



Final v1.0 - 12Dec2020

Sustainable Business Models for a Meaningful Connectivity to Digital Public Goods

Josef Noll (University of Oslo (UiO), Norway), Danica Radovanović (Basic Internet Foundation, Serbia), Jabhera Matogoro (Tanzania Community Networks Alliance), Rashid Ally (Bayama Orphanage and Community Services (BOACSE), Tanzania), Joseph Bishi (Chairman, Community Networks, Zimbabwe), Addisalem Genta (Aambo University, Ethiopia), Catherine Kimambo (African Child, Tanzania), Sarbani Banerjee Belur (IIT Bombay, India), Barrack Otieno (AHERI, Kenya)

Overview

This report summarises the research on **sustainable business models for access to digital public goods (DPGs)**. The [United Nations High-Level Panel on Digital Cooperation](#) established in their report “[The Age of Interdependence](#)” a set of recommendations for increased participation and inclusion in the digital society. This report focuses on the recommendations 1A “access” to digital networks and 1B “Digital Public Goods (DPGs)”, and how the sustainable business can be established to achieve these recommendations.

The report reads as follows: first, it addresses the goals of this work, then, provides a short background, including the commentary on the recommendations from the High-Level Panel for Digital Cooperation. The section also provides how current DPGs are established and distributed.

The second section addresses **scenarios for access and content creation** and building the framework for an assessment. The following chapters 3-5 address examples of **technical architectures answering the need of free access to content in resource-constrained environments**. Chapter 6 concentrates on **mapping digital public goods to access models** and conclusions and **recommendations for the way ahead in providing access to information and meaningful connectivity**.

Table of Content

[Overview](#)

[Table of Content](#)

[Goals](#)

[1. Background](#)

[2. Answering the needs for a meaningful connectivity](#)

[2.1. UNICEF: GIGA and Connect](#)

[2.2 DTCs \(Digital Transformation Centres\)](#)

[2.3 Business models and DPGs \(Digital Public Goods\)](#)

[3. Sustainable business models for internet connectivity](#)

[3.1 Compilation and analysis on connectivity business models](#)

[3.1.1. Operator business model](#)

[3.1.2 A regional driven business model in Zimbabwe](#)

[3.1.3. Community networks business model](#)

[LibreRouter: Open-Source Hardware for Community Networks](#)

[Wakoma \(South Africa\)](#)

[AHERI community-based connectivity model](#)

[Development of a Comprehensive Business Plan for Community Network](#)

[3.1.3. Public Private Partnership model \(4-P Model\)](#)

[Validation of the 4-P model on the ground](#)

[Revenue generation as part of the 4-P model](#)

[3.1.4 Internet Lite business model](#)

[3.1.5 Hybrid business model for connectivity: Picosoft, Nepal](#)

[3.2 Framework basis for connectivity business model](#)

[3.3 Recommendations for business models on connectivity](#)

[4. Business models for content](#)

[4.1 Compilation and analysis of content business models](#)

[4.1.1 Institutional model](#)

[4.1.2. Freemium model](#)

[4.1.3 Donation model](#)

[4.1.4. Public frame contracts model](#)

[4.1.5 Open-source content model](#)

[4.2 Framework basis for provisioning content model](#)

[4.3 Recommendations on way ahead](#)

5. CONCLUSION

Appendix: Ongoing Discussions and Examples

[A.1 Community Network in Tanzania](#)

[A.2 The freemium business model for access](#)

[A.3 Feasibility study of low OPEX for school connectivity in Tanzania](#)

[A.4 Workshop on Sustainable School Connectivity \(February 2020, Tanzania\)](#)

[A.5 Dialogue with UCSAF in TZ on school connectivity](#)

[Realisation of School Connectivity in Tanzania](#)

[A.6 Community Network in Zimbabwe](#)

[A.7 School Connectivity and free access to health and education in Ethiopia](#)

[A.8 Information from South Africa and other countries](#)

[A.9 Satellite connectivity - case study](#)

REFERENCES

List Of Images

- [Figure 1. The LibreRouter view for ubiquitous connectivity](#)
- [Figure 2. Data usage and number of users from traffic data](#)
- [Figure 3. The freemium model for access, with free access to Internet Lite and premium access to broadband content, as an option for bringing the Internet to rural areas](#)
- [Figure 4. TV White-Space link in connecting Base Stations for rural access to Internet](#)
- [Figure 5. Base-station to user connectivity using TV White Space](#)
- [Figure 6. Multilingual Children Stories - Open Source Platform](#)
- [Figure 7. The three dimensions of the National Knowledge Portal for digital empowerment](#)
- [Figure 8. OPEX calculations for a collaborative model on school connectivity](#)
- [Figure 9. School connectivity - locations of schools for affordable OPEX](#)
- [Figure 10. A.8-1: Principle overview over the broadband connectivity by eLearning Solutions](#)

List Of Tables

- [Table 1. Connectivity models overview with costs taken from field work in Africa \(SSA\)](#)

Goals

This paper aims at addressing the following two main goals:

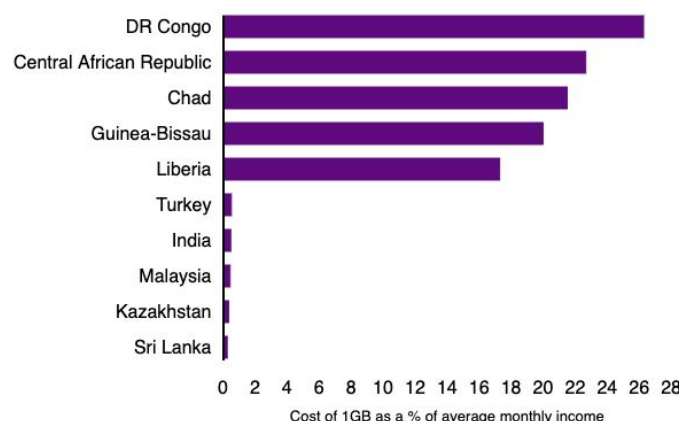
1. **An analysis of state-of-the-art in Sustainable Business Models:** Perform an overview over business models for both access and content.
2. **Recommendations for sustainable access to Digital Public Goods:** Establish recommendations based on the framework for evaluation.

1. Background

Half of the world is still not connected to the Internet, and therefore, has no access to connectivity, digital content and services. A variety of projects, governmental and global initiatives have been established for connecting the unconnected. Though, “affordable access” and digital inclusion is still far from being realized for the people at the bottom of the pyramid.

When the report “Age of Digital Interdependence”, on digital inclusive future, was published on 10/6/2019, the UN Secretary-General António Guterres raised the awareness that governments, academia, and the civil sector should work together on digital inclusion and lessening the various forms of the gap. The UN High-Level Panel on Digital

Cooperation launched its report “Age of Digital Interdependence” with recommendations where the Basic Internet Foundation, with its DigI project efforts around the world was an ideal epitome for Global Digital Inclusion and building Internet access around community needs. This report focuses on the recommendations **1A “access” to digital networks** and **1B forming an alliance for “Digital Public Goods (DPGs)”**, and **how the sustainable business models can be established to achieve the recommendations.**



For many people in the Global South, access costs to the Internet and prices for smart devices are prohibitive, and lock them out from the transformative powers provided by the Internet and smartphones. According to the World Wide Web Foundation, the Internet is considered affordable when a gigabyte of data costs no more than two percent of average monthly income. This is not the case everywhere. In Zambia, for example, 10 mb of daily access on a monthly basis costs \$7. A truck driver in Zambia typically earns \$100 a month. A study by the Alliance for

Affordable Internet (A4AI) shows that the costs of 1 GB in a number of African countries exceeds 15% or even 20% of the average income¹.

Buying a smartphone would be a full one month salary investment. In the industrialized Global North a \$100 smartphone is a small investment. It is not so for the billions of people who make their living in the informal economy in the Global South. The monies earned are quickly consumed in prepaid phones, school fees and for basic necessities, leaving little available cash for internet access and smartphones. For financing, people would turn to microfinance options had it been affordable — formal banking is not an option due to many formal requirements and disinterest from traditional banks to serve the bottom of the pyramid.

Here, we are turning to the **Digital public goods (DPGs) that represent digital products, standards, and the software, data and algorithms that drive them.** They serve to educate us, help us thrive in our professional lives, enrich our cultural experiences, and ultimately do good for the benefit of humankind (DPG, 2019). Examples of these goods exist all around us in the areas of information, education, healthcare, finance, and more. Digital public goods with benefits that potentially extend to all countries, people, and generations. They are public in the traditional economic sense as opposed to private; and global as opposed to national. The global public goods are non-rivalrous and they are non-excludable.

So far, digital public goods imply the following categories: **Software, Standards, and Data and content.** Technologies and content with licensing and design which makes it possible to scale widely, in different contexts, and be adapted for contextual needs. DPG are relevant both on national and international level in regards to digital identity, financial inclusion, health management, and education management.

However, there are challenges and obstacles in DPGs fully deployment and implementation to be solved:

- Limited coverage of Internet connectivity e.g. only 24% of the population in Sub-Saharan Africa use mobile internet²,
- the cost of devices and data,
- lack of literacy and digital literacy skills,
- lack of local language content,
- Lack of stable power,
- Digital gender gap, and
- social norms and safety concerns preventing access to the internet.

Developing countries can benefit from the DPGs technologies offered by this innovation. By implementing the various digital tools and pursuing strategic policies, it will be possible to reach more of the most vulnerable groups in society and those who are left behind. As Minister of Foreign Affairs Ine Eriksen Søreide (Government. no, 2019) said, in developing countries,

¹ Gaius Kowene, "Congo student: 'I skip meals to buy online data', BBC News, Kinshasa 24 November 2019, <https://www.bbc.com/news/world-africa-50516888#>

² <https://www.itu.int/en/ITU-D/Statistics/Documents/facts/FactsFigures2019.pdf>

digital solutions can be used to speed up efforts to achieve the SDGs. With the help of DPGs, the Governments will be able to reach more people in rural areas, people with disabilities, and people living in slave-like conditions. Ms Eriksen Søreide also said that digital tools can for example be used to provide earlier warnings of natural disasters; ensure more effective documentation of the needs on the ground and faster registration of vulnerable people; have a financial and business facilities easier such as make cash transfers faster and more secure; offer technology-based solutions for providing legal assistance to individuals; or secure information and documents digitally before and during a disaster, in order to safeguard the rights of people affected by crises with regard to identity, property ownership etc.

2. Answering the needs for a meaningful connectivity

This section focuses on the need for meaningful access, and provides initiatives and examples of how schools in the Global South are connected. Starting point is **Project Connect and the follow-up GIGA initiative**, with the goal of bringing broadband to the schools.

Thereafter, experiences from the ground are presented, prior to the framework for analysis.

2.1. UNICEF: GIGA and Connect

GIGA is a unique partnership launched by the ITU, the UN specialized agency for information and communication technology and UNICEF, the UN Children's agency. This is an initiative to connect every school to the Internet, and every young person to information, opportunity and choice. GIGA is made up of four pillars - each with connections to—and support from—country governments, technology partners, and leaders across the United Nations (UN).

UNICEF's project Connect is part of GIGA. **The Connect project** aims at mapping the connectivity of all existing schools as a step towards ensuring that every school is connected to fast and reliable internet. Announced during the UN General Assembly meetings in September 2019, project Connect has the vision of this initiative to ensure that every child is equipped with the information, skills and services they need to shape the future they want in the digital era. School connectivity is an essential part to enable the vision.

The 'GIGA' initiative comprises four pillars:

- Map connectivity of every school and use it to show where connectivity demand is, and use new technologies like artificial intelligence (AI) to create a real-time map of school locations and their connectivity level.
- Finance a Common Bid that aggregates connectivity demand in schools (pooled across multiple countries) and creates a cost-forecasting model to make connectivity more affordable.
- Connect every school to the Internet and create a monitoring system to oversee the level and quality of connectivity delivered by service providers (ISPs).

- Empower young people with skills by investing in, and scaling, open source solutions that – with connectivity – will be available to children, teachers, and administrators.

This new Working Group can potentially support GIGA, for example by:

- building compelling business cases that can attract the very high levels of required funding,
- providing access to relevant policy makers and regulators to simplify complex issues like spectrum and licensing,
- creating the right playing field so the initiative is also attractive for industry players

Over the coming year, UNICEF and ITU plan to accelerate the launch of GIGA with a focus on a small number of countries in the first phase.

The power of connectivity and digital inclusion cannot be understated, as being an enabler for economic growth and a critical factor in fulfilling the SDGs, particularly SDG 10: Reducing inequalities, SDG 4: Quality education and SDG: 5 Gender Equality. Telecom operators and ICT agencies play a key role in this mission, together with stakeholders across the public and private arenas.

By leveraging combined strengths and creating partnerships with stakeholders, industries, academia and international organizations, we can succeed in bringing life-changing technologies to the world at scale. **Innovative partnerships to support the work of digital inclusion on a global scale are the essential core to reach out to every community.**

2.2 DTCs (Digital Transformation Centres)

Another **related Digital Skills training initiative is Digital Transformation Centres (DTCs)** by the ITU (International Telecommunication Union). ITU launched the Digital Transformation Centres (DTCs) Initiative in partnership with Cisco in September 2019 during ITU Telecom World held in Budapest, Hungary.

The primary function of DTCs are to **deliver digital skills training to enhance digital literacy and foster uptake of digital tools** among those at the bottom of the social pyramid and to improve livelihoods, and thus, bridge the third level of digital divide. Also, DTCs aim to improve the capacity of policymakers to design and implement digital skills programmes, and further conduct them to ensure **scalability and self-sustainability in digital skills capacity development.**

Ten (10) DTCs have been selected for the first phase which will run for 18 months from January 2020 to the end of July 2021. The 10 DTCs have been selected from Africa (4), Americas (3), and Asia Pacific (3) regions. At the end of the first phase, an open call will be made for more potential DTCs to join the network.

2.3 Business models and DPGs (Digital Public Goods)

The **link between anova business models and DPGs (Digital Public Goods)** in relation to the primary goal of the **free access to the internet and information for all**, ordinales in **two basic sustainable discourses and recommendations**.

One discourse indicates that the **internet and the access to the information is the human right for connecting the unconnected**. Digital divide, as sociological phenomenon creates excluded, discriminated groups who do not have access to the internet, to information, or maybe to the necessary skills for using devices and digital media software. In today's information society, being left on the outside can have a profound effect. Living in the margins without access to information technologies such as the internet, impacts an individual's engagement not only in political and social, but also educational life.

*The digital inequality that reflects in the **lack of connectivity presents the level 1 of digital divide**.*

On January 1st, 2016, the 17 Sustainable Development Goals (SDGs) of the 2030 Agenda for Sustainable Development Officially came into force, proclaiming access to the internet as a basic human right and fundamental to achieving sustainability goals. This presented a rare opportunity to impact billions of lives, and is win-win for all stakeholders: service providers, users, national governments, content providers, and equipment manufacturers.

Higher penetration of internet and ICT bring advantages to everyone in society:

I. Inhabitants gain access to governance, educational and healthcare resources, offering the possibility of socioeconomic improvement for themselves and their families.

II. Digital inclusion is vital for six key sectors in local governments: health, education, financial services, retail, government and agriculture.

