# PAPER 13

## REVIVAL OF LAST MILE CONNECTIVITY PROJECTS UNDER PPP Mode

1.  **7 Domestic companies in mid-2019 had submitted proposals on last mile connectivity under USOF Project. These were submitted along with ITI.**

    a)  **Lekha Wireless,**
    b)  **Saankhya Labs,**
    c)  **Nivetti Systems**
    d)  **Resonous,**
    e)  **Signal Chip,**
    f)  **Sookhta,**
    g)  **Aristrome**

    **There were more submissions from Tejas Networks, VNL etc also/**

2.  **All proposals of similar nature can now be revived under PPP mode and VoICE Paper 11 methodology can be starting point. Fine tuning and modifications can be done under guidance of USOF Administration.**

3.  **Annex A and B have submissions made by Lekha Wireless and Saankya Labs. There were similar submissions by other 5 through ITI and by Tejas Networks and VNL though others.**

**Lekha Wireless**

**Proposal for Pilot Project for 4G Network for personal mobile broadband in rural areas as part of BharatNet with USOF funding**

**Part A**

IDENTIFICATION

1. **Title of the Pilot Deployment:** 4G Network for personal mobile broadband as part of last mile connectivity of BharatNet.

2. **Specific Area of Pilot Deployment:**

   We would like to deploy 4G LTE network in GPs identified by USOF. Preferred state for the pilot deployment in state of Karnataka / Tamilnadu / Andhra Pradesh within 150Kms around Bengaluru.

3. How does the pilot fit into the objective of the scheme ie., "reap the benefit of innovation and strategy for better utilization and improved service delivery to the citizens by utilizing BharatNet"?

   Lekha Wireless is technology company based out of Bengaluru incorporated in 2010. We have developed a range of wireless communication products involving technologies like 4G and WiMAX. The 5G products are under development.

   Below are salient points with respect to Innovation and strategy for extending the BharatNet coverage till the last mile.

   - The product is based on popular access technology **LTE standard**, enables mass deployment in the next phase of the project.

   - **Coverage area** of 5 km per eNodeB for a typical rural deployment scenario. The User end devices can be any commercial off the shelf LTE devices like any smart phones and low-cost LTE routers.

   - Proposed technology provides advantage with respect to coverage, **ubiquitous connectivity** and mobility compared to WiFi. The connectivity for the users of the network is no longer limited to a hotspot in the village.

   - Each sector can have a **capacity** of 200 mbps/ 100 mbps respectively for FDD and TDD system with 20MHz channel BW. Proposed deployment is any of the popular LTE bands in

the country for example Band 41, Band 40, Band 3, Band 1 or Band 5. The capacity can be further extended by a factor of 2 as part of carrier aggregation feature on the same HW as part of software upgrade roadmap.

- **User density** of 1000 users per cell and up to 100 active users are supported. Compared any other technology that provides point to point connectivity LTE has huge cost benefit for connecting such large number of users in the last mile.

- Inhouse developed technology includes hardware and software stacks enables complete ownership for manufacturing and long maintenance of the network. Lekha works with local contract manufacturing to build the base stations and we can enable local companies to take care network maintenance enabling true objective of **Make in India** vision**.**

- **Modular & SDR** architecture for the low power portion of the system. This enables small turnaround for building / tuning the product for different frequency band support and power levels with changes absorbed only on the high power RFE module.

- Scalable Platform and Software based radio enables easy **roadmap** all the way up **to 5G**.

- Embedded Radio for easier Installation & Management of the eNodeB equipment at site.

Highly efficient radio amplifiers and design approach makes Lekha eNodeB very power efficient. The design allows long hours of operation with battery back up which is important for rural area.

4. **Duration :**          10 months which includes 3 months observation period.

Refer to the detailed project plan below.

5. **Total Project Cost**                          10 Crores

6. **Name of the Applicant**                  Lekha Wireless Solutions Pvt Ltd.

7. **Name of concerned Civic authority**  ITI Limited, Bengaluru

8. **Capability of the organization/Individual**

a. Available expertise with the applicant

Lekha is OEM of 4G eNodeB equipment. The technology used for both HW and Software are indigenously developed. Lekha has expertise of deploying the 4G network for special

purposes like Private network for industrial automation and tactical communication networks along with partner's core network.

b. List of ongoing and completed projects/pilot deployments

| Project Title | Start Date | Completion Date | Pilot Project Deployment cost | Sponsoring Agency/Customer |
|---|---|---|---|---|
| Development of LTE based eNodeB and UE | November 2017 | June 2021 | Supply of LTE eNodeB and UE for tactical network. 11 cores | BEL Bengaluru. Project obtained through tendering. |
| iDEX challenge LTE LAN on Naval ships of Indian Navy. | October 2019 | September 2019 | 3.2 crores | Atal Innovation Mission, DIO, Niti Aayog |
| Deployment of LTE Private network in CBRS band | January 2020 | TBD | Done in partnership mode. Cost TBD | Ondas Network Inc USA. |

