IEEE Connecting the UNCONNECTED™ CHALLENGE

An IEEE Future Networks Program

2021 WINNING PROJECTS

INTRODUCTION

The IEEE Connecting the Unconnected Challenge is a competition program started in 2021 by the IEEE Future Networks Initiative (FNI). It seeks to reward and spotlight innovative, early-stage work to address one of society's most pressing issues: that Internet access remains elusive for nearly half the world's population.

Having an Internet connection is a lot more than being able to surf the Web. It means having direct access to goods and services around the world and the payment systems that facilitate that commerce; it means an exponential increase in access to educational opportunities; and it means a 24/7 connection to information that can keep people safe and informed.

In our inaugural year, IEEE honored 12 teams from five continents for their innovations across three categories: Technology Applications that increase broadband access or otherwise enable connectivity where it never existed, Business Models that result in increased affordability for internet access, and Community Enablement solutions to convince populations to adopt available broadband access.

Competitors could choose from these categories in two primary tracks: the Proof-of-Concept track, for teams or individuals who had a demonstrated (but early-stage) solution with measurable results; and the Concept Only track, for teams or individuals with a novel idea that had not yet been tested.

Please join us in congratulating this year's winners. In these pages you'll discover a wealth of innovation and inspiration that points a way forward for humanity to fulfill the promise of the Internet: to connect everyone.

Sudhir Dixit
Ashutosh Dutta
IEEE Connecting the Unconnected Co-Chairs

BEST OVERALL WINNERS

Best Overall Proof-of-Concept

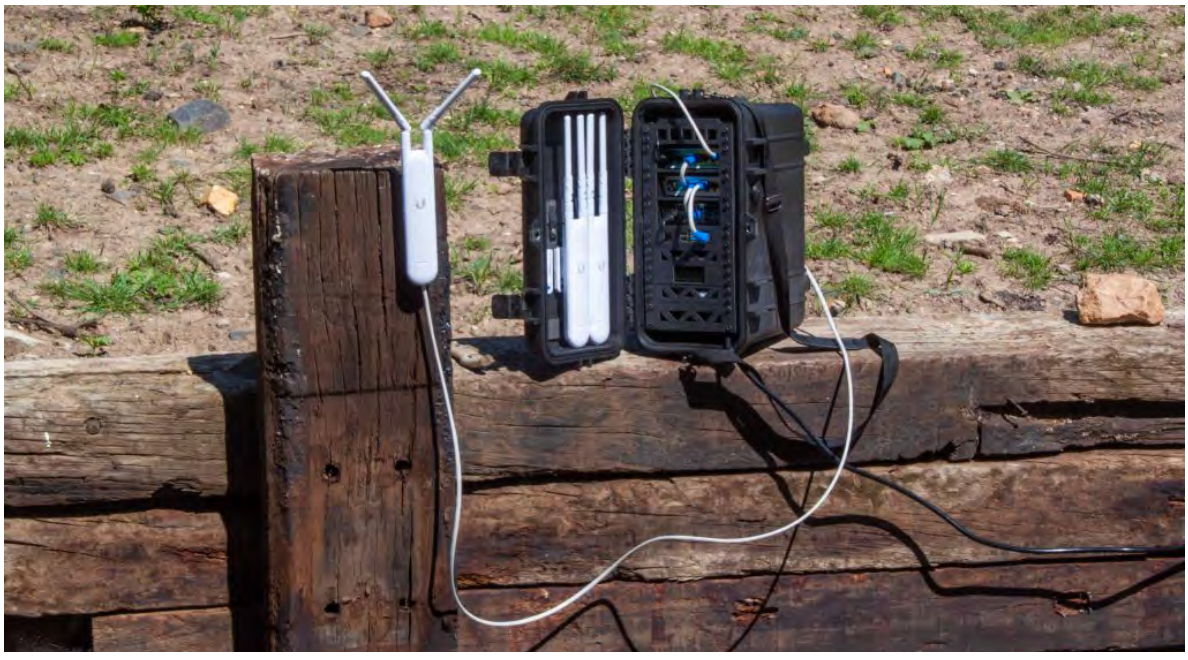
The Nimble – An Open Source, Portable, and Offline-first Wireless Mesh Network designed for and by Underserved Communities
Eric Nitschke (USA, with deployments in Czechia, South Africa and Canada)

More than 2.9 billion people around the world remain unconnected even though over 95% of the population theoretically lives within reach of the Internet. Digital inclusion initiatives are working to address barriers to access including affordability, lack of digital skills, and limited access to electricity. Even after these challenges are addressed, slow speeds, infrequent access, shared devices, and the absence of relevant content in local languages make connectivity less than meaningful for many.

Rather than waiting for coverage and content to make its way to the last mile, the Nimble project focuses on tackling these challenges by enabling communities to build their own localized infrastructure and elevant content and services right at the first centimeter.

The Nimble is an open source, portable, and offline-first wireless mesh network. Importantly, production is done entirely by communities, who co-design and build their networks using locally available hardware and 3D printed components. The 3D designs can be freely downloaded and modified to fit local requirements. To build capacity into the network deployment process, we make open training resources available for "non-techies" on nimble planning, design, 3D printing, construction, configuration, and deployment.

After building the portable network infrastructure, communities have the opportunity to customize what goes on it. Community-curated content can be loaded, together with with free and open-source services that enable 1) online or offline video and audio; 2) calling and messaging; 3) social networking and eLearning; 4) high-speed file-sharing and synchronization; 5) wireless network management; 6) media streaming' 7) collaborative document and spreadsheet creation; and much more. New services can be integrated into the open ecosystem which prioritizes tools that enable locally relevant content creation.



PROJECT IMPACT

By empowering underserved communities to connect themselves in ways they find relevant and meaningful, the Nimble project seeks to localize both supply and demand-side approaches to digital inclusion.

On the supply side, distributed manufacturing of Nimble units reduces the cost and increases the speed of building community wireless networks. Wakoma partners are using this approach to expand the reach and functionality of existing networks and to seed new, low-power networks within and beyond the reach of the Internet. To sustain these networks, communities can share the cost and ownership of infrastructure and offer services which help generate and circulate revenues in local communities instead of going to incumbent operators.

