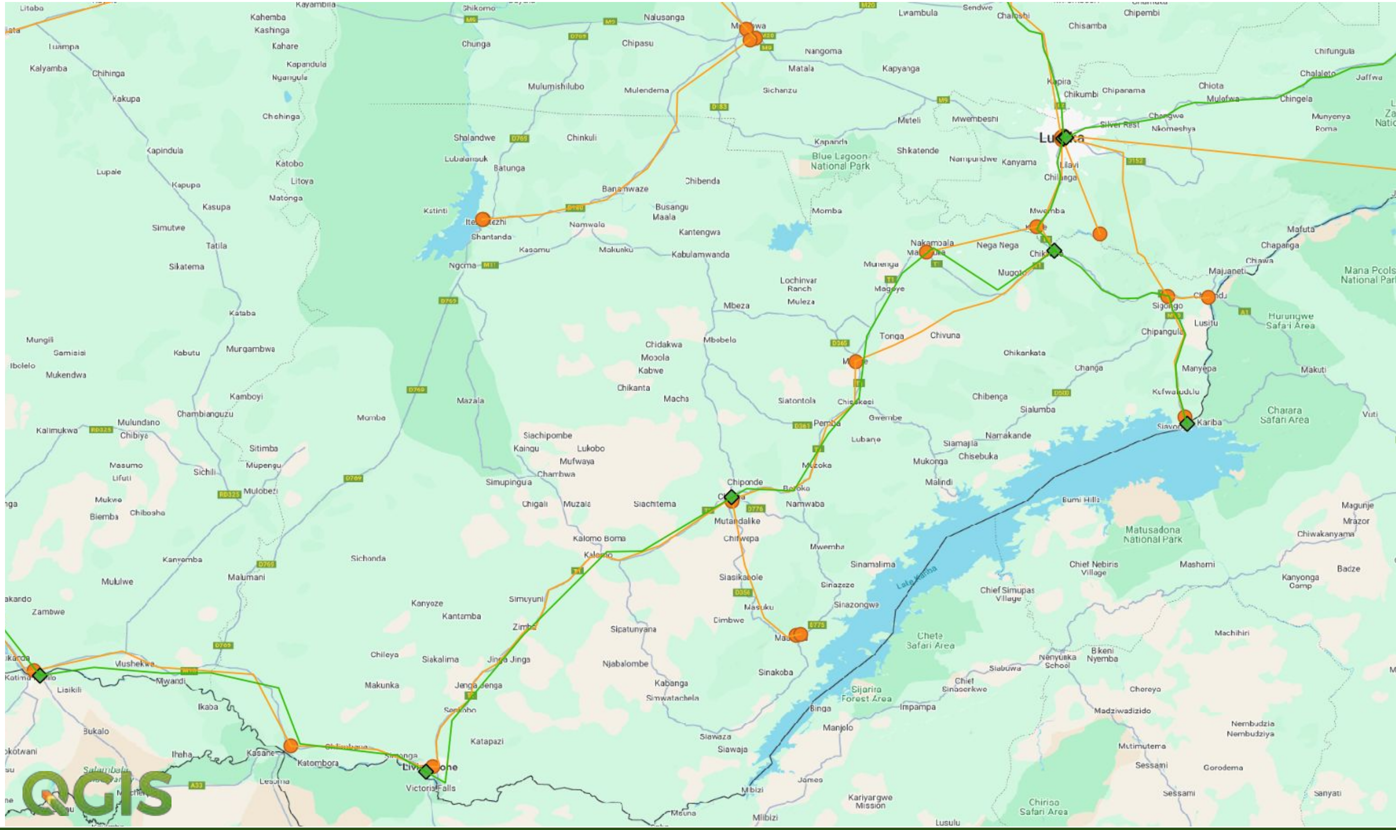
Liquid Intelligent Technologies



Example - Zambia

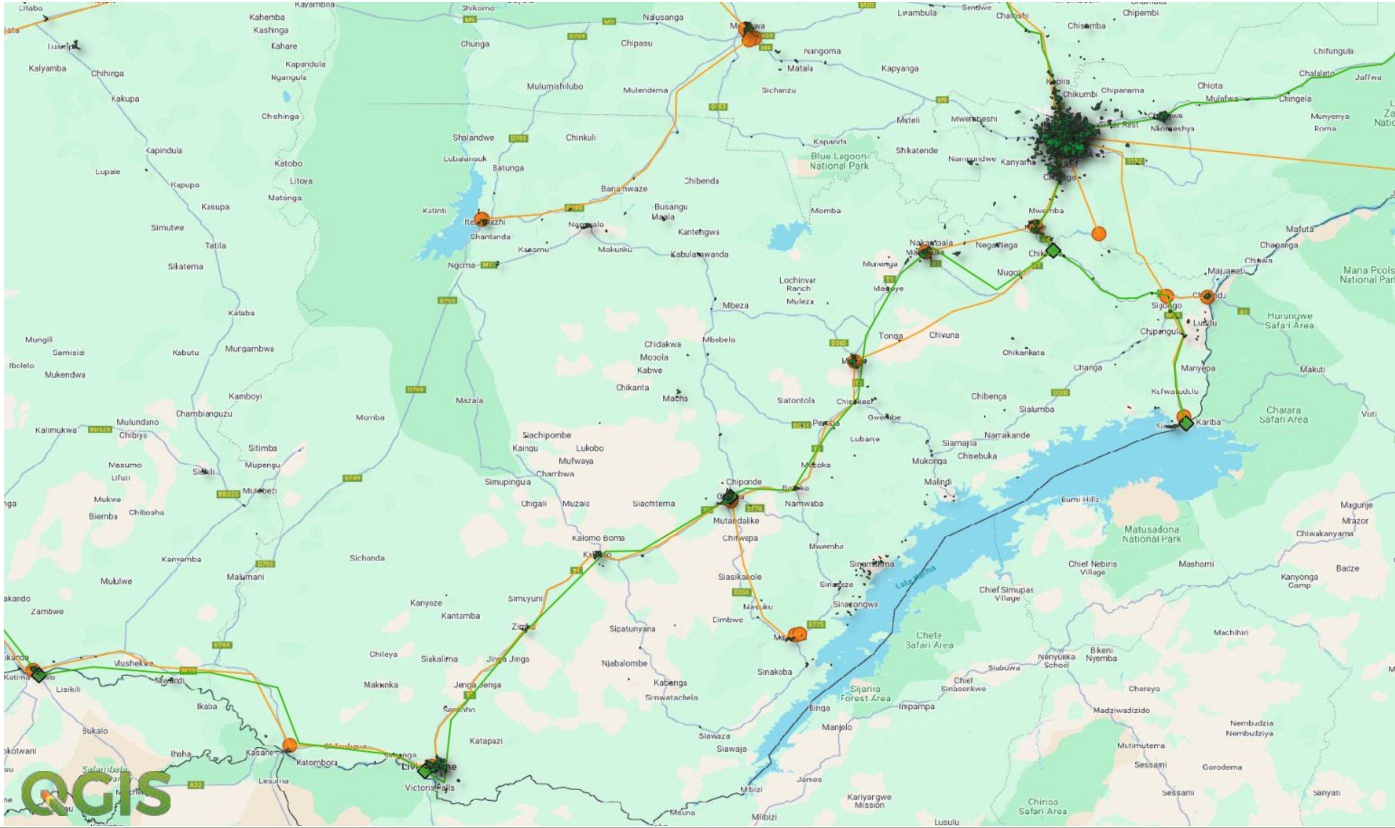
Fibre networks

- Airtel
- ZESCO



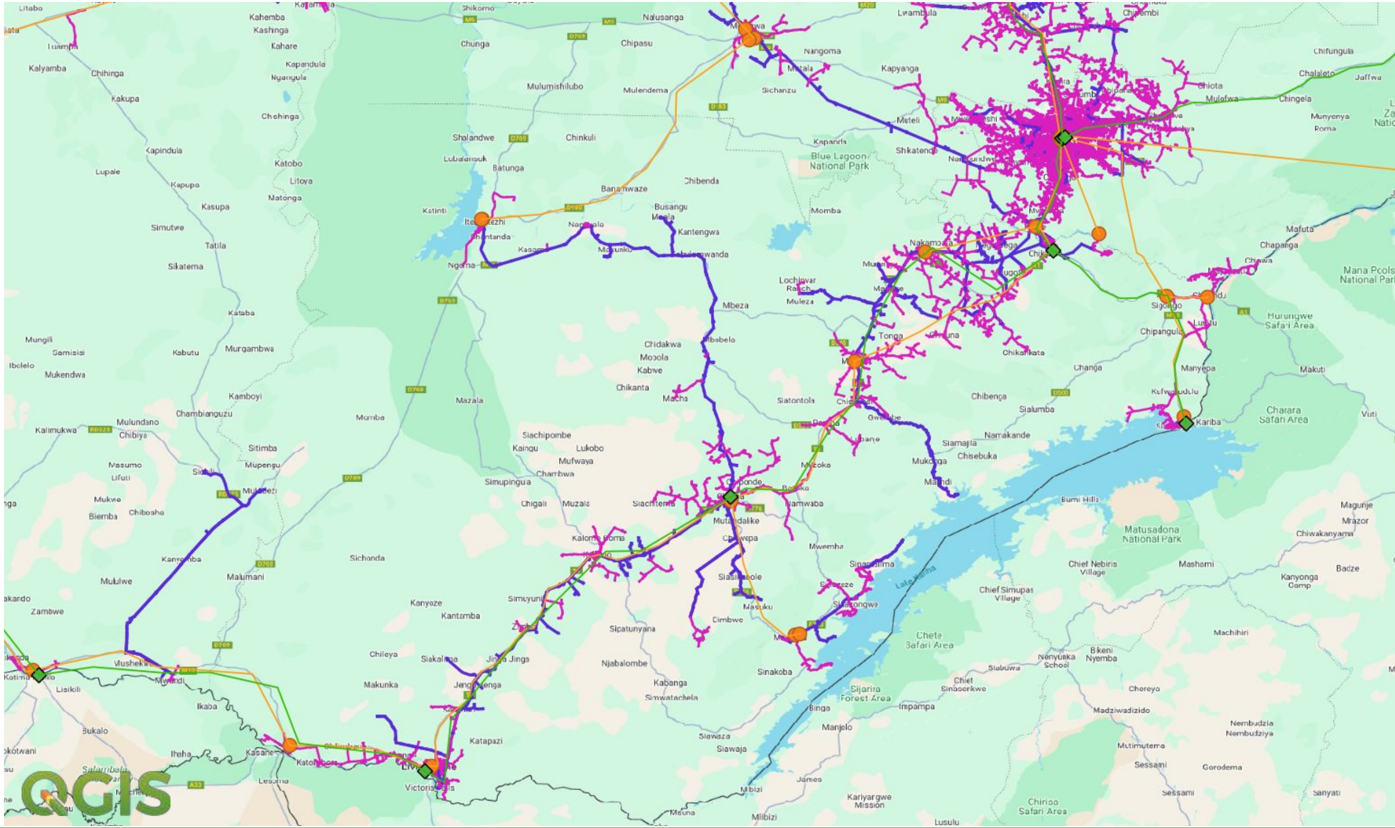
Example - Zambia

Fibre networks and populations over 500 people



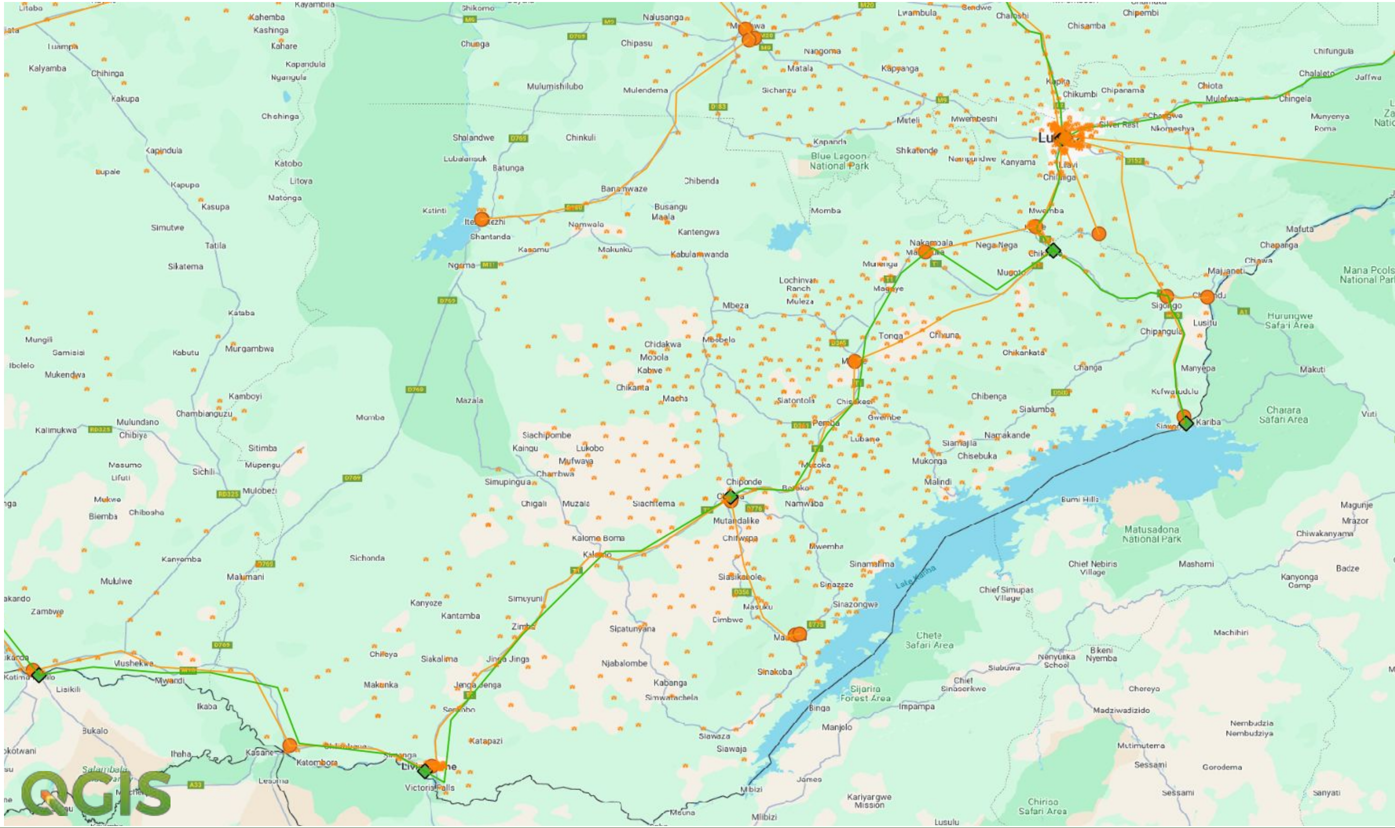
Example - Zambia

Fibre networks and medium voltage electricity distribution



Example - Zambia

Fibre networks
and schools



Understanding demand and supply

Demand and supply modeling

Legend
- User input field (links to demand model)
- CPM characteristics (generated)
- Model outcomes (generated)

Community characteristics

Total potential users	300
Average weekly household income ($US)	$50
Population growth rate	5%
Area (sq km)	5