**Part B**

1. **Brief description / Background about the organization/ Institution**

   Lekha Wireless Solutions Pvt Ltd is a Self-funded Indian private limited company registered under companies act and based out of Bengaluru. Founded in   2010 by Amarnadha Reddy and Ramu Srinivasaiah with a vision to be best-in-class solution provider in the areas of Wireless Communications systems and Embedded Systems. Since inception, Lekha has been focusing on Technology development and R&D to bring out home grown Products in the areas of WiMax, 4G LTE and 5G Technologies.  With a team strength of 170 Engineers, Lekha holds several IPRs in the 5GNR, LTE & wireless domain and has published several articles in this area.

   Detailed Company Profile is enclosed as an attachment in Annexure1

2. **Background of the problem which pilot project Addresses**

   We understand that government has successfully connected fiber optic connectivity up to the Gram Panchayat (GP) Level. This pilot Project envisages much need wireless voice and data connectivity from the GP to the common man in the villages thereby digital empowerment in the Rural areas.   Lekha Wireless has extensive experience in wireless development and has brought out

innovative products & Technologies in this area proposes to take up this Pilot Project under this USOF scheme.  A detailed Proposal is here with enclosed as an Annexure 2. After implementing this Pilot Project with 128 active users and 1000 registered users, a village user will be able to get a data rate of up to 1 Mbps.

3. **Description of Pilot Deployment**

    a.  Objectives of the pilot deployment

    The Aim of this Pilot Project is to provide reliable personal mobile broadband services to smart phone users and government institutions in remote villages of the country which includes voice & data communication.

    b.  Preliminary investigation done by Organization/Individual

    We understand from our discussions with USOF officials and study of materials available on USOF web site here are our submissions
    - BharatNet reaches today mostly about 28% of the urban population and the objective is to reach 72% rural population which are still not connected.

    - The village institutions for eg., schools, health centers, post office, police station etc are potential beneficiaries of the last mile connectivity of BharatNet.

    - The data consumption over the last 3 years on BharatNet is expanding at the rate of 40% per annum.

    - There are about 1.25 Lakh GPs across the country are connected to respective Block with a dedicated BharatNet fiber with 1 gbps link as part of BharatNet Phase II.

    - The Phase II of BharatNet combination of Underground Fiber+ Aerial Fiber+ Wireless Backhaul + Satellite Back haul.

    - The target is to complete the connectivity to all 2.5Lakh GPs in the country.

    Lekha wireless intend to deploy one eNodeB per GP there by covering all the villages institutions and citizens within the coverage range of 4 to 5 kms around the GP. For more detail of the proposed network architecture can be found in the Annexure 2. Lekha's proposed network provide an opportunity to extend the BharatNet to end users through 4G/LTE technology which provides personal mobile broadband connectivity wirelessly.

    Preferred state for the pilot deployment is in the state of Karnataka with proximity to Lekha's work location Bengaluru. This will help us reducing the logistic overheads.

    c.  Domestic Component in the Pilot Deployment

| Sl No | Component | Home Grown? | Comments |
|---|---|---|---|
| 1 | PHY Layer Software | Yes | Design and IP ownership. |
| 2 | L2 and L3 Software | Yes | Design and IP ownership. |
| 3 | High power RF design | Yes | Design ownership |
| 4 | Baseband HW design | Yes | Design ownership |
| 5 | Mechanical and electrical design. | Yes | Design ownership |
| 6 | Semiconductor components like SoC and radio components | No | Imported. |
| 7 | Antenna, Cables and accessories. | No | Commercially of the shelf items procured locally. |
| 8 | Core network | No | Sourced from other Indian partner companies. |

d. Linkages

Below diagram shows the network element and activities at various locations in order to deliver the network.