III. The impact of broadband penetration on the growth of national GDP is well documented and can range anywhere from 0.9% to 3.6% (ITU, 2012).

IV. Corporations have access to new markets and this leads to more jobs, higher profits, and economic growth. In particular, the value proposition to the operators is significant to grow the number of subscribers, revenues and brand loyalty as a good corporate citizen. Studies have shown that 40% of free internet service users migrate to full paying subscribers within one month of signing up to free service.

All this creates a fertile ground for implementing **the second sustainable discourse and recommendation** as a link between business access models and DPGs (Digital Public Goods), and that is **the formation of the information and knowledge content platform initiatives and alliances**.

The digital inequality that reflects in the lack of the meaningful content and digital skills development presents the level 2 of digital divide.

Those knowledge content platform initiatives and alliances can take a various configurations:

- I. information spot websites and apps,
- II. National knowledge portals,
- III. Open access digital repositories,
- IV. Open data and open source libraries,
- V. Digital literacy skills curricula and training materials,
- VI. Holistic digital transformation centers,
- VII. Multimedia content both online and offline, etc.

This way, through direct collaboration of governments, organizations, and private entities, we are including and supplementing the UN's recommendation 1b to 1a.

And the open source strategies have started to come true on the global level. A recent example, on October 21st 2020, the European Commission approved its new [Open Source Software Strategy 2020-2023 of the Commission](#)³. This is an important step towards achieving the goals of the overarching [Digital Strategy of the Commission](#) and contributing to the Digital Europe programme.

The internal strategy, under the theme "Think Open", sets out a vision for encouraging and leveraging the transformative, innovative and collaborative power of open source, its principles and development practices. It promotes the sharing and reuse of software solutions, knowledge and expertise, to deliver better European services that benefit society and lower costs to that society. The Commission commits to increasing its use of open source not only in practical areas such as IT, but also in areas where it can be strategic. The strategy recognises the importance of collaboration across the Commission, with Member States, companies and the public at large for building new, innovative digital solutions that work across borders and towards technological sovereignty.

In the period to come, we will see how these new open source strategies, along with the continuous recommendations of the UN Panel for Digital Cooperation, have put those lines into the practice globally, and eventually reach a positive impact to the local communities and society on a global scale.

³ The European Commission adopts its new Open Source Software Strategy 2020-2023 . Available at https://ec.europa.eu/info/news/european-commission-adopts-new-open-source-software-strategy-2020-2023-2020-oc-t-20_en

3. Sustainable business models for internet connectivity

Providing connectivity is typically performed through either **land-line, mobile networks or satellite connectivity**. Some trials are ongoing for usage of TV white space, which due to lower frequencies has a much longer reach. According to the Web Foundation⁴, **Internet access is different from availability**, which refers to whether or not internet service is a possibility (e.g., whether or not mobile internet coverage is available where a person lives). One of the **most significant barriers to internet access** for the 50% of the globe still offline today (and even for some who are online, but have limited access) is the **high cost of connecting to the internet**².

Given the experiences from the ground in countries in Africa and in India, Table 3-1 presents an **overview of the estimated connectivity costs** together with some comments for each of the technologies.

Type of transmission	Bandwidth/Cost	Comments
Mobile Network - package	10 GB ~15 USD/month	Wholesale approach can drop prices to 10 GB for 5-7 USD/month Needs local point of presence, as costs per user for broadband educational tools are excessive. Lack of 3G and 4G networks in remote regional areas Territorial coverage limited to where there is a critical mass of number of users to ensure viable business case for operators and unlikely to change as the business case will always drive the investment
Mobile Network - link	4 Mbit/s ~400 USD/month	Operators require specific equipment, bad cost/benefit as compared to package solution Lack of 3G and 4G networks in remote regional areas
Terrestrial Radio/TV white space	Max 2-8 Mbit/s	Long range, good coverage. End user equipment for TV white space is expensive Limited bandwidth Needs backhaul connectivity
Directive radio links	Up to 150 Mbit/s	Typical range for each tower is 10-20 km. Especially suitable where landscape provides natural tops for towers. Excellent community model. Needs local expertise Needs backhaul connectivity Critical mass of users required
Fibre		Expensive roll-out (CAPEX). Needs a governmental plan. Last mile connectivity not solved
GEO satellite	1 Mbps ~1000	CAPEX: VSAT terminal is expensive, need electricity

⁴ Web Foundation on Affordable Internet:
<https://webfoundation.org/2018/04/what-is-affordable-internet-access-anyway/>

	USD/month (declining)	
LEO satellite, e.g. Starlink	20-50 Mbps for ~100 USD/month (Starlink 99 USD/month)	Antennas (VSAT) terminal need to follow the satellites, need subsidise for initial CAPEX, e.g. 2500 USD for Starlink receiver system

Table 1. Connectivity models overview with costs taken from field work in Africa (SSA)

Most of the operating models behind the types of transmission presented in Table 3-1 have their own business models, e.g. an already existing national plan for roll-out of fibre, where for example, school connectivity is performed as an add-on.

What is more important to analyse is the **affordability of access**, i.e. how much can a school (or the government) afford for the Internet connectivity. As pointed out in the appendix, the OPEX costs need to be typically below 100 USD/month:

- In Tanzania⁵, an maximum of 20 USD/month is envisaged
- In Ethiopia⁶, the state provides 70 USD/month for Internet access to schools
- In Zimbabwe⁷, EDUNET operates with 60 USD/month for Internet access to schools

What we clearly see is the **link between digital literacy and affordability to pay**, meaning that in areas with low digital literacy levels, the willingness to pay for Internet connectivity is much lower than in areas where Internet adoption is more advanced. Furthermore, the value-perspective of participation in the digital ecosystem is not evident for the majority of people. Thus, we need to focus on “a **free entrance**” to the **digital world**, to be able to point out the value for the local society.

In the following sections, we are overviewing the above proposed **business models on connectivity** (1a) and **business models for the content - information and knowledge** (1b).

3.1 Compilation and analysis on connectivity business models

In this section we are focusing on specific geographies in regards to sustainable business models for connectivity **starting with different geographies across the world** – these regions include East/West Africa, South Asia and Central/Latin America.

⁵ Based on a Workshop on Sustainable School Connectivity in Feb2020 in Dar es Salaam with Community members and public authorities,
https://its-wiki.no/wiki/Digl:TZ-Sustainability_SchoolConnectivity_Feb2020

⁶ Numbers were provided by the Secondary and Preparatory School of Koye, as part of the pilot on school connectivity, see [A.7 Digital Public Goods for Ethiopia](#)

⁷ White paper by Edunet, providing VSAT connectivity to schools: [A.6 Community Network in Zimbabwe](#)

This section looks into different **business models that will enable the provisioning of connectivity to remote areas in an efficient and sustainable manner**. For this, we are compiling and analyzing different efforts so that we can obtain insights around things that have worked and things that haven't worked and make recommendations on the way forward. The following subsections present an overview of different business models for provisioning connectivity.

3.1.1. Operator business model

Telecom Operators worldwide are facing major challenges due to the major dynamic changes enabled by disruptive technologies, and to make the sustainability of their business models. The value is moving to a totally different market as ICT technology evolution is creating new opportunities in new market sectors. Many Operators have realized this and are updating their way of working to remain relevant in changing times by innovating their business models to stay afloat. The network operator- driven business models that rely primarily on subscriber revenue have brought the first 3 billion people online and will continue to grow, but the assessment uncovered wide consensus that most of these actors do not see rural, low-income markets as commercially viable⁸. This digital gap risks leaving the rest of 50% of the global population without access to the Internet.

Operator business model implies access to the internet on commercial terms ordering of Internet access by one school at a time. Here the focus is on connectivity which is the core business of the Operator. The key factors for consideration are subscriber growth, Average Revenue Per User (ARPU) growth/Connectivity, etc.

3.1.2 A regional driven business model in Zimbabwe

The «Murambinda Rural Community Network Project» that aims to provide affordable Internet access to the remote rural community in Murambinda, Buhera District. Murambinda is now a local innovation hub potential to build and sustain a multi-node community network to enhance access. The national e- learning, e-health and e-government programs provide the initial anchor points for the network. Murambinda Works went into partnership with TelOne, the service provider having widest fibre coverage in rural Zimbabwe. Murambinda Works offers affordable internet access to rural schools, health facilities, government institutions and communities at large on a revenue sharing basis through the partnership with TelOne.

Murambinda works provide access through a bulk shared connection where costs of connectivity are shared among the community depending on capacity but eventually accommodating everyone. A school automated management software is a system deployed with the network as this will be an element that will add value to the network. Where schools can use for school management purposes at the same time these schools become local hubs for

⁸ USAID: Business models for the last billion, available:
<https://mstarproject.files.wordpress.com/2016/05/business-models-for-the-last-billion.pdf>

development of local content, locally hosted by Murambinda works, which will be accessed by the community from the local network hotspots some service at free costs and others at affordable price.

The current infrastructure powered by solar connects 8 schools having a capacity to connect 80 of the 216 schools in the district. The schools only need a Customer Premise Equipment (CPE), catching up radio links up to 16 km from the sectorial antennas built to connect these schools. The schools mentioned here are the schools currently connected after support from the Internet Society. These schools are connected as business entities. A community engagement meeting was conducted in Murambinda on the 15th of November 2018, which was attended by many schools from the district. There was a great interest shown in having access to connectivity from their schools. Joseph Bishi, a chairman for Zimbabwe Community Network Initiatives, has attended 4 Africa Community Network Summits hosted by Internet Society since inception in 2016 and in the last 2 years as a member of the program committee member for organization the Africa community network summit.

3.1.3. Community networks business model

Community networks present small-scale connectivity initiatives that are created, coordinated, and used by local small communities, with the focus on the individuals they serve. Usually, they deploy low-cost equipment, open source software technologies, zero-rating operations, and they provide 'last-mile' connectivity, a final connectivity leg to the user.

A bottom-up initiative is designed to take into consideration community needs, language, and cultural context, and community networks involve the community from the start in building networks. They are managed sustainably, they have a replicable mode, and they do not depend on external funding. Very often, community networks can focus on the provision of services, such as content-sharing platforms or apps, relevant to their users.

LibreRouter: Open-Source Hardware for Community Networks

The LibreRouter is an Open Source Hardware WiFi Router designed⁹ from the ground up for Community Networks. It is designed for community networks that are organized by a group of people such as neighbors in order to share local and other content without a profit motive. It is produced with features that aim to make it easier for communities to install their own mesh network. During 2019, the first version of this device went into production and is expected to be tested and used in different community networks around the world.

⁹ LibreRouter specifications: <https://librerouter.org/technical-specifications/>

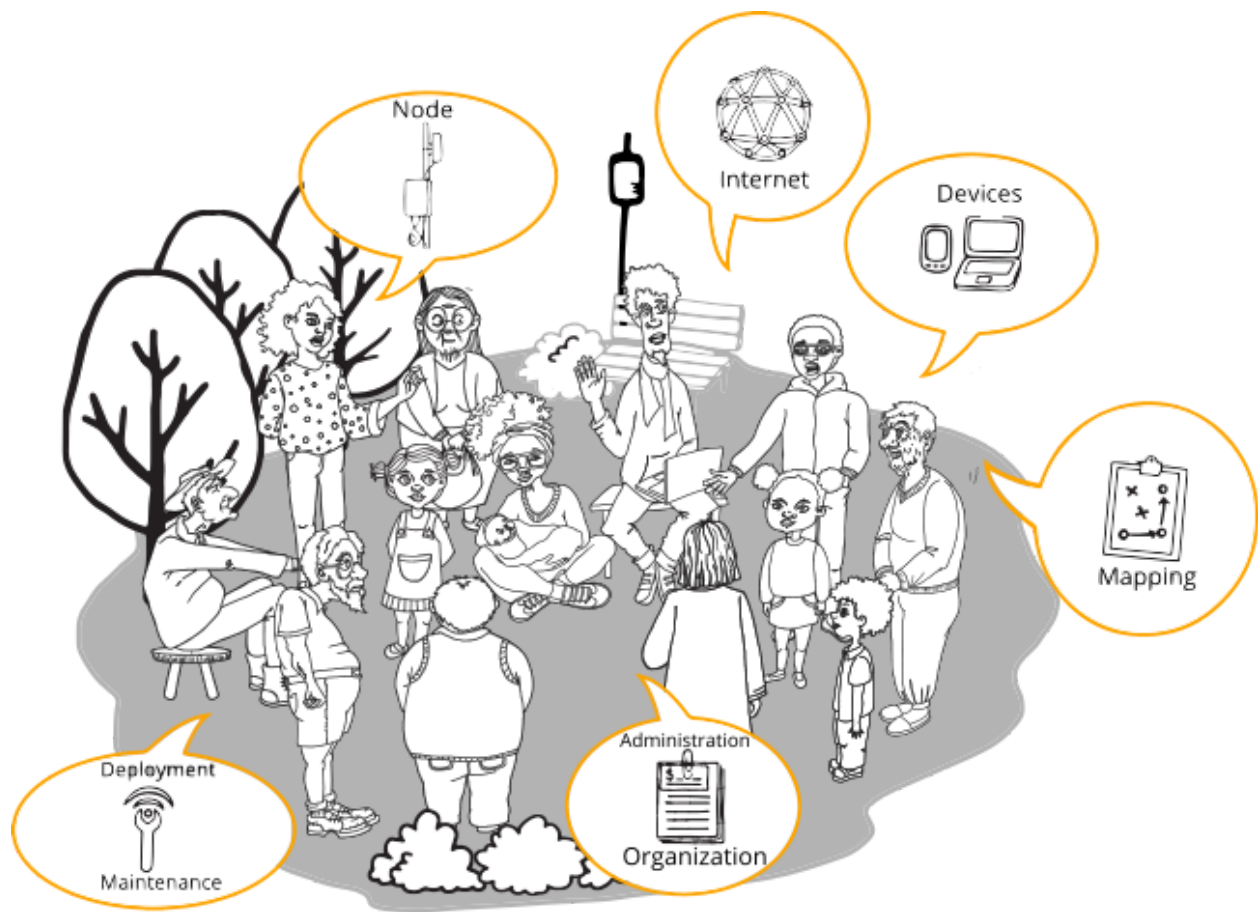


Figure 1. The LibreRouter view for ubiquitous connectivity

The firmware shipped with the LibreRouter is [LibreRouterOs](#). LibreRouterOs is a firmware based on [LibreMesh](#) and [OpenWrt](#) with official LibreRouter support. Most of our software development happens directly in the LibreMesh and OpenWrt projects. The hardware design project lives at <https://gitlab.com/librerouter/boards>. Other components for Community Mini Server:

- Raspberry Pi image: <https://gitlab.com/librerouter/pi-gen>
- SoporteRemoto Server: <https://gitlab.com/librerouter/soporteremoto-tiers>
- Community Hub: <https://gitlab.com/librerouter/soporteremoto-dashboard>

One of the difficulties encountered to advance with its implementation, has been the approval required in some countries for its operation. In Colombia, the entity in charge of certification is the Communications Regulation Commission (CRC), to whom a request was submitted to confirm whether the certification process was required for its implementation in the country. At

the end of October, the CRC issued a notification confirming that this process is not required for use in Colombia. This gives the CRC a free hand to carry out tests and implementations in community networks or other citizen connectivity initiatives. Currently, local organizations such as NuestraRed.org , Semillero Red Fusa Libre and Colnodo have LibreRouter equipment for testing, training and implementation.

