

**APT EBC-J Category II: ICT Pilot Project for Rural Area**



**Effective Broadband Infrastructure for Development of Communities  
in  
Dullu Municipality  
Karnali Province  
Nepal**

**Final Report**

September 29, 2019

**Submitted By**

Center for Information and Communication Technology for Development, (**ICT4D**), Nepal  
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## **Acronyms**

<b>AP</b>	Access Point
<b>APT</b>	APT Pacific Telecommunity
<b>BBL</b>	Building Bye Laws
<b>CAPEX</b>	CAPEX Expenditure
<b>CDN</b>	Content Delivery Networks
<b>IPT</b>	Integrated Property Tax
<b>IRS</b>	Intermediate Repeater Stations
<b>ITU</b>	International Telecommunication Union
<b>ITU-T</b>	International Telecommunication Union - Technology
<b>LAN</b>	Local Area Network
<b>LMC</b>	Last Mile Connectivity
<b>LMS</b>	Learning Management System
<b>MBR</b>	Main Backhaul Route
<b>MoCIT</b>	Ministry of Communication and Information Technology
<b>MoFAGA</b>	Ministry of Federal Affairs and General Administration
<b>NBC</b>	National Building Code
<b>OFC</b>	Optical Fiber Cable
<b>OPEX</b>	Operating Expenditure
<b>SaaS</b>	SaaS
<b>SM</b>	Subscriber Module
<b>UAV</b>	Unmanned Aerial Vehicle
<b>WAN</b>	Wide Area Network
<b>WPL</b>	Wireless P2P (Point to Point) Link

## **Executive Summary**

This final report has been submitted to Asia Pacific Telecommunity Secretariat, Bangkok, Thailand for “Bridging the Digital Divide in Dullu Municipality, Nepal.”

The Pilot Project Summary, Introduction, and Project Area Description are covered in Section 2, Section 3 and Section 4 respectively. These sections detail the background and motivation of implementing this project. Dullu Municipality is a remotely located region of Nepal, and the project team believes that connectivity that underpins citizen centric services will bring about meaningful and sustainable change. Section 6 delves into the Project Priority, and the selection of appropriate technology intervention that is context driven and applicable to Dullu Municipality. Section 7 compares the proposed timeline of the project with the actual activities with descriptive details of each activity along with their associated dates. Section 8 focuses on the project’s uniqueness which are Public Private Partnership model to ensure long term sustainability and applicability, the Do-It-Yourself technology associated with network layout, and a collaborative health delivery model for Dullu Municipality’s residents. Section 9 discusses the finer nuances of the actual Optical Fiber Cable and Wireless Point to Point network in great detail. Section 10 describes the current applications that are being used by the hybrid network in Dullu and the advantages to the local residents. Section 11 mentions the possible future research and way forward activities which may be continued with project extension and which will build on top of the current project. Section 12 describes the feedback which was collected at Dullu through discussions with local residents, business owners, and civil society members. Section 13 reports on the feedback of the joint Japanese Team of KDDI Foundation and OCC, Inc., Japan in detail. Section 14 mentions Dr. Haruo Okamura’s ITU-T activities and contribution to the project. Section 15 covers the activities of the Inauguration Ceremony held at Dullu Municipality on May 29, 2019. Section 16 describes the current status of the project and ICT4D role which is ongoing. Section 17 covers the accounting and budget details. Section 18 delves into future expansion of the project with domains of citizen centric services and resilience through locally cached systems and networks. In Section 19, the contribution of each project team is mentioned, while in Section 19, the project team acknowledges the assistance from Dullu Municipality, Dullu Hospital and its doctors, and APT. Section 20 is the conclusion of the entire project. The project team acknowledges the contribution to the success of this project to all stakeholders.

## **1. Summary of the Pilot Project**

This project envisions to implement scalable and robust information/communication infrastructure to provide various broadband related services to Dullu Municipality, Dailekh District, located in Western Central Nepal. Dullu Municipality consists of approximately 5,900 households, with a population of approximately 45,000. Even though it has been declared a municipality, Dullu lacks a modern and robust communication network and its development indices (health, education, etc.) are one of the lowest within Nepal.

Hence, the project team's effort was to establish a highly available ICT network that will underpin outreach efforts in communication, educational, health, tourism, commerce, etc. However, the proposal specifically focused on telecommunication infrastructure development, which will thereby provide the framework to provide telemedicine services. The project envisions the same infrastructure to support a web based educational/academic network in addition to deliver effective Government to Citizen (G2C) services.

Dailekh district, which encompasses Dullu Municipality, has approximately a total population of 261,000. Unfortunately, the entire district has only one district level hospital. The doctor to patient ratio is extremely low and in certain instances made worse, since patients have to travel for many hours and even days to reach a basic health service center for the most ordinary medical examination. This project's success will benefit a myriad of online services for approximately 50,000 people (apart from the Dullu population).

Our project proposal included the installation of a unique lightweight and robust optical fiber cable where the cable has a stainless steel tube that protects the optical fibers. One of the many advantages of such a cabling system is that it ensures a stable, robust and low capital investment network, which can overcome a wide range of geographical barriers and climatic conditions. The project also aimed to establish wireless links to connect remote ward offices with Head Office of Dullu Municipality and the District Hospital to support online services and various web based applications that are relevant to holistic community development.

## **2. Introduction**

The details of the pilot project are mentioned below.

### **2.1 Project Details**

*The project details are as follows:*

1. *Project Name:*

Effective Broadband infrastructure for development of communities in Dullu Municipality, Nepal

2. *Reference:*

APT/Cat-II/Result/App/2017, 9 January 2018

3. *Category:*

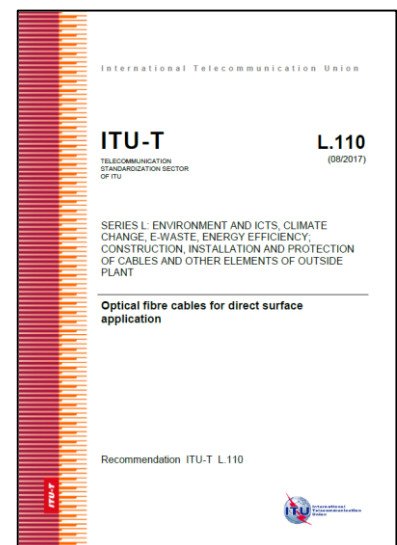
ICT Pilot Projects for Rural Areas (Category II) 2017 funded by Extra Budgetary Contribution from Japan.

## 2.2 Objectives

The objectives of this pilot project are as follows:

1. To comply with the *APT Objective*: Promote telecommunication services and information infrastructure and maximize the benefits of information and telecommunications technology for the welfare of the people in the region;
2. To comply the *Grant Objective*: To narrow down the digital divide through the promotion of pilot projects to support access to ICT in rural areas and to facilitate development of ICT infrastructures/services in the region. This project's sustainability is based on the Public-Private Partnership (PPP) model its success can be replicated in other parts of the country or region;
3. To establish a sustainable and robust broadband infrastructure and provision for online services related to governance, health and education. However, the major focus is on communication infrastructure development and delivery of health services in order to ensure an effective and affordable health delivery paradigm. The project also aims to develop an information system based on health data generated during the health services delivery process.

4. To deploy and test an affordable and sustainable optical fiber cable network under non-trivial natural environment conditions in Nepal. The solution is completely in consonance with the newly ITU-T standardized L.1700, L.110 and L.163. The ITU-T L Series documents are available in **Annex 2**. It is a unique direct burial optical fiber cable encased within a stainless-steel tube. This design renders it inherently stable and robust against foraging wildlife, geological conditions, and climatic events. The cable is thin, light-weight, and can be easily handled. Thus, it can be installed on a low cost basis on the ground, buried, suspended and repaired as needed. The reliability of the optical fiber cable link is extremely high and it can be implemented through a do-it-yourself (DIY) approach by local communities. Hence, APT grant could effectively lead to a chain reaction within the larger South Asian regional context of similar remote and rural regions;



**Figure 1: ITU-T L.110**

5. To deploy wireless solutions to connect remote governance centers, i.e., municipal ward offices;
6. To align with The Broadband Policy of Nepal has embraced key objectives to provide meaningful, affordable and reliable broadband services in urban areas and universal access to broadband services in rural, remote, unserved and underserved areas. Its mission statement has clearly outlined the need to develop a broadband network with a special focus on rural and remote areas for bridging the digital divide; thereby

leveraging broadband services for achieving sustainable development outcomes. Hence, the grant definitely justified the policy.

### **2.3 Purpose of this Pilot Project**

The major pilot project purposes are:

1. *Implementation of optical fiber cable technology in rural areas to narrow down digital divide*

The ITU-T standardized optical fiber cable (L.110) will ensure that a scalable, cost-effective, and resilient network is available to service providers in the area. This project's holistic implementation methodology will deliver a novel perspective in sustainable technology operations and management. These business case processes of introducing modern networking technology in can be shared with other countries.

2. *Demonstration of relevant applications over broadband*

Broadband Internet is an effective tool that must be deployed to access necessary and effective citizen services for the holistic growth of the entire community. This network will underpin many such services, which will positively affect the development of Dullu Municipality.

3. *Introduction of Innovative Products and Service Delivery Models*

- Armored optical fiber cable: Will encourage community participation through a DIY methodology. Special training, trenching, and cable management is avoided.
- Wireless Devices: These devices will be deployed to ensure 100% connectivity with all municipal ward offices that are not directly accessible through the fiber network.
- Telemedicine Services Model: The municipal health services will be delivered through two major models, which are Community Accessibility and Collaborative Consulting. Modern medical devices, which are both accurate and conform to POCT (point of care testing) will be introduced to facilitate both models.

4. *Effective use of grant for community development*

The grant will have a direct impact on the people and community of the Project area in Nepal by ensuring proactive public health campaigns through supporting 'Safe Motherhood Programs', 'Diabetes and Hypertension (NCD)', and 'Senior Citizen Programs'.

5. *Capacity Building of Municipal Ward Offices*

With municipal ward offices spread over Dullu Municipality in different rural, the broadband network will support citizen service delivery. These citizen centric public services will ensure effective and grassroots governance. It will save accessibility time, ensure transparency, and contribute towards developing a 'participatory democracy' framework within the municipality.

## **2.4 Partners in this Pilot Project**

The project group partners and key personnel include the following:

### **1. Applicants**

- Ministry of Communication and Information Technology (MoCIT), Nepal
- Centre for Information and Communication Technology for Development (ICT4D), Nepal
- Dullu Municipality, Dailekh, Karnali, Nepal
- KDDI Foundation, Japan
- Global Plan, Japan
- OCC Japan, Japan

### **2. Chief Expert**

Dr. Bhushan Raj Shrestha (ICT4D), Nepal

### **3. Project Coordinator**

Mr. Pavan Shakya (ICT4D), Nepal

### **4. Accounting Coordinator**

Mr. Yosuke Uchiyama (KDDI Foundation), Japan

## **2.5 Outline of the Pilot Project**

This pilot project includes the following major activities

1. Design, implement, and handover a robust broadband network underpinned by optical fiber cable within Dullu Municipality to deliver various citizen centric services, and provide resilient backhaul connectivity to third party service providers. This network connected Dullu Municipality Head Office, Ward Offices, Schools, Government Offices, and Dullu Hospital.
2. Point-to-multipoint broadband connection among Dullu Municipality, remotely located health stations and Municipal Offices.
3. Delivery of telemedicine and community health services, distance learning, and effective e-governance services over highly available network connectivity, which have been facilitated by Dullu Municipality.



**Figure 2: Aerial View of Dailekh District, Karnali Province, Nepal**

Optical fiber connection between main building (estimated 8-12 km for backhaul connection) In order to provide effective G2C service and as part of the e-governance program, thirteen point-to-multi-point wireless connecting Dullu Municipality office with remote offices is proposed. This will help citizen to access to avoid hours of walking in tough hilly areas to get services. The same link will serve as telemedicine network.

## **2.6 Project Milestones**

1. Acceptance to APT refer to the selection
2. Reconfirmation of this project among members
3. Kickoff meeting (5 persons 2 nights from Japan to Nepal)
4. Research and study in each organization
5. 5 months after selection, the interim report (Activity and Accounting)
6. Design and procurement
7. Network installation
8. Evaluation of Project and Feedback
9. Improvement and Wrap-up meeting (5 persons 2 nights from Japan)
10. Final report to APT (Activity and Accounting Report)
11. Presentation at ADF-16.

## **2.7 Expected Output and Local Contribution**

These project deliverables, and contributions by the direct project beneficiaries demonstrate the nature of the direct and sustainable impact to the Dullu Region and the commitment in ensuring the project's success completion and its long term sustainability.

1. All concerned citizens in the project area including service providers will benefit from a robust backhaul technology in remote and rural geographic conditions.
2. The local government and the central government can run value added services over the network.
3. Community health and public health initiatives that align with both Central, Provincial, and Local Governments will ensure targeted health programs and SDG mandated health indicators.
4. The network will provide an underpinning support system that provides security, economy, education and healthcare to its residents.
5. The citizen centric services delivered over the network will be part of the development process and provide an impetus for transparent and accountable governance.
6. Dullu region will be accessible for both field and academic research. It will be able to provide necessary infrastructure to conduct experiments and foster an academic and learning environment.

## **2.8 Justification to the Brunei Statement**

The Pilot Project was aligned with the APT Brunei Statement, and are justified by the salient and unique features.

### **a. Conducive Policies for Sustainable growth of ICT and Smart Digital Economy**

Since one of the project owners will be Dullu Municipality, the city office responsible for the harmonic growth of the concerned city will be directly involved to make the project successful and sustainable thereby harnessing conducive environment for the effective usage of ICT.

### **b. Safe and secure society through ICT**

As envisioned in the proposal, the network will be deployed for various application including security features and effective information system required as per the community need.

### **c. Trust and Confidence in ICT**

With the effective usage of inclusive service like telemedicine in the project area, the trust and confidence of such implemented project will be highly evaluated by the project community.