**State Headquarters**      **Zone**    **Block**     **GP**       **Village**
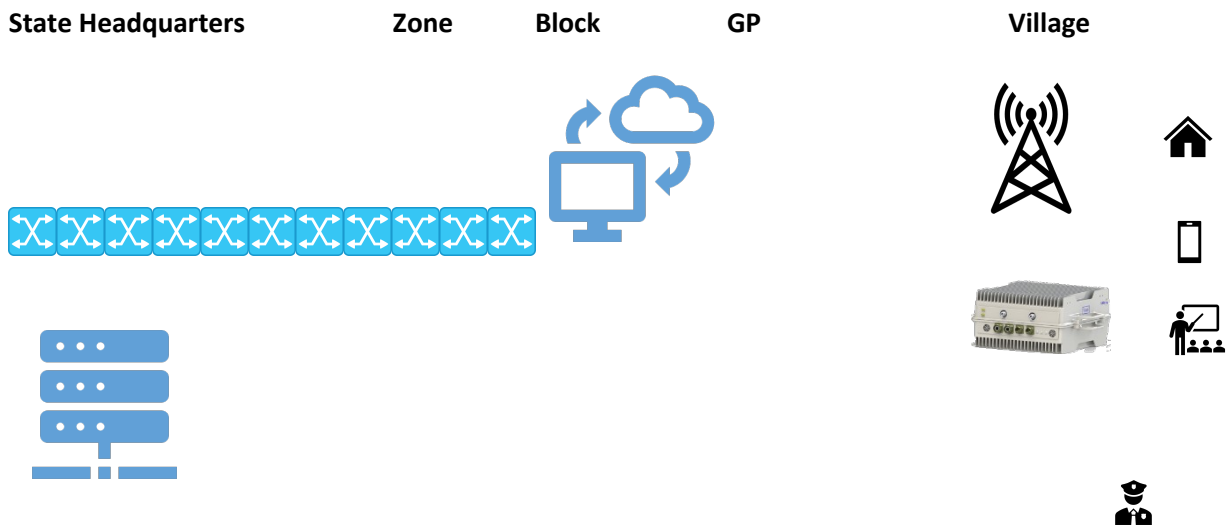


*Need to install NMS,*                     *Setup eNodeBs  Issue SIM cards*

*And EPC here*                             *and antenna here*

Below are linkages to other organization in delivering the services

         d.1)Internet services from BhartNet – BBNL/BSNL?

d.2) Space and provisions at NoC to setup server for installing the EPC and NMS. - BBNL

d.3) Installation of eNodeB at the GPs. This require necessary permission to put up the towers. Provision for electricity and space for equipment like eNodeB, power supply etc at the site. Require support from USOF.

d.4) Support for installing the LTE routers in 2 government building per village. Issue of provisioned SIM cards for valid users.

d.5) Permission and support for integrating the eGovernance application to the network. Service providers like CSC?

e. Other organizations working in this area

The 4G RAN products are being supplied by both domestic and international players.
Other Domestic Players
   a) Resonous

   b) Sooktha

   c) Signal Chip

   d) VNL

   e) CDOT

   f) Tejas

Popular International players are

   a) Ericsson

   b) Nokia

   c) Huawei

   d) ZTE

   e) Samsung

f. Methodology: Detailing stepwise activities and sub-activities

f.1) Cell Site identification

   f.1.a)    Identification of coverage area.

   f.1.b)       Perform RF survey.

RF survey is conducted to determine the cell sites.

f.1.c)       Identify the cell sites for the coverage area.

Cell sites are identified, and planning is performed. Frequency planning if applicable needs to be performed at this stage.

f.1.d)    Determine the height of the mast and trigger the site preparation activities.

f.2) Installation and Commissioning

f.2.a)    Installation of EPC.

Install the EPC at the central location. The EPC will have connectivity to all the cell site eNodeBs. Confirm that the EPC can communicate to the internet gateway.

f.2.b)       Installation of eNodeBs at identified cell sites

Install the eNodeB at the site.
Install the Antennas at the tower top.
Route the RF cables from the eNodeB base band unit to the antenna.

f.2.c)       Commissioning of the eNodeBs

Power ON test of eNodeB.
The eNodeB will be updated with the appropriate software and        configurations and will be monitored for any alarms.
Return Loss (RL), VSWR etc. will be verified.
The antenna positions will be adjusted based on the feedback from       RF Survey.
Other commissioning activities to make sure that the network is live.

f.3)       Coverage verification

f.3.a)       Drive tests

Drive tests are performed to verify the coverage in different locations and data is collected.

f.3.b)       KPI Analysis

Analysis and optimization of key performance indices.

4. **Work Plan**

Phase-wise plan for action up to post pilot deployment activities detailing time schedule, milestones may clearly be indicated. PERT/GANTT may be attached.