Location (country)	Indonesia
Users per household	4

User types

Business	5%
Service providers (government)	1%
Households (above median income)	22%
Households (below median income)	73%
SUM to 100%	100%

Physical characteristics

Terrain	None
Vegetation	None

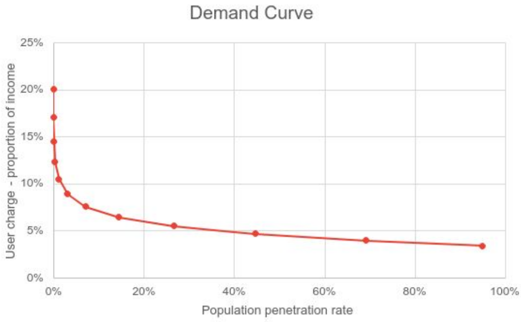
Commercial/economic charactertitics

Technology solution	4G Handset 700 MHz
System Life (years)	10
Required rate of return	2%
Number of towers (range 1-16)	1
Number of sectors (range 1-4)	1
Backhaul solution	Fibre 1G
Expected ratio opex/capex	15%
Target quality Index (Note - not implimented)	1.0
Subsidy as % of capex (access and power $US)	50%
Year 1 traffic requirement (GBs/user/month)	50
CPE cost per household	100
Handset cost per user	0