### **d. Sustainable ICT ecosystem for Innovation**

The project has thought of effective usage of broadband, which means, the infrastructure will be deployed for information technology as well. Hence, innovation (as per the local need) in terms of information system is well thought of and will be encouraged among youths.

### **e. Capacity Building and Institutional Development**

With the effective usage of ICT and broadband services, it is envisioned that community will come forward to develop or enhance skills thereby seeking/applying relevant information that is required to survive, adapt, and thrive in the fast-changing world.

### **f. Fostering regional cooperation for ICT Development**

Though the project is being thought of in a small part of Nepal, its success will can be replicated and

studied at various levels to adopt lessons-learnt.

The pilot project envisioned the operational modality under a socio-entrepreneurship and PPP (public private partnership) model. Both models have two major components - active participation of the local organization/community/government as one P, government stake as another P, and their interaction as the third P. Since the community benefitted from the project, their active participation was essential. Similarly, the role of government actors like Ministry of Communication Information Technology (**MoCIT**), Dullu Municipality, and District Office of Dailekh were also pertinent for long term sustainability.

Their contribution in policy formulation and necessary co-ordination at different stages, both prior to and during the project implementation phases provided the necessary impetus for the successful handover and current operation of the project. The dialogue between the project team (ICT4D) and these entities continues and any formal requests related to the APT Dullu Project are communicated.

## **2.9 Support from the Beneficiaries, Stakeholders, and Government of Nepal**

The Government of Nepal through its various entities have contributed indirectly and directly to the success of sustainability of the pilot project. The ICT4D project team has been in regular communication and have updated various agencies through official and informal channels:

1. Dullu Municipality fiscally contributed in labor wages, electric grounding, training workshops, and heavy machinery costs to total amount of approximately USD 20,000.
2. ICT4D contributed in office space management, local resource management, travel of engineers and other technical human resources for a total cost of approximately USD 10,000.
3. The **MoCIT** has contributed the ICT development of Dullu Municipality by approving and facilitating the deployment of the OFC backhaul network through various approvals. They also approved the tax exemption of customs duty and value added tax (VAT) on imported Optical Fiber Cable.
4. Mobilization of USO fund has been sought through the Government of Nepal's Rural Telecommunication Development Fund (**RTDF**) for the expansion of the services that the pilot project may provide to adjoining villages and to replicate the project in other similar areas for the benefit of the local community.
5. Ministry of Federal Affairs and General Administration (**MoFAGA**) through Local Government Communities Development Program (**LGCDP**) was approached for e-governance activity related to the local communities to avail government services. ICT4D contributed through a separate project to Dullu Municipality's e-governance initiatives and an Electronic Building Permit System (**e-BPS**) application was deployed for safe livelihood through building code permissions and compliance.
6. Ministry of Health and related agencies contributed by supporting telemedicine programs in the pilot project area.

## 2.10 Sustainability of Pilot Project

The project team envisioned a multi-sectorial, multi-stake, and uniformly distributed business model that would foster long term project sustainability through participatory democracy, and citizen involvement.

1. Apart from government contribution, the project team was able to successfully involve the local community through Field Group Discussions, and other brainstorming sessions to participate and come forward to ensure the sustainability of the operations.
2. The local government agencies, including Dullu Municipality, will be participating in the pilot project in terms of labor and other required local resources.
3. During and after the completion of the project, the local business community will come forward to help to make the project sustainable thereby undertaking business modalities of the proposed project. Such business initiative will be very useful for the operation and maintenance of the project too.
4. The local authorities will be providing access to lay the fiber and to erect tower (if necessary) to host the network.
5. Later in the phase, the network will be connected to the national backbone by utilizing the local resources and Internet access will be made available. Such initiative will have higher impact on the sustainability of the project.
6. The local schools and other development partners will be taking initiative to run the project under PPP model which is again another business model for the sustainability of the project.
7. As positive feedback spreads to other villages, regions this will increase demand of networking services, e-governance services. We envision that it will not be limited to G2C, but rather G2B and/or B2B at all level.

## 2.11 Approved Budget by APT

The following summary describes the budget approved by APT.

<b>S N</b>	<b>Item Description</b>	<b>Amount (USD)</b>
<b>1</b>	Equipment procurement	135,675
<b>2</b>	Shipping Fee	14,000
<b>3</b>	Business Trips	24,888
<b>4</b>	Miscellaneous	3,400
	<b>Total Budget (USD)</b>	<b>177,963</b>

**Figure 3: APT Dullu Project Budget Summary**

### **3. Pilot Project Area Description**

Dullu Municipality is an emerging semi-urban region located in Dailekh District of Western Central Nepal's Karnali Province, with 5,900 households and a total population of around 46,000 and is historically, culturally and ethnically diverse with myriad flora and fauna including herbal plants. The municipality consists of 13 ward offices (municipal administrative units) in addition to the main head office.

This region is primarily rural with agriculture and small trade being the main source of livelihood. Most Human Development Indices are below Nepal's national average and availing basic education and health services are difficult. By effective usage of ICT - delivery of comprehensive public services, availability of affordable and effective health care, provision of essential education facilities, and creation of an inclusive learning environment, all of which address their relevant Sustainable Development Goals - the basic standard of living of the citizens in the Municipality can be raised.

The Project's envisioned Public Private Partnership (**PPP**) model – comprehensive, collaborative, inclusive, sustained, relevant, individual and institutional investment - has been designed to stimulate the development process, thereby deliver impetus to local multi-sectorial commercial activity, bring about socio-economic changes, and ensure project sustainability.

Dailekh District, (of which Dully Municipality is one of several Local Governments) has a total population of around 261,000 but only one district level hospital. The ratio of doctor to population low and people have to travel for hours and even days to reach the nearest health post for basic check-up. Community based health posts have limited connectivity with the central Dullu Hospital with four doctors to cover large catchment area of 157 sq. km (61 sq. mi) (larger than Kathmandu Metropolitan City – Capital City of Nepal) and consultation between health paramedics and doctors used to be limited and insufficient.

There are approximately 60 public schools, but internet access is either poor or in most cases non-existent. While there is a keen desire to implement online learning resources, technology challenges remain along with awareness and teaching methodology, which will be able to leverage introduction of accessing online classes, and teaching material.

Dullu Municipality borders the largest river of Nepal – The Karnali River, yet access to water remains elusive due to hilly terrain and complex central government water access regulations, especially related to hydropower electricity projects. Thus, Dullu residents have to pump water from Karnali River's tributaries, which are not perennial. The dry or low water level tributaries during the dry season lead to lower irrigation supplies. Through communication and sensor technology, GIS mapping, and smart grids, these issues can be mitigated. The project team believes that such smart applications going forward will be able to provide further enhanced services and improve livelihoods of Dullu residents.

#### 4. Status Prior to Pilot Project Implementation

The existing GSM network based services are neither reliable nor consistent and is just sufficient for voice communication. Actual data rates are not sufficient for any service delivery (e.g., health, education, e-governance, etc.). This situation has not improved even after project implementation, which underscores the importance and sustainability of the pilot project.

The main Dullu Hospital has a daily patient inflow of about 75 patients and specialist/expert medical professionals do not visit remote areas (i.e., Dullu Municipality) due to poor road and transportation infrastructure. Additionally, patients in such remote and rural areas cannot afford treatment (Figure 4) at even the closest urban center (e.g., Surkhet – Karnali Province Capital – at a four hour drive) for regular check-ups.

Such devastating situation was not only degrading public health but also had an adverse effect on the development processes of the entire community. Hence, the proposed health delivery model along with compact modern medical devices not just only ensured remote health care services delivery, but also promoted community health care through regular health camps and targeted initiatives with health information system development of the entire area. The pilot project assisted in early diagnostic process by establishing a robust communication network between rural and urban health care providers.

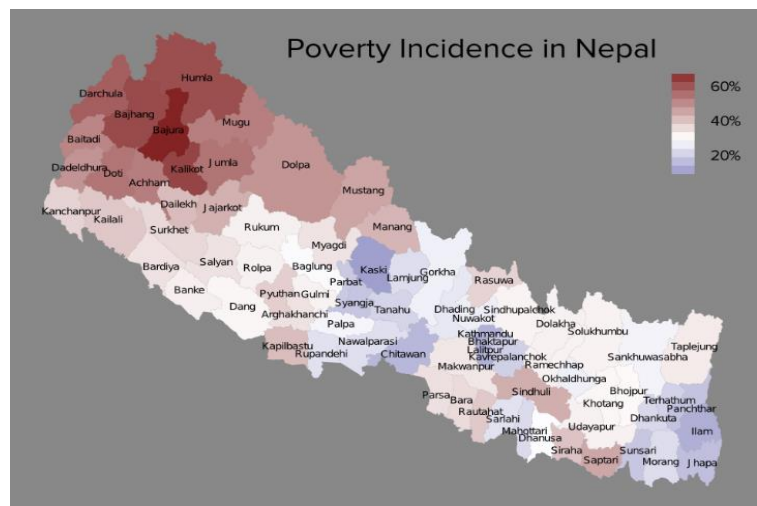


Figure 4: Poverty Incidence in Nepal

#### 5. Priority of Project Area and Technology Selection

Rural connectivity has been traditionally focused on wireless links in exclusion of all other backhaul technologies. This has been mainly due to the CAPEX of laying optical fiber cables due to civil work related expenses.

The new standard by ITU-T of L.1700 has identified affordability of communication technology as its highest priority followed by the best-effort reliability. Thus, the project team has focused on implementing and high data rate, upgradability, flexibility, scalability and environmentally friendliness for backhaul communications

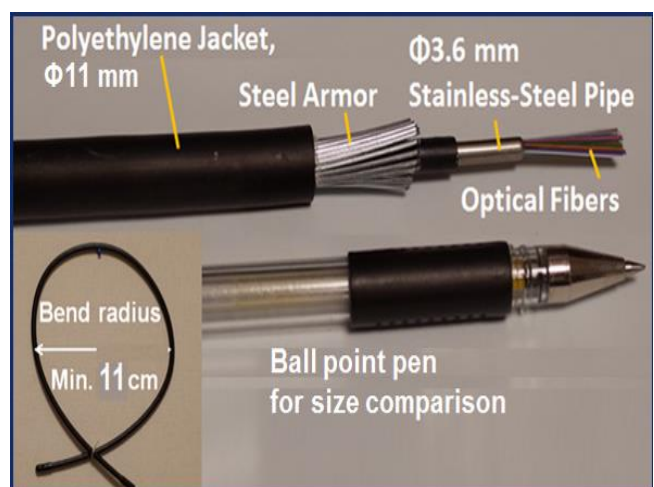


Figure 5: ITU-T L.110 Optical Fiber Cable

in rural areas in developing countries. The local community can ensure and enhance the link security and reliability in a do-it-yourself manner including watchdog activities and the use of light tools, if necessary. The proposed wireless access points will contribute to the relevance of effective optical backbone connectivity for high bandwidth data sharing at the local level.

We proposed to use a telemedicine kit product, which can be carried to the rural areas in a convenient way. This is



**Figure 6: Portable Telemedicine Kit**

based on a collaborative and comprehensive cloud based examination platform, which can be accessed by medical professionals to access patient data at any point of care. It streamlines diagnosis at an affordable cost by deploying heart, lung, cardiovascular, vital signs, imaging and lab clinical assessments. The data is non-proprietary, hence can be accessed by any analytical tool or external medical healthcare facility system. The kit consists of accurate and highly streamlined medical devices that function independently of each other. The kit has both Wi-Fi and Mobile connectivity options along with Ethernet and SIM ports. These options

make it an ideal system for rural and remote medical healthcare delivery.

## 6. Project Activity Timeline

### 6.1 Proposed Activity

These project phases were developed during the proposal. They underwent certain modification and addition of activities during actual implementation.

<b>S N</b>	<b>Activity Description</b>	<b>Place</b>	<b>Objective</b>	<b>Time Period</b>
<b>1</b>	Acceptance of the proposal by APT	APT		FEB 2018
<b>2</b>	Detailed discussion of the project among stakeholders	Nepal	to develop strategy to move ahead	APRIL 2018 (Kickoff)
<b>3</b>	Designing of the network topology / site visit and interaction with the local community	Nepal	to get first-hand information on the requirement of the project area, to be familiarized with the concerned local and national stakeholders	APRIL 2018
<b>4</b>	Procurement of equipment and commissioning	Japan	to procure necessary hardware required for the project (based on the site survey) and to bring it to Nepal for installation	MAY2018  JUNE – JULY 2018 (procurement)
<b>5</b>	First Report to APT		to update APT of ongoing project status	AUG 2018
<b>6</b>	Installation, testing and commissioning of the network	Nepal	installation of the network and its testing	AUG 2018 (Installation)
<b>7</b>	Training and strengthening of the locals involved	Nepal	Training to be provided to the local community, authorities and relevant member	SEPT 2018
<b>8</b>	Operation of the network	Nepal	To run the project in full capacity with local community and to get feedback (Improvement)	SEPT 2018
<b>9</b>	Final Report to APT	Nepal	To update and wind up the first phase of the project (Completion)	FEB 2019 (Completion)

## 6.2 Actual Project Timeline

The actual project implementation activities have been describe below. Certain unforeseen delays due to transportation and ensuring local participation were encountered. However, the project was an overall success as *community feedback and service deliver over the network has been extremely positive and wide spread in the municipality.*