| Sl No | Activity Detail | Start | End | Comments |
|---|---|---|---|---|
| 1 | Signing of MoU with USOF | T0 | | Considered as start of the project |
| 2 | Ordering components and trigger manufacturing of | T0 | T1= T0+16 weeks | The activity will be completed with fully tested |

| | | | | |
|---|---|---|---|---|
| | equipment. Produce integrated and tested unit. | | | equipment ready for deployment |
| 3 | Identification of sites frequency planning and site survey. | T0 | T2=T0+6 weeks | Planning for site preparation done. |
| 4 | Site Preparation | T2 | T3=T0+12 weeks | Ordering, shipping of site equipment to erect towers, cabling etc. |
| 5 | Transportation equipment | T1 | T4=T0+20 weeks | Antenna installed on all the towers. |
| 6 | Installation and commissioning | T4 | T5=T0+26 Weeks | Complete installation and commissioning at all sites. |
| 7 | Start operations. Includes connectivity validation, integration of EPC and EMS. Provisioning of SIM cards. All other preparation to start the service. | T5 | T6 = T0+30 Weeks | End of this activity the monitoring period can be started. |
| 8 | Monitoring Period | T6 | T7 = T0 + 42 Weeks | 3 month observation period. |
| 9 | Training and handover of network. | T7 | T8 = T0 + 48 weeks. | This includes training and handholding ITI for maintenance. |
| 10 | End of support period | T6 | T9 = T6+53 Weeks | 1 year support from the launch of services. |

5. **Outcome of pilot deployment**

After implementing this Pilot Project, 20 GPs will be installed with complete Base stations. A 4 to 5 km ubiquitous wire 4G coverage will be established in each of these GPs with 1000 registered Users and 128 concurrent users for each of the GPs with a road map for extending the user density to 300 users on the same HW. With this, total area covered will be (75Sq Km X 20GPs) 1500 Sq Km with 15000 active users and 1800 concurrent users. The Users will experience a personal Broadband, roaming with a shared bandwidth of up to 100 Mbps for each of the GPs.

- The Proposal covers comprehensively the following:

- Supply of Base station along with the Core Network with associated Antenna & Cables including Power System (UPS &Solar Power)

- SIM Management, billing & Network management

- Services covers Supply of equipment to the field, Installation, Testing & Commissioning, Maintenance during the observation period and maintenance of the network up to 1 year.

6. **Likely Impact [Social/Economic]**

- Voice, Video and data services to citizens in village over the smart phone and other LTE devices.

- The proposed pilot project clearly brings out opportunity for delivering of existing eGovernment services ubiquitously over mobile platform like cell phones of citizens in the villages within coverage area around the GP. The proposal includes integration of IP network to application servers of CSC (common service centers) for e-Governance applications.

- The Proposal is comprehensive in providing the 4G network for rural broadband including the model of revenue generation through VLEs (Village level Entrepreneurs).

- Disaster alert system integrated over 4G network.

- Roadmap Features that can be delivered as software upgrade

    o TV broadcast over the LTE network,

    o position server and direction of arrival to provide position of each user in the network.

    o NB - IOT network which can enable largely agricultural automation.

7. **Parameters for monitoring effectiveness of Pilot Deployment**

- Number of villages connected.

- Average number of users in the network

- Additional use cases added if any.

- Equipment up time

- Cost comparison in achieving the connectivity.

- Amount of data traffic

- Comparison with other technology in existing BharatNet for last mile connectivity.

- Power consumption and efficiency of the 4G network.

8. **Suggested post pilot deployment activities.**

- Lekha is committed to offer extended warranty or AMC beyond 1 year at the rate of 12% of the equipment cost per annum.

- We expect USOF to consider the companies with successful trails for other bigger USOF projects on nomination basis.

- Lekha is committed to upgrade the software to add necessary bug fixes and features as part of maintenance.

**Saankhya Labs' Fixed Wireless Point to MultiPoint Connectivity Solution**

**for**

**Pilot Project for Utilization of BharatNet under USOF**

# Part A – Identification

## A.1. Title of the Project

**Saankhya Labs' Fixed Wireless Point to MultiPoint Connectivity** Solution based on IEEE 802.22 standard for Pilot Project for Utilization of BharatNet under USOF.

## A.2. Specific Area of Pilot Deployment

Saankhya Labs (SL) recommends executing this Pilot in Rural Bengaluru, Karnataka. Specific villages will be identified after the project approval. Based on the outcomes of the RF survey, we shall recommend other locations as well.

## A.3. How does the Pilot fit into the Objective of this Scheme

Saankhya Labs provides a 100% indigenous Fixed Wireless Access (FWA) product based on a global standard, the IEEE 802.22, designed specifically for Rural Broadband Connectivity. The product is designed, developed & manufactured in India including the baseband chip which is the heart of the system.

This best in class, innovative solution can be used to increase the usage of BharatNet and enable easy deployment of broadband services to the villages that are located beyond the Gram Panchayats where there is zero connectivity, at present. Our Fixed Wireless Solution can facilitate online classes and can also enable Broadband Connectivity to unconnected village institutions like Schools, Primary Health Centers, Community Health Centers, Post Offices, Anganwadis, Police Stations, etc…

It provides robust long-distance wireless broadband connectivity to remote areas without digging/laying underground cables.