A central reason that adoption falls so far behind availability is that many people don't see the value in the Internet. To ensure that the resulting experience is meaningful, communities decide how they want to use their nimble networks. This can include creating and managing their own content and services, in their own language, in the way they want. It also can utilize 'offline-first' approaches that enable more control over access and data, and a safe 'on-ramp' to the internet where users can develop the digital skills needed to navigate the Internet safely and effectively.

If closing the gap between internet availability and adoption requires communities to see the value in the Internet, there is no better way than to empower communities to build it themselves.

Best Overall Concept

Ba11y, Crowdsource a11y reporting platform

Rahma Utami and Muhammad Noor (Indonesia)

This concept seeks to address the lack of participation of persons with disabilities (PwD) in improving the accessibility to digital products. Although it's true that some countries have established laws to include PwD, expertise in the field remains limited because of the lack of awareness of this topic. Digital access also tends to become an act of compliance for some sectors, instead of listening and accommodating the user's concerns. Organizations consider it efficient and practical just to use automated tools or post-release audit experts to evaluate and increase their accessibility application. There is often little to no involvement of PwD in the process.

PROJECT IMPACT

The Ba11y/A11y concept is designed to onboard PwD in order that they can provide insightful feedback. It extracts and lists measurements and indicators that are descriptive and relatively easy to understand. These indicators can be set through specific questions, checklists, or multiple options to maintain objectivity and standardize the evaluation. The PwD therefore evaluates the accessibility of the products and emphasizes their impact, such as the inability to finish some actions, the necessity of assistance of sighted people, or even life-threatening situations. This personal impact evaluation adds nuance to the implementation, from compliance to increasing a PwD's quality of life.

This concept allows PwD to report a website, an app, or a specific page on a website and app with an accessibility issue. To be a reporter, a PwD needs to sign up with the Ba11y platform and declare their disability condition. The Ba11y platform automatically scans the website or app through an online API after the reporter inputs the website or app URL. The reporter will fill out a set of questions and statements that are true to their experience and provide a subjective evaluation. The questions will be divided into sections, such as accessing the page, images and non-text elements.

Every report will appear on the Ba11y public dashboard, which intends to surface the problem to a broader audience. A website or application can be reported by one or more people. A counter of the number of users reporting the same issue will be shown on the public dashboard to increase the urgency. Social media mentions will leverage this visibility. Ba11y also offers an alert feature for companies to provide feedback to the PwD Community reviewing their service.

FIRST PLACE CATEGORY WINNERS: PROOF-OF-CONCEPT

Technical Proof-of-Concept 1st Place

InterGram: Advanced Digital Development Centers for Delivering Essential Community Services over High-speed Broadband in Rural India

Sarat Pradhan, Niladri Pradhan, and Soumyaprakash Das (India)

InterGram is an eCommunity center that utilizes high-speed broadband as a medium to deliver a variety of relevant services in the areas of education, financial services, agriculture, e-commerce and healthcare to rural populations in India. InterGram is a cost-effective amalgamation of advanced technologies such as virtual reality (VR/AR), Web sensors (IoT), cloud signage and artificial intelligence (AI/ML). It boosts the local economy by stimulating job creation, increasing household income, improving digital skills and expanding general awareness.

PROJECT IMPACT

The InterGram initiative will have a significant positive impact on the quality of life of Odisha's rural population by enabling it to enjoy the true dividends of a digital economy. Broadly speaking, an InterGram center offers the following advanced services to rural citizens:

Live coaching classes for low-income students and job seekers conducted by city-based instructors through live video streaming sessions. Shared tablets, desktops and display screens are provided at the center.

Farm Clinics for farmers that process real-time field data for advance forecasting, detection and communication of pathogen/pest attacks, extreme weather events and abiotic stresses. Data is displayed in the local language at the center.

Enhancement of traditional instruction-led education through emerging AR/VR technologies that expand new knowledge retention (e.g., modern farming equipment or financial technologies) through immersive experiences.

Assisted E-commerce to empower low-literacy rural users to sell local handicrafts, handloom and agricultural products to buyers in India and abroad through trained digital agents at the center.

Remote telehealth consultations with doctors and specialists at city hospitals along with AI-assisted early screening of serious diseases among rural patients in static/ambulatory formats. The first InterGram center is currently operational in the Jajpur district of Odisha state in eastern India and will eventually be scaled up to cover all 209 rural development blocks in the state.

Business Model Proof-of-Concept 1st Place

Napo Project: Platforms to Increase Sustainability and Impact of Communications Services

Ignacio Prieto-Egido, Cesar Cordova Bernuy, Leopoldo Liñan Benitez and Juan Antonio Paco Fernandez (Spain)

The Napo model was ideated as a way to build alliances and increase the sustainability and impact of communications services. The aim is to deploy mobile communications (voice and data) and public services (eHealth and tele-education) in isolated communities by combining low-cost wireless technologies and an innovative business model.

The model is based on partnerships with strategic actors to combine public and private resources and directly impact the living conditions of the population. The stakeholders might vary from project to project, but they will typically be public institutions, universities, non-government organizations (NGOs), and cellular operators. Public institutions will provide the long-term infrastructure in the form of towers. Telecommunication operators will install and manage the network as well as the mobile service for the clients.

By structuring the model this way, deployment costs are reduced so the service is economically feasible and sustainable. For their part, NGOs and universities ensure that telecommunications services are used by the health system (eHealth) and by the educational system (tele-education). In addition, they are charged with training the communities' inhabitants to take advantage of other online services such as mobile banking and administrative procedures. The Napo model has been sponsored by the EHAS Foundation, the Pontifical Catholic University of Peru (PUCP) and the Rey Juan Carlos University.

PROJECT IMPACT

Qualitative and quantitative studies on the Napo Proof-of-Concept show how the communication systems that are deployed have contributed to improving citizens' quality of life. Five key factors were analyzed through surveys and interviews with the beneficiaries: well-being, public management, community participation, local economy and education. The information collected by the field study confirmed the acceptance and demand of connectivity by the population. Because of the Napo model, people are more connected to their friends and family in other communities, providing personal peace- of-mind and the possibility to ask for help and information. Being connected also boosts citizen participation and access to information on issues of interest to their community, generating groups of interaction and social cohesion.

Regarding public management, 87 percent of local authorities surveyed have noticed improvements in communication with other managers and attribute them to better access to telephony. Some 93 percent say they have been able to provide better service to citizens. Moreover, the response capacity, in an emergency, is much higher for authorities with access to mobile telephony (60 percent compared to 30 percent).