S N	Activity Description	Place	Objective	Time Period
1	<b>Proposal Acceptance by APT</b>	APT	The formal grant contract was signed.	Feb 2018
2	<b>Kickoff Meeting</b>	Nepal	Detailed project discussion was held among stakeholders to develop project strategy and discuss details.	Apr 2018
3	<b>Site Survey and Project Discussion</b>	Nepal	Project team visited project site and interacted with the local community to acquire first-hand information on the requirements of the project area, and familiarized with concerned local and national stakeholders	Apr 2018
4	<b>Network Design</b>	Nepal	An OFC/Wireless Network topology was designed to ensure uniform broadband connectivity to all Dullu Municipal offices, specific schools, and Dullu Hospital.	Apr 2018
5	<b>Health Service Delivery Model</b>	Nepal	An innovative Health Service Delivery Model was developed to ensure a collaborative and consultative model that would be proactive and address community health and public health initiatives.	May - Aug 2018
6	<b>Procurement of OFC</b>	Japan	Optical Fiber Cable Procurement process was completed as defined by the project	Sep -Nov 2018
7	<b>First Report to APT</b>	Nepal	Project Update Report was sent to APT	Dec 2018
8	<b>Procurement of Additional Network Devices</b>	Nepal	Optical Network Equipment Procurement (required for the OFC/Wireless network) process was completed as defined by the project	Jan - Mar 2019
9	<b>Public Private Partnership (PPP)</b>	Nepal	Design of PPP model was developed which would address project	Jan - Mar 2019

			sustainability and future operation.	
<b>10</b>	<b>Procurement of Medical Devices</b>	Japan Spain	Medical Equipment Procurement was completed as defined by the project.	Mar - May 2019
<b>11</b>	<b>Network Implementation</b>	Nepal	Installation, Testing, and commissioning of the network was completed.	Mar - May 2019
<b>12</b>	<b>Capacity Building</b>	Nepal	Training and technical strengthening workshops were provided to the local community, relevant authorities, and maintenance personnel on network operation and maintenance.	Mar - May 2019
<b>13</b>	<b>Project Inauguration</b>	Nepal	Project Inauguration and Handover Ceremony was done at Dullu Municipality	May 2019
<b>14</b>	<b>Community Feedback</b>	Nepal	Community Feedback was collected to mitigate any operational issues, maintenance concerns and develop improvements. This activity was started in May 2019 but continued even after the inauguration ceremony, since project team was and still is committed in ensuring project success.	May - Aug 2019
<b>15</b>	<b>Final Report to APT</b>	Nepal	Final Report included all project details and current status was submitted to APT.	September 2019
<b>16</b>	<b>Continued Support by ICT4D</b>	Nepal	Continued Effort by the project team (mainly ICT4D team) even after delivery of the Final Report to continue supporting the project.	May 2019 – Present

### **6.2.1 APT Project Acceptance**

On February 2018, the formal APT Grant contract was signed between ICT4D, KDDI Foundation and APT. Documents were exchanged over email with APT Secretariat in Bangkok, Thailand.

### **6.2.2 Kickoff Meeting**

The Kickoff Meeting was held from April 9 to April 17, 2018. This included the Site Survey and Project Discussion.

### **6.2.3 Site Survey & Project Discussion**

Teams from ICT4D, KDDI Foundation, and Global Plan held detailed project implementation discussions. Technology selection, project site survey, meetings with local government authorities, support by Nepal's entities, and much more was discussed. This formed the basis of project implementation workflow that represents the rest of the timeline.

### **6.2.4 Network design**

ICT4D team designed and submitted the network implementation plan for review and improvement. There were a number of suggestions by KDDI Foundation to further enhance and expand the network (through both OFC and wireless Point to Point links) to ensure uniform access and thereby ensure sustainability through a pan-municipal contribution for operations and maintenance.

### **6.2.5 Health Service Delivery Model**

ICT4D developed a combination of two major health service delivery models that encompass collaborative consulting that addresses capacity building of medical service delivery professionals as well as creating a mobile community health model, which targets specific community members through augmenting existing Government of Nepal initiatives. These include Safe Motherhood Program, Non-communicable Diseases (NCD) such as Diabetes, Hypertension, etc. and Senior Citizen Health. These two models found much support by the local community as well as the medical team members at Dullu Hospital.

### **6.2.6 Procurement of OFC**

ITU-T L.1700 based ITU-T L.110 Optical Fiber Cable was procured from OCC (Ocean Cable and Communication, Japan). This special cable has been designed for remote and rural regions whose profile is similar to Dullu, Nepal. The OCC F-PAC (trademark brand) is the L.110 implementation of ITU-T L.1700 specifications and is globally recognized standard. The rugged terrain consisting of landslides, muddy roads, hills, high winds, and excessing rainfall during the monsoon months is an ideal project area for the implementation of such optical fiber cable.

### **6.2.7 First Report to APT**

ICT4D and KDDI Foundation submitted the first project progress report to APT Secretariat in October 2018. This report covered the review of all project related activities until then, and requested further time extension due to difficult logistics of project implementation at such remote project area.

### **6.2.8 Procurement of Additional Network Devices**

ICT4D initiated the procurement of additional network equipment to ensure last mile connectivity to all predetermined access points. These included Cambium Point to Point Antennas, Microtik Routers, Cables, etc. The details can be obtained in **Annex III**.

### **6.2.9 Public Private Partnership (PPP)**

ICT4D developed a PPP model to ensure the active and sustained participation of Dullu residents in the implementation and long term management of the pilot project. The results have been encouraging, despite it being a new concept within the ICT domain, since almost all projects are managed on full ownership. The Dullu-APT PPP Model consisted of allowing likeminded community individuals to invest in a basket fund, which would be used for operations and maintenance. The income source is dependent on

community availing internet services through either an annual or semi-annual subscription. Thus, it is a two-tier pay services layer – consumer and cooperative – each of whose payment subscription depends on the choice by the resident. The profit is also distributed according to the level of investment, and contribution to the sustainability of the project.

The cooperative leases the fiber network on a long term basis (e.g., 5 years, 10 years, etc.), and invites fee based membership options. The cooperative provides internet services to the local community. The collected fees and service charges form the basis of income generation, which is used for lease payment to the Dullu Municipality, Operations and Maintenance of the network. This allows for the outsourcing of the network by the municipality to a local business, contributes to local entrepreneurship, and skill development. It also ensures the local economy is stimulated through local services.

#### **6.2.10 Procurement of Medical Devices**

ICT4D researched and tested a myriad of miniaturized medical devices and point of care testing devices to ensure mobility and accuracy. These devices were needed to ensure that medical team would be able to capture vital signs, ultrasound of organs, test for lung related ailments, diabetes, hypertension, cardio functionality, skin related conditions, allow for imaging inner ear issues, much more. Another requirement was to ensure that medical data be in open format to allow for easy storage, transmission, and access by other – including remote specialists – to provide additional consultation. This collaborative consultation model was designed to address capacity building of doctors located at Dullu Hospital.

The mobile unit model based on specific health challenges faced by the community were addressed by ensuring light weight, and dust resilient and physically hardy devices which would be given to a paramedic team. The mobile team would visit remote settlements and gather health related data. Any out of the ordinary test result would trigger a request to the resident to follow up with the nearest health post for further evaluation. Thus, this model created a doorstep health model and also contributed to building a socio-economic/medical database of municipal residents.

#### **6.2.11 Network Implementation**

The OFC and Wireless P2P hybrid network was designed by the ICT4D team along with input from KDDI Foundation and Global Plan members. The OFC network was laid along the major roads of Dullu and those Ward Offices that were within 200 meters were connected with last mile fiber connectivity. However, those last mile points which remained unconnected through last mile fiber connectivity were provided internet access through Wireless Point to Point. Because of Dullu region's mountainous terrain, it is not always possible to provide full wired connectivity, especially with fiscal constraints. Thus, the pilot project was implemented on a hybrid model.

#### **6.2.12 Capacity Building**

ICT4D team provided training to various groups on different subjects. These included medical device handling, medical data capture and transmission, distance learning tools, OFC splicing and architecture, network design, cable laying, data center management, wireless device configuration, and testing of network issues.

### **6.2.13 Project Inauguration**

The project was inaugurated on May 29, 2019, which signified the completion of all major project activities and handover of network ownership to Dullu Municipality. The inauguration ceremony included officials from KDDI Foundation and APT. It was also attended by team members of ICT4D, Global Plan, and OCC.

### **6.2.14 Community Feedback**

ICT4D and KDDI Foundation members collected community feedback immediately following the Inauguration Ceremony.

### **6.2.15 Final Report to APT**

The Final Report was submitted to APT Secretariat, which included the complete project summary.

### **6.2.16 Continued Support by ICT4D**

ICT4D still continues to provide technical and management support to the local cooperative and Dullu Municipality to address sustainability and long term planning issues.

### **6.2.17 Other Applications and Services**

Dullu Municipality is running the Federal Government's Integrated Property Tax System, Electronic Building Permit System, and Health and Medical Records System.

## **7. Unique Features of Pilot Project**

There were two main distinctive features which differentiate this project most grant funded initiatives. Essentially, both the network implementation and its associated sustainability models were based on community participation.

### **7.1 PPP (Public-Private-Partnership)**

The PPP model was designed to ensure long term sustainability and low cost operational costs. The model is dependent on Dullu Municipality's realization that it cannot sustain such a network through personnel recruitment, training, and retention. Additionally, it is a government entity, and flexibility and agility issues arise due to the necessity to adhere to multiple government labor and workforce regulations. Since the local government is forward thinking and open to new suggestions, ICT4D and Dullu Municipality designed a collaborative lease model in which a local cooperative will handle the operations and maintenance of the network, spearhead commercial and residential customer marketing, and retain an available and trained workforce. Such a model's modalities will ensure high level of Quality of Service (**QoS**) delivery, which addresses sustainable and continuous service delivery requirements of Dullu Municipality to its residents. A cooperative lease model which is part of the PPP umbrella of Public – Dullu Municipality, Private – Local Company/Cooperative, and Partnership – High Quality of Service Delivery is the cornerstone of sustainable projects. Our PPP model has ensured that each resident, business, and public entity that receives internet services is financially invested in the safety and sustainability of the OFC network. This type of local community involvement ensures that the partial/non-burial cable will survive due to active participation and alertness of community members.

### **7.2 Do-it-Yourself**

The OFC technology has been uniquely designed for low cost, 'do-it-yourself' (DIY), surface burial in which non-

sophisticated tools may be employed. The PPP model supports this technology through various sociological-economic-service delivery factors, which have been discussed in Section 9.1. In addition, the OCC's DIY OFC cable is unique that is the first product design based on ITU-T L.1700 recommendations and ITU-T L.110 design models. It is therefore a unique product that is most applicable in locations and regions similar to Dullu Municipality, Nepal. Such technology and implementation methodology can be easily replicated in rural/remote regions across the globe, including developed, developing, and least developed countries.

The major cost factor - almost 80% - of all OFC implementation models include trenching and ducting. The OCC F-PAC cable is terrain and weather resilient and hence does not require any major civil works, and thus leads to major cost reduction, which addresses low income rural communities and various SDG.

DIY based OFC implementation will foster rural connectivity and provide an incubation platform for local businesses and services including agriculture, food processing, health delivery, online learning, and much more. Thus, this project has been able to lay the foundation for entrepreneurs to avail information, markets, and resources from across the globe.

### **7.3 Rural Community Health Delivery Model**

ICT4D designed a collaborative and consultative model that addresses both the collection of community health longitudinal indices as well as capacity building of medical health professionals. While the former ensures that the local government and medical team are aware of local health issues of their residents, the latter builds towards their capacity to handle out of the ordinary issues, and provides a mechanism for institutional knowledge building and training for current and future medical professionals.

Both these models are currently being used and refined to better address the community needs, medical team's requirements, and future scalability. The medical intervention in the Dullu-APT Project has been a major success of delivering services that are important to and address most basic citizen needs. Our model has been well received by local government authorities and the ICT4D team is currently working on introducing additional components which may be used to implement mass screening of genetic related diseases and other NCDs. Early detection has been one of the most successful means of avoiding disease progression, and this project has been part of that endeavor.

## 8. Network

The design, construction and implementation of the hybrid network (OFC, Wireless P2P) consisted of identifying the main OFC route, which serves as the Municipal Backhaul Route (**MBR**) and Last Mile Connectivity (**LMC**) and Wireless P2P Links (**WPL**). The network consists of Intermediate Repeater Stations (**IRS**) and ensures connectivity to the Dullu Municipality Head Office, 13 Municipality Ward Offices, 3 High Schools, Dullu Land Mapping Office, and Dullu Hospital.

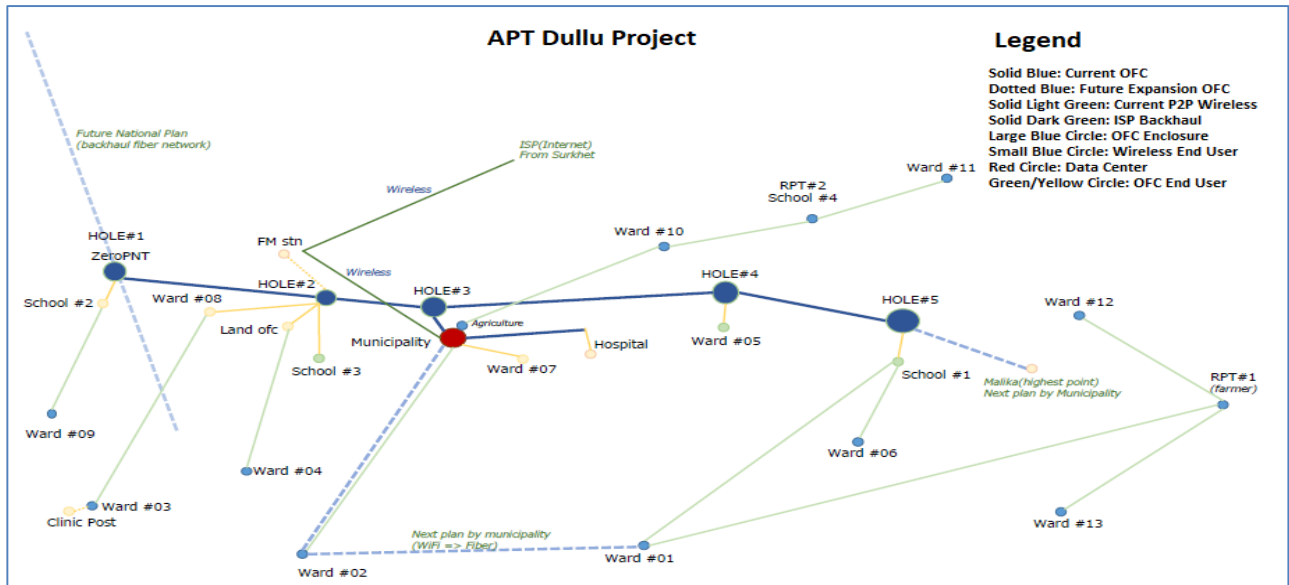


Figure 7: Final APT Dullu Network (May 25, 2019)

### 8.1 ITU-T Recommendation

The OFC implemented in the Dullu municipality is manufactured by OCC, Japan based on ITU-T L.1700, affordability-first concept, ITU-T L.110, lightweight and robust on-surface applicable cable, and ITU-T L.163, installation of L.110 Cable; L.1700 identifies technology-independent requirement of rural centric connectivity, whereas L.110 and L.163 respectively specify optical cable and its implementation that best meet L.1700.