## A.3.1 Uniqueness and Innovation of Saankhya's Fixed Wireless Point to Multi-Point Solution

- SL's FWA (Fixed Wireless Access) products are India's first FCC certified Fixed Wireless Access

Solutions.
- SL's FWA products are designed and developed in India, including the main Baseband Processor, which is based on a Saankhya Labs patented Software Defined Radio (SDR) chip.
- SL's FWA products are the world's first IEEE 802.22 standard compliant WiFAR technology product. Competing FWA vendors' equipment are based on proprietary protocol which are not interoperable with other vendor products.
- Works in the UHF band (470-698 MHz). Operates in Non-Line of sight. Better Penetration through foliage. Long range communication (upto 15 Kms).
- Field upgradable and remote management of equipment through Element Management System (EMS).
- Suitable for sparsely populated rural India where coverage, costs and power considerations are important.

## A.4. Duration

The entire project duration including supply of equipment, installation & commissioning and trial will be no more than one year.

This detailed project plan will be optimized during the project planning phase.

## A.5. Total Project Cost

The complete cost of the project as per the detailed scope defined in Part B is Rs. 9.99 Cr.

## A.6. Name of Applicant

Saankhya Labs Pvt. Ltd.

## A.7. Name of Concerned Civic Authority

ITI Limited, Bengaluru.

## A.8. Capability of Organization / Individual

### A.8.1    Expertise Available with the Applicant

Saankhya Labs is a Chipsets to Systems Company for 5G Broadcast, 5G Broadband and Satellite Communications products based on Saankhya's patented Software Defined Radio (SDR) semiconductor technology. Saankhya Labs is India's first fabless semiconductor company with the world's first production SDR.

Saankhya Labs has **30 international** patents including 5 Standard Essential Patents covering NextGen "6G" RAN and convergence. Saankhya Labs, in partnership to ISRO, provides satcom &

terrestrial communications solutions for the Indian Army.

Saankhya Labs' solutions include industry's first IEEE 802.22 compliant Fixed Wireless Access systems for rural broadband connectivity, satellite communications modems for IoT applications and multi-standard DTV modulators and demodulators.

Some of Saankhya's solutions that are deployed in the field are –

- S-Band Locomotive Tracking System for the Indian Railways, including a two-way MSS terminal for tracking of locomotives to enable Real Time Information System (RTIS) of Indian Railways and corresponding hubside Equipment.
- S-Band Vessel Tracking System for the Indian Navy, including a two-way MSS terminal for tracking shipping vessels and fishing trawlers at deep sea and corresponding hubside Equipment.
- S-Band Satellite Mobile Radio Terminal device designed to operate with ISRO's GSAT Satellite Network.
- Broadcast Radio Head (BRH) for NextGen Digital Terrestrial Transmission (DTT), deployed with a Tier-I operator in the US.

## A.8.2    List of Ongoing and Completed Projects / Pilot Deployments

The following table is a list of ongoing & completed Projects / Pilot Deployments for SL's Fixed Wireless Access products.

| Sr. N | Project Title | Start Date | Completion Date | Project / Pilot deploymen | Sponsoring Agency |
|---|---|---|---|---|---|
| 1 | IIT Delhi | Aug 29, | Sep 04, | 676,9 | IIT, |
| 2 | IIT Varanasi | Feb 03, | Feb 10, | - | Saankhya |
| 3 | IIT Srikakulam | Mar 29, | Mar 31, | - | Saankhya |
| 4 | IIT Mumbai | Apr 14, | Apr 25, | - | Saankhya |
| 5 | IIT Hyderabad | May 09, | May 18, | - | Saankhya |
| 6 | University of Illinois, US | May 09, 2018 | May 14, 2018 | 3,032,420 | University of |
| 7 | JP Systems Corporation, | Jun 05, 2018 | Jun 25, 2018 | 1,374,304 | JP Systems |
| 8 | Microsoft Corporation, | Jun 20, 2018 | Jul 05, 2018 | 737,000 | Microsoft |
| 9 | TEVET Llc | Jul 16, | Jul 25, | 1,625,4 | Tevel |
| 10 | Africom, Zimbabwe | Feb 22, | May 17, | 763,8 | Africo |

| 11 | Citek, South Africa | Apr 05, | Jun 15, | 916,4 | Citek |
|----|---------------------|---------|---------|-------|-------|
| 12 | Mobile DST, South Korea | Aug 20, 2019 | Dec 20, 2019 | 613,200 | Mobile DST |
| 13 | EMS Rotoura, NZ | Jan 05, | Mar 25, | 265,2 | Rotorua |

# Part B – Details of the Project
## B.1. Brief Description/Background about the Organization/Institution

### B.1.1 ITI Limited

ITI Limited, is a PSU under the Ministry of Communication in the field of Telecom Manufacturing & Services (Turnkey Solution Provider). After serving the country (DoT, BSNL, MTNL, Indian Army, Indian Airforce etc.) in the field of Switching, Transmission, Terminal Equipment & Networking, presently, ITI is handling the following tasks.