Annual traffic growth rate	10.00%

Solution outcomes

Access Model Capex per expected user	$224
Annualised access model capex per user	$24.97
Lowest Cost Power System Type	Reliable
Power annual cost per user	$32.60
Monthly average cost of service	$5.21
Additional private costs as per user	N/A
Annual operator earnings	$1,859
Total annual costs	$4,855
Annual EBIT	-$2,995
Population supported	99
Proportion of total users supported	33%

If red, adjust towers and/or sectors so that USERS SUPPORTED >80% and <96% to avoid under-servicing or over-servicing and excessive costs



Community outcomes

	Proportion in population of users (don't edit)	Internet Full Price charged per month	Subsidy	User charge per month	Penetration rate	Number of users	Annual Operator earnings	Annual user payments	Annual user - additional costs	Consumer Surplus ratio	Consumer Surplus	Social to Private Benefit ratio	Total Benefit
Corporate/business	5%	$5.21	$2.40	$2.81	95%	5	$294	$159	$0	#DIV/0!	#DIV/0!	1	#DIV/0!
Service providers	1%	$5.21	$2.40	$2.81	100%	0	$31	$17	$0	#DIV/0!	#DIV/0!	2	#DIV/0!
Households (above median income)	22%	$5.21	$2.40	$2.81	95%	20	$1,264	$682	$0	#DIV/0!	#DIV/0!	0.5	#DIV/0!
Households (below median income)	73%	$5.21	$2.40	$2.81	6%	4	$270	$146	$0	0.00	$0	0.5	$0
Overall	100%	$5.21	$2.40	$2.81	30%	30	$1,859	$1,004	$0	#DIV/0!	#DIV/0!	0	#DIV/0!

Key Factors

- Population distribution
- Power availability
- Access technology
- Ability to pay
- Power requirements
- Device cost
- Terrain
- Backhaul
- Take up

Thank you