Small businesses also show better performance because mobile services give them more access to market information. That means streamlining delivery processes, establishing relationships with similar establishments in other communities, and optimizing business management. Regarding education, 95 percent of students in connected towns have access to a cell phone, 50 percent use it to search for information, and 33 percent use it to study with supporting materials.

Community Enablement Proof-of-Concept 1st Place

Empowering Digital Participation and Affordable Access Through the iNethi Platform

David Johnson and Melissa Densmore (South Africa)

iNethi ('nethi' translates to 'network' in isiXhosa) provides an open source community-based services and content sharing platform to take advantage of the locality of interest in a community. iNethi seeks to build community ownership of the services and content that are provided via a local network. Decisions about choices of services and content are made collectively through workshops with community members. iNethi has a three pronged approach. It seeks to facilitate affordable access to the internet, provide free access to relevant high-value content and services and empowers local champions in the community to own their own infrastructure and services all with an eye toward uplifting the socio-economic conditions in the community where it is deployed

The modular and scalable nature of the iNethi platform makes it suitable to a range of environments from small-scale deployments providing offline access to digital content in a taxi to large-scale deployments with 1000s of users accessing services in a wireless network across a wide geographic area.

PROJECT IMPACT

The system was deployed in September 2018 in Ocean View - a township on the outskirts of Cape Town. The network is fully owned by the community, currently consists of 20 hotspots, continues to grow and is available to anybody who is within range of one of the Wi-Fi hotspots.

During COVID-19 lockdowns, iNethi was used to enable teachers from Ocean View High School to share education content with pupils at no cost in Ocean View in Cape Town. iNethi has also provided low-cost internet at 1/10th of the cost of mobile data networks, thus saving money for internet users in the community and providing income for the directors of the cooperative that run the network in Ocean View.

Furthermore, the iNethi services that allow community members to advertise their businesses, share digital resources relating to healthcare, education, music, and entertainment increase community cohesion and make more people aware of the talent in the community and provide additional income streams.

FIRST PLACE CATEGORY WINNERS: CONCEPT ONLY

Technical Concept 1st Place

Bamboo Towers for Low Cost, Affordable Internet Connectivity to Remote Rural Areas

Sarbani Banerjee Belur, Siddhartha Ghosh and Subhrajit Dutta (India)

In extremely remote rural areas, the most expensive part of establishing Internet connectivity comes from building the infrastructure to the technology, most often in the form of a steel tower. The construction of those towers requires specific equipment and skills as well as a certified design. To make rural connectivity cost-effective and affordable, this concept explores the use of bamboo as the primary material for building towers. Bamboo is a naturally occurring and low-cost building material widely available across a large swath of Asia. Bamboo towers have great potential to enable connectivity in rural areas. They are less costly than steel and involve local businesses and entrepreneurs. In connecting the unconnected areas, bamboo towers can encourage communities to set up their own Internet infrastructure by building bamboo towers and masts. Bamboo towers can also enable community ownership of Internet infrastructure.

PROJECT IMPACT

Using bamboo for tower construction increases the availability of affordable and sustainable communications infrastructure for remote rural areas. A partnership between the Association for Progressive Communications (APC) and India's Department of Civil Engineering aims to construct and demonstrate a design for 15-meter-high wireless communication towers using locally available bamboo in at least three Asian countries (India, Indonesia and Thailand). The partnership is evaluating the effect of local conditions such as wind load, bamboo species selection and treatment, and local soil conditions, by monitoring the towers and testing the components. The goal is to create a detailed set of guidelines, including photos and videos, such that the construction process can be replicated in a systematic way in other locations around the world.

Community Enablement Concept 1st Place

Internet Access in Ecuador's Amazon

Joel Pliskin, Bruno Taborga, Soledad Mills, and Robert Marsh (USA and Ecuador)

Inveneo and Equitable Origin Inc. are U.S. registered 501(c)(3) nonprofits using Internet connectivity to bridge the digital divide in developing countries. Together, this project will improve the world by helping to mitigate the effects of climate change and combat COVID-19 in Indigenous communities, while strengthening the rights of indigenous peoples in Latin America.

Indigenous peoples are an important force in the fight against climate change. According to a recent United Nations report, indigenous peoples of Latin America are by far the best guardians of the region's forests, with deforestation rates up to 50 percent lower in their territories than elsewhere. There is clear evidence that indigenous peoples play a vital role in conserving these forests. It is therefore in everyone's interest to protect indigenous peoples and their cultures. Connectivity allows indigenous peoples to gain access to crucial information, which helps strengthen their rights, gain access to education and health services, increase opportunities for civic participation and enable communication among communities. The risk of indigenous peoples being overlooked both in pandemic mitigation efforts and in the post-COVID-19 recovery process is growing exponentially. This project supports and empowers communities to become more resilient and create sustainable livelihoods.

PROJECT IMPACT

In order to bridge the digital divide and help connect Indigenous Peoples to the internet, Inveneo and Equitable Origin are working with the Corporacion Nacional de Telecomunicación (CNT), the National Telecommunications Corporation of Ecuador. The government of Ecuador is promoting Internet access for all Ecuadorian citizens as a matter of policy and CNT, as a state-owned agency, is cooperating in support of this policy.

This technical solution is one that Inveneo has successfully implemented in numerous locations in Africa, Haiti and South Asia. The project uses off-the-shelf equipment and standard IEEE 802.11 Wi-F signals to create a connection between the village and a nearby cell tower. This can be done at a much lower cost than satellite Internet connectivity. The solution uses two radios, one on the cell tower and the other on the main target location in the village to create a pencil-beam Wi-Fi connection. This connection can then be distributed from the main location to other village locations, either by Wi-Fi or by wire.

While this solution is simple in concept, it is not necessarily easy to execute. Experience and training are needed to properly survey, design, install, commission and maintain these systems. This technique requires a clear line of sight between the tower and the destination village. Inveneo has undertaken a preliminary survey of the region using Google Earth to determine if it can be successfully used in this application. An in-person survey is needed for verification. As part of this project, Inveneo and EO will identify and train a number of local people to administer and support the connection and to assist users. Training and documentation will be provided in Spanish and Inveneo engineers will be available for remote support. This will allow trained indigenous leaders to take over the initiative on the ground and attend to the project.