Wakoma (South Africa)

Wakoma works with organizations to build community networks where backbone provision is available, as well as offline contexts. The Nimble <https://wakoma.co/nimble/>, developed by Wakoma, is a rapidly deployable mesh/community network solution that enables communities to use the freemium model or any model of their choosing.

The advantage of Norway of "knowing each other" resulted in the political focus by BasicInternet, a.o. through the contribution on the Governmental White Paper on "digital transformation and development policies", see [Digl:Publications](#) or directly https://www.regjeringen.no/no/dokumenter/meldst11_summary/id2699502/?ch=2

Common goals of open source platforms:

- be able to work in resources-constrained environments, both with respect to bandwidth costs and capabilities of the server
- based on open source modules to ensure applicability by every community
- scalable, to be deployed in small communities on e.g. low cost single-board computers, in areas and on a country level
- enables easy "drag and drop" content and course creation
- enables off-line capability, e.g. allowing students to take the content home
- user management
- supporting a freemium model and other models for content, with e.g. free courses and premium certificates through exams, memberships, paid courses, etc.
- monitoring and usage reporting (of statistical data), to allow feedback to donors of content, e.g. Global Health Media
- applicability in other community networks

The [Learning Management System](#) (LMS)/Community Platform and Nimble <https://wakoma.co/nimble/> built by Wakoma contain these features, and are built solely on open source hardware and software. Examples are:

- Dockerized services, allowing the free mixing of functionality needed in a specific community or context
- Wordpress for easy creation of content and front-end management

- Nextcloud for file hosting and easy sharing, and Nextcloud Talk for video/voice chat.

Wakoma is also working with partners VPUU <http://vpuu.org.za> and iNethi <http://inethi.org.za> to collaboratively develop new features and functionality useful for community networks and other community-based connectivity initiatives around the world. Eric is also a proponent of OpenZIM <https://github.com/openzim> and the work being done by the Kiwix <http://kiwix.org/> and Internet in a Box IIAB <https://github.com/iiab> teams.

AHERI community-based connectivity model

Africa Higher Education Research Institute (AHERI) and Basic Internet Foundation signed a Memorandum of Understanding to cooperate and collaborate in providing Infrastructure that guarantees affordable access to the Internet and information in unserved and underserved communities. AHERI is a project under Community Initiative Support Services (CISS) a non governmental organization based in Kisumu City in the Republic of Kenya with operations in three counties of the former Nyanza province that is Kisumu, Siaya and Homabay. Community Initiative Support Services focuses on food security , poverty reduction and youth engagement, preventive health and transformative masculinity, environmental management and conservation. AHERI on the other hand facilitates collaboration and knowledge exchange among Africa Universities in the areas of e-learning and public Health.

Following the Memorandum of Understanding Signed between the Africa Higher Education Research Institute (AHERI) a Project under Community Initiative Support Services International (CISS) and Basic Internet Foundation, a site Survey was conducted on 16th and 17th January 2019 at five different sites spanning three counties.

The Survey was conducted in the following counties:

1. Kisumu County
2. Homa Bay County
3. Siaya County

The Survey was spearheaded by a Project team from AHERI backed up by a Secretariat.

Objectives of the site visits and survey are:

1. To identify areas with limited access to the Internet either due to low availability or high costs.
2. To conduct a feasibility study on implementation of local information spots with the primary objective of distributing development oriented information and local content using the Basic Internet solutions model.
3. Deployment of a high bandwidth local distribution network supporting local collaboration and content distribution. The community servers will be pre-loaded with education, health and development information that will be freely available to local citizens.

4. A Business option for providing premium Internet. The Freemium model of access promotes free access to information (text, pictures and local video), and premium access to entertainment, games and other bandwidth-demanding content. Premium access will be availed through the sale of Internet Vouchers.

Development of a Comprehensive Business Plan for Community Network

Having analysed the varying conditions in the different sites, the team agreed that for sustainability, a comprehensive business plan for a Community Network (Community Wireless Internet Service Provider) would need to be developed and further funding sourced beyond the seed capital provided for by Basic Internet Foundation and Community Initiative Support Services – AHERI. In the upcoming period, the progress will be monitored.

3.1.3. Public Private Partnership model (4-P Model)

The Public-Private-Panchayat Partnership (4-P) model developed and validated on the ground for its sustainability in villages where connectivity has been enabled by the project. This partnership model was commonly developed for all the 25 villages in Palghar. The main reason behind developing the partnership model has been to throw light on how different partnerships can facilitate connectivity to the remote, rural villages. The model also lays stress on the fact that no single entity i.e private telecom operators or the government is responsible for enabling connectivity to the unserved. Important aspects of the model are i) The Panchayat i.e the village administration has been introduced into the partnership model alongside the public and private partners and ii) the partnership model adopts a bottom-up approach with the involvement of the villagers focusing on the local and regional needs with regards to connectivity. As the Panchayat represents the village administration, and is elected by the people of the village and backed by district and state government, its participation adds value to the partnership in terms of authority, ownership and financial disbursement¹⁰ The 4P model has been commonly developed for all the 25 villages in this project. **This partnership model can be universally adopted for enabling connectivity to the remote, rural areas.** The highlight of this model is **building up on partnerships with important stakeholders that are associated with rural connectivity.**

The role of each of the partners in this partnership model is as follows:

The Panchayat owns the network at the village level i.e. purchases the bandwidth and enables revenue generation by reselling the bandwidth to the villagers. The Panchayat also plays a major role in defining priorities for the local digital needs of the villagers. Local youth from the villages are appointed as VLEs by the Gram Panchayat, and operate and maintain the network in the village.

- The private sector partner provided the bandwidth which enabled connectivity to the 25 villages.

¹⁰ Further details about the 4-P model can be found in Belur, S.B et al. 2017.

- The public sector partner plays a vital role in technology innovation, deploying the network and providing the capital expenditure (CAPEX) funding for setting up the network infrastructure in the villages.

Validation of the 4-P model on the ground

A partnership model is not sufficient in itself if it does not have revenue generation as an important part of it. **The revenue generation aspect of the partnership model addresses sustainability of the connectivity after the unconnected villages are connected.** For the validation of the 4-P model on ground, the first step has been to identify the two important cost indicators i.e. CAPEX and operational expenditure (OPEX). For setting up a network, there is a CAPEX investment that is needed and the OPEX needs to be recovered. Revenue generation has, as a result, been identified as an important aspect of the model without which the model cannot be sustained. This incentivises the Gram Panchayat and the VLE to maintain the network in the village. Usage of the connectivity was also analysed through monitoring traffic data which helped in understanding the bandwidth requirement at each Gram Panchayat.

In order to test the sustainability of the 4 P model, the 25 villages have been divided into two groups each with a different revenue generation method. The villages were segregated into groups based on their proximity to the highway (Mumbai-Ahmedabad highway). 15 villages that are located close to the highway comprising one group and 10 villages that are located in the remote tribal areas comprised the second group. Community-led network has been set up in the 10 villages due to the remoteness and unconnected status of these villages. Alongside the 4 P model, two different revenue generation methods are validated and tested in these two groups of villages. While the partnership model will enable the feasibility of connectivity reaching the unconnected, **the revenue model addresses sustainability of the connectivity through revenue generation.** The two models are combined and validated in the two groups of villages to test the **model's viability, scalability, replicability and adoption in different village contexts.** So depending on the village location, the stakeholders can be identified and the revenue model can be worked out which can ensure connectivity and its sustainability to the remote, rural villages.

The first step in the validation process has been to look into the traffic data of all the 25 villages. The network went live in the month of October 2017. Initial analysis of the traffic data from all the villages suggest that connectivity is being used by the people. Usage data and number of users followed from October 2017 to March 2018 (as shown in Fig.3) shows an increase in number and data usage has increased month wise. This can be viewed as satisfactory service in terms of internet availability and speed.

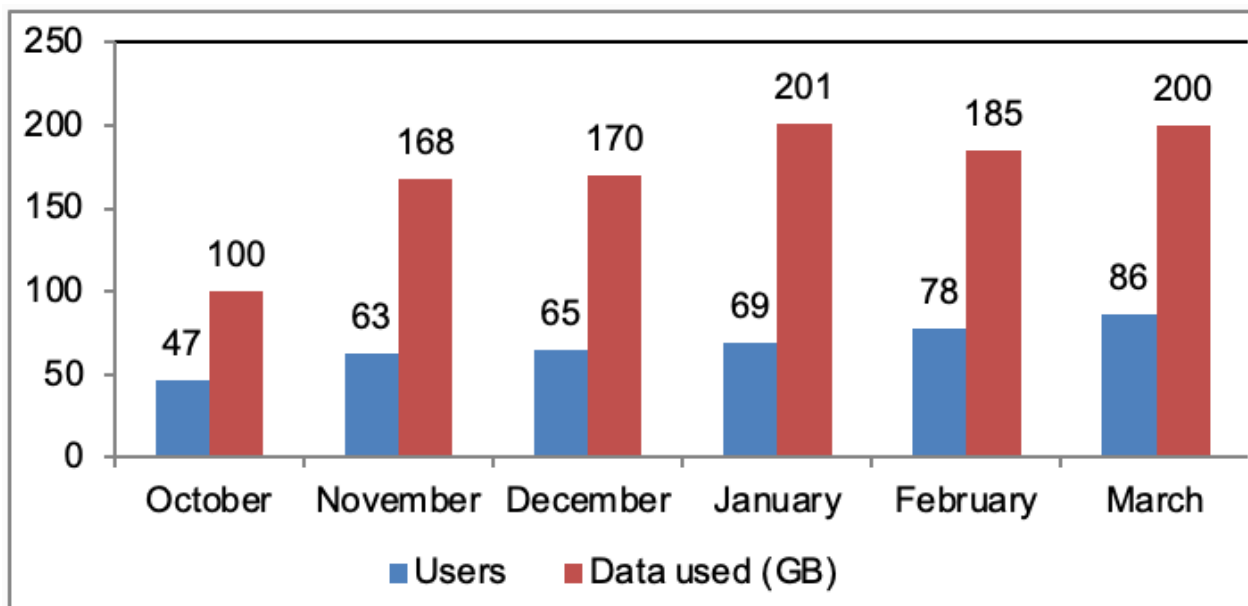


Figure 2. Data usage and number of users from traffic data

Data on monthly uploads and downloads by the internet users in these villages show that there are more downloads than uploads. From October 2017 to March 2018, the downloads have increased from 96 GB to 154 GB, on the other hand uploads are lesser than downloads though follow an increasing trend (from 6 GB to 15 GB). This is in line with consumer patterns where downloads are more than uploads.

The traffic data of the 25 villages also gives a broad overview of the utilisation of bandwidth by the users in the form of websites most visited. As shown in Fig.4, 40% of the bandwidth has been used for Windows updates, followed by YouTube, Hotstar and visits to Microsoft.com. In the case of Windows updates, this is likely to be the result of automatic updates by the software vendor. As the illiteracy levels are high i.e 60% in these villages, viewing websites such as YouTube and Hotstar are mostly visited. Users mention that as they are illiterate, they are unable to do keyword search, hence these websites are preferred over other websites.

Revenue generation as part of the 4-P model

In the 15 villages cluster (the first group), the revenue model is through the local ISP. The local ISP has enabled 2 Mbps bandwidth at each Gram Panchayat office and gets directly paid by the Gram Panchayat. The local ISP further sells the bandwidth inside the village as part of its marketing strategy and generates revenue from the connectivity. The Gram Panchayat office pays a fixed price of INR 1000 (USD 14) for 2 Mbps of bandwidth. This cost includes the bandwidth cost, operation and maintenance of the link and device cost if the device needs replacement due to damage. However, as the Gram Panchayat office does not use the entire bandwidth; the unused bandwidth is sold to the villagers in the form of 'pay as you use' daily coupons of a duration of one-hour each costing INR 10 (14 USD cents). This connectivity is

accessed at the Gram Panchayat office. It has been observed that on an average, 5-10 people use the internet at the Gram Panchayat office per day, which totals to INR 50 to INR 100 (70 USD cents to USD 1.40) per day and results in a monthly income of INR 1500 - INR 3000 (USD 21 – USD 42). This contributes to the monthly revenue of the Gram Panchayat . Out of this amount, INR 1000 is paid to the local ISP. The Gram Panchayat office plans to use the accumulated amount for development activities within the village.

The second set of 10 villages has a VLE-focused revenue model where CSC WiFi Choupal has acquired 30 Mbps bandwidth from a local ISP and distributes the same to different villages depending on internet use and number of customers in each village. The VLEs maintain the network in these villages and sell bandwidth to the villagers in the form of coupons based on the fixed pricing plan. The monthly customer base of the VLEs include new customers as well as returning customers. The revenue plan of the VLEs has been devised in a way that it maximises profit for the VLE, thereby providing incentive to perform. It has been observed that of the coupons sold per month, 40% of the coupons sold are of INR 10 (14 USD cents) in value, which gives 500 Mb of data for 10 days. The next popular coupon amount is INR 100 (USD 1.40) purchased by 22% of villagers, which is valid for 28 days, and which gives 12 GB of unlimited data.

Revenue information suggests that in those villages where there is a substantial use of internet data and a large customer base, the monthly revenue generated by the VLE is in the range of INR 5000 to INR 6000 (USD 70 to USD 84). In other villages, the monthly revenue generated is INR 3000 to INR 4000 (USD 42 to USD 56) on average.

In the months to follow, it is expected that the number of broadband subscribers will increase which will directly have an effect on the revenue generated by the VLEs. A steady growth in revenue generation by the VLEs suggests that the model will perform well and also offers lucrative value for the investment made. A nominally pricing plan for data will facilitate greater usage by rural villagers.

3.1.4 Internet Lite business model

Internet lite is proven technology and provides free access to text, pictures and local content, e.g. education or health videos on a local server. Internet lite is the digital child of the Non-discriminating access for Digital Inclusion (DigI), is a three-year innovation project, funded by The Research Council of Norway and the Norwegian Ministry of Foreign Affairs. The business model supports the concept of a Social Solidarity Economy. One user paying for video access for 10 minutes will support 300 users for 10 months with free access to information.

The Norwegian-supported piloting of Internet lite is ongoing in Tanzania, and has a value proposition in reaching the remote villages. The main target is to establish domestic pilots in rural Sub-Saharan Africa, which are dedicated to spreading health, and educational information locally. The pilots with available health information is the key goal for health knowledge uptake

and retention, behavior change, digital literacy uptake, and crucial to solving many social challenges. In this project, we are pursuing to unlock the value of access to the Internet, by allowing free access to non-video digital content on the web and access to local video server, with plans to deploy in areas with or without the infrastructure, typically near health facilities, educational institutes, and public meeting spots. The Internet lite model can serve and is replicable to any low-income country and area without the internet access, both in public activities in the digital space or private, through the freemium model.