- Design, Manufacturing and Implementation of Secrecy devices for Indian Defense Networks (DCN, NFS etc.)
    - Laying of OFC for NFS
    - Bharat Net Projects
- Maintenance of ASCON Phase III Network for Indian Army; going to implement ASCON Phase IV Mega Network
    - SWAN Projects
    - Maintenance of 2G & 3G Mobile Networks
    - NGN (Triple Play)
    - GPON
    - Smart Energy Meter
    - Data Centre
    - Smart cards, RuPay & Mastercard
    - Mini PCs
    - Solar Panel Manufacturing
    - Setting up Wi-Fi networks for BSNL/BBNL
    - TAG ITI Wallet
    - Face Mask for Covid-19

### B.1.2 Saankhya Labs

- Saankhya Labs is a communication solutions company that provides communication products based on its award winning, patented Software Defined Radio (SDR) SoC platform. Saankhya Labs offers a wide range of communication products for applications in broadband, satellite and broadcast communications. With several international technology patents and unique 'chips-to-systems' expertise, Saankhya Labs' solutions include industry's first IEEE 802.22 compliant Fixed Wireless Access solution for rural broadband connectivity, satellite communications modems for IoT applications and multi-standard DTV modulators and demodulators. Saankhya Labs is working on creating cutting edge technology in NextGen TV and communications solutions for 5G and beyond.
- Saankhya Labs is driving "Make in India" in electronics design and manufacturing and has invested 100+ Cr to develop solutions that power rural broadband initiatives like "Digital

India" and indigenous defense communication equipment. The company is widely recognized in the semiconductor industry as a pioneer in Software Defined Radios and Cognitive RAN and has several international patents and IPRs in this space. These technologies are key elements for the "Network of the Future".

- Saankhya Labs is also a technology partner for ISRO and has designed indigenous Satellite phones and SDR manpack solutions for the Indian defense sector.
- Saankhya Labs has 30+ international patents including Standard Essential Patents and several awards to its credit. The company is headquartered in Bangalore, India.

## B.2.  Background of the Problem which the Pilot Project Addresses

Gram Panchayats (GP) are connected to the Internet under the BharatNet program. However, BharatNet is under-utilized as many sparsely populated villages are located at a distance from the GPs, service provisioning is restricted, due to the time taken and costs incurred to lay fiber to these remote villages. Coverage area of WiFi installed in the GP is limited to ~50 – 100m from the Wifi hotspots which are typically installed at the GP. The average number of users per GP is quite low. In addition, the sparse population in these remote villages creates a very difficult business case for laying the fiber to these villages.

Newer, innovative & indigenous wireless technologies are now available to circumvent these limitations and ensure faster service delivery to subscribers in sparsely populated remote villages. This will increase the usage of BharatNet.

## B.3.  Description of Pilot Deployment

### B.3.1    Objectives of the Pilot Deployment

The objectives of the pilot are

a.  Bring reliable network access to 264 villages
b.  Increase the utilization of BharatNet
c.  Demonstrate wireless connectivity using Saankhya Labs' Fixed Wireless Access products

The pilot aims to connect GPs to villages using an innovative wireless communications technology designed, developed and manufactured entirely in India using the UHF spectrum from 470 to 698 MHz. This pilot will cover 66 GPs and 264 villages.

ITI and Saankhya Labs propose an IEEE 802.22 (WiFAR) based solution to provide broadband access to rural areas, which otherwise remain unconnected to the rest of the world due to the lack of affordable broadband infrastructure.

The deployment architecture uses the novel concept of FWA technology as a back-haul or middle-haul network to extend the broadband connectivity from GP to remote villages with last mile access, using WiFi Hotspot. Users can then use personal devices like phones, tablets or laptops to access the internet and use other CSC services.

This project is a pilot and not a technology demonstration. Saankhya Labs' Fixed Wireless Access technology trials have been successfully concluded at IIT-D, IIT Hyderabad and IIT Bombay, and internationally in USA, Scotland, New Zealand, South Korea, South Africa, etc. using indigenous equipment. This project will showcase all Digital India's services at an affordable price. Its endeavor  is to provide a template for speedy mass scale deployment through domestic manufacturing.