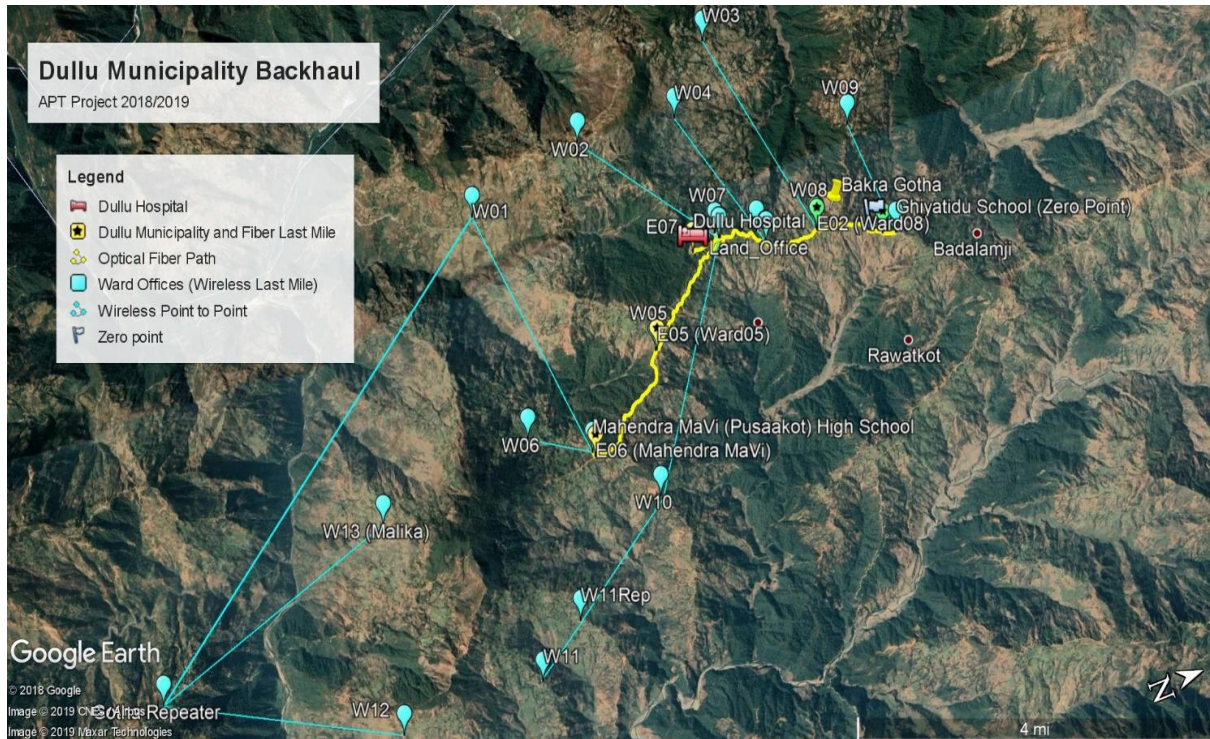
F-PAC is the design of OCC's engineers based on L.110 recommendations and is lightweight all-terrain cable, which can be manually installed throughout the year in any weather condition due to its resilient architecture and design. It is based on OCC's submarine cable technology and the robustness and tenacity associated with such cables is the key feature of this newly designed OFC.

### 8.2 Dullu Municipality WAN

The Dullu Municipality WAN design underwent a few changes from Project Discussion phase to actual implementation. The reasons were due to the actual landscape and testing of WPLs. The project team was also given a number of suggestions on route selection to ensure long term cable and equipment safety. Figure 6 refers to the final schematic design, while Figure 7 is its Google Earth Image.

### 8.3 Optical Fiber Cable Layout Process

The OFC was basically laid in shallow trench, which was approximately 30 cm deep. The trench was cleared of rocks and any hard material that might damage the actual optical fibers. Although there are multiple protective layers,



**Figure 8: Final APT Dullu Network (Google Earth)**

due to lack of black topped roads, the project team had to ensure extra safety in OFC handling. Eventually the municipality will be constructing roads and it is necessary to deploy the fiber out of the range of any future civil work and development project including water delivery, sewage systems, rain water culvert, etc.

These layout recommendations were vetted and designed by the OCC Cable Management Team, whose on-site engineer facilitated the layout process during installation. Certain recommendations also underwent modification with input from ICT4D Technical Team and Dullu Municipality's technical advisor.

### 8.4 Access Point

The WPLs were installed to ensure uniformity in internet access in each predetermined Municipal Ward Office, and High School. Those locations that were along the **MBR**, were connected with fiber **LMC**. These consisted of three Ward Offices, Dullu Municipality Head Office, Dullu Hospital and three High Schools. However, the rest of the ten Ward Offices were connected via **WPLs**, which required two **IRS**. The WPL were based on AP-SM one to one connectivity and were needed since Dullu Municipality's terrain is spread over a wide area and full OFC connectivity is not possible within pilot project limitations.

## **8.5 Internet Backhaul Connectivity**

The main internet access into Dullu Municipality's LAN has been linked with Surkhet, the largest urban settlement and Karnali Province's Capital City. The wireless backhaul is from Surkhet to Narayan Municipality, which rests on the ridge next to Dullu Municipality and then repeated to Dullu Municipality's Head Office. A wireless backhaul link needs to reflect capacity usage so as to avoid network traffic bottleneck issues and the project team has been evaluating the connectivity usage to ensure bandwidth is dynamically released to segment off network slowdown by Dullu Network.

## **9. Project Impact**

This project has been successful in mitigating serious local challenges, some of which include healthcare delivery, governance, and citizen centric service delivery at Dullu Municipality. The project team designed, implemented, and has followed up (even after the project hand over) to understand and analyze the implications of interventions which were implemented.

### **9.1 Healthcare Delivery**

ICT4D along with specialists and health informatics experts from Dhulikhel Hospital's General Medicine & Emergency Department and Community Outreach Department respectively developed a collaborative and consultative healthcare solution, which has been introduced at Dullu Hospital. While much work remains in terms of expanding the reach of this novel healthcare delivery model, the pilot project's test results have been extremely positive, hopeful, and form the basis for full scale implementation at the earliest. The project was able to overcome the technology gap with the OFC and Wireless Point to Point communication network and it also provisioned for three medical healthcare kits that have been a major breakthrough in diagnosing a wide range of ailments. These telemedicine based healthcare kits consist of multiple miniaturized medical testing devices (e.g. ECG, Ultrasound, Blood Pressure, Blood Sugar, Spirometer, etc.) that are accurate, and provide standard and open format data items.

#### **9.1.1 Prenatal Care**

Nepal's Safe Motherhood Program has gained international recognition for its effective and wide spread implementation. This has mainly been due to empowering local community with trained healthcare workers that are able to deliver public health messages, as well as provide basic care to pregnant women and young infants. However, certain issues remain in rural and remote communities mainly based on lack of communication and exchange of latest treatment and healthcare issues. The network was able to address these issues, and also provide ultrasound devices for pre-natal testing and data capturing for archiving purposes.

#### **9.1.2 Senior Citizen Services**

ICT4D suggested a new healthcare initiative to provide door-to-door services to evaluate health of senior citizens in the Dullu area. This is based on the proactive community health model that is being advocated by many public health professionals globally. This would encompass healthcare paramedics or nurses to travel to distant communities and examine patients with a focus on senior citizens. It also provides a tool for resident data collection and builds a trust basis between the medical community, the Dullu residents,

and local community leaders. This proves to be absolutely essential in ensuring the long term success and sustainability of the project. This movement can be considered as a regional and local participatory healthcare impetus.

### **9.1.3 Mobile Health Camp**

ICT4D also encourage Dullu Hospital to initiate local health camps in the remote regions within Dullu. Since many local communities and homes are clustered on hilltops that are extremely inaccessible from the main town, residents and especially women have commuting difficulties. This leads to lack of regular healthcare checkups and even availing health services during needs requires time and money. Mobile healthcare camps have provided services to these areas for free of charge and have been enthusiastically welcomed by the entire community. It has allowed for public health related screening for diabetes and blood pressure related issues. Also many women's issues related to sexual health and reproduction were addressed, which would otherwise have been relegated to a later time in a patient. This has been mainly possible because of the specialized healthcare kit along with network accessibility.

## **9.2 Citizen Services**

Dullu Municipality has started to witness the changes in business practices with online services. A few of these have been detailed below.

### **9.2.1 Vital Statistics Registration**

The Federal Government's mandate is to record the birth, death, marriage, and other important events of each of its citizens. The general practice at Dullu Municipality and its 13 Wards has been to record these on individual file folders, which are later manually tabulated and sent to the central Vital Registration Office in Kathmandu, Nepal. Currently, there have been exceptional changes in entering all citizen related information through an online portal. Thus accountability, transparency and efficiency have dramatically increased since project implementation.

### **9.2.2 Building Permit Services**

The ICT4D team was responsible for implementing the Electronic Building Permit System (e-BPS) at Dullu Municipality. This allows for the archival of current file folder based records through digitization. It also ensures compliance of all building structures going forward with Nepal's National Building Code (**NBC**) and Dullu Municipality's Building Bye-Laws (**BBL**). NBC deals with structural issues, while BBL informs architects, and potential building owners of laws and regulations surrounding regional and locational aesthetics. BBL is developed through the joint effort of Dullu Municipality's urban planning department, elected leader's vision, and summation of town hall type meetings between local residents and Dullu Municipality's administration, and domain experts on river management, forestry, environment, and much more.

### **9.2.3 Integrated Property Tax**

Dullu Municipality has recently implemented Nepal's Integrated Property Tax (**IPT**) system, which was possible only due the project's broadband network connectivity. IPT has implemented at multiple municipalities across Nepal, and requires robust and reliable connectivity with central databases, which

reside in Kathmandu, Nepal's capital city. Previously, all property tax related documents were sent by courier mail, which was time consuming, and cumbersome to track and manage. This led to severe backlog and residents needed to visit the municipal office multiple times to ensure delivery of their tax forms, and acceptance by the central government to avoid any late penalty fees and charges. This scenario has been completely upended with the new OFC network.

### **9.3 Online Learning**

The project's original mandate was to provide hybrid connectivity to Dullu Municipality's Ward Offices, and Dullu Hospital. However, four high schools that were along the main OFC backhaul were also provided additional connectivity during the onsite implementation. While, all these schools had a dedicated computer lab, lack of connectivity was limiting access to online learning resources. Lack of books, and appropriate teaching material had hindered the learning process at these schools. Due this reason, student and teacher absenteeism was rampant. The school administration was extremely grateful and has been to leverage this connectivity to their advantage. School community is able to access learning, teaching, and administration resources available online. Additionally, there are possibilities of inter-school interaction within Dullu. This had a major positive impact on the teachers, students, municipal staff and residents. Some learning initiatives include khanacademy.com, moodle.com, and many other online and open source Learning Management Systems (LMS).

### **9.4 Business Incubation**

Another major impact through the project's implementation has been on the region's business environment. Entrepreneurs have brainstormed new ideas based on online services, which are possible due to internet service delivery. Private businesses are training their workforce with global best practices and language courses have also started. The project team members have met and advised local businesses and digital technology practitioners on policy proposal, technology adoption, and system integration at various formal and informal interactions.

### **9.5 Tourism Development**

Dullu Municipality's Mayor, Mr. Ghanshyam Bhandari, has envisioned to develop his region as major tourist hub, which would provide transportation and communication connectivity in western Nepal, which also ensconces Dullu Municipality. These plans had been held hitherto due to lack of reliable connectivity. With the OFC, tourism, recreation, and regional connectivity have taken prime importance to the leadership of Karnali Province. ***The National Planning Commission's Chairperson also intends to declare Dullu Municipality the flagship bearer of 'Digital Karnali'. This is a major and has long term impact on Dullu region's importance and visibility of this project.***

### **9.6 Social Impact**

There have been myriad social changes in Dullu. The most impactful has been the availability of options to residents, many of whom searched for seasonal and long term jobs in neighboring India due to visa-free travel and employment opportunities. However, this type of economic migration had become untenable with arable land lying untilled for many years, with most of the workforce leaving the region on a semi-permanent arrangement over the

past many years. The technological impact is evident that many returnees and potential migrants are now searching for opportunities in improving agriculture and animal husbandry options within their local communities. This has long term impact on social structure and community development with local residents taking upon themselves to build, invest, and foster their communities.

## **10. Public Services and Contextual Applications**

### **10.1 Health Delivery Model**

ICT4D developed two major components of a holistic health care model that targets rural communities and remotely located medical professionals. Both these models are complimentary and work will together. These concepts were developed after many discussions with Community Hospital Service Providers in both urban, semi-urban, and rural areas of Nepal. Many medical professionals and health informatics engineers and scientists were brought into the conversation, along with Dullu Hospital's Medical Team and Local Government officials.