There is great demand from Indigenous communities for access to reliable broadband connectivity throughout Latin American Amazonia. This project represents a pilot project that we expect to replicate in indigenous communities throughout the region, leading to transformative change for these communities and a better future for the peoples of the Amazon. Using well-understood technology, through a partnership with a major telecommunications partner and a good understanding of the community's needs, we can bring Internet connectivity to remote Indigenous villages.

SECOND PLACE CATEGORY WINNERS: PROOF-OF-CONCEPT

Technical Proof-of-Concept 2nd Place

OVERCOME21: CBRS Deployment in the Fruit Belt Neighborhood in Buffalo, NY

Filippo Malandra, Nicholas Mastronarde, Sunha Kim, Zhangyu Guan, and Houman Saberi (USA)

This project deploys a network infrastructure to provide high-speed Internet connectivity to households in the underserved Fruit Belt neighborhood of Buffalo, New York. The team uses the Citizen Broadband Radio Service (CBRS) band to provide wireless backhaul for in-home Wi-Fi networks. CBRS refers to the 150 MHz of spectrum from 3.55 GHz to 3.7 GHz (which has been recently opened by the FCC) and provides favorable propagation conditions to serve a small neighborhood. The pilot is serving 150 households in the first year, with a plan to scale up the number of households served in subsequent years. This expansion will be possible with limited capital expenditures because of the favorable position of the transmission site and the ability to exploit unused capacity of the network.

Some 64 percent of the Fruit Belt's population has broadband access, which is lower than the 73 percent access rate among American adults. Moreover, 70.3 percent of Fruit Belt households are classified as being low connectivity households, which either have no Internet connection at all or depend on one specific connection type (dial-up only, cell only, etc.). To make things worse, there is a white-BIPOC (black, indigenous and people of color) broadband access gap of 15 percent, with only 62.3 percent of the Fruit Belt's BIPOC population having Broadband access, in contrast with 77.3 percent of its white population.

PROJECT IMPACT

There has been concern among policymakers and administrators over the so-called digital divide. This concern has only intensified because of limited Internet access at public places, such as schools and libraries, during the COVID-19 pandemic, which could further widen existing inequalities. Our project aims to narrow the digital divide by offering high-speed Internet access to underserved households in the Fruit Belt to bring its current low access rate (63.8 percent) closer to the average American access rate (73 percent) during the pilot, and well-above the average American access rate in subsequent years. Moreover, considering higher proportions of BIPOC individuals (85.2 percent of the Fruit Belt population), this project will decrease the white-BIPOC digital divide, which needs to be addressed to promote social inclusion of BIPOC individuals.

This project develops, validates and refines instruments to measure engagement in Internet use for health, education and workforce development. This project also collects background information such as demographic information, gender, educational backgrounds and perceived health conditions.

Business Model Proof-of-Concept 2nd Place

Aggregating Energy & Connectivity in Rural Africa – ICT Hub Model – Case Study Nakivale, Uganda

Conrad Ekisa, Patricia Oviedo, Joaquin Aviles Lopez and Benson Olobo (USA and Uganda)

The ICT Hub Model addresses what remains very prevalent: the urban-rural connectivity gap. Worldwide, 72 percent of urban households have a connection versus 37 percent of rural households. This gap dramatically increases in Africa (28 percent vs. 6 percent) and gets even worse in Sub-Saharan Africa. There are many obvious factors that contribute to this gap, like the lack of infrastructure investment and commercial viability of service provision in rural areas. Another key factor is the lack of access to electricity.

The concept i4SD is a social enterprise that uses innovation to change the way infrastructure systems are designed and operated. It works at the intersection of local data analysis, traditional infrastructure planning, smart metering technologies and digital payments to deliver bankable infrastructure projects, enabling access to services for larger segments of the population. With i4SD, the gap can be framed as an opportunity to aggregate service provision in rural areas and explore innovative and unconventiona business models that can lead to a breakthrough in access to both electricity and connectivity.

PROJECT IMPACT

The i4SD team has been working mainly in sub-Saharan Africa with the Earth Institute at Columbia University and UNDP with more than 250 infrastructure projects. They developed several solar mini-grid projects in Tanzania, Rwanda, Uganda and India, including setting up ICT centers and providing access to electricity to institutions, productive activities, small retails and households. The team is a multicultural and committed group with offices in New York, Uganda and Rwanda. Talented engineers take leadership roles in the operations and management of the projects.

The pilot is located in a sub-zone called Rubondo with a total of 9,508 households, and a population of 35,101. The concept is providing reliable and stable electricity through solar hubs and battery storage to three main areas of impact: an institutional compound, including a health center, school, UNHCR offices and other local institutions; an ICT Center that will provide relevant skills training for the local market and will track the employment rates of course graduates; and an Energy Business Hub & Cybercafe at the trading center that will leverage its location and generate direct income by providing electricity to small business. It will also provide services and sell affordable smartphones and energy products.

Community Enablement Proof-of-Concept 2nd Place

TV White Space & Community Networks Cooperative Societies: Feasible Alternatives to Connect the Unconnected Rural Population

Jabhera Matogoro, Nerey Mvungi, Anatory Justinian, and LuzangoMfupe (Tanzania)

The current digital divide has developed partly because mobile network operators and commercial Internet service providers do not see value in investing in rural areas where the return on investments takes a longer period to be realized. To connect the unconnected population, different solutions ranging from wired to wireless technologies have been investigated using either top-down or bottom-up approaches. This concept uses a community-owned, bottom-up approach and low-cost television white space (TVWS) technology to connect the unconnected population and schools in rural Tanzania.

Results from the pilot by the University of Dodoma confirmed that TVWS infrastructure is better suited to bypass physical obstacles such as heavy foliage, hills and other topographical challenges presented by rural areas. It's also cheaper in terms of initial investment as it avoids most of the expensive wired infrastructure or spectrum fees required by fiber and mobile networks solutions.

The use of geo-location spectrum database in a dynamic-fashion contributes to the efficient spectrum utilization to serve more populations. The economic business model combines seven parameters: 1-4) public-private-partnership+people (4P), 5) income generating activities, 6) capacity building and 7) local content which is missed in the existing telecommunication system design. The community networks cooperative society approach is a self-sustainable model where members of the community network buy shares and pay entry fees as agreed in the by-laws.