## B.3.2    Preliminary Investigations done by the Organization / Individual

The Benefits of Fixed Wireless Access solution from Saankhya Labs are multi-fold

a. Laying optical fiber is an expensive & time-consuming process which requires obtaining approvals for RoW, digging, laying ducts, permissions from the local utility companies & governing authorities, etc. Post laying of these cables, the operations & maintenance of these optical fiber cables require skilled labor & expensive tools for splicing. In contrast Saankhya  Labs FWA solution enables infrastructure deployment as well as operations & maintenance  without extensive digging.
b. Across many countries, a technology called Fixed Wireless Access over UHF spectrum is being  used to provide internet access in rural areas. The UHF spectrum from (470 to 698 MHz),  traditionally reserved for terrestrial TV transmission is under-utilized in India with only one or  two 8-MHz channel being used by Doordarshan. The main advantage of this UHF frequency  range in 470 to 698MHz band is that even at a very low power, signals propagate across long  distances using small tower heights, compared to other technologies that operate at 900,  1800 or 2400MHz. This is beneficial for rural broadband.
c. The signals travel long distances due to the excellent propagation characteristics of electro-magnetic (EM) waves in the UHF band. As a result, we require a fewer number of installations  to cover a given geographical area. This leads to lower CAPEX and lower OPEX.
d. Smaller towers/poles that are used decreases the setup cost because a simple pole made of 2.5inch GI pipe is sufficient (i.e. total height of 20-30 feet above ground level for user side equipment and 30-50 feet above ground level for Base Station). An existing cellular tower can  be reused at the back-haul location.
   e. Fewer towers are required and therefore the setup cost is lower.
   f. Extremely low op-ex due to low power consumption.
   g. Local manpower can be trained for easy installation, maintenance and speedy deployment.

## B.3.3    Domestic Component in Pilot Deployment

The 4 main components of this solution are Designed, Developed & Made in India. Detailed

specifications of the FWA BS & CPE are included in B.9 Annexures.

1. **Meghdoot Base Station SLB802ODU** - Long range wireless broadband access to subscribers over UHF spectrum.

➤ Achieves long range up to 15 km

➤ Supports non-Line of Sight (non-LOS) and Line of Sight (LOS) operation in both point to point (PTP) and point to multi-point (PMP) topologies

➤ Fixed wireless broadband solution

➤ Operates in TDD (Time Division Duplex) mode

➤ Maximum aggregate data rates of 25Mbps (8MHz) and 20Mbps (6MHz)

➤ Database support based on leading database providers

➤ Support both bridge and router modes of operation

➤ Both centralized and local device management using Saankhya's Element Management
➤ System solution

➤ EMS for ease of operation and remote monitoring and installation

➤ User Authentication and security using WPA2-PSK with AES-128 encryption

➤ FCC Certified Base Station (FCC ID -2AUUC-MEGHDOOT)

*Figure 1 Meghdoot Base Station*

2. **Omni Antenna Specification**

| Electrical Specifications | |
|---|---|
| Frequency Range | 470 – 698MHz |
| Gain | 6dBi |
| Horizontal Beam Width | 360° |
| Vertical Beam Width | 17°± 2.5° |
| Polarization | Vertical |
| Nominal Impedance | 50 Ω |
| VSWR | ≤ 1.8:1 |
| Input Power | 50W |
| Side Lobe Level | ≥ 10 dB |
| Connector | N Female |
| **Mechanical Specifications** | |
| Dimension (L) | 1550 mm |
| Radome Diameter | 40 mm |
| Total Mass | < 1.5 Kg. |
| Radome Material | PVC |
| **Environmental Specifications** | |
| Temperature Range | -20°C to+70°C |
| Wind Load | 120 Kmph |

*Figure 2 Omni Antenna for Base Station*

**3.** **Dhaval CPE Modem SLC802ODU** - Long range wireless broadband access to subscribers over UHF spectrum.

- ➢ Achieves long range up to 15 Kms

- ➢ Supports non-Line of Sight (non-LOS) and Line of Sight (LOS) operation in both Point to Point (PTP) and Point to Multi Point (PMP) topologies

- ➢ Fixed wireless broadband solution

- ➢ Support for TDD (Time Division Duplex) mode

- ➢ Maximum aggregate data rates up to 25Mbps (8 MHz) and 20Mbps (6MHz)

- ➢ Database support based on leading database providers

- ➢ Support both bridge and router modes of operation

- ➢ Both centralized and local device management using Saankhya's Element Management System (EMS) Solution