The **OFC/WPL** has been able to underpin the delivery of these services and there have been myriad changes in health care delivery in the region. These include the mobilization of Community Health Model and Capacity Building, both of which require advance technology. The ICT4D team researched various medical device vendors and were able to select a novel, compact multi-device system from an EU based vendor. The devices are lightweight, robust, and at a reasonable cost which made them the ideal product for Dullu.

Capacity building is mainly collaborative consulting with specialists and also being able to access and develop a local institutional database of case history for reference by current and future medical professionals. Such a repository of case history reflects the major local ailments and provides a roadmap for the medical team.

### **10.2 Citizen e-Government Services**

There are three major applications that avail services over the Dullu Network. These are Integrated Property Tax, Electronic Building Permit System, and Local Video Conferencing services. These services are in addition to the Vital Registration System, Information Bulletin Services, and Health Information System. There is a requirement to delivery Citizen Charter Services over mobile phones, which also requires internet connectivity. The project team has been actively involved in needs assessment of other services since the formal handover of the project and is ensuring the sustainability of the network.

### **10.3 Residential and Commercial Internet Delivery**

The local cooperative has yet to distribute commercial internet connections to businesses and residents and the fiscal model of revenue generation is still being developed in close coordination with Dullu Municipality. There are also discussions on upgrading the Internet Backhaul Link from Surkhet to Dullu via possible fiber connectivity to avoid wireless backhaul issues such as lightening and power requirements.

## **11. Additional Research**

There are a number of additional research topics that can be explored on the basis of the established OFC network at Dullu Municipality. These have been discussed below:

### **i. Integration with Frontier Technologies**

Game-changing frontier research in the domains of IoT, Nanotechnology, Bioplastics, Unmanned Aerial Vehicles (**UAV**), Blockchain, Big Data, Artificial Intelligence, Cloud Storage, Software-as-a-Service applications, Content Delivery Networks (**CDN**), and many others require a high bandwidth, robust backhaul connectivity, and highly reliable system and hence will rely on the APT Dullu Network infrastructure solution.

IoT can be used for myriad sensing applications and data collection systems; UAV for delivery of medical supplies to remote medical teams for treating patients; Blockchain for instilling confidence in data; AI for intelligent decision making; Cloud for accessing and managing central data; SaaS for accessing applications through a cloud server, which lowers acquisition and maintenance costs (**CAPEX** and **OPEX**); CDN for quicker access to data, etc.

All these technologies will eventually be underpinned by the network and the efficacy of these will depend on a robust and high capacity network.

### **ii. Network and Backhaul**

The current network is a hybrid of OFC and WPL. The project team believes that long term sustainability of WPL in lightning prone areas such as Dullu can be challenging, hence there needs to be an active intervention of converting to fully OFC network.

The Backhaul is currently over wireless links, which has the same issues and would need OFC to the backhaul point of presence. These require further planning and route design in addition to cost and labor considerations.

### **iii. Health Model**

The Health Model covers two major components of Community Health and Medical Capacity Building. These can be expanded to cover early childhood inoculation and mass screening of atypical diseases and non-communicable diseases. These type of ailments are vastly spread over rural Nepal and require urgent intervention. In addition, Dullu Hospital needs special equipment that targets Safe Motherhood Programs, which mandates special attention to pregnant women and early childhood years for both the mother and child.

### **iv. Extension of Medical Coverage Area**

The current medical service delivery is done through ten health posts spread over thirteen wards and the Dullu Hospital. However, in this setup has not been able to provide care in remote areas even within Dullu

with a population of approximately 46,000 people. Hence, remote video conferencing between Dullu Hospital and each Health Post, along with periodic mobile health camps are necessary. The medical devices procured by the project are ideal for such a model and will serve the community in good stead.

**v. Online Learning Resources**

There are approximately 60 schools consisting of High Schools (12<sup>th</sup> Grade) and Middle Schools (10<sup>th</sup> Grade) and Elementary Schools (5<sup>th</sup> Grade) in Dullu Municipality. The recent government mandate requires each school to upgrade to the 12<sup>th</sup> Grade level. This will entail hiring and training of teachers and school administrators. Since teacher training courses are limited in Dullu, the project team has suggested the use of online learning resources for both potential teachers and students. The established network with appropriate connectivity upgrade will be able serve these needs.

**vi. E-government**

The ICT4D team has done extensive research on local governments across Nepal and focused on citizen services and delivery methodology. The team's research has led to the **MoFAGA** develop a new system of e-governance services in the 753 municipalities of Nepal, of which Dullu Municipality also belongs. The delivery of e-governance services requires awareness, training, and outsourcing to kiosk type of setups that serve as citizen service centers run by private entrepreneurs. This may be also considered a PPP model with the public (local government) outsourcing its service stack to a private (service center owner) entity to ensure delivery of a predetermined partnership (e-governance services delivery) to benefit the service seeker.

## **12. APT Project Evaluation by Local Community**

The project team was able to conduct various informal and formal discussions with the Municipal Staff, Local Community, Organized Civil Society Community Members, Health Professionals, and Educators.

- i. The local community target group mainly comprised of patients, small business owners, general public engaged in small trades, agriculture, construction, and livestock traders. They were in almost complete agreement that connectivity along with the supported citizen targeted services are essential, but were concerned that despite of access to and proliferation of smart phones, due to certain bureaucratic issues, the actual realization of availing services and good governance might take longer to implement and be delivered to the average resident.

The project team believes that this is a valid concern and thus have focused on spreading awareness and emphasized that the positive digital governance paradigm, while based on connectivity, requires meaningful and sustained changes in the governance and work flows based on positive User Experience (UX) applications. With the introduction of three major citizen centric applications (e.g., Integrated Property Tax, Building Permit System, and Health Consultation Services), the project team is confident that e-governance will be further entrenched in Dullu Municipality's governance model.

- ii. Organized Community Members are part of various local social organizations and NGOs. They were largely positive about connectivity, although wanted an expansive engagement that targets larger and wide spread community capacity building and training workshops. They specifically mentioned out-migration by Dullu's youth, and the impact which it is having on community mobilization, social fabric, and local economy. They mentioned that long term and sustainable community development would require regular intervention through experts, due to lack of technical and structural capacity within the local government.

To address these issues, ICT4D team has been able to liaison with local ICT entrepreneurs to provide introductory and advance courses to interested community members. ICT4D also plans to propose a long term capacity building program to address these concerns.

- iii. The Municipality Staff have been positive about the implementation of the project, and welcomed the development of the PPP model, which has outsourced the major daily maintenance responsibility of the network to the local cooperative. Such a model also provides business and employment opportunities to the local community members which is aligned with the elected leadership's initiatives.

### **13. Evaluation by the Joint OCC/KDDI Foundation Team**

The KDDI Foundation Team was extremely impressed and appreciated the collaborative effort of the ICT4D Team along with assistance by Dullu Municipality and the collective enthusiasm by local community. It is necessary that all stakeholders have a contributing roles and responsibilities, along with certain objectives being met, which addresses and enhances their professional endeavors. The deployment and co-implementation of the various application systems, along with their successes, has been heartening and fulfilling. It is also important to mention that such participatory implementation and operational models based on context driven PPP has been spearheaded for the first time within the intersection of the ICT and development sectors of Nepal. Ergo, the Japanese Team believes that the replication of this model can and will be based on lessons learnt, architectural design parameters, and business work flows that were developed for the APT's Dullu Project. This is a major achievement for within the sum totality of APT Projects and especially in Nepal's context.

OCC Inc., Japan had sent their team during the installation and training phases. They too have been greatly satisfied with the dedication and attention given to engineering and management detail in ensuring the assimilation of knowledge transfer, which must accompany technology transfer for sustainability through PPP model. OCC Inc., Japan deputed Mr. Masayasu Ishikawa, Senior Manager – Telecommunication Business Unit, and Mr. Toshihide Goto, Cable Management Engineer, both for whom it was an amazing experience, given the project area of rural and remote Nepal. Mr. Ishikawa has had a wide range of global experience in cable installation and implementation projects and provided holistic and nuanced advice on APT Dullu Project's implementation process and sustainability initiatives. Mr. Goto was also involved in the cable layout process

and provided hands-on training by setting an excellent example of contributing in all aspects of the project implementation.

The total experience and evaluation of the project has been positive by the Japanese Team, and we at ICT4D are grateful for their involvement, attention to detail, and technical expertise.

#### 14. Inventor and Rural Development Initiative

Dr. Haruo Okamura, a high-speed optical transmission and standards expert, has been the lead designer and incubated the concept of participatory rural connectivity through low cost engineering technology. He developed the DIY-based optical cable solution which has focused primarily on affordability with best effort in



reliability. The solution meets the three recently published ITU-T Recommendations that he worked as the Editor. These are L.1700 (Requirements and framework for low-cost sustainable telecommunications infrastructure for rural communications in developing countries, 2016), L.110 (Optical fiber cables for direct surface application, 2017) and L.163 (Criteria for optical fiber cable installation with minimal existing infrastructure, 2018). Nepal Telecom Authority (NTA) named the solution as “Okamura Model” and this solution with 10-km optical cable was implemented following L.163 in west Nepal. A part of the cable was manually placed on the ground’s surface in an unexplored jungle (Figure 9) in Dullu municipality, March 2019. Such an unprecedentedly affordable and simple laying the optical cable under difficult condition is hoped to globally open the door to connecting the remaining unconnected areas. Dr. Okamura has worked with NTT Labs, NEC, Corning Inc. (USA), and Waseda University as a visiting professor and has served as a vice chairman of ITU-T SG15 and ITU-T TSAG. He is currently the chairman of IEC SC86C (fiber optic systems and active devices).

**Figure 9: OFC (F-PAC) Laying in Jungle Terrain**

Dr. Okamura has worked with NTT Labs, NEC, Corning Inc. (USA), and Waseda University as a visiting professor and has served as a vice chairman of ITU-T SG15 and ITU-T TSAG. He is currently the chairman of IEC SC86C (fiber optic systems and active devices).

#### 15. Inauguration Ceremony

The Inauguration Ceremony and official Project Handover was completed on May 29, 2019. It was a whole day

event with speeches and talks delivered by various officials and luminaries. Dullu Municipality was represented by its Mayor, Mr. Ghanshyam Bhandari, the APT Secretariat was represented by Mr. Sakai, and KDDI Foundation was represented by Mr. Yosuke Uchiyama and its President, Mr. Suzuki. Global Plan Inc. was represented by Dr. Haruo Okamura, OCC Inc. was represented by Mr. Tomaru, ICT4D was represented by Mr. Manohar Bhattarai – Chairperson, Dr. Bhushan Raj Shrestha – Project Lead, Mr. Pavan Shakya – Project Coordinator, Mr. Gyanendra Maharjan – Technologist, Mr. Abhimanyu Pandey – Technologist, and Dullu Hospital was represented by its Superintendent, Dr. Pooja BC.

Other attendees included Ward Chiefs of almost all thirteen wards, Deputy Mayor, media personnel, and local community members. The speeches and the subsequent discussion focused on new technologies, their relevance to Dullu Municipality and similar locations and communities across Nepal, as well as the long term sustainability of the project.

Dr. Haruo Okamura mentioned that his invention, the L.1700 and L.110 cable's birthplace will henceforth be known as Dullu Municipality, Karnali Province, Nepal. Mr. Ghanshyam Bhandari, Dullu Municipality Mayor, was grateful to all guests and wished everyone well in our future endeavors.

## **16. Project Current Status**

The project is currently being operated with minor improvements needed on an ad-hoc basis, which mainly are PoE switches needing replacement due to the high incidence of lightening and electrical surges. The main Data Center which houses the core router and optical switch is operating well and is being maintained by a local ICT expert who provides advice to Dullu Municipality on technology related issues.

ICT4D team is in regular contact and provides various suggestions to Dullu Municipality for smooth maintenance and sustainability. The team is also planning a trip to Dullu in December 2019 to provide on the ground support. There is a plan to upgrade to the backhaul link from outside to Dullu and throughput should reach about 50 Mbps, which would be shared amongst all end users using the Infrastructure installed in May 2019.

## **17. Final Accounting and Review**

### **17.1 APT budget**

Regarding the accounting of this APT EBC-J project, all the expenses related to the project objective were met with APT granted amount. There were some configuration and product changes due to strong request of local people and data security and location issues. However, the adjustments to the budget allocation and negotiated discounts with vendors resulted in meeting all budgetary requirements. Additionally, KDDI Foundation donated some telemedicine kits as well.

### **17.2 KDDI Foundation Donation**

KDDI Foundation donated two telemedicine kits for the general Hospital in Dullu Municipality according to ensure

effective healthcare delivery at point of care. Also, for the future study, the prototype of Telemedicine kit developed by NICT (National Institute of Information and Communications Technology) in Japan was donated for further implementation studies and review of healthcare diagnoses practices of beneficiaries. The major and essential requirement was that each individual's original healthcare data must be located in his/her country's location of diagnosis. There is also a need for accurate, miniaturized, and reasonable price systems, which can be expanded across the nation, especially rural areas.

### **KDDI Project Summary**

According to the allocated and approved budget along with dome donation, the results of final OFC network, Hybrid last mile connectivity, and telemedicine healthcare services delivery is far superior than our proposal submitted to APT in last year. The grant funded project's network and healthcare system is being widely used, has high quality, and has full community support by grateful Dullu Municipality residents.

## **18. Future Expansion**

The APT Funded Grant 'Bridging the Digital Divide in Dullu Municipality' has been officially handed over to the local government. However, long term sustainability also requires constant monitoring and intervention, which ICT4D is committed in doing. We believe that this project will pave the way for similar PPP model based sustainable projects with eager local communities who want to build their regions for positivity and meaningful change. Public education regarding privacy of data, security, and vigilance is essential, especially with data security and medical records.

The project team believes that further enhancement of the network and application intervention at Dullu Municipality will add to the value chain and provide meaningful changes to its residents and a wide range of stakeholders.