Members of the community networks are encouraged to use the service at a cost which helps to generate income for future sustainability. Membership categories vary from individual to organization membership including the Savings and Credit Cooperative Society as well as the Agricultural and Marketing Cooperative Society with different cost schemes for each category. The business charges a small fee from each Internet user connecting to its public Wi-Fi infrastructure. Schools and community centers are the first deployment before a broader deployment to the general public at large. The other revenue streams include charges from running digital literacy programs and local content generation. The revenue streams may also include advertisements, promotional content or sponsorships by private sector enterprises. The project is on target to connect more than 21 million users through this approach in rural Tanzania in a period of ten years.

SECOND PLACE AND HONORABLE MENTION CATEGORY WINNERS: CONCEPT ONLY

Technical Concept 2nd Place

Intelligent and Cost-effective Multipath TCP (MPTCP)-based Framework for the Satellite Internet

Shiva Raj Pokhrel and Anwar Walid (Australia)

Existing satellite communications technologies are not sufficiently robust, affordable, and capable of facilitating Internet services for remotely distributed unconnected populations. A constellation of Low Earth Orbit (LEO) satellites can be designed to provide broadband Internet in unconnected places worldwide, which is an attractive prospect for countries trying to connect remote areas. This research develops techniques for analyzing and designing cost-effective LEO communication for remote Internet applications, including remote schools, farms, factories, and harbors to enable affordable services globally. The project develops a cost-effective, intelligent satellite communication system for the Internet, based on Multipath TCP (MPTCP) for seamless handovers and minimal Doppler effects (connecting multiple LEOs simultaneously, harnessing both radiofrequency and free space optical bandwidths). It uses successful features of the advances in MPTCP and federated learning by employing, an iterative intelligent sensing scheme.

PROJECT IMPACT

Despite the rapid spread of internet use across Asia and the Pacific, almost 2.4 billion people, or 55 percent of the region's population, remain offline, according to the latest data from the United Nations International Telecommunications Union (ITU). More than 3 billion people live farther than 10 km from high-capacity fiber optic cable infrastructure, making the prospect of accessing broadband internet unlikely. The populations of the Asia-Pacific region, particularly in underserved geographies and countries with low international bandwidth, such as land-locked developing states and small island developing countries, could benefit and leverage this solution to expand their Internet connections. Of particular importance to this project are the figures reported by the ITU: Some 81 percent of people in the least developed countries, 73 percent of people in landlocked developing countries, and 50 percent of people in small island, developing states are without Internet access. Our solution can address this digital divide and the gap of Internet accessibility using LEOs.

Although the fields that will benefit from this project in developing countries are many, two areas – with the highest risks but also the highest potential rewards – are farming and harbors (automation/orchestration). The greatest expense is in the design and operation of a fully distributed decision-making system over costly satellite links capable of performing remote communications, such as the logistics of automating a harbor, supply-chains, moving containers, and communicating with incoming and outgoing ships. The weather, waves, marine life and other watercraft that vessels encounter on the open sea will require a ship's crew to possess a local knowledge base to withstand uncertainty and enable prompt communications with the global system.

Business Model Concept (Honorable Mention)

Deliverance: Portable Sonography for Pregnancy and Childbirth in Remote Areas

Joann Canning and Roxanne Giannikos (USA)

Childbirth is both a precious and precarious event in a woman's life. About 295 000 women died during pregnancy and childbirth in 2017 (WHO). The vast majority of these deaths (94 percent) occurred in underserved and low-resource regions with Sub-Saharan Africa and Southern Asia accounting for approximately 86 percent of the total. Despite gains in this area, many complexities of pre/postnatal care and childbirth remain unaddressed. Physicians are rare in such areas, midwives are poorly equipped, and nurses are often unprepared for complicated deliveries or even the essentials of prenatal care. To minimize the mortality rates due to pregnancy and childbirth in under-resourced regions, new solutions are needed.

This concept calls for placing a connected portable handheld sonogram/ultrasonography device in the hands of a nurse or a midwife. In preparation for this, the midwife or a nurse will be enrolled in a sonography certification track (both remote and hands-on). Scalability derives from a requirement that s/he supports the next generation of users. S/he will receive a debit card that will cover her fees directly for each service rendered (i.e., the microenterprise option), ultimately empowering the woman economically. Nurses/midwives associated with the business will reach out to obstetricians and gynecologists to supply an inexpensive fee-based advisory service, in the Cloud, from the physician's home. After review of the transmitted file, the physician will generate an actionable report to the remote nurse/midwife. Language proficiency, clinical qualifications, and openness to new technologies are the prerequisites to all involved.

PROJECT IMPACT

It is envisioned to develop the prototype in the UAE. The prototype involves design validation, user interface builds, review of clinical compliance regulations, database requirements, and addressing connectivity issues of remote geographies. This will be done as a comparative assessment with several portable handheld sonography devices. This will not be a human trial. The test in remote geographies will be the Proof-of-Concept (PoC). Several non-UAE locations are under consideration for the PoC. The business has had expressions of interest from several educational institutions, research organizations and international community-based bodies, and has received in-kind contributions for moving forward.

The business goals are to save lives as well as to build an empowerment vehicle for women in lower-income/resource-limited communities by introducing a novel microenterprise model.

2021 SELECTION COMMITTEE JUDGES

Jeff Abramowitz

Jeff Abramowitz is president and chief executive officer of PowerCloud Systems, a company he conceived while entrepreneur-in-residence at PARC. He is included in the Computer History Museum for his 20-year track record of piloting new technology transitions in the networking industry.

Widely known for driving market adoption of 802.11g while at Broadcom, Abramowitz has developed successful business initiatives involving performance, ease-of-use and technology integration. He also led the creation of industry-wide consortiums promoting interoperability and cooperation (WLANA and the Wi-Fi Alliance). His vision and leadership helped accelerate the technological direction of wireless networking and create the standards-based Wi-Fi market we have today, which includes co-authoring the original IEEE standard for Wi-Fi. Abramowitz also served as an executive at 3Com Corporation, Azimuth Systems, Intersil, and No Wires Needed. Abramowitz received a BSME from the University of Pennsylvania, an MSEE from the Massachusetts Institute of Technology, and an MBA from Stanford University.