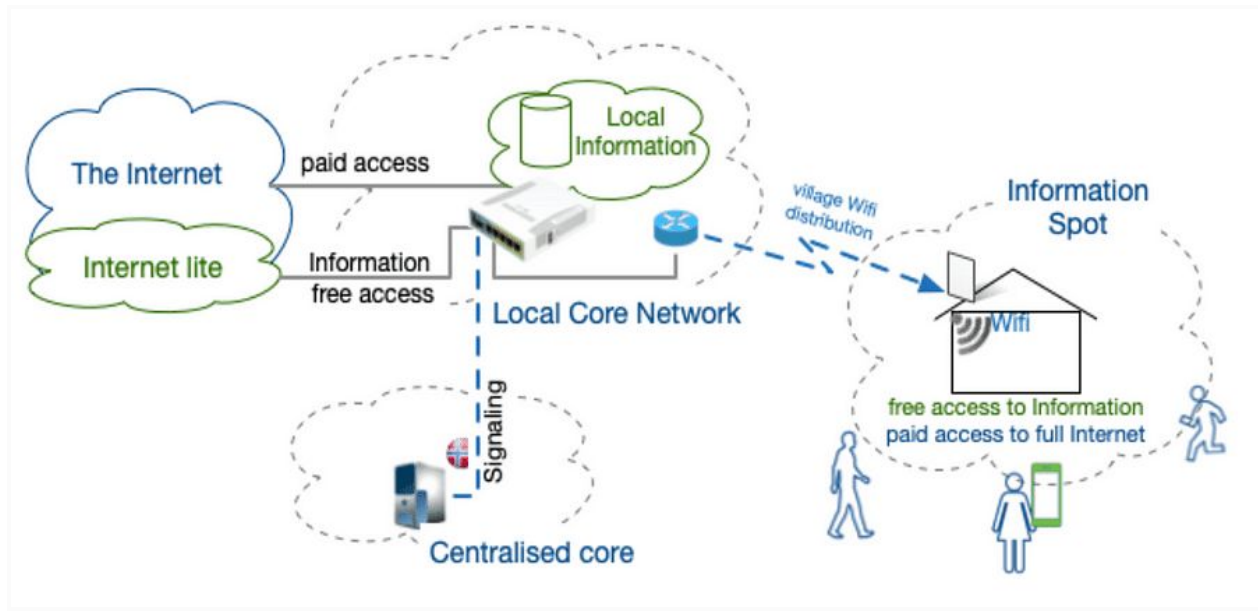


Figure 3. The freemium model for access, with free access to Internet Lite and premium access to broadband content, as an option for bringing the Internet to rural areas

The business model suggested by Internet Lite adopts the freemium style, where access to basic information is free and full Internet access (e.g., to videos, games, full web-sites) is paid, e.g., through specific data plans offered by the mobile operators. Internet Lite pilots demonstrated that the free services take ca. 2.5% of the bandwidth, leaving the rest for commercial operations. This percentage can be covered by the businesses through various schemes like tax or other state supported funding programs. Thus, Internet Lite is not proposing a diluted or in any way an inferior mobile service.

3.1.5 Hybrid business model for connectivity: Picosoft, Nepal

Using a site-based hybrid technology approach that combines TV white space (TVWS), fiber optic, and line-of-sight service, Unlimited Wireless Internet from Picosoft provides fast, high-speed Internet service in rural areas of Nepal where cable and asynchronous digital subscriber line (ADSL) Internet are not available. Picosoft donates and installs computer labs in

public schools in rural Nepal and provides connectivity to those schools and to government offices

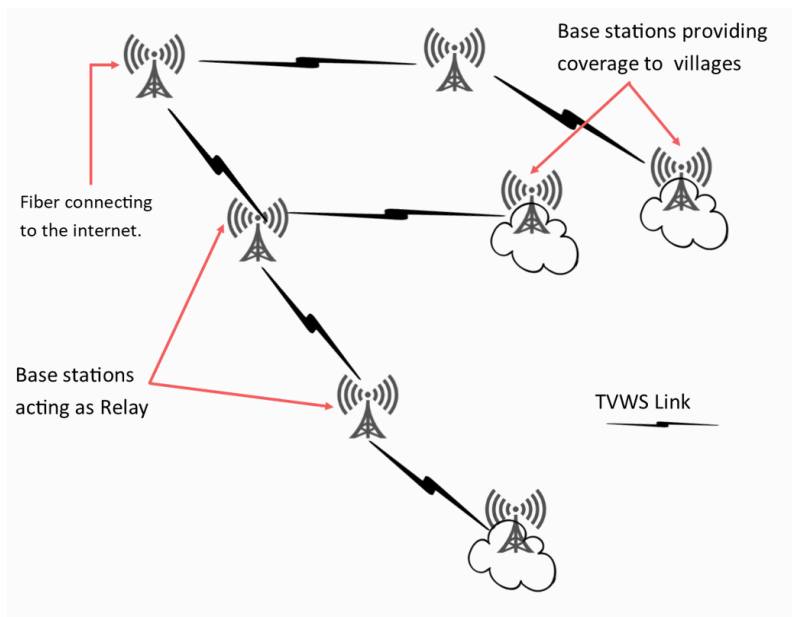


Figure 4. TV White-Space link in connecting Base Stations for rural access to Internet

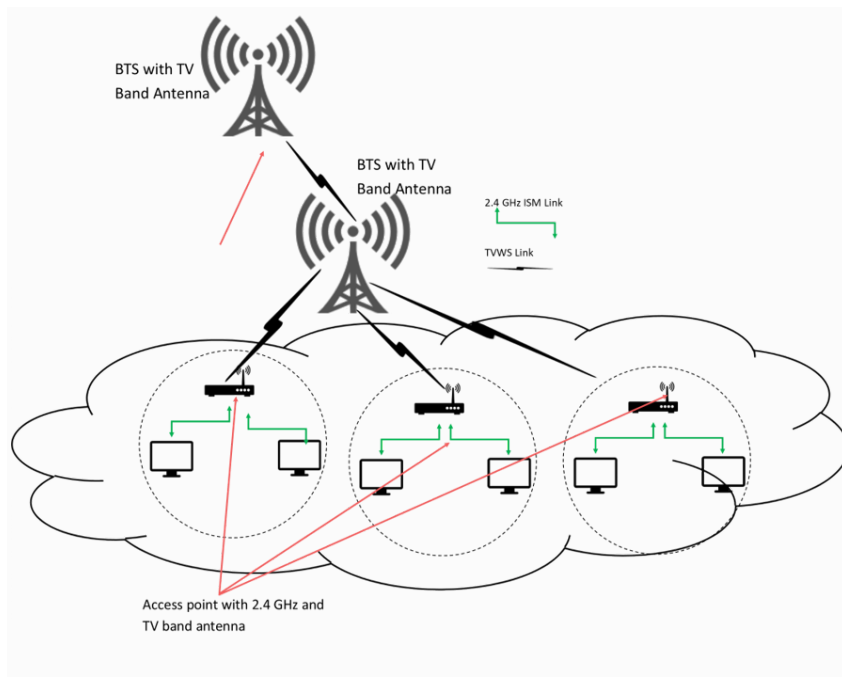


Figure 5. Base-station to user connectivity using TV White Space

The aim of the Picosoft¹¹ is to distribute internet services to the rural community schools and communities where ISPs have not been able to reach yet. The project started with Dhading district connecting twenty community schools as the first step which will impact more than 100,000 households.

One of the biggest problems in rural areas in Nepal is to meet the device points, the houses are separated by longer distances and it's very difficult for cable and fiber optics to meet this. The traditional structures can only go about five kilometers. With a cell tower or other device, TV White Space technology can reach at least 18 km and service many more customers at one time.

3.2 Framework basis for connectivity business model

The previous chapters have outlined the most promising business models for access. 4 business models, in order to analyze them, they are related to available funding and expenditure in the area. And thus, given the specific region and incomes, one should base the business model on GPA and expected income in the region.

The differences in the business models are related to

- Available GPD - affordability to support the monthly (OPEX) costs for connectivity
- Available support to address initial capital expenditure (CAPEX), e.g. a satellite terminal
- Digital Literacy - fostering the ability to request digital services
- Combined use of connectivity, i.e. one access per location or combined access shared amongst users/institutions.

Depending on the GDP, one of the solutions from 3.2-3.5 should be the core of the framework for connectivity

3.3 Recommendations for business models on connectivity

In this chapter, we've provided an overview and analysis of specific geographies in regards to sustainable business models for connectivity. We've looked into the initiatives in regions of East/West Africa, South Asia and Central/Latin America that **enable the provisioning of connectivity to remote areas in an efficient and sustainable manner.**

In this closing section, we propose four **recommendations for the business models on connectivity.**

R1: A tailored business model plan. First and foremost, the basis for any sustainable model for connectivity would imply a **comprehensive business plan** that would need to be developed and further funding sourced based on the local socio-economic background. The

¹¹ Picosoft, source: <https://www.picosoftnepal.net/#service-block-main>

essence of that plan is that it **addresses and meets users needs** and their ability to use and pay for the service. The business model for connectivity also must **respond to and deliver value to the users** that pay for the service, and convert those payments through the proper design and operation of the various elements of the value chain. Good business model design protocol and implementation involves internal and external factors concerned with users, suppliers, and the broader business environment. In areas with low ability to pay, and little or now digital literacy, we suggest to start with basic connectivity (“access to information”). When demand increases, so does the ability/willingness to pay for the connectivity, allowing for a scale-up to either community network, PPPP network or other low-cost shared solutions. At the end of the day, given that an “affordable backbone” is available, the operator business model may topple the existing networks, delivering mobile internet access.

R2: Sustainability and Scalability. We’ve seen that digital technologies that could provide universal connectivity - exist. The value and improved livelihoods that governments, the community, tech companies, network operators, internet service providers, and, low-income regions and communities gain from sustainable Internet connectivity is undeniably relevant.

The challenges lie in **financing, networking, and regulatory environments** as well as **deploying and scaling business models that can sustainably provide connectivity to low-income regions. There is a need for new, innovative and integrated approaches to support the last billion connectivity ventures and initiatives.**

Proposed tools for **sustainability** and **scaling** last billion business models for connectivity include¹²: i) **pipeline development project preparation.** Donors and other capital providers can help drive investment by covering some of the up-front costs of connectivity investments, reducing cost and risk to capital providers; ii) **Grants and other concessionary financing** can be critical to the development of early stage ventures; iii) **near- commercial financing** can provide the critical missing component to making the risk/return profile attractive to other investors. iv) de-risking instruments and other Loan guarantees tools can help shift the risk/return profile of businesses, giving investors and lenders greater confidence of repayment due to the backing of a respected third party. v) **Knowledge sharing and Technical assistance** – platforms can help ensure that connectivity startups benefit from the lessons learned and shared experience of the substantial international network of those individuals and organizations with a stake in supporting connectivity for the world’s poorest.

R3: Innovative and cross-sector partnerships. Scaling the solutions will require innovative and cross-sector partnerships that bring together a variety of multi stakeholder organizations with an interest in standardized and universal connectivity.

By deploying an **early-stage blended finance, seed funds, and implementation of blockchain and incubation services to emerging connectivity business models**, public and private partners can work together to bring high-impact, viable ventures to scale. **This**

¹² USAID: Business models for the last billion: <https://mstarproject.files.wordpress.com/2016/05/business-models-for-the-last-billion.pdf>

approach to scaling a connectivity ecosystem for the world's poorest region requires leadership and collaboration.

With the half of the world population of unconnected people, mostly concentrated in two sub-regions, India and Sub-Saharan Africa, **connectivity partners must combine unified, global coordination and knowledge sharing** with joint efforts and action steps to grow connectivity initiatives focused on low-income countries. For example, partners in East Africa could build on the existing BoP digital solutions in the region by ensuring that mobile network operators, ISPs, and tech companies, are coordinated as key partners, investors, and solution providers. In West Africa and Central Africa, connectivity stakeholders can learn from the East African success in building up networks of incubators and financing options while working to address the policy and regulatory challenges in the region.

These approaches would use the tools for **sustainability** and **scaling** (described above)—grants, technical assistance, credit guarantees, risk insurance, direct financing, investment pipeline development, and knowledge sharing among others – in a strategic manner to complement and support private sector investment in the next billion connectivity businesses.

R4: a step further towards meaningful connectivity. We should move forward based on the insights obtained during the research, and go beyond the basic access, aiming for **meaningful connectivity, a scenario** where people have:

- a) a fast connection,**
- b) enough data, and**
- c) can connect regularly on a device that suits them, by**
- d) deploying digital skills.**

Meaningful connectivity focuses on the core components required for an internet connection that gives people the power, flexibility, and freedom to engage in online activities that improve their livelihoods. Those activities are online learning, conducting business, creating and sharing content, managing finances, and accessing information about healthcare. Making sure people have the skills they need to navigate the online world safely is equally relevant.

We conclude that the **development of solid and strategic frameworks on business models for connectivity, content, and data sharing are of utmost importance**. These three types of frameworks not only help the development of the connectivity, content, and data initiatives, but also **help governments incorporate sustainability, scalability, and accountability into their connectivity programs** and build optimized processes for strategic decision-making.

4. Business models for content

This chapter looks into different **business models for delivering content to remote areas in an efficient and sustainable manner**. Starting with the same regions and geographies, we provide an overview of different possible **structures and dynamics for content**.

As we are moving **towards inclusive digital economy and society**, the UN recommends that a broad, multi-stakeholder alliance, create a **platform for sharing digital public goods (DPGs), engaging talent and pooling data sets, in a manner that respects privacy, in areas related to attaining the SDGs¹³**. Thus, the **1b) recommendation of the High level panel for Digital Cooperation, highlights the need for business models for open-source content**. The digital content landscape is diverse, and it depends what **type of content** we engage, e.g. education, higher education, entrepreneurship, digital health, or innovation. Promoting and producing digital public goods to accomplish a more equitable world—the internet's **open source should be adopted and supported**.

4.1 Compilation and analysis of content business models

In this section, we are providing compilation and the analysis of the content business models, with a special emphasis on the open-source models as being recommended by the UN's report "The Age of Interdependence". There are a number of different open-source business models which can be put in action according to the exact scenario they have to serve. The only common thing among them is that they do not require the user to be charged for the traditional software license fees.

Here we take an overview and analysis of the following proposed content business models:

- i) **Institutional model** - implies multi partnership cooperation of institutions,
- ii) **Freemium model** - free with limited content, and premium with full access - used often in internet web-based services and mobile phones industry,
- iii) **Donation model**, a model based on donations for production and campaigns,
- iv) **Public frame contracts model**, where the public supports a certain development, and
- v) **Open-source content model**, as being the basis for Digital Public Goods (DPGs).

¹³ The Age of Digital Interdependence, Report of the UN Secretary-General's High-level Panel on Digital Cooperation June 2019:
<https://digitalcooperation.org/wp-content/uploads/2019/06/HLP-on-Digital-Cooperation-Report-Executive-Summary-ENG.pdf>

All these proposed content models below have an educational trait and intention for the underserved communities.

These business models for content are just some of the existing examples since mapping the entire content models present on the Internet would take a studious examination and would require the length and width for this kind of analysis.

Finally, our suggestion is the **Free access to the National Knowledge Portal**, which can hold Education, health, governmental information and digital public goods, which you can look at 4.2 subsection.