The project team's innovative Public Private Partnership model in which community mobilization has been included is essential for long term sustainability – both fiscally and contextually. While the general operation and maintenance (O&M) is expected to be handled by a community organization with local members, the network's usage and citizen centric services also needs local input. While the technology might still be developed with external assistance, the design and motivation should lie within the community.

These issues require further research, investigation, training and continued support from both within and outside the community. ICT4D was established with these ideals and will continue to provide support to APT Project at Dullu Municipality.

There is an ongoing requirement of expansion of services, and many possibilities in the future of realistic and practical technology interventions, which include patient centric healthcare (e.g., Collaborative and Consultative Systems, etc.), resilient networks (e.g., NerveNet by NICT-Japan, etc.), IoT in Agriculture (e.g., Fujitsu, etc.), Online

Learning Resources (e.g., Moodle, etc.), Video Conferencing (e.g., Jitsi, etc.), Mobile Banking (e.g., OpenBankProject, Open Core Banking System, etc.) and much more similar systems.

## **19. Contributions of Project Partners**

Dr. Haruo Okamura's vision to connect rural communities in the remotest regions of the globe was a constant reminder of our project's main objective and our entire team had many great learning experiences from his travels and scientific work. He brought along great encouragement and enthusiasm and developed team work for all of us.

Mr. Yosuke Uchiyama, represented the KDDI Foundation as the Accounting Coordinator for this project. His insights in project management and implementation guidelines were invaluable. He spearheaded the project's timely success and contributed much with his dedication to the project.

The OCC Inc. team generously contributed with sharing their technical expertise and capacity building of Dullu's local community members. During the implementation phase, the OCC Team suggested context specific engineering solutions in consultation with the ICT4D team, to address many onsite challenging conditions.

ICT4D provided administrative coordination, technical expertise, and implementation ability in managing this project. It also provided in kind HR contribution of approximately USD 6,000.00 and actual financial contribution of about USD 3,000.00 (domestic air travel, lodge, etc.). It worked with close coordination with all implementing partners and beneficiaries to ensure long term PPP model based sustainability and delivery of services to the people of Dullu.

## **20. Acknowledgement**

The Project Team is also indebted to Dullu Municipality, its dynamic Mayor, Mr. Ghanshyam Bhandari and Dullu Hospital Superintendent, Dr. Pooja BC (along with her team of Dr. Sandeep Khadka, Dr. Suman Subedi, and Dr. Vivek Koirala) for enthusiastically supporting this project and in ensuring its success.

Dullu Municipality availed their heavy machinery, workforce HR wages (approximately USD 6,000.00), Wireless Poles (USD 3,000.00), Earthing (USD 2,000.00), and municipal employees (Mr. Gyan Mani Nepal – Education Chief, Mr. Ramesh Upadhyaya - Personnel, Mr. Tej Raj Sharma – Chief Administrative Officer, Mr. Nirajan Hamal – Dullu Municipal Technologist, and many more).

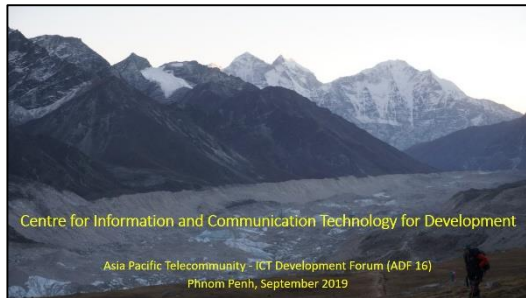
We are especially grateful to Dullu Municipality residents who wholeheartedly welcomed us. Some of them include Mr. Raju Acharya – Local Businessman and Community Leader, Mr. Tej Pratap Shahi – Civil Society Member and Community Leader/Organizer, Mr. Dhan Bahadur Shahi – Designated Local Project Contributor, and much more.

We are also grateful to Ministry of Communication and Information Technology (**MoCIT**) in providing guidance and ensuring compliance with bureaucratic and technical regulations to ensure smooth implementation of the project.

All the Project Partners wish to express their gratitude to APT organization, which provided an opportunity to serve one the most remote and inaccessible communities and locations of Western Nepal. We believe it provided an invaluable implementation and research experience to our team in project implementation at Dullu, Nepal.

## Appendix I: ICT4D Presentation at ADF-16

Mr. Pavan Singh Shakya, Executive Director ICT4D, presented the APT Grant Project “Effective Broadband Infrastructure for Development of Communities in Dullu Municipality” at Phnom Penh in September 2019 during the APT Development Forum 16. The presentation has been attached.



Slide 1



Slide 2

**Mission:** ICT for Development & Empowerment - by the community, for the community

**Vision:** Effective usage of ICT for socio-economic development within the PPP model

**Objectives:**

- Research - To customize products and services to better match clients & customers.
- Collaboration - With the community, for the community.
- Applications - That are relevant and developed with time bound schedules.
- Assistance and Training - For the local community.
- Advocacy - Identification of current public policy limitations and strategy development.

**Established:** August 23, 2015 as Not-for-Profit private limited company under Office of the Company Registrar

Slide 3

**What do we do?**

**We do not grow Cocoa; yet we aspire to deliver the best chocolate**

**TECHNOLOGY INITIATIVES**

- IoT for Development
- Telemedicine/Health Informatics
- Relevant e-Governance Applications
- Learning Resources/Skill Development
- Connecting the un/under served Community

**ADVOCACY INITIATIVES**

- Promote integrated and relevant technology platforms for development structures like governance, education, health, etc.
- Ease technology introduction, adoption, and incubation as per Community needs and facilitate through a sustainable model

Slide 4

**APT: Dullu, Nepal Project Overview**

**Effective Broadband Infrastructure for Development of Communities in Dullu Municipality**

**Project Details**

- Total Budget: USD 178,000
- Time Frame: March 2018 - May 2019
- Supported by: KODI Foundation

Slide 5

**Effective Broadband Infrastructure for Development of Communities in Dullu Municipality**

- A municipality in Karnali Province in the Western Region of Nepal
- Population: approximately 45,000
- Historically, culturally and ethnically rich area with diverse flora and fauna including herbal plants
- Untapped natural resources, e.g., gas, etc.
- Consists of 13 ward offices (municipal administrative units)
- One hospital with four doctors to cover large catchment area of 157 sq. km (61 sq. mi) (larger than Kathmandu Metropolitan City – Capital City of Nepal)

Slide 6

**Effective Broadband Infrastructure for Development of Communities in Dullu Municipality**

Ward Number	Area (sq.km)	Population
1	33.35	2,284
2	30.63	2,942
3	35.91	3,295
4	7.27	2,693
5	13.98	5,278
6	26.75	5,991
7	6.06	1,567
8	10.97	3,960
9	13.56	3,161
10	15.06	5,705
11	33.51	4,336
12	10.46	2,676
13	56.07	4,201

Due to poor accessibility, people have to walk for hours to avail public services, health care services, or higher education

Slide 7


**Effective Broadband Infrastructure for Development of Communities in Dullu Municipality**

**Project Objective**



- Effective usage of broadband to narrow the digital divide in DTF method (involvement of local community for deployment and sustainability of the project)
- e-Governance practice (good governance over Intranet)
- Availing various training programs including teaching/learning/skill development over Intranet links

Slide 8



*ICT Pilot Project for Rural Areas: 2017*  
**Effective Broadband infrastructure for development of communities in Dullu Municipality, Nepal**

Effective Broadband Infrastructure for Development of Communities in Dullu Municipality	
<b>Project Objective</b> <ul style="list-style-type: none"> <li>Development of Health Information System (compatibility with other government hospitals)</li> <li>Delivering community health type services to the needy people of rural areas (effective telemedicine service with appropriate technology)</li> <li>Spearheading modular family health campaigns in close coordination with public health messaging which address Safe Motherhood, Diabetes/Hypertension, Inoculation/Early Childhood Development Issues, Senior Citizens, Local Context Issues, e.g. Pulmonary Issues, etc.</li> </ul>	 

**Slide 9**

Effective Broadband Infrastructure for Development of Communities in Dullu Municipality	
<b>The Network</b> <ul style="list-style-type: none"> <li>Built 12 km long optical fiber broadband infrastructure</li> <li>Connected three ward offices over optical fiber cable</li> <li>Connected ten ward offices with wireless links underpinned by fiber backbone</li> <li>Connected one hospital with fiber optic cable which provides broadband link for telemedicine services</li> <li>Connected four schools for ICT based learning tools (3 OFC, 1 Wireless)</li> <li>Contributed to the Mission of Dullu Municipality to connect all health posts and schools over Intranet link for effective ICT based solutions</li> </ul>	 

**Slide 10**

Effective Broadband Infrastructure for Development of Communities in Dullu Municipality	
<b>Project Contribution</b> <ul style="list-style-type: none"> <li>ITU-T standardized 48 core L 110 optical fiber cable</li> <li>Cambium e-Force 200 wireless devices</li> <li>Microtik Router/Optical Switch</li> <li>Fiber cable accessories including switches, CPE, ODF, enclosures, patch chords, terminal boxes, tripod jack, etc.</li> <li>Power back-up systems</li> <li>Special contribution from KDDI Foundation: Two sets of telemedicine equipment</li> </ul>	 



**Slide 11**

Effective Broadband Infrastructure for Development of Communities in Dullu Municipality	
<b>Municipality Contribution</b> <ul style="list-style-type: none"> <li>Required vehicles and machineries for optical fiber laying process</li> <li>Labourers or civil works during laying of optical fiber</li> <li>Electrical Grounding system for equipment provided by the Project</li> <li>Towers and metal poles for repeater stations and wireless points</li> <li>Excavating tools, etc.</li> </ul>	  

**Slide 12**

Effective Broadband Infrastructure for Development of Communities in Dullu Municipality	
<b>ICT4D Contribution</b> <ul style="list-style-type: none"> <li>Health Care Delivery Model Development</li> <li>Project Management with required Human Resources</li> <li>Co-ordination at the Municipality level</li> <li>Co-ordination with Central and Provincial government authorities</li> <li>Technical Surveys and Research Activities</li> <li>System Design Audit and Review</li> <li>Logistic Arrangement</li> </ul>	 

**Slide 13**

Effective Broadband Infrastructure for Development of Communities in Dullu Municipality	
<b>PPP Model</b> <ul style="list-style-type: none"> <li>Formation of Steering Committee at Municipality level for: <ul style="list-style-type: none"> <li>Monitoring and supervising Project Activities</li> <li>Monitoring Project scopes and services after handover</li> <li>Setting up guidelines for operation of the Project</li> </ul> </li> <li>Formation of User Committee at Ward level for: <ul style="list-style-type: none"> <li>Effective operation and maintenance of network</li> <li>Catering to expansion of network</li> <li>Creating business model for the long term project sustainability</li> </ul> </li> </ul>	 

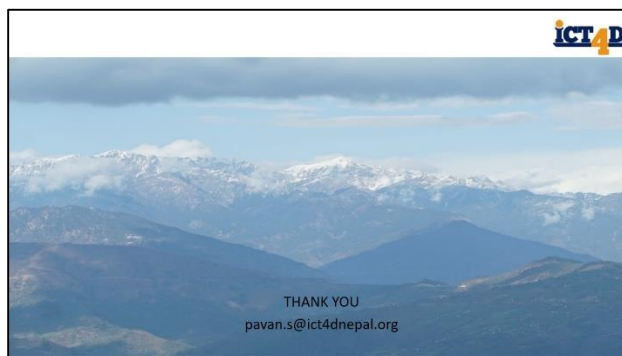
**Slide 14**

Effective Broadband Infrastructure for Development of Communities in Dullu Municipality	
<b>Achievement / Effectiveness of the Project</b> <ul style="list-style-type: none"> <li>Delivering health services through the usage of technology in specific health care system, e.g. Safe Motherhood, Adolescence, Senior Citizens, etc.</li> <li>e-governance services at each Ward office. Effectively using the intranet for Integrated Tax System of Nepal Government.</li> <li>Effective skill development and learning resource delivery with ICT based materials</li> <li>Opportunities for delivery of public services over various information systems</li> <li>Human network for knowledge sharing</li> <li>Tax exemption in Nepal for any APT funded project.</li> </ul>	 

**Slide 15**

Effective Broadband Infrastructure for Development of Communities in Dullu Municipality	
  	

**Slide 16**



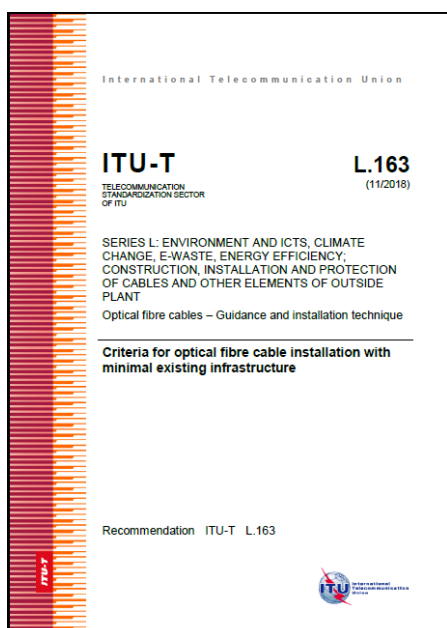
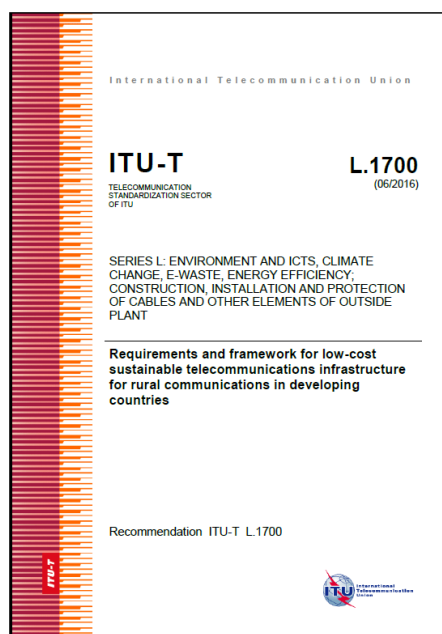
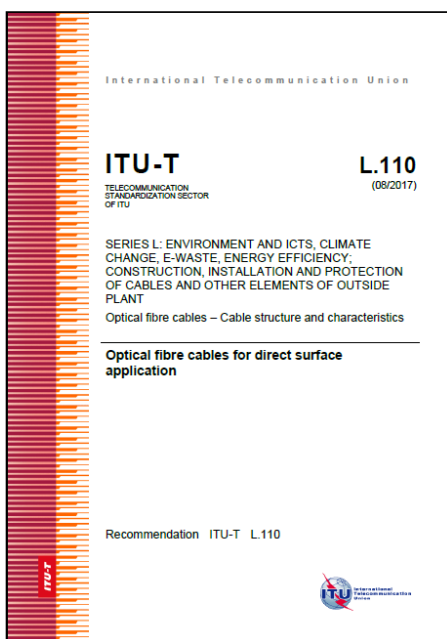
## Appendix II: ITU-T L Series

The ITU-T L Series documents are developed to address rural connectivity, with a focus on affordability and global connectivity to bridge the digital divide.