Elizabeth M. Belding

Elizabeth M. Belding is a Professor in the Department of Computer Science at the University of California, Santa Barbara. Prof. Belding's research focuses on mobile and wireless networking, including network performance analysis, and information and communication technologies for development (ICTD). She is a co-developer of the AODV routing protocol for mobile networks, on which 802.11s and Zigbee technologies are based in part. Prof. Belding applies her wireless network expertise to a wide range of contexts and is particularly interested in improving Internet and cellular accessibility in developing and resource-challenged communities worldwide. She is an ACM Fellow, AAAS Fellow and IEEE Fellow.

Aaron Deacon

Aaron Deacon is the founder and managing director of KC Digital Drive, a nonprofit civic organization with a mission to make Kansas City a digital leader. He works with mayors, entrepreneurs and civic leaders in Kansas City and around the world to help build ecosystems that connect infrastructure, emerging technology and social impact. He also leads Kansas City's participation in a number of global initiatives including U.S. Ignite, NIST's Global City Teams Challenge, the IEEE Smart City Initiative and the MetroLab Network.

Prior to working in the civic sphere, Deacon honed his skills in innovation management, design thinking product development, strategic planning and qualitative and quantitative research as a consultant and project director for a variety of Fortune 500 clients. He is the founder and principal of the research and strategic planning firm Curiolab. He earned a Master's degree in social science from the University of Chicago and a Bachelor's degree in history from the University of Dallas and taught high school Latin for two years in between.

Jeff Evans

Jeff Evans is a researcher with the Information Communication Laboratory at the Georgia Tech Research Institute, where researchers work to solve complex problems in computer science, information technology, communications, networking and sociotechnical systems. Customers have included those in the Department of Defense, emergency response and health care systems spaces. Evans' research has focused primarily on modes of communications in emerging technologies, particularly wireless systems, and he is involved as a project director for several advanced network and multimedia communications programs. One of his main research foci involves ensuring applications' performance as they migrate across different networks for legacy systems and emerging, high-bandwidth access technologies.

Evans helped co-found GTRI's Foundations for the Future (F3) program, which helps to bring Georgia Tech's expertise into the state's K-12 classrooms. ICL also has nationally recognized initiatives that includes the FalconView™ Program, the National Information Exchange Model information exchange standards; communications research and antenna networks, both for troops and for evaluating IED countermeasures; emergency management technologies; and are developing a comprehensive approach to the Internet of Things.

Paul Garnett

Paul Garnett is Founder and CEO of the Vernonburg Group, a consulting firm based in the United States that works with large and small corporate, international organization, and national government clients to close the global broadband gap, with a focus on policy and regulation, access to financing, technical due diligence, and project and program management. Prior to starting the Vernonburg Group, Garnett spent 12 years at Microsoft where we created and led the Airband Initiative, leveraging a partner-driven approach to extend broadband access to unserved communities in the U.S. and in over 20 emerging markets. This included investing in 25 internet service providers and connectivity hardware and solution providers and running a grant fund focused on early-stage companies.

Prior to launching the Airband Initiative, Garnett led Microsoft's global spectrum policy work and started the Dynamic Spectrum Alliance. Prior to Microsoft, Garnett worked for CTIA-The Wireless Association, the United States Federal Communications Commission, the law firm Swidler Berlin, and Price Waterhouse. Garnett has a Juris Doctor Cum Laude from the Catholic University of America Columbus School of Law and a Bachelor of Arts in Political Science from Union College.

Kurtis Heimerl

Kurtis Heimerl is an assistant professor at the University of Washington working broadly on the space of technology for poverty alleviation with a particular attention to Internet access. He was a recipient of the 2014 MIT "35 under 35" award, the 2018 UW early career Diamond Award, and won "Best Paper" awards at CHI, COMPASS, PETS, and DySPAN and two "Community Awards" at NSDI. Heimerl occasionally publishes on the UWCSE ICTD Blog and serves as a technical advisor at Madrona Venture Labs.

Heimerl's research focus is on the topic of improving Internet access, with a focus on cellular technologies. His goal is to empower communities to solve their own communication issues. The research is currently aimed at making LTE appropriate for community use. He is also focused on issues of environmental sustainability and conservation. Heimerl continues to work with a conservancy in Kenya to develop human-centered tools for community engagement.

Ron Hutchins

Ron Hutchins serves on the faculty in the Computer Science department at the University of Virginia. He participates broadly across networking and research computing. Hutchins worked at the Georgia Institute of Technology in the early 1980s to create a networking laboratory in the College of Computing teaching data communications courses there. After moving to the role of Director of Campus Networks in 1991, he founded and led the Southern Crossroads network aggregation (SoX) across the Southeast. In 2001, after receiving his Ph.D. in computer networks, Hutchins took on the role of Chief Technology Officer for the campus including research computing in his portfolio. In August of 2015, he moved into the role of Vice President of Information Technology for the University of Virginia, working to build partnerships across the campus and the state.

Ramiro Jordan

Jordan is professor and Associate Dean of Engineering for International Programs at the University of New Mexico. He has a quarter-century of experience creating and leading STEM education, R&D and entrepreneurial organizations and activities in Ibero-America and other regions in the world. He is a leader in international engineering education research. Jordan has proven capabilities in fund-raising and creating partnerships, regionally and internationally, among academia, industry, government and multilateral organizations. He also has extensive experience in education, industry and entrepreneurship. Jordan received a B.E. in Electrical Engineering from the Universidad Nacional de La Plata, Argentina in 1981. He received an M.S. and a Ph.D. in Electrical Engineering from Kansas State University in 1984 and 1987, respectively.

Abhay Karandikar

Professor Abhay Karandikar is currently the Director of the Indian Institute of Technology Kanpur, one of the premier technical institutes of India. Before that he served as Institute Chair Professor in the Department of Electrical Engineering at Indian Institute of Technology Bombay, where he also served as Dean (Faculty Affairs) and Head of the Electrical Engineering Department. He spearheaded a national effort in setting up Telecom Standards Development Society of India, India's standards body for telecom with participation of all stakeholders.

Karandikar was the founding member and former Chairman of TSDSI. He serves as member of the Board of Governors of IEEE Standards Association. He was also a member of the Telecom Regulatory Authority of India from January 2017 to January 2020. He was member of a forum on 5G set up by the Government of India and chaired the 5G Spectrum Policy Task Force. He currently chairs 6G Spectrum Policy Task Force and has several patents issued and pending, contributions to IEEE, 3GPP standards, contributed chapters in books and copious international journal papers.