4.1.1 Institutional model

Best praxis from India: Spoken Tutorial

Spoken Tutorial is a multi-award winning educational content portal. Here **one can learn various Free and Open Source Software all by oneself**. Self-paced, multi-lingual courses ensure that anybody with a computer and a desire for learning, can learn from any place, at any time and in a language of their choice. All the content published on this website is shared under the CC BY SA license. The Spoken Tutorial project is **the initiative of the "Talk to a Teacher" project of the National Mission on Education through Information and Communication Technology, launched by MHRD, Government of India**. Spoken tutorials represent a **variety of tutorials on various Free and Open Source Software (FOSS) in several Indian regional languages**, link: www.spoken-tutorial.in.

The main objective of this project is **to promote IT literacy for education and improve the employment potential of learners in India, using FOSS (free and open source software)**. ICT is an important area that provides jobs to a large number of students. Software creation, electronic design automation (IC design), numerical computing, and modelling and simulation are some of the ICT areas. Spoken Tutorial aims to pass on the knowledge of technology and free and open source software (FOSS) through the website to the millions in our country, who lack opportunities and/or access to learn any software. **Spoken Tutorial is a project within Indian Institute of Technology Bombay**. The project is governed by the Principal Investigator (PI). The current PI of the project is Prof. Kannan Moudgalya, Professor of Chemical Engineering, IIT Bombay. The broad roles and responsibilities of the project is met by the project itself and PI oversees the entire project. Due to the **availability of the tutorials in English and Indian languages as well as accessibility in both offline and online modes, the spoken-tutorials have played an invaluable role over the last 11 years in increasing the employability of rural youth through IT skill development**. In addition to IT-literacy, Spoken-tutorial project have also created tutorials on different occupations for e.g. the biogas plant series that is predominantly meant for masons to learn how to construct a biogas plant on their own. Since 2018, the Spoken Tutorial project has expanded to include **health and**

nutrition as a focus area. These tutorials are created with the intention of training health workers across India in a **scalable fashion**.

The Spoken tutorials can be utilised for global outreach to benefit different countries. However, in the context of **international outreach**, there are constraints about utilizing funds from the (Indian) Human Resource Development Ministry for activities not directly benefiting Indian citizens. Notwithstanding this, with bare-minimum expense at non-Indian languages (dubbing, outreach, etc), the spoken tutorials have been well-received in non-Indian languages too since many years. In fact, recently, Afghanistan and India entered into an agreement to pursue Digital Education initiatives, in which the spoken tutorials also form an important item to share ¹⁴. This is a recent example about the relevance of spoken tutorials in other countries also. As mentioned above, though the content created by the project is of interest outside India too, as an Indian Government funded project, there is only a limited amount of resources that Spoken Tutorials are able to invest in outside-India initiatives.

4.1.2. Freemium model

Freemium in its basis presents a two-tiered user acquisition model that splits users into either a free tier or a premium tier depending on whether or not they pay for an account. Free users have limited access to product features while premium users gain greater access to features, services, or virtual goods that expand the functionality of the free version of the content or software. This is often in a time-limited or feature-limited version (for example, free textual basic information) to promote a paid-for full version (e.g. multimedia content, premium videos, etc.). This business model has been used in the software industry since the 1980s, and here we implement it for the content purposes, as well.

Several factors contribute to the popularity of a freemium business model. Free features are a powerful **marketing tool**, the freemium model allows a new project **to scale up and attract a user base without expending resources on costly campaigns**. The monthly subscription fees are a more **sustainable factor of revenue** than the online advertising model. Social network sites are powerful drivers, for example, many web-based services offer incentives for referring to a family and friends. Freemium model is more successful than 30-day free trials or other limited-term offers, as users are aware of inconvenient cancellation processes and find indefinite free access more compelling.

Freemium landscape and use in B2B technology, software, Web Apps, Cloud has continued to evolve rapidly. Here are some of the notable **web-based services freemium** examples are the New York Times magazine, Survey Monkey tool, Spotify, Evernote, Skype, LinkedIn. Here we analyse the most used professional social network site LinkedIn's model.

LinkedIn

¹⁴ <https://pib.gov.in/newsite/PrintRelease.aspx?relid=186523>

LinkedIn is an **online professional networking site** that enables individuals to post resumes, to create the content, post updates, and connect with other professionals. Founded in 2003, the original insight that led to the company's founding was the lack of an online community for professional relationships and career advancement. LinkedIn is structured as a Freemium model, the core functionality of posting job experiences and connecting with other people is free to anyone willing to sign up. More advanced functionality costs money and focuses on recruiting, getting hired, and other fundamental needs. Today, LinkedIn has 675 million monthly users in over 200 countries, of which, 61 million LinkedIn users are senior level influencers and 40 million are in decision-making positions. 91% of marketing executives list LinkedIn as the top place to find quality content. LinkedIn generates three times more conversions than Twitter and Facebook.

The LinkedIn freemium model uses the **network effect strategy** where the core features are provided for free, but the company charges money for extended features to recruiters as well as job seekers to aid job search. Monetize, aggregate behavioral data, etc. This is the idea behind the majority of social network sites– if you aren't paying for the product, then you are the product. Or you're creating the product through the use and content creation use of the system, which makes LinkedIn the number one channel B2B marketers use to distribute content at 94%.

LinkedIn offers four premium subscriptions, some aimed at specific customer segments, (such as recruiters), deeper search functionality, better email capability, and more visibility into who has viewed the users profile. LinkedIn is a successful company, it was one of the first freemium companies to go public.

Successful companies perceive the freemium **content model** as a revenue source and as a potential source of **innovation**. **Dropbox** is a good example. Back in 2008, when it was launched, it was primarily a service for backing up files. Then, it expanded the service by offering shared folders, making it a collaboration tool. The latest features allow the syncing of smartphones and other connecting devices and the automatic uploading of photos. Next new features increased the value of the premium service.

More and more digital initiatives, companies, and across industries that are increasingly using the freemium content model: from online media to education (where players may eventually seek to monetize mostly free online courses).

4.1.3 Donation model

Donation content model is a model based on **donations for content production, management, and campaigns**. A donation content model works because people will contribute in order to support the initiative or a project. In most cases, the contribution is monetary.

For example, Wikipedia famously publishes regular calls for donations via headers on their website and wiki pages. Couple of years ago, Wikipedia raised \$91m dollars USD from 6.1 million different donations, including \$60m from desktop and mobile banners and email.

The main challenge of the donation content model is that it is **not sustainable** from point of view from continuous and steady support and contributions. Beside Wikipedia, here we're overviewing **Global Health media and Khan academy** projects that relies on donation business models for their content production and campaigns.

Global Health Media Project produces and distributes clinical teaching videos for frontline healthcare workers in low-resource settings. The videos provide high-quality, step-by-step visual instructions that are easy to understand and put into action. It helps frontline health workers save lives by producing instructional videos for those who have limited access to basic health information and training.

Project goals include **design and development of high-quality video and animation to help train health workers more effectively in low-resource settings**. Global Health Media feature: safe up-to-date standards of care that are practical for low-resource settings, good production values, and instructional design that convey information in an accessible way. Also, the project distributes them widely through **open access on the Internet, where they can be streamed or downloaded for offline use**. They are intended to be **complementary tools for pre-service and in-service education**.

The content is based on international guidelines, with review by global content experts. The project field-test the videos among frontline health workers. Animation clips are added to bring out teaching points with the voice-over to enable them to be narrated in many languages. Videos are brief, and use close-ups so that they can be viewed clearly on the small screens of mobile devices.

The first two media projects are a series of videos on newborn care, and a short animated film on cholera transmission and prevention. For the newborn care series, we have prepared 30+ video scripts following international clinical guidelines (drawing from WHO's Management of Newborn Problems and Save the Children's Care of the Newborn).

Primary sources of funding of this project are in-kind contributions and donations. Percentage of **total funding from this source is 51-60%**¹⁵. Additional sources of funding of this project include government and self-funded (bootstrapped). More about this project: <https://globalhealthmedia.org>

Khan Academy is a non-profit educational organization created in 2008 with the goal of creating a **set of online tools that help educate students**. The organization **produces short lessons in the form of videos**. Its website also includes supplementary practice **exercises and materials for educators, thus, much of the content in the Khan Academy library is oriented to the K-12 world**. All resources are available for free to users of the website and app with free world-class education content via an online video library, practice exercises, and

¹⁵ Global Health Media project, main page: <https://healthmarketinnovations.org/program/global-health-media-project>

assessments. It offers access to learning for the better by providing free, world-class education to anyone anywhere at no cost to the learner.

Khan Academy project is mostly funded by **donations coming from philanthropic organizations**. According to the words of its founder, Salman Khan, the Khan has no business model, by being asked whether he thinks his nonprofit model is sustainable¹⁶. For example, in 2010, Google donated \$2 million for creating new courses and translating content into other languages, as part of their Project 10100 program. The organization has attracted enough investment to subsidize its approximate \$3 million annual operating budget.

Despite the fact that the main challenge of the donation content model is the **contributors' unpredictability** and on the longer run it doesn't fulfill sustainable factors, the above examples showed that it is possible to maintain quality, scalability and sustainability through this donation content model.

4.1.4. Public frame contracts model

Public frame contracts model is the content model where the **public stakeholders support a certain development, involving several partners from the public sector**. The successful example of the public frame contracts content model is the Health Information Systems Programme (HISP).

The HISP approach to action research and information systems design was initially influenced by a number of union-based action research projects in Scandinavia in the 1970s and 1980s¹⁷. The focus in the earlier **participatory design projects** was on empowering workers who were affected by or threatened by new technology, by exploring ways in which their influence over technological solutions could be ensured. Later projects shifted toward actively producing technological alternatives by involving workers in cooperative design at the workplace. The philosophical grounding of the design approaches followed by HISP may be seen as a continuation of these perspectives, **with a goal to explore ways in which disadvantaged communities, regions and countries could appropriate ICTs for their own empowerment**.

User participation and rapid prototyping in the context of use, combined with capacity building, all at multiple organisational levels of the health hierarchy, became the basis for the development approaches used to pursue this goal.

The Health Information Systems Programme (HISP) is a sustainable and scalable research project enabling and supporting health information systems implementation in

¹⁶ The problem solvers. Inside the Higher edu:

<https://www.insidehighered.com/news/2011/12/07/khan-academy-ponders-what-it-can-teach-higher-education-establishment>

¹⁷ The Process of Developing the DHIS. UiO, available:

<https://www.mn.uio.no/ifi/english/research/networks/hisp/hisp-history.html>

more than 100 developing countries. HISP is a global movement to strengthen Health Information Systems in Developing countries that started in South Africa in the 1990s.

HISP¹⁸ at UiO is one of the leading organisations in this movement and our contribution includes in-country capacity building and implementation support, research, a PhD program, and hosting the core DHIS2 software development team.

With the explosive demand for District Health Information System – Version 2 (DHIS2) and its growing worldwide impact, the Health Information System Program (HISP) at the University of Oslo (UiO) responds to the **current donor community of global health leaders’ request to assess DHIS2’s financial state** and project its future needs in human capital and financial resources. **This analysis and business plan¹⁹ addresses specific needs related to the core resources** required to meet the growing demand, continue to build in-country local capacity, and build and expand the platform.

After conducting a series of interviews and in-depth discussions with the donor base, the HISP regional network and Ministries of Health (MoH), partner Universities and International Non-Governmental Organizations (INGOs) and analyzing resource needs, HISP UiO presents this multi-year business plan. This plan **charts the direction of the core resources of DHIS2**, its planned future growth and expectations, financial needs, and focus of investment dollars. The growth and impact of DHIS2 has been spectacular. The robust, open-source health information platform has become a global necessity with its implementation in 60 countries. DHIS2 is a product of the Health Information System Program (HISP) research and development movement initiated in 1994 by researchers from the University of Oslo (UiO) and the University of Western Cape, South Africa. **DHIS2 has become the dominant de facto global health information system of record.** It is a platform upon which governments and Ministries of Health (MoHs) across continents are relying upon for analysis, decision-making and investment in the tracking, managing and prevention of disease and pandemics, and for monitoring and evaluation support.

The challenge ahead for HISP UiO is not primarily of a technical or skills nature, as the HISP network possesses plenty of both. Rather, **the challenge lies in ensuring that the core resources—the functions that maintain and innovate—are adequately funded over time.** There is growing consensus among the donor community that funding for the ‘core’ team is imperative to maintain and grow DHIS2 both in country implementation sites and in its home office at UiO. **Of paramount importance is the attraction of additional funders so the system can continue its pace of tremendous growth—all with the goal of creating sustainable NHIS globally.**

¹⁸ Health Information Systems Programme (HISP), available:

<https://www.mn.uio.no/ifi/english/research/networks/hisp/>

¹⁹ The HISP UiO Business Plan for DHIS2 Core Resources 2016-202. Available:

<https://www.mn.uio.no/ifi/english/research/networks/hisp/hisp-uio-business-plan-2016.pdf>

In the beginning, the funding of HISP came from the Norwegian agency for development cooperation (Norad), the University of Oslo, the Norwegian research council, the Norwegian university council, donors and the governments in the countries where the project was implemented. Other agencies including PEPFAR, the Global Fund, UNICEF, GAVI, CDC, USAID, WHO, and Bill and Melinda Gates Foundation have also funded HISP. Another source of funding is regional organisations such as EMRO (East Mediterranean Regional Office, WHO), supporting regional implementations of DHIS2. Today's funding of HISP comes from international and national organisations related to the development of the DHIS2 software and country support in terms of implementation and capacity building.

UiO is also supporting the project by supporting the contribution from faculty members. **UNICEF and the World Health Organization (WHO)** are also supporting the core resources at UiO as well as particular initiatives.

Maturing over 20 years, HISP is now active in more than 100 developing countries and has scaled to achieve global success (Gyamfi et al, 2019)²⁰. HISP is today a global network constituted of Independent HISP groups (like HISP South Africa, HISP India and HISP Uganda), Universities (like University of Dar es Salaam and Universidade Eduardo Mondlane), Ministries of Health, NGOs, global policy-makers, global donors, researchers, students, social entrepreneurs, individual consultants, and more. **The success lies in sustainable and scalable software and a thriving community.** The community supports the development and implementation of HISs used in the management and prevention of diseases and pandemics. While the changing contexts of implementations and funding uncertainties make future events in the network difficult to predict, HISP must remain committed to **open participatory approaches and focus on balancing stability with growth towards sustainability.**

4.1.5 Open-source content model

When we think about open source, we generally think of open source software. With software, open source allows anyone to inspect, modify and enhance the code. The biggest examples of open source software are Linux, Red hat and Android who proved that open source can be as profitable as their proprietary counterparts. Free does not necessarily mean unprofitable. The difference between both types of software lie simply in the **business model**.

On the other side, **open-source content** presents any work that others can copy or modify freely by attributing to the original creator, without needing to ask for their permission. This can be applied to a variety of multimedia formats, including documents, datasets, textbooks, academic journals, films, videos, and music. Open-source content is said to be under an open licence. The OpenContent website once defined OpenContent as 'freely available for modification, use and redistribution under a license similar to those used by the open-source /

²⁰ The Dynamics of a Global Health Information Systems Research and Implementation Project
<https://ep.liu.se/ecp/161/013/ecp19161013.pdf>

free software community²¹. Over the past decade, the open content model has been used to develop alternative routes towards higher education dynamics. Open content allows a free way of obtaining higher education that is "focused on collective knowledge and the sharing and reuse of learning and scholarly content²²." There are multiple projects and organizations that promote learning through open content, including OpenCourseWare Initiative, Khan Academy. Some universities, like MIT, Yale, and Tufts are making their courses freely available on the internet.