(Reference: <https://news.itu.int/new-standards-broadband-mount-everest/>)

[ITU L.163](#) focuses on the installation, maintenance and repair of lightweight optical cable, addressing factors such as cable tension and temperature, cable-route planning, and the selection of cables and cable-installation schemes. The recent approval of ITU L.163 completes the series of standards, following the rural communications framework provided by [ITU L.1700](#) and the optical cable design specified by [ITU L.110](#). The complete ITU-T publications can be

downloaded from the respective previous hyperlinks.



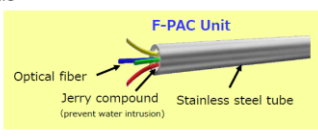
## Appendix III: OCC Cable Specification

Ocean Cable Company, Japan has defined their implementation of the ITU-T L.110 as F-PAC cable and is their trademark and model. The specification of the F-PAC cable is as below.

### Features of F-PAC

#### F-PAC (Fiber Packed Armored Cable)

- Optical fiber unit housed in a protective stainless steel tube
- Robust and easy to handle
  - Thin and lightweight
  - Water-proof
  - Rodent-proof
  - Non-flammability
  - Corrosion resistance



- Enable low cost construction and maintenance free
- Verified by more than 20 years of experience in the field
  - Already shipped more than 25,000km

### F-PAC: Cost-effective Solution

- Robust optical fiber cable that can be directly laid in shallow underwater and underground without duct.
- Provide low-cost and high-reliable optical network solution.


#### Conventional Cable

- Fix on wall
- Duct

#### F-PAC Cable



- Underwater
- Direct Burial

- Waterproof structure**
  - Cost reduction of civil engineering work by simple implementation
  - Improvement of maintenance and reliability
- Max length up to 12km**
  - Minimize hand-hole and connection points
  - Low connection loss
- Thin and lightweight cable**
  - Space saving for stock
  - Safe workability

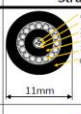
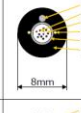



### Advantages over Conventional Cables




Superior features are marked in yellow

Type	Armored F-PAC	Double Armored Loose Tube
Application	direct burial, underwater	Direct burial
Fiber Count (Single Mode)	4 ~ 24 Loose cable 1 ~ 48	N.A. 6 ~ 60
Typical Outside Diameter	11.0 mm	19.7 mm
Approximate Unit Weight	180 kg/km, 200 kg/km(Frame Retardant)	362 kg/km
Allowable Tensile Strength	3,500 N	2,670 N
Allowable Lateral Pressure	5,000 N/100mm	1,960 N/100mm
Allowable Bending Radius	Static 110 mm	197 mm
	Dynamic 220 mm	394 mm
Cross Section		
Standard cable length	As Ordered	1,000 m
Maximum cable length per drum	12,000 m	2,000 m

### F-PAC Cable Lineup (1)

Type	Structure	Feature and Application
Armored F-PAC		<Feature> <ul style="list-style-type: none"> <li>Robustness, strength and flexibility</li> </ul> <Application> <ul style="list-style-type: none"> <li>Direct burial</li> <li>Sewage system and Dam conduits</li> </ul>
F-PAC with tension member		<Feature> <ul style="list-style-type: none"> <li>Superior compatibility with standard parts and materials</li> <li>Excellent workability</li> </ul> <Application> <ul style="list-style-type: none"> <li>Rural areas</li> <li>On the premises of important facilities or within the buildings.</li> </ul>
F-PAC cord		<Feature> <ul style="list-style-type: none"> <li>Mechanical properties of a stainless tube and thinness</li> </ul> <Application> <ul style="list-style-type: none"> <li>on the premises of factories and important facilities</li> <li>for security systems in such facilities</li> </ul>

### F-PAC Cable Lineup (2)


Unit	Armored F-PAC	F-PAC with T.M.	F-PAC Cord
Application	direct burial, underwater	Aerial, Duct, Indoor	Aerial, Duct, Indoor
Fiber Count (Single Mode)	4 ~ 24 Loose cable 1 ~ 48	4 ~ 12 1 ~ 24	4 1 ~ 8
Typical Outside Diameter	11mm	8mm	3.5mm
Approximate Unit Weight	180kg/km 200kg/km(*)	70kg/km 85kg/km(*)	17kg/km 20kg/km(*)
Allowable Tensile Strength	3,500N	850N	280N
Allowable Lateral Pressure	5,000N/100mm	1,960N/100mm	1,960N/100mm
Allowable Bending Radius	Static 110mm	80mm	60mm
	Dynamic 220mm	160mm	70mm
Cross Section			
One Continuous Length	As Ordered	As Ordered	As Ordered
Maximum One Length	12,000m	12,000m	12,000m

(\*) for Flame-Retardant type

### ITU-T Standards for Robust Optical Cables

New ITU-T Recommendations for robust optical cables are published.

- L.1700: Affordability concept in rural areas (in Jun/2016)
- L.110: Optical cables for direct surface application (in Aug/2017)
- L.Sup.22: Informative examples (in Apr/2016)
- L.163: Cable laying method (in Nov/2018)



**F-PAC is fully compliant with these ITU-T standards.**

### Appendix IV: Project Area Map



Figure 10: Administrative Map of Nepal (7 Provinces, 77 Districts)



Figure 11: Administrative Map of Karnali Province, Nepal

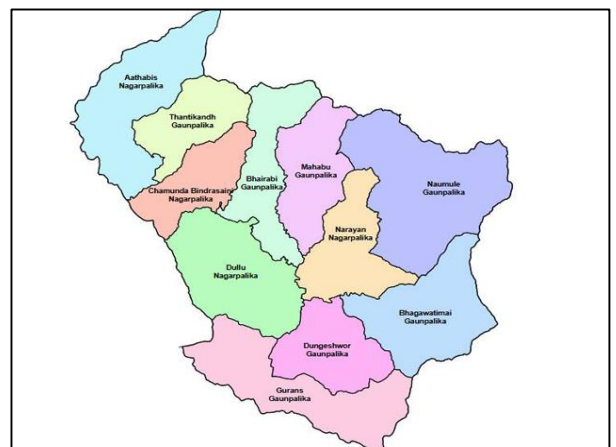
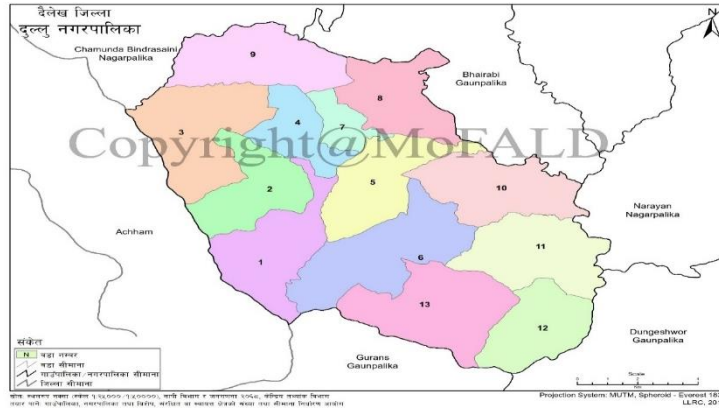
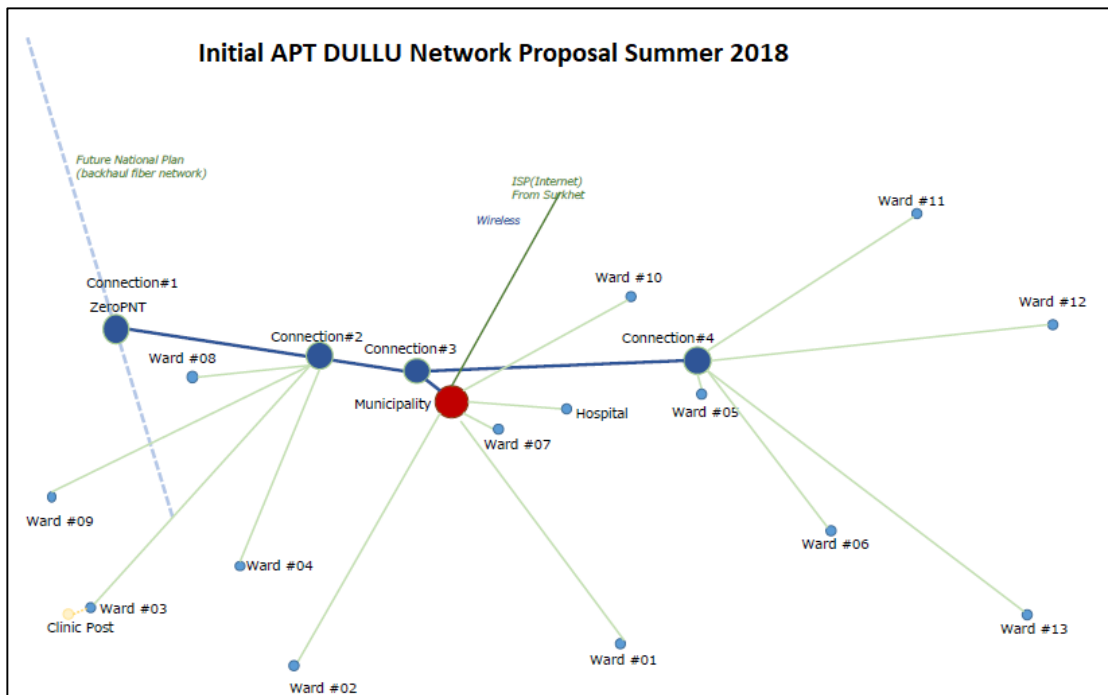


Figure 12: Administrative Map of Local Governments in Dailekh District (including Dullu)



**Figure 13: Figure Administrative Map of Dullu Municipality (13 Ward Offices)**



**Figure 14: Initial APT Dullu Project Network**

## Appendix V: On-Site Implementation Item List

APT Dullu Project Equipment List						
Human Resource						
S N	Equipment Details	Quantity	Unit	Unit Price		Amount
1	Rental of OTDR/Splicing Machine/	1	Lump Sum	1450		1,450.00
2	Safety Accessories for Site	1	Lump Sum	1250		1,250.00
3	Splicing and Testing of fiber core	50	per core	15		750.00
4	Point to point wireless setup	7	per site	150		1,050.00
5	Point to multi point wireless setup	4	per site	100		400.00
6	Tower installation (Repeater)	1	nos	300		300.00
7	Mono pole installation	14	nos	30		420.00
Optical Devices						
1	Mikrotik Cloud Core Router	1	nos	1,530.00		1,530.00
2	Fiber Switch	1	nos	1,050.00		1,050.00
3	ODF	1	nos	325.00		325.00
Electricity and Power						
1	Inverter	3	nos	250.00		750.00
2	Battery	6	nos	425.00		2,550.00
3	Electrical Earthing	3	nos	450.00		1,350.00
4	PVC pipe	1	nos	200.00		200.00
5	16Amp DB MCB	3	nos	35.00		105.00
6	Sub-meter	3	nos	35.00		105.00
7	Two way wall socket	12	nos	25.00		300.00
8	DC cable (meter)	100	nos	2.00		200.00
9	AC cable (roll)	3	nos	55.00		165.00
10	Electric Tape (roll)	20	nos	2.00		40.00
11	Cable Ties (packet)	2	nos	25.00		50.00
12	Cable shoes (pcs)	50	nos	2.00		100.00
Wireless Devices						
1	Radio P2P	22	nos	230.00		5,060.00
2	Cat6e Cable	3	Box	170.00		510.00
3	RJ45	1	per packet	10.00		10.00
4	Router	13	nos	120.00		1,560.00
Data Center						
1	CPE/MC	9	nos	165.00		1,485.00
2	SFP	10	nos	55.00		550.00
3	12U Rack	1	nos	295.00		295.00
4	Burial Enclosure	10	nos	150.00		1,500.00
5	Fiber Patch chord	10	pc	15.00		150.00
6	Fiber Patch chord	10	pc	15.00		150.00
7	Terminal Box	9	nos	95.00		855.00
8	6 core OFC	1500	per mtr	0.45		675.00
9	Fiber Tripod Reel jack	1	nos	1,800.00		1,800.00
10	POE Swtich	3	nos	320.00		960.00
11	Synology NAS	1	nos	1580		1580.00
Spare Equipment						
1	POE Gigabit DC Injector, 15W	15	nos	12.00		180.00
2	5.5 volt 3.5 amp hap AC	15	nos	8.00		120.00
3	8 watt, 10-28 volt hap AC lite	15	nos	8.00		120.00