Fatema Kothari

Fatema Kothari is the Director for Operations & Strategic Initiatives for Microsoft's Airband Initiative within the Technology & Corporate Responsibility organization. She leads Airband's global operations to expand internet connectivity to unserved communities through partnerships across five continents. Fatema is an avid advocate for gender parity in technology. She served on the board for the global non-profit Girls in Tech SF for three years and currently is an advisor to leading women entrepreneurs from Africa through the TechWomen program run by the U.S. Department of State. As an advisor on digital equity, Fatema has also contributed her expertise to the Federal Communications Commission's Advisory Committee. An engineer by education, Fatema holds a Master's degree in Telecommunications from the University of Maryland, College Park. Outside of work, Fatema spends her time experimenting with DIY craft projects and plotting exhaustive maps of her future travels.

Kate Krukiel

Kate Krukiel is the General Manager of the newly formed United Nations Digital Solutions Centre focusing on incubation of innovative solutions to drive efficiencies for back-office services. In addition, she is the Managing Director of Sera Afrika, a data driven policy start up based in Nairobi. She has more than 20 years of experience building solutions, teams, and business models to spur social and economic development. Krukiel brings expertise in the creation of sustainable partnerships between government, private sector and the UN/NGO world which are critical to the successful development of Africa. Most recently Krukiel was the Global Director of Strategic Partnerships within Microsoft's Worldwide Industry organization, which created transformational change through technology. In that capacity she bridged the digital divide in partnership with a multitude of international organizations, including primarily the United Nations. In this role she developed a deep understanding of creating impact across the private sector to development space, including a TEDx talk.

Andrés Martínez-Fernnández

Andrés Martínez-Fernnández is Vice-Rector for Planning and Strategy and Associate Professor at the School of Telecommunications Engineering of the Rey Juan Carlos University. He is an expert on telecommunications engineering and telecommunications networks in developing countries. He has been a member of the Ashoka Social Entrepreneur Network since 2009. His main line of research is oriented towards the application of ICT to improve the quality of life of isolated and dispersed populations in developing countries, working especially in rural communications and telemedicine.

Martínez-Fernnández has directed many research projects funded by national and international entities such as the European Commission, the World Bank, the Inter-American Development Bank, the Andean Development Corporation, AECID or USAID. He has published more than 30 articles in high-impact indexed journals and edited and written several books on the subject. He has promoted the creation and coordinated of the EHAS Foundation from its inception until 2017.

Marja Matinmikko-Blue

Marja Matinmikko-Blue is Research Director of Infotech Oulu and Director of Sustainability & Regulation at 6G Flagship in the University of Oulu, Finland. Previously, she worked as Research Scientist and Senior Scientist at VTT Technical Research Centre of Finland Ltd. from 2001 to 2015. Matinmikko-Blue completed her Dr.Sc. in Telecommunications Engineering in 2012, and Ph.D. in Management Sciences in 2018 at the University of Oulu.

She conducts multi-disciplinary research on technical, business, and regulatory aspects of mobile communications in collaboration with industry, academia, and regulators. Matinmikko-Blue has coordinated several national research project consortia that have successfully demonstrated the world's first licensed shared access (LSA) spectrum sharing trials and introduced a new local (private) 5G operator concept. She has published more than 170 scientific publications and prepared more than 150 contributions to regulatory bodies. She coordinated the preparation of twelve 6G white papers in 6G Flagship and led the development of the white paper on 6G Drivers and the United Nations SDGs.

Frank McCosker

Frank McCosker is the Director of Global Good Net Works where he specializes in developing Strategic Partnerships for clients globally. He is an advocate and senior advisor for the TV White Space industry globally. McCosker is also an expert in developing innovative ways to make access to finance more affordable for the ICT ecosystem in African countries.

He spent 20 years at Microsoft in various roles, including as General Manager of Affordable Access and Smart Financing in Microsoft's 4Afrika Initiatives. He was responsible for designing and implementing affordable access projects in many countries on the African continent utilizing new technologies including TV White Spaces and dynamic spectrum allocation.

Throughout his career, McCosker has combined a distinguished career of business, philanthropic and humanitarian leadership with a personal life of public service. He graduated in Business Studies (B.A. with Honors) from the Polytechnic of North London in 1991 and prior to joining Microsoft worked in variety of roles in ICL including General Manager of ICL Ukraine, where he spent two years.

Helena Mitchell, Ph.D.

Helena Mitchell is a Regents' Researcher at the Georgia Institute of Technology. This title represents the highest status bestowed by the Board of Regents, University System of Georgia. In tandem, Dr. Mitchell is Principal Investigator for the Rehabilitation Engineering Research Center on Wireless Technologies, which through research and development works to create a transformative future for people with disabilities to access the wireless ecosystem. She was the founding executive director of the Center for Advanced Communications Policy, developing a diversified funding portfolio from entities such as NSF and Dept. of Education.

She has previously served as PI for projects funded by the U.S. Department of Homeland Security. Dr. Mitchell's areas of specialty include advanced technologies, emergency/public safety communications, regulatory policy, and universal service to vulnerable populations. She has held executive positions at the Federal Communications Commission and U.S. Department of Commerce in Washington, DC. Dr. Mitchell received her doctorate from Syracuse University.

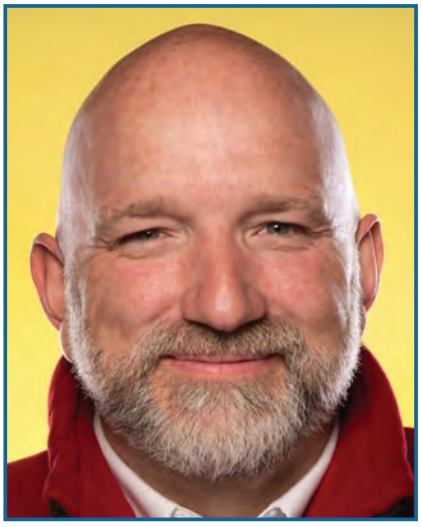
James Moed

James Moed is a Design Director at Viasat where he leads teams of designers and researchers focused on delivering internet connectivity to hard-to-reach places, from rural villages to jetliners. For the past 17 years he's worked with product teams around the world to understand customers' real lives, inspiring new ventures and user experiences.