There are numerous projects and initiatives deploying the **open source content business models**, and Wikipedia is probably the most known for it. Also, **Wikipedia is a specific content model** as it represents a **combined content model**.

The majority (if not all) the open-source content models contain the participatory content design that is community-centered with the donation business model dynamics.

Below we've selected some notable open-source content models relevant to education and skills building both for children and adults.

Story Weaver is an open source platform by Pratham Books for multilingual children's stories. India's Pratham Books' StoryWeaver platform offers **open source children's books** and encourages users to translate, adapt and use the content for free. It addresses all the issues around the lack of content by using an open **access framework and technology** as force multipliers combined with a platform that supports translation and re-mixing stories. As part of its mission to make books available and accessible to all children, it created SW which not only provides access to thousands of high quality storybooks for children to **build their reading skills but also provides simple tools that enable users to translate or version the books to their local contexts**. This has led to a huge amplification of books and there are over **13,000 books available in 183 languages** and users across the globe are using and contributing to building this world class open library for children.



Figure 6. Multilingual Children Stories - Open Source Platform

²¹ Open content, available: <https://web.archive.org/web/19990128224600/http://www.opencontent.org/home.shtml>

²² One year or less, Open content. 2010 Horizon report. Available: <https://web.archive.org/web/20120316120303/http://wp.nmc.org/horizon2010/chapters/open-content/>

All storybooks are open-licensed²³, and can be used and adapted freely - with appropriate attribution - to suit a user's needs. To amplify our reach, we are open sourcing the code as well, so that developers across the world can use it as is, or adapt it to meet their needs. Users can read, download and print all stories, with some tools for content creation to enable people to repurpose the content into more languages and versions. Users can translate a story in a language of their choice or create a story from an image bank of over 2,000 images. **The goal is to bring together content users and content creators to create a participatory culture that will catalyze the creation of more content.** StoryWeaver brings together publishers, educators, parents and children on the platform and allows educators to adapt the stories to make versions that are locally relevant²⁴.

The Global Digital Library is an open collection of high-quality early grade reading resources, made available for web, mobile and for print. The Global Digital Library is a flagship initiative within the Global Book. The Global Digital Library (GDL) is being developed to increase the availability of high quality reading resources in languages children and youth speak and understand. The GDL will collect existing high quality open educational reading resources, and make them available on web, mobile and for print. It will also facilitate translation and localization of these resources to more than 300 languages. The goal is to make at least 50.000 titles in 100 languages available on the GDL-platform by the end of 2020.

The GDL, funded by the Norwegian Agency for Development Cooperation, Norad, is redoubling its efforts to ensure that the open-source platform is accessible for all users. The GDL promotes the use of a "born accessible" philosophy, to encourage authors and content creators to take accessibility into account from the beginning of the book creation process.

GDL-content is currently being provided by the following initiatives and organizations²⁵; Bookdash, Asia Foundation's Let's Read, Storyweaver, African Storybook Project, USAID missions, All Children Reading: a Grand Challenge for Development, URC and the Global Reading Network. GDL's open source-digital infrastructure has so far been provided by NDLA and the New York Public Library.

BC Campus supports the work of the B.C. post-secondary system in the areas of teaching, learning, educational technology and open education. This involves the coordination of collaborative projects that span across multiple institutions, introducing and supporting innovations about the ways in which people learn, and helping institutions evaluate and develop good practice in the use of technology for learning. Open Education Resources: Open Textbook project. Professional learning opportunities (ETUG, SCoPE, communities of practice for educators and educational technologists). Learning management systems (Moodle,

²³ StoryWeaver Open Source. Available: <https://open.storyweaver.org.in>

²⁴ Pratham Books' StoryWeaver: Open Source Publishing for India's Children. Available: <https://publishingperspectives.com/2016/01/pratham-books-storyweaver-open-source-publishing-for-indias-children/>

²⁵ Global Digital Library. Available: <https://blog.digitallibrary.io/about/>

Desire2Learn); web conferencing systems (Blackboard Collaborate); collaborative educational programs; student data exchange (ApplyBC, CoursesBC, MyCreditsBC, TranscriptsBC).

PLOS - Public Library of Science is a library of open-access journals and other scientific literature under an open-content license. It encompasses a myriad of online publications in natural, social and technical sciences. It launched its first journal, PLOS Biology, in October 2003 and (as of October 2015) published seven other journals. The organization is based in San Francisco, California, and has a European editorial office in Cambridge, Great Britain. The publications are primarily funded by payments from the authors.

OER Commons, founded in 2007, is a public digital library of open educational resources. It is a freely accessible online library that allows teachers and others to search and discover open educational resources (OER) and other freely available instructional materials.

OER Africa, founded in 2008, aims to provide a home for all African Open Education Resources (OER) courseware. OER Africa is undertaking collaborative work to develop the professional competences and skills of stakeholders within African higher education institutions so that they can implement OER practices to improve the quality of teaching and learning.

4.2 Framework basis for provisioning content model

In the previous sections, we have outlined the most promising business models for content. We've analysed five structured content business models present in the current digital landscape: **Institutional model**, **Freemium model**, **Donation model**, **Public frame contracts model**, and **Open-source content model**, as being the basis for Digital Public Goods (DPGs).

All these proposed content models have an **educational dynamic and intention to empower and educate underserved communities**, and thus, **contribute to digital inclusion**.

The **differences** in these content business models are related and **depend on various geographies and national GDP (gross domestic product) and affordability factors to support these initiatives and projects**.

The following **basis and factors** for the **framework on the content business model** that need to be taken into consideration to the current and future initiatives and projects are the following:

- **Digital literacy.** This factor is often foreseen in many international initiatives on connectivity and access. Digital capabilities represent a **crucial empowering agent in governmental, economical and educational settings**, as work and personal lives become increasingly technologized. Stakeholders **should plan digital skills programs** with the aim that the program trainees have better digital skills for improved livelihoods. These are crucial for scalability.
- **Scalability.** Basic connectivity and access to information increase the demand, and increase the understanding, further scale-up to either community network, PPPP

network and at the end of the day, given that a “affordable backbone” , provides a full operator model.

- **Freemium model.** Providing free content and connectivity on a freemium model will allow people to have the benefit of free content and broadband connectivity, however by providing vouchers to pay for wifi connectivity and paid content, it allows the system to be sustainable.
- **Regulatory framework.** Reduction of import taxes on devices, connectivity, techno-infrastructure, enabling affordability and meaningful connectivity to the content and information for all.

The promising examples include **mixed models with combined approaches** as we have seen above in the case of Wikipedia, Global digital library, which presents the **participatory content model, community centered**. Here, for the future content frameworks and initiatives, **we propose the digital knowledge portal** that involves collaboration with various stakeholders and includes international partnerships.

Provisioning the National Knowledge Portal (NKP) model

The National Knowledge Portal adds next to the Digital Literacy programs an entire universe of possibilities to a country. **The platform caters for different working and educational environments**. The NKP will allow the Government to:

- Creation of a **nationwide digital content portal**
- Access **real time data** enabling fact based decision making (nationwide analytics to support learners, students and teachers).
- Analytics provides data to track content usage of curricula to ensure students track towards the optimal learning outcomes.
- Create a **personal learning environment** for each learner that gives them access to worldwide content as well as the integration of **localized content for education**
- Integrate local content through the transformation of local books to ebooks creating/transforming a publishing local industry
- The option for countrywide content collection owned in-perpetuity

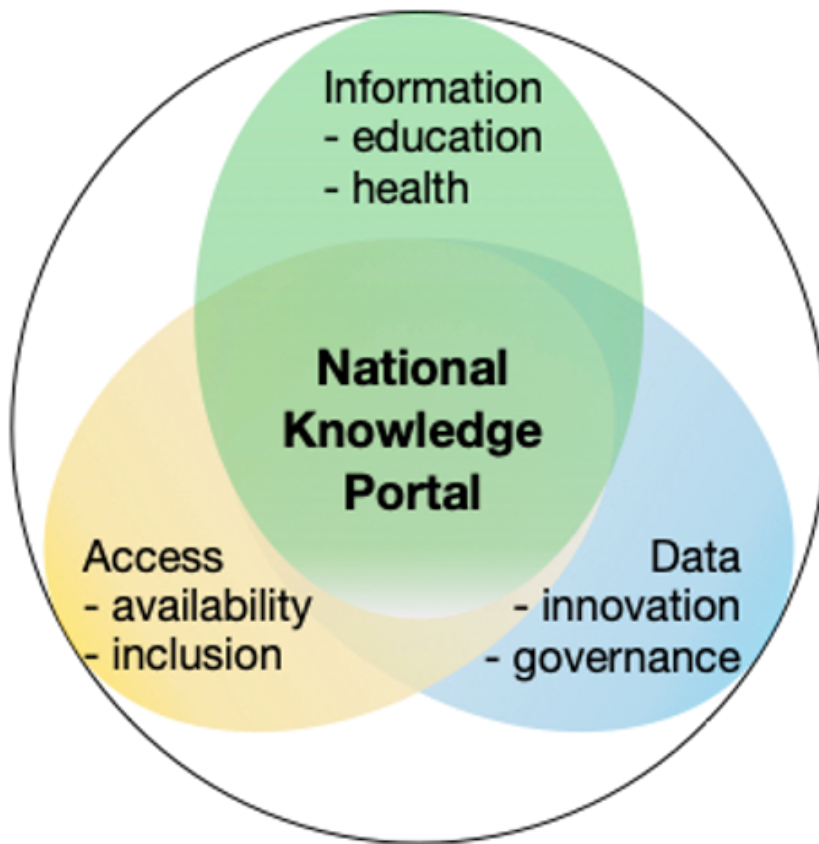


Figure 7. The three dimensions of the National Knowledge Portal for digital empowerment

It is a unique, comprehensive, **learning and engagement platform** that facilitates **the hosting and distribution of learning content to learners, students and academics at scale**. The platform enables learners to engage deeply with the learning content to help improve their results. **Comprehensive insights around content usage and utilisation along with student engagement and study patterns** are then returned to the stakeholders to support better outcomes.

The platform can provide access not just to Digital Skills Foundation but to all the learning content from over 1,300 of the top global educational content producers and can also be utilised to host and distribute Government developed materials as well as provide access to the digital market for Rwandan Publishers. The key to the success of a Knowledge Portal is the **Localization and Knowledge transfer which should be the key objective of any government**. Data and content should be managed and owned where possible through key elements of the solution to enable a greater degree of control, management and Government branding of the program which is done from the first day. The Knowledge portal can be used online and offline or be put on a CAP in the non connected environment avoiding large downloads. In order to be sustainable the knowledge portal provides a possibility for an

e-commerce platform whereby the government can recover, get paid or decide to provide certain information/training for free.

4.3 Recommendations on way ahead

In this chapter, we've provided an overview and analysis of sustainable business models for content. We've looked into successful initiatives with various dynamics and structure of the business models that **enable the provisioning of content in an efficient and sustainable manner.**

In this closing section, we are moving forward based on the insights obtained during the research, and we propose **recommendations for the future content business model projects:**

i) **digital skills initiatives and frameworks.** In order to accomplish the “meaningful connectivity” and accessibility, and deployment of the digital content, we recommend digital skills training programs on a national level. **Making content and digital skills as a part of a meaningful connectivity framework should be on priority list.** This will empower local communities and create a fertile ground for **educating the vulnerable and marginalized groups in the society, empowering them with information and knowledge** on how to use digital tools and access the online information efficiently, and interact and produce content in the safe manner. Which brings us to,

ii) **human-centric approach to the content use and meaningful connectivity.** The latest report by UNICEF, ITU, UNESCO, and Giga Connect, called “*The Digital Transformation of Education: Connecting Schools, Empowering Learners*”²⁶, provides a methodology and framework for connecting schools to the Internet. The focus is on the **human element of connectivity, the type of solutions and content that can empower learners, teachers, and entire communities once connectivity has been established.** We agree with this and that **synergy of the purposeful content use and the affordable and solid access** having in mind the users and their needs and wants, **is what we call a meaningful connectivity.**

iii) **multiparentership and various stakeholders collaboration**, that will contribute from a multidisciplinary point of view. Setting up a **productive collaboration model** between the organizations is not easy. This model needs to comprise explicitly stated benefits, efforts / risks, metrics which measure quality of collaboration and some work rules, and further benefit on content management.

iv) **communities of practice and sense of ownership** as one of the tools to reach for **sustainability and scalability.** One of our basic human needs is to belong to a group, a community, and a sense of belonging and ownership - empower local communities where

²⁶ The Digital Transformation of Education: Connecting Schools, Empowering Learners .Broadband Commission for Sustainable development. September 2020 Available:

https://www.broadbandcommission.org/Documents/working-groups/SchoolConnectivity_report.pdf

participation and engagement contribute in content planning efforts. Especially to communities of women and girls. The pandemic has brought into even sharper focus the need to bridge the gender digital divide. The content and the connectivity must work better for women and girls.

v) regulatory policy frameworks that directly support economic and social inclusion, **and specifically the content management** of such initiatives. **Policies should be specific and localized to each country**, the framework process for policymakers is **to define strategies, standards, and milestones towards achieving access and content** for meaningful connectivity goals.

5. CONCLUSION

This research paper addresses business models for access to non-profitable content, e.g. Digital Public Goods, as well as the creation of the content. The analysis shows that business models for access are **predominantly driven by commercial interests**, focussing on **profitable content** such as Bollywood, Premier league, and **provide access** to users who **already** have an understanding of the **value of mobile Internet**, typically by extending the coverage of the mobile network in areas where there is sufficient request.

This **purely commercial** approach favours the **digital divide**, as **rural coverage** is only achieved through specific governmental instruments. These instruments are **regulations**, e.g. coverage of 96% of the population, or **incentives** through e.g. the Universal Access Fund (UAF, UCSAF), supporting directly the development of mobile broadband in rural areas.

The novel concept addressed in this paper is the **scalable model**, where

i) the **initial access** is provided through local information spots, e.g. at schools, community centres, market places. Using partnerships with mobile operators, the operational costs for such an information spot can be brought down to less than 20 USD/month.

ii) When demand increases, **access** can be **shared** amongst several partners, allowing the deployment of satellite access at typical 60-200 USD/month. Alternatively, community networks can reach out to a provisioning point from an Internet Service Provider (ISP) or a governmental fibre end-point.

iii) Given a typical take-up of the Internet by 10% of the population will result in the **interest of mobile operators** for the provision of mobile broadband through 3G, 4G or 5G networks.

Furthermore, the **freemium model** for **access** will create a low-entry to participating in the digital society. The freemium model suggests free access to information, i.e. the National Knowledge Portal, and premium access to broadband services, as established by the government in Ethiopia.