**Figure 15: List of Onsite Implementation Budget**

## Appendix VI: APT Dullu Project On-Site Photographs



**Figure 17: APT Dullu Project Data Center (Optical Router/Switch/Patch Panel)**



**Figure 16: APT/KDDI Foundation/ICT4D Project Inauguration Day**



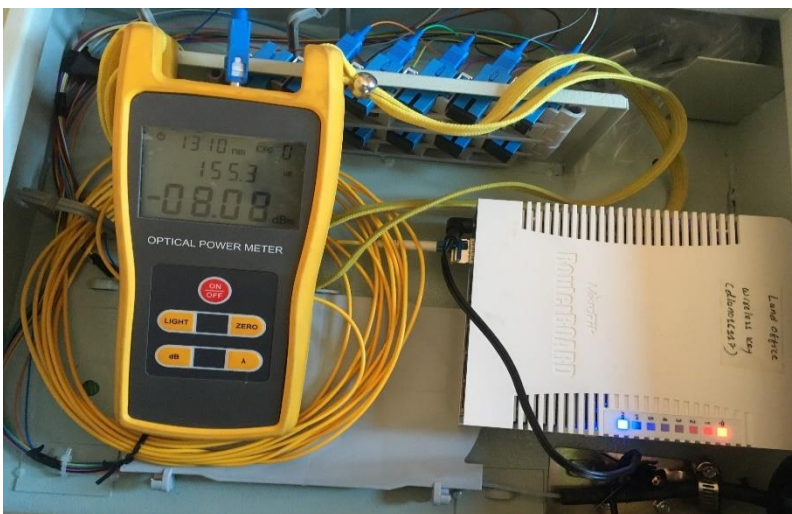
**Figure 18: APT Dullu Project Inauguration Day**



**Figure 19: CPE Fiber Terminal Box**



**Figure 20: Dullu Municipality, Ward 1 Wireless Point to Point Relay Install**



**Figure 21: Optical Line Testing**



**Figure 22: Health Kit Inspection by APT/KDDI Foundation Team**



**Figure 23: Discussion with Dr. Pooja BC (Left), Superintendent, Dullu Hospital**



**Figure 24: Dullu Patient Health Check**



**Figure 25: Dullu School Connectivity**



**Figure 26: Optical Fiber Laying along Hilly Terrain**



**Figure 27: Typical Dullu Landscape**



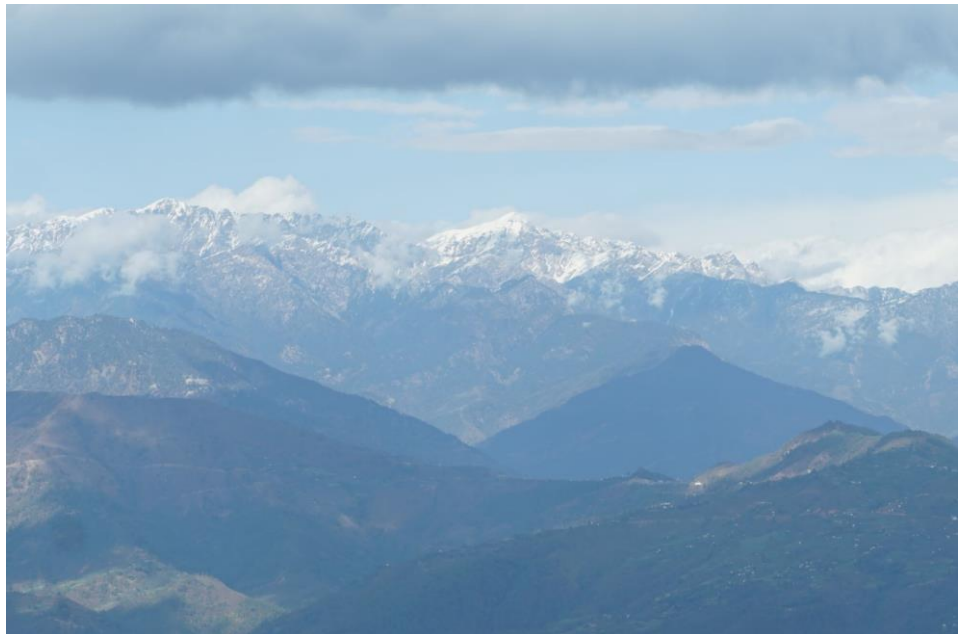
**Figure 28: Dr. Okamura Laying OFC in Jungle and Hilly Terrain**



**Figure 29: Do-it-Yourself (DIY) OFC Layout by Local Community in Dullu Settlement**



**Figure 30: Dullu Municipality Ward 9 Wireless Antenna P2P Link**



**Figure 31: Mountain Range viewed from Dullu**



**Figure 32: Manual OFC Layout (clearing of rocks and pebbles, laying of soft sand around the OFC, and refilling with original/native soil**



**Figure 33: OFC Layout on 'cliff' side of a raised road**



**Figure 34: Dullu Terraced Farms. (Lahana River on upper right hand side – a tributary Karnali River)**



**Figure 35: OFC Layout**



**Figure 36: Dullu Municipality High School near Ward 6 (OFC Start Point)**



**Figure 37: Dullu Municipality Ward 11 School and Health Post**



**Figure 38: OCC Optical Fiber Cable Drum being transported from storage to installation sites**



**Figure 39: Cable Drum mounted on Tripod Jack**



**Figure 40: Wireless Antenna Install on Repeater Station at Rithha Farmer's Private Land**



**Figure 42: Optical Fiber Cable unrolling by pickup and training of Dullu residents**



**Figure 43: Creating Figure-8 Cable prior to layout (Mr. Ishikawa and Mr. Goto from OCC)**

**Figure 41: Hilly Terrain Site Inspection Dullu Municipality (near Ward 9) (Mr. Uchiyama, Mr. Bhushan, Mr. Abhimanyu, Mr. Ishikawa, Mr. Pavan L to R)**





**Figure 44: Dullu Municipality Storage of Cable Drums**



**Figure 45: APT Dullu Project Data Center**



**Figure 46: Computer Classroom Dullu Municipality Ghyiatidu High School**



**Figure 49: Meeting at Dullu Municipality Ward 13**



**Figure 48: Inauguration Day with KDDI Foundation, OCC, Global Plan, ICT4D, May 2019**



**Figure 47: Dullu Municipality Technologist, Mr. Nirajan Hamal. Currently pro-bono contribution of managing network in post- project handover phase.**



**Figure 50: Center of Dullu Municipality Fiber Layout**



**Figure 51: Fiber Layout over the Dullu Jungle**

## Appendix VII: APT Dullu Project IP Schematic

APT Dullu Project IP Schematic shows all WAN, LAN, and Device IP Addresses and Logical Connections

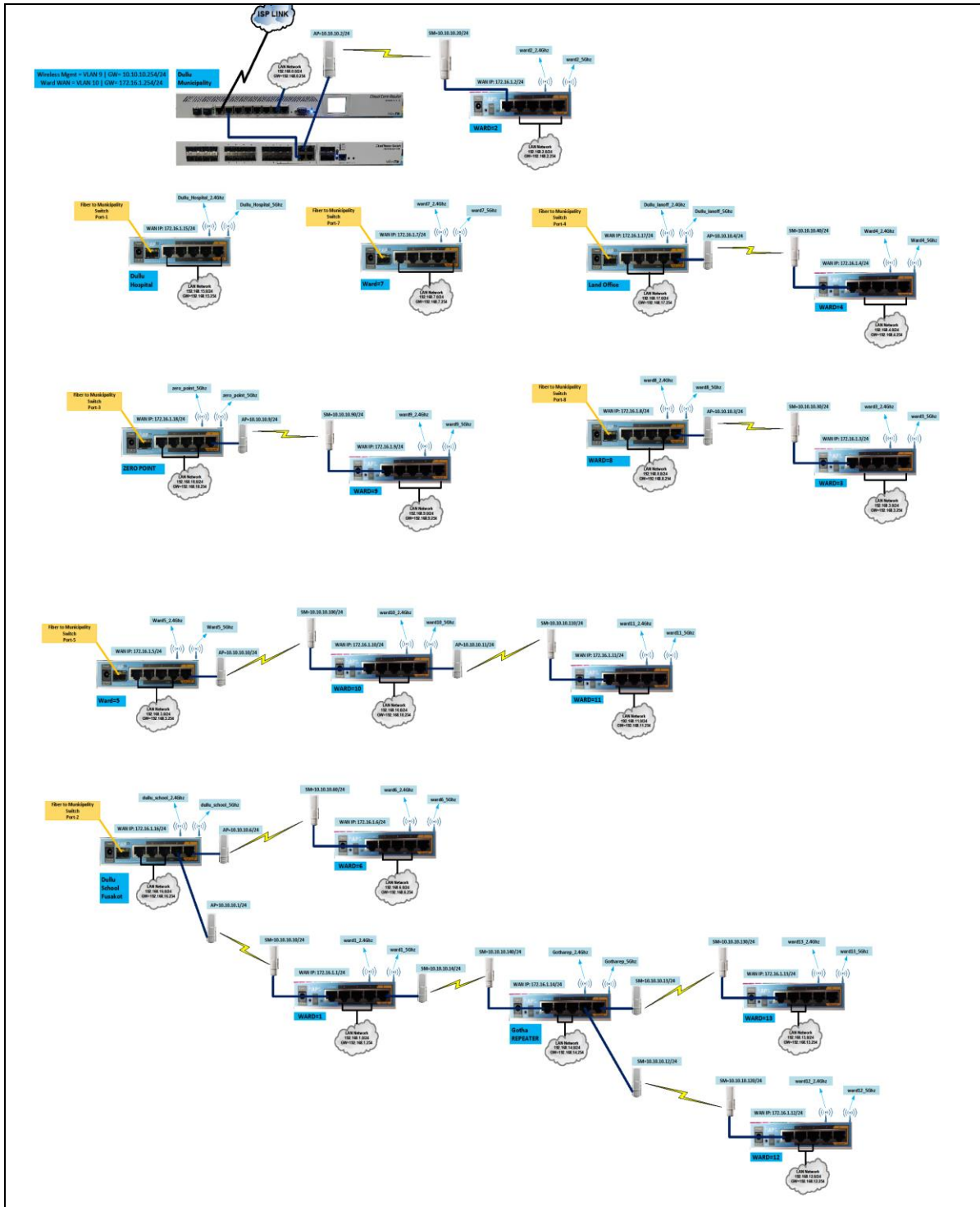


Figure 52: APT Dullu Project IP Schema

### Appendix VIII: Future Proposed Project

Proposed APT Dullu Phase 2 Network Schematic. Extension of existing network, development of applications, and with NerveNet Network Resilience (NICT, Japan) that are contextual to Dullu Municipality Residents and applicable in the development sectors of health, education, governance, personal finance, agriculture, transportation, and commerce.

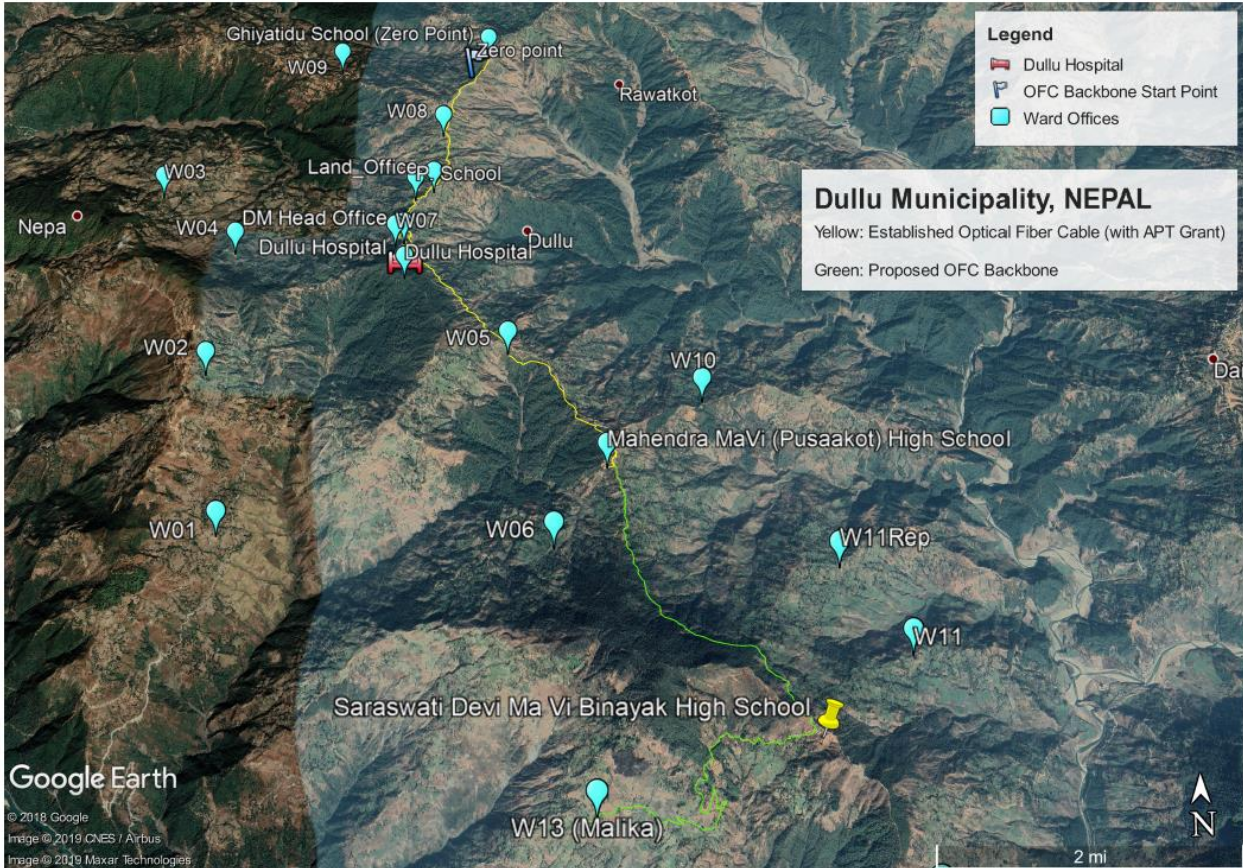


Figure 53: Future Network Expansion Phase 2