Bitange Ndemo

Bitange Ndemo is Professor of Entrepreneurship at the University of Nairobi's Faculty of Business and Management Sciences. His research centers on the link between ICTs and small and medium enterprises with emphasis on how ICTs influence economic development in Africa. He chairs the Kenya Distributed Ledgers and Artificial Intelligence Taskforce that is developing the country's roadmap for digital transformation. He is an advisor and board member to several organizations including Safaricom, OECD Expert Panel on Artificial Intelligence and Blockchain, and World Economic Forum's Global Blockchain Council.

Ndemo is a former Permanent Secretary of Kenya's Ministry of Information and Communication in Kenya where he was credited with facilitating many transformative ICT projects including building of undersea cables, open data initiatives and the Silicon Savanah. He is a Senior advisor to U.N.'s Global Pulse (Big Data initiatives) and the UNCDF's Better than Cash Alliance and UNICEF's Innovation Council. He is an Open Data/Big Data evangelist and dedicated to simplification (visualization) of data for ordinary citizens to consume.



Gisli Olafsson

Olafsson is a Member of Parliament in the Republic of Iceland. Upon his election to the parliament he brought a lifetime of experience in crisis management, innovation, digital transformation and helping those in need to the capitol. Over the past two years Olafsson has led the digital transformation of one of the largest social enterprises in sub-Saharan Africa in the role of Chief Technology Officer. In the midst of a global pandemic, his team leveraged an accelerated technological transformation to continue the organization's operations in some of the most austere environment possible. Before that he led the digital transformation of the oldest investment bank in the Nordics as their Chief Technology Officer. Olafsson has mentored founders and has advised CEOs, CTOs, CIOs, executive directors, and government officials. He sits on the boards of organizations around the world and has spoken at more than a hundred conferences. He also mentors and guides start-ups in Silicon Valley, the Nordics, and Africa.

Louis Otieno

Louis Otieno has more than 30 years of experience in business as well as the information and communications technology sphere and has worked for private companies such as Microsoft as well as for government led companies. After spending time working in the Unites States, Otieno returned to Africa in 1997 to spearhead Microsoft's expansion across Africa. He held multiple influential positions within Microsoft, including Director for Marketing, Director for Business Operations, Director of the Enterprise Sales Groups and General Manager for East and Southern Africa. He was one of the highest ranked Africa-based directors at Microsoft.

Otieno was the founding director of 4Africa, a Microsoft-led initiative which was launched to use ICT to accelerate its growth. On behalf of Microsoft, Otieno worked with various African governments and regional organizations to develop new innovation led policies. He mentors numerous young professionals in Africa, some of whom have gone on to lead multinational ICT businesses and organizations across Africa.

Moses Owiny

Moses Owiny is the founder and CEO of the Center for Multilateral Affairs (CfMA) a platform that seeks to aid policy thinking and contribute to research integrating global south perspectives in domestic, regional and global policy discourses. His most recent research work focused on cybersecurity and state capacity in Uganda as well as an assessment of how internet shutdowns undermine Cyberstability in the East African region.

In June 2021, he served as an external co-chairman and program committee member for the 10th edition of RightsCon. In 2011 he worked with the YWCA of Gennesee County in New York, building ICT capacity and supporting projects that improve the career ladder of local low-income women. Moses is an alumni of the 2014 African School on Internet Governance. He is also the Global Youth Catalyst for the Gender in Agriculture Partnership (GAP). He holds a (Hons) Bachelors Degree of Arts, a Masters Degree in International Relations and Diplomatic Studies, from Makerere University and a Post Graduate Diploma in Public Policy and Governance (1st Class Honors) from Uganda Management Institute.

Harri Saarnisaari

Harri Saarnisaari received his Ph.D. from the University of Oulu in 2000, where he has been with the Centre for Wireless Communications since 1994. He is a university researcher and his current research interest includes remote area connectivity within 6G. He led the 6G white paper writing group on remote area connectivity in 2020.

Javier Simó-Reigadas

Javier Simó-Reigadas got his Telecommunications Engineering B.Sc. and M.Sc. degrees in 1996 with the Technical University of Madrid (UPM). He dedicated 11 years as a professional to promoting connectivity and information dissemination of disadvantaged communities in developing countries and for organizations working for development and human rights, working at EuroSur Network (Spain), Songhaï (Benin), BorgouNET (Benin), and EHAS (Spain & Latin America). After receiving his Ph.D. (UPM, 2007), he participated in more than 20 research projects and produced more than 50 international publications including papers in journals, international conferences, books and book chapters, most of them on ICT for developing regions. He joined the URJC in 2005 where he is currently an associate professor. He has earned two master's degrees (2008-2014), been Deputy Director of Academic Organization at the School of Telecommunications Engineering between 2012 and 2017, and since 2017 has served as director of the school.

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Ashutosh Dutta

Ashutosh Dutta is senior scientist and 5G Chief Strategist at The Johns Hopkins University Applied Physics Laboratory (JHU/APL). He is also a JHU/APL Sabbatical Fellow and adjunct faculty at Johns Hopkins. He serves as the chairman for Electrical and Computer Engineering in the Department of Engineering for Professional Program at Johns Hopkins. An IEEE Fellow, his career spans more than 30 years and includes positions as Director of Technology Security and Lead Member of Technical Staff at AT&T, CTO of Wireless for NIKSUN, Inc., Senior Scientist and Project Manager in Telcordia Research, Director of the Central Research Facility at Columbia University, adjunct faculty at NJIT, and Computer Engineer with TATA Motors.

Sudhir Dixit

Sudhir Dixit is a co-founder and Senior Fellow at the Basic Internet Foundation in Norway and heads its San Francisco office. An IEEE Fellow, Dixit has more than 30 years of experience in computer networking and telecommunications and related fields. From 2015 to 2017 he was the CEO and Co-Founder of a start-up, Skydoot, Inc, in the cloud-based and collaboration space. From December 2013 to April 2015, he was a Distinguished Chief Technologist and CTO of the Communications and Media Services for the Americas Region of Hewlett-Packard Enterprise Services in Palo Alto, CA, and before that was the Director of Hewlett-Packard Labs India from September 2009. Prior to joining HP Labs Palo Alto, Dixit held a joint appointment with the Centre for Internet Excellence (CiE) and the Centre for Wireless Communications (CWC) at the University of Oulu, Finland. From 1996 to 2008, he held various positions with leading companies, such as BlackBerry, Nokia. From 1987 to 1996, he was at NYNEX Science and Technology and GTE Laboratories (both now Verizon Communications).

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