Connect the Unconnected and Leaving No One Behind concepts argue that digital technologies will only help progress **towards an inclusive society** if we think more broadly than the important issue of access to the internet and digital technologies. **Access is necessary, but is insufficient.** To capture the power of digital technologies we need to cooperate on the broader ecosystems that enable digital technologies to be used in an inclusive manner. This entails:

- i) **policy frameworks** that directly support economic and social inclusion,
- ii) **strategic efforts** to bring vulnerable and marginalised groups to the fore,
- iii) important investments in both human capital and infrastructure,
- iv) **smart regulatory** and standardized environments, and
- v) significant efforts to assist workers facing disruption from technology's impact on their livelihoods.

Affordable and meaningful access to the internet **should be a human right**, and **digital public goods**, the future of education, and **the need for regional and global economic policy cooperation** is the way ahead to an equal and **inclusive society**. The paper suggests a scalable model,

Appendix: Ongoing Discussions and Examples

A.1 Community Network in Tanzania

Tanzania is facing a growing number of people connected to internet and communication services, especially through mobile technology, with 42 % of the population subscribing to a mobile service in 2018, and more than 8 million new mobile internet subscribers added since 2010. (GSMA 2019). However, the rural-urban gap in internet connectivity is widening; while 86 % of the rural citizens have no access to the internet, 46% in urban areas are connected. (Research ICT Africa, 2017).

In Tanzania, almost half of the population does not have access to affordable Internet. Even those with Internet access, it is still not affordable for them to be online all the time and from everywhere. The reasons behind this large digital divide are partly, due to lack of infrastructure, lack of digital skills and literacy, high cost associated with broadband access and cellular services, lack of local content, poor policies and regulations, high spectrum cost and lack of local and indigenous engineers. We believe that; meaningful universal connectivity will be realized if various stakeholders are collaborating to address the above-identified challenges in Tanzania.

Furthermore, we believe that the use of community-based bottom-up approaches is among the feasible solutions to address the digital divide. It is the only remaining alternative to be embraced in achieving meaningful universal connectivity in Tanzania. It is this belief that has inspired us to form the "**Tanzania Community Networks Alliance (tzCNA)**". tzCNA has been registered in Tanzania under the Non-Government Organizations Act No. 24 of 2002 with **Reg. No. ooNGO/R/0742** to operate at the National Level effectively from 05th November 2019²⁷.

A.2 The freemium business model for access

Digital inclusion efforts of the Basic Internet Foundation (further on: the Foundation), especially in [#SDG3](#) Health and [#SDG4](#) Education got honoured by the UN High-Level Panel, and thanks to Nikolai Astrup, former Minister of Development (Norway), Vint Cerf (Google), and the Panel members to appreciate that stakeholder collaboration and Digi project "Free access to information for all" became viable. The Foundation machinery is fueled by the concept "Internet is a human right", which makes it essential to contribute to the UN High-Level Panel. Some of the recent contributions were also recommendation reports derived from a roundtable discussion compiled by most of the crucial players.

The technical concept is based on building affordable information spots, encompassing the freemium model for access to the Internet. For more information on this model, please see section 3.1.4.

²⁷ Tanzania Community Network <https://tzcna.or.tz>

A.3 Feasibility study of low OPEX for school connectivity in Tanzania

In a meeting with UCSAF in January 2020, we discussed piloting a sustainability model in connecting 10 schools. The roles are:

- UCSAF: invite to meetings with TelCo for "leadership" towards sustainable connectivity, supporting costs for installation(?)
- BasicInternet: configuration (we), consulting (African Child), help (African Child)
- Telecom: provide (SIM), partially co-finance SIM usage (e.g. 10 GB package for 6/12 months), developing a "wholesale" to give us 5 SIM cards under one contract (I have with Telia 8 SIM cards under one contract here in Norway).

The advantage for Telecom operators in this business model are:

- Increased business through sales of SIM cards
- Direct contribution to SDG indicator 4.A.1 "the percentage of schools connected to the Internet", and SDG 3
- Best Corporate Social Responsibility (CSR), as the Mobile Operator contributes to the SDGs and creates business.
- Fostering future business through Digital Literacy and Societal Empowerment.

The OPEX cost model is presented in the figure 8 below, indicating that the costs for equipment amount to around 300 USD/information spot, while currently the configuration costs are around 700 USD/spot, plus additional costs for shipment/tax and local installation.

Device & Shipment		Installation and Digital Training			
\$ 300	equipment	around \$ 1,000/site			
\$ 700	configuration				
\$ 300	shipping, tax				
\$ 1,300	Total info spot				
Economy of \$ cuts					
# of info spots	Device + Inst. = Total	OPEX/m	Note		
1 - 10	1,300 + 1,000 = 2,300	\$ 20	*1		
10 - 100	1,000 + 700 = 1,700	\$ 12	*2		
100 - 1,000	800 + 300 = 1,100	\$ 10	*3		
> 1,000	700 + 250 = 950	\$ 8	*3		
Notes on OPEX					
*1 Each spot has a SIM card, typically OPEX costs: 15-20 USD/10 GB/month					
*2 One contract covering 5-10 SIM cards, total 60-100 GB/month					
*3 Wholesale contract with operators with 100+ SIM cards and 1TB data/m.					

Figure 8. OPEX calculations for a collaborative model on school connectivity

The OPEX cost model is based on the collaboration with Telecom operators, by bundling SIM cards into one contract (“wholesale”).

This connectivity for schools can be adopted to every other country, with roles like

- The coordinating role for school connectivity, typically Ministry of Education or Telecommunications, or regional development fund
- Equipment provider, typically Basic Internet Foundation
- Local organisation for installation and management of schools, also managing wholesale of SIM cards for connectivity, typically Educational Foundation
- Collaborating Telecom partner for the wholesale of the SIM cards.

An adoption of this business model is also viable for the access to a National Knowledge Portal including Digital Public Goods.

A.4 Workshop on Sustainable School Connectivity (February 2020, Tanzania)

The objectives of the panel Discussion on Approaches, Challenges, and Sustainability of Community Networks and School Connectivity, included contributions from Governmental representatives addressing sustainability in school connectivity.

During the panel and the discussion we reached a common understanding of the success of sustainable school/community connectivity. UCSAF (Universal Communication Service Access

Fund) supports school connectivity and is inviting a proof-of-concept involving 10 schools. Main conclusions were:

1. **OPEX costs** need to be affordable for the local communities/schools. It has to be ensured that the OPEX costs can be covered locally, thus a target of max **20 USD/month** is envisaged for rural areas. If there is a certain demand, then access solutions with higher costs can be considered.
2. The **Internet** needs to be **centred around people** and need to **answer the needs of the local communities**. The main goal should be to *empower the society*, including content hosted locally.
3. Both inclusion of **policy makers** and **policies to ease the roll-out of community networks** are essential for the success of digital inclusion. Community networks find their role in areas where mobile operators don't see a viable business model.

More detailed **Recommendations from the participants and the panel on Sustainability in School/Community connectivity**:

1. Improve and sustain School connectivity

- a. Forge **partnership with education stakeholders** e.g. Ministries of Education, content developers e.g. Institutes of Education, ShureDirect, and Universities in order to improve the availability of relevant **local contents** which are context-specific to different users
- b. **UCSAF pitch** this project as an **education project to the Ministry of Education, Science and Technology (MEST)** so as we can get tax exempted on importing of network equipment
- c. UCSAF will support/provide the CAPEX to connect 156 (schools/villages)

2. Improve and sustain Information Spots in the community networks (CNs)

- a. Organize a **stakeholders consultative meeting** with telecom operators, tower owners, regulators and relevant Ministries/Agencies to discuss policy, legal and **regulatory frameworks that support non-profit community networks**
- b. Discuss with mobile network operators on a possibility the **bulk SIM contracts** for easier management of community networks connectivity
- c. Conduct **sensitization of the community** on paying for the monthly bundles to sustain the established connectivity/community networks

d. Advocate the **use of TVs for displaying the health videos in health facilities** instead of using shared tablets or other smart devices. This approach will avoid contamination/transmission of infections.

3. Organizational support and **sustainability of Community Networks (CNs)**

a. **Involve local government authorities** e.g. district councils in establishing, promoting and sustaining community networks (CNs)

b. Promote **provision of peer support among CNs** within and beyond countries

c. Promote the use of affordable/cheap, scalable and sustainable solutions for CNs

d. Promote the use of cheap and renewable energy source e.g. solar power systems or batteries for powering CNs

e. Cultivate **multi-disciplinary approaches/teams** in establishing and managing CNs

f. Conduct research on ways to establish, **sustain and role of CNs in accelerating the attainment of SDGs**

A.5 Dialogue with UCSAF in TZ on school connectivity

Background: The DigI project²⁸ had communications with UCSAF in 2018, focussing on “digital health information to rural villages”, and below is the narrative on the school connectivity.

“The Basic Internet and associates team kindly wanted to learn, concerning the context of agreements that exist between you and Vodacom, related to the projects that your office have been undertaking, or yet to start and if possible, we kindly ask your office would be pleased to share with us.”

The map below is showing the regions of the selected schools, and it represents school connectivity map.

²⁸ “Non-discriminating Access for Digital Inclusion” (DigI), Project with 11 partners with focus on Digital Health Information for people in rural areas. DigI.BasicInternet.no

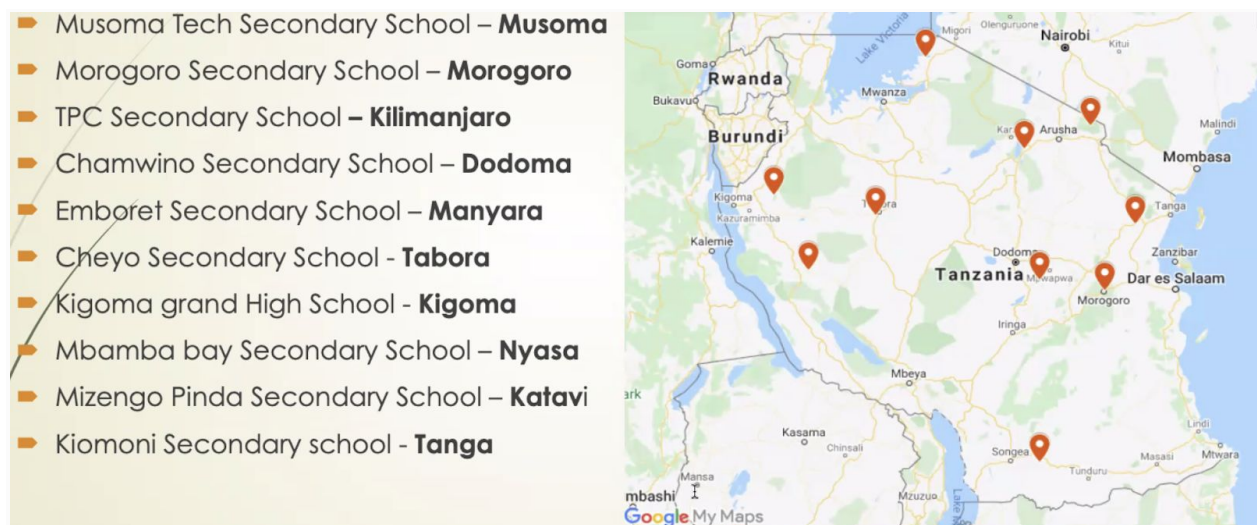


Figure 9. School connectivity - locations of schools for affordable OPEX

Through this agreement, UCSAF will identify schools that have been given computers and Vodacom will add some few computers and connect the schools with the internet using their widely available network countrywide. The internet connectivity cost is free for the first two years.

Q1: Are there limitations to the Internet connectivity?

Q2: Is the Internet provided through the 3G/4G network, or through dedicated IP links?

It shall also be an honor for us as stakeholders, to learn from your plans to connect villages, as they would be of help for us to know, and learn from towards realization of the common goals that your office and ours share, yours being the supreme recognized standards, with mandate from the laws of the land.

The Fund is being tasked to ensure that it extends communication service in rural and urban underserved areas. Currently, about 704 wards having more than 2,500 villages have received or are in final stage to receive communication service after construction of towers by Service Providers through Subsidies from UCSAF. Apart from the 704 lots/wards, in July 2019, the Fund floated Rural Telecom Phase 4 Project to extend service in 521 wards, however, only 252 wards managed to get service providers who showed interest to extend communication service using subsidies from the Fund. Therefore, after signing the contract, construction will commence in January 2020.

Q: How do you define “extend communication service”? Does it include coverage requirements, e.g. minimum received signal strength (RSSI)?

Q: What do you exactly mean by tower provision? Are we talking about 2G, or does it include Internet or Mobile Internet (3G, 4G)?

Without hesitation, we would also like to bring the matter of the meeting date, at your table. The team is humbly waiting for your schedule, arrangements and setting of the date and activities related to our meeting, so as we may plan for our two delegates' (as previously stated in our last email) attendance without delay. We look forward to hearing from you on this matter, too.

Additional to that, your opinions are of the greatest value towards strengthening the impact of the projects, which are going to change the lives of the people who were once not properly connected to the world.

Therefore, as a prudent and appropriate government Authority, we would love to hear your opinions/ views/ suggestions over the Buzz model that is to provide 3% of the bandwidth as free access to DPGs.

These initiatives are excellent, however, we are of the view that 3% is small, unless we have missed a point here.

This implies 3 percent provision of "Internet lite", where only lightweight Internet is provided over the mobile network. Heavy content such as videos are stored locally in information spots

In the light of the above, we are generally hopeful to hear from you soon, as we are looking forward towards our future meeting in Dodoma after your confirmation. The people of Tanzania are also looking up to your involvement, as a key to one of their doors in unlocking varieties of potentials towards development and brighter future for the children of Africa, right here in Tanzania.

Realisation of School Connectivity in Tanzania

In the meantime, the COVID-19 pandemic showed clearly how important digital inclusion is, not only for providing digital health information, but also for inclusion in times where schools and universities are closed. In Aug2020 the kick-off for the school-connectivity collected public partners (UCSAF), private companies (Vodacom Foundation, Tigo, TTCL, ShuleDirect), NGOs (Africa Child, Basic Internet Foundation, Internet Society Tanzania) to agree on the feasibility of School Connectivity with an OPEX of less than 20 USD/month.

The school connectivity pilot project contributes directly to SDG target 4.1 on the percentage of schools connected to the Internet, and creates the international showcase for School connectivity in rural areas. As such, the results of the pilot are both an input for the national strategy by UCSAF and the Ministry of Education (MoE), a contribution to GIGA, the partnership on school connectivity launched by ITU and UNICEF, as well as the mobile operator alliance GSMA. Furthermore, the school connectivity pilot will instantiate the priorities "access, skills, regulations and inclusion" of the Government of Norway for "Digital Transformation and Development Policy". The main focus is on the sustainability of operational expenses (OPEX) for school connectivity, based on three models to be evaluated through the pilot.

Connectivity of schools start in January 2021, with partners like TIGO, TTCL Corporation, Vodacom Foundation, Shule direct, Basic Internet and African Child Projects as coordinators. It will be a 1 year pilot project.

A.6 Community Network in Zimbabwe

The «Murambinda Rural Community Network Project» that aims to provide affordable Internet access to the remote rural community in Murambinda, Buhera District. Murambinda is now a local innovation hub potential to build and sustain a multi-node community network to enhance access. The national e- learning, e-health, and e-government programs provide the initial anchor points for the network. Murambinda Works went into partnership with TelOne, the service provider having widest fibre coverage in rural Zimbabwe. Murambinda Works offers affordable internet access to rural schools, health facilities, government institutions and community at large on a revenue sharing basis through the partnership with TelOne.

Murambinda works provide access through a bulk shared connection where costs of connectivity are shared among the community depending on capacity but eventually accommodating everyone. A school automated management software is a system deployed with the network as this will be an element that will add value to the network. Where schools can use for school management purposes at the same time these schools become local hubs for development of local content, locally hosted by Murambinda works, which will be accessed by the community from the local network hotspots some service at free costs and others at affordable price.

The current infrastructure powered by solar connects 8 schools having a capacity to connect 80 of the 216 schools in the district. The schools only need a Customer Premise Equipment (CPE), catching up radio links up to 16 km from the sectorial antennas built to connect these schools. The schools mentioned here are the schools currently connected after support from the Internet Society. These schools are connected as business entities. A community engagement meeting was conducted in Murambinda on the 15th of November 2018, which was attended by many schools from the district. There was a great interest shown in having access to connectivity from their schools. Joseph Bishi, a chairman for Zimbabwe Community Network Initiatives, has attended 4 Africa Community Network Summits hosted by Internet Society since inception in 2016 and in the last 2 years as a member of the program committee member for organization the Africa community network summit.

A.7 School Connectivity and free access to health and education in Ethiopia

During the African Innovation Week 2019²⁹ (AIW2019) actors like IBA Ethiopia, Basic Internet Foundation and University of Oslo, together with the Ministry for Innovation (MinT), have developed the concept note «Digital Public Goods for Ethiopia». In meetings with a.o. The Minister for Telecommunication, the CTO of Ethiopian Telecom and representatives from the Minister of Education details were discussed on how to use the license conditions for the mobile networks to achieve digital inclusion and school connectivity.

The Ethiopian government has already announced corporate social responsibility (CSR) activities from those applying for mobile licenses. These mobile licenses will be rewarded by March 2020. The model was discussed, whereby 3% of the bandwidth need to be given for provision of DPGs, where the government will define national public goods in addition to the digital (global) public goods.

As an example of Internet connectivity, Koye Feche School outside of Addis Ababa was connected using a directive antenna with an Ethiopian Telecom SIM card, and providing access through a Wifi information spot. These installations were performed during the African Innovation Week 2019. The information spot provides free access to health videos and other information stored on a local content server, as well as Internet Lite through the Internet over the mobile network and the system is working except for the SIM card issue. According to the school, they have a budget for Internet close to ETB 2,500 (approx € 70) per month. So the school can purchase the SIM card for 30 GB per month, which costs them ETB 1,800 (approx. € 50). In 2020 the data costs for unlimited went down to ETB 1,900, down from previously ETB 4,900 (€ 138).

As a response to the COVID pandemic, the government in Ethiopia introduced **free access** to health and education, notably the access to the Ministry of Health, the COVID-19 information page, the Ethiopian National Health Institute (EPHI) and the **National Digital Library (NDL)** (see figure 10). To our knowledge, this is the first implementation of a **license regulation** for free access to non-profitable information, which can be extended towards a “**free access to the National Knowledge Portal**”³⁰

²⁹ “Building The Future Leaders of Africa”, African Innovation Week 2019 - Connecting Innovators, Investors, Businesses and Organizations for a Sustainable and Inclusive Future, African Union Commission Headquarter, Addis Ababa, Ethiopia, 28Oct-2Nov2019, <https://africaninnovationweek.com/>

³⁰ The “National Knowledge Portal”, bringing digital public goods out to everyone in the society - <http://NationalKnowledgePortal.net>

COVID-19 response Implementation in Ethiopia

- Government Ethiopia - Agreement
 - “free access to health & education”
 - Ministry of Health
 - Ministry of Education
- Ethio Telecom offers “zero rating”
 - Health (MoH): MoH.gov.et
 - Ephi.gov.et & Covid19.et
 - Education: National Data Library NDL.ethernet.edu.et
- follow-up from discussions after African Innovation Week (AIW2019)

BasicInternet.org
 @Basic4all
“Free Access to Internet”

ግንቦት 24 ቀን 2012 ዓ.ም

እትኩ ቤሉኩም የክፍተኛ ኮምፒውተር ተቋማት ተማሪዎች እና ሙያህራን ኮምፒውተር ወረራዎችን ከ <http://ndl.ethernet.edu.et/> በነፃ ማግኘት እንዲችሉ እደረገ

በአገራችን የኮቪድ 19 (COVID-19) ወረርሽኝን ለመከላከል በመንግስት በኩል በርካታ እርምጃዎች እየተወሰዱ ሲሆን ከእነዚህም መካከል የገፅ ለገፅ ኮምፒውተር በማድረግ ተማሪዎች ሲታዩት እንዲቆዩ ወደርጉ ይታወቃል።

ከዚህ ጋር በተያያዘ ኩባንያችን ከግንቦት 21 ቀን 2012 ዓ.ም ጀምሮ የክፍተኛ ኮምፒውተር ተቋማት መምህራን እና ተማሪዎች ከኮምፒውተር ጋር የያያዥነት ያላቸውን እጋዥ ወረራዎች ከ <http://ndl.ethernet.edu.et/> በነፃ ማግኘት እንዲችሉ በማድረግ የመማር ማስተማር ሂደት እንዲቀጥል የበኩሉን እስተዋል ማድረግን በይስታ ይገልጻል።

በተመሳሳይ ሁኔታ ኩባንያችን ለወረርሽኙ ወቅታዊ ወረጃ ለህብረተሰቡ እየሰጠ የሚገኙትን የጤና ሚኒስቴር <http://www.moh.gov.et>፣ የኢትዮጵያ ህብረተሰብ ጤና ኢንስቲትዩት <http://www.ephi.gov.et> እንዲሁም የተቀናጀ የኮቪድ 19 መቆጣጠሪያ ስርዓት ድረ-ገፅን <http://www.covid19.et> በነፃ እንቀረብ መሆኑ ይታወቃል።

A.8 Information from South Africa and other countries

In **South Africa**, the Soweto Wireless User Group (SOWUG) has established a radio distribution network for connecting to the Internet. The organization seeks to erode the digital divide in Africa. They include digital literacy training and deploy wireless hotspots. As of 2017, more than 1,000 people, including 50 youth and 10 businesses, have received digital literacy training. The SOWUG has also deployed upwards of 20 free, public hotspots. The SOWUG is an example of a solution for accessibility and ICT familiarity in underserved communities that is constrained by funding.

Soweto, originally a collection of settlements on Johannesburg’s outskirts, is now a township with a population of almost 1.3 million. Internet access in the province is uneven. While the province is home to 80 percent of South Africa’s 2,100 Wi-Fi hotspots³¹, these are located within Johannesburg and not in Soweto, even though it is one of the most densely populated areas in the whole country.

A majority of households use mobile devices to connect to the Internet. With an eye toward developing better broadband infrastructure, the government’s “South Africa Connect” project has set two target goals: 90 percent of the South African population should receive Internet at 5 megabits per second (Mbps) and 50 percent of the country’s population should connect at average speeds of almost 100 Mbps. The Municipality of Johannesburg has plans to install

³¹ Soweto Wireless User Group, available: https://1worldconnected.org/project/africa_communitynetwork_sowetowirelessouthafrica/

1,000 Wi-Fi hotspots and is contemplating a 900-kilometer-wide network for households. This deployment will not necessarily aid those in rural areas, however.

Small Base Transceiver Stations are used to link to mini antennas at the client site. SOWUG uses to charge each client with ZAR 400 - 500 per month³² (~25-30 €). The Soweto is also a research and development hub for the development of new services, solutions and products that will help address social and economic challenges through operation of a community network and other infrastructural projects.

SOWUG hotspots serve approximately 1,000 devices with 150 simultaneous daily connections. Many users use multiple devices to access Wi-Fi. Ninety-three percent of users have utilized the hotspots over computers, 52 percent have used the network on their mobile phones, and 25 percent of users have connected on tablets.

SOWUG has provided digital literacy training to more than 1,000 individuals, which includes 10 businesses, 10 households, and 50 youth community members. Users at the SOWUG office use the Internet for a variety of tasks, such as writing a résumé, job searching, email, research, taking webinars, and viewing talks by distinguished individuals.

A.9 Satellite connectivity - case study

Satellite connectivity for schools is a common concept in areas where mobile broadband (3G, 4G) networks are not deployed. The technical concept is based either on geostationary (GEO) satellites or low earth orbit (LEO) satellites.



Figure 10. Typical VSAT satellite dish for GEO satellites

GEO satellites are positioned in an orbit synchronous with the point on the Earth, thus rotating in 24 h around the Earth. It means that the satellite is positioned roughly 36,000 km above the Earth. Such a high altitude has advantages and disadvantages:

³² Rashid Ally (BOACSE), Private information, Jan2020

- Costs of satellite launch
- Delays of 250 ms (120 ms up and 120 ms down)
- Large antennas needed to compensate for the energy loss from communication over 36.000 km
- + Pointing always to the same point on Earth
- + Stationary equipment
- + 1 m VSAT antenna can handle typically 20-40 Mbit/s

The 0.98 cm VSAT antenna from iNet³³ is given as an example, providing 43 dB (at 19.5 GHz) and 46 dB (at 29 GHz) and

However, connectivity is expensive. As UNDP has pointed out in a meeting³⁴, the OPEX costs are still around 1000 USD for a 1 Mbit/s line. Expectations are that costs for satellite communications will drop by a factor of 10 by 2025, mainly due to the massive investments in low earth orbit (LEO) satellites.

Some providers such as eLearningSolutions³⁵, a company located in Zimbabwe and South Africa, provides satellite-based connectivity for 60 USD/month with 5 Mbps download speed and 2.3 Mbps upload speed. The company has specialised to connect schools to a central hub.

EDUNET is providing access to cost effective broadband connectivity to education. This solution connects to a single network: The Ministry of Education, Provincial and District Offices, All schools, Curriculum Development Units, Production & Broadcasting Studios.

The network allows:

- Effective distribution of high quality content (open source as well as commercial content)
- Development of educational content through the teachers creating local content
- Scalable Continuous competency development
- Real time data through an EMIS and direct contact between all the entities
- Collection of learning insights allowing continuous improvement cycle
- Collaboration between students to improve educational outcomes

³³ 0,98 cm VSAT antenna <https://www.digisat.org/inetvu-fly-98h-98cm-ka-band-flyaway-auto-acquire-vsant-antenna>

³⁴ Information exchange UNDP-Basic Internet Foundation, Jan2020, https://its-wiki.no/wiki/BasicInternet:UNDP-BasicInternet_information_exchange_Jan2020

³⁵ eLearning Solutions, <https://elearningsolutions.biz> located in Zimbabwe and South Africa

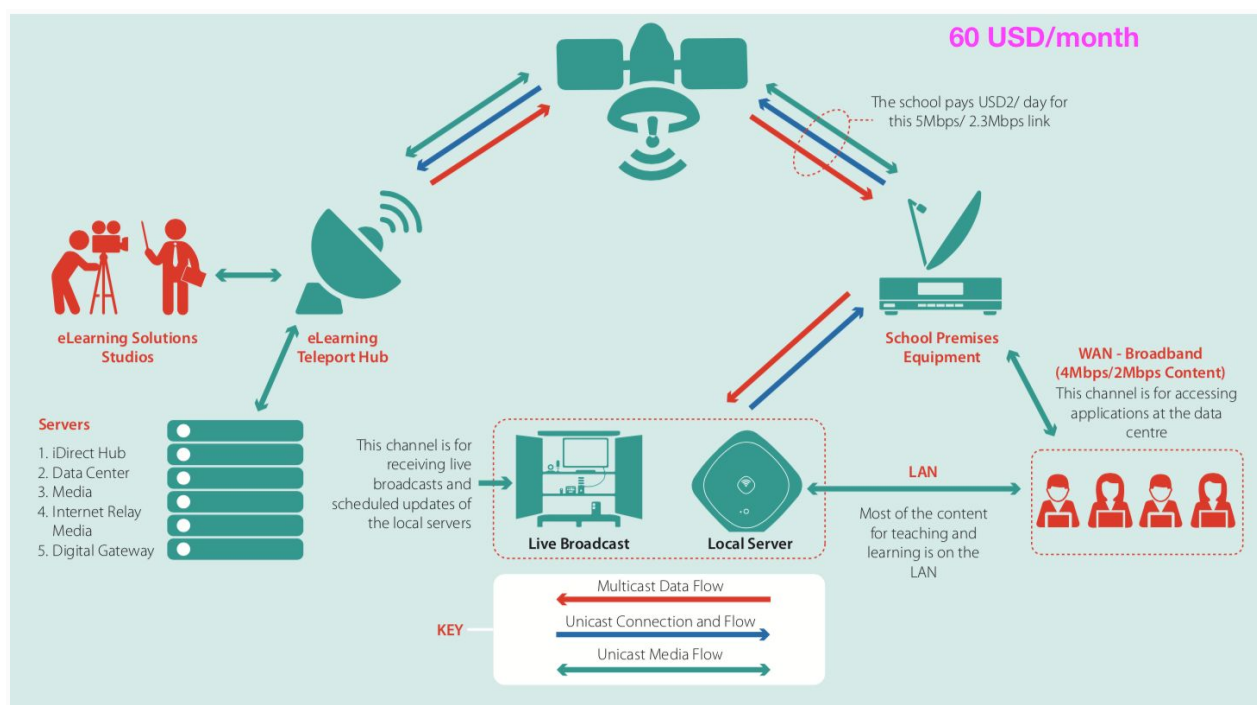


Figure 11. A.8-1: Principle overview over the broadband connectivity by eLearning Solutions

REFERENCES

1. Business models for the last billion, USAID:
<https://mstarproject.files.wordpress.com/2016/05/business-models-for-the-last-billion.pdf>
2. Digital Public Goods, available at: <https://digitalpublicgoods.net>
3. Norway at the forefront of efforts to share digital public goods. (2019). Available,
https://www.regjeringen.no/en/aktuelt/digital_goods/id2682727/
4. GIGA project: <https://giga.partners>
5. Landers (2019). GIGA: A look at the new partnership to develop digital inclusion.
Available:
<https://www.ericsson.com/en/blog/2019/11/giga-partnership-for-sustainable-development>
6. Project Connect: <https://www.projectconnect.world>

7. Business models of Internet service providers, Available *pdf:
https://www.researchgate.net/publication/332819076_Business_models_of_Internet_service_providers .May 2019, Netnomics 20(3). DOI: [10.1007/s11066-019-09130-7](https://doi.org/10.1007/s11066-019-09130-7)
8. Silent airborne 4G : <https://www.4gremote.com>
9. Helikite Aerostat To Lift The World's First Airborne 4G Base Station
<https://www.uasvision.com/2013/10/02/helikite-aerostat-to-lift-the-world's-first-airborne-4g-base-station/>
10. ITU, Digital Transformation Centers. DTC resources, Phase 1
<https://academy.itu.int/main-activities/digital-transformation-centres-initiative/onboarding-workshop>
11. Virtual Fiber for High-Speed Fixed Broadband. Available:
https://terragraph.com/wp-content/uploads/2019/02/Terragraph_MikebudaTrial_Whitepaper.pdf