- ➢ EMS for ease of operation and remote monitoring and installation

- ➢ User Authentication and security using WPA2-PSK with AES-128 encryption

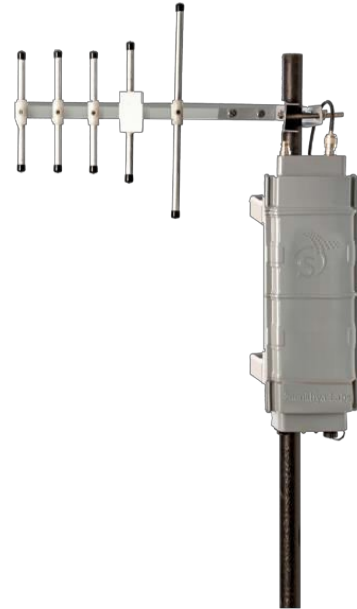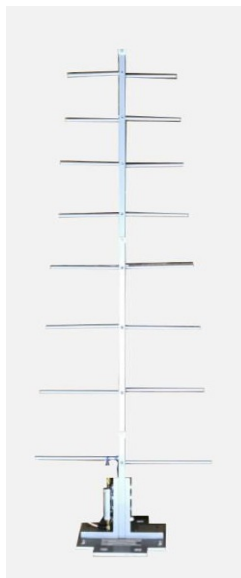- ➢ FCC Certified CPE Modem (FCC ID -2AUUC-DHAVAL)

*Figure 3 Dhaval CPE*

**4. Yagi Antenna Specification**

| Electrical Specifications | |
|---|---|
| Frequency Band | 400-698 MHz |
| Impedance(ohm) | 50 |
| Gain | 9dBi |
| Polarization | Vertical |
| Radiation | Directional |
| VSWR | 2:1 |
| Horizontal Beam Width | >50 deg |
| Vertical Beam Width | >80 deg |
| Out of band Rejection | >15 dB to 40 dB |
| Max. Input power | 10 W |
| Output Cable | SMA (M) |
| **Mechanical Specifications** | |
| Antenna Material | Aluminum |
| Diameter | 1240x350x140 mm |
| Color | Gray |
| Weight | < 2.5 Kg |
| **Environmental Specifications** | |
| Operating temperature (°C) | -50～80 |
| Wind Load | 115 Kmph |

*Figure 4 Yagi Antenna for CPE*

### B.3.4    Linkages

1. Saankhya Labs is a Wireless Communication Semiconductors and Solutions Company. The Base Station (BS) & Customer Premise Equipment (CPE), recommended for this Pilot project, are made in India. These products are based on Saankhya's patented Software defined Radio (SDR) semiconductor technology.

2. ITI will be the Services partner, viz. Installation & Commissioning, Support, etc. They will also be provider of other equipment & accessories like Outdoor Wifi AP, WLC, poles, Masts, Solar Plant, UPS, Battery, etc.

3. Backhaul connectivity at the Base Station location to be provided by USOF.

4. Spectrum required for this pilot is to be provided by USOF. The requirements are as specified in the table below.

| Start Freq | End Freq | Center Freq |
|------------|----------|-------------|
| 534        | 542      | 538         |
| 542        | 550      | 546         |
| 550        | 558      | 554         |

In conclusion, we require 3 channels of 8 MHz each, i.e. a total of 24 MHz.

5. AMC for all equipment to be issued as a separate project budget.

### B.3.5    Other Organizations working in this area

1. Adaptrum
2. Whizpace
3. Runcom

# B.3.6 Methodology: Detailing stepwise activities & sub-activities
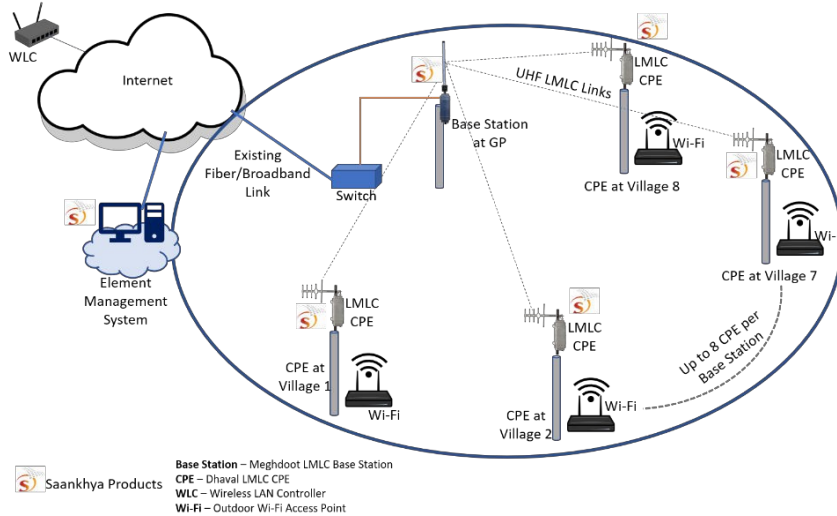
## B.3.6.1 Deployment Architecture



*Figure 5 Solution Architecture*

A single 8Mhz bandwidth base station provides a maximum of 25mbps*. With 1:3 frequency reuse, the setup needs 24MHz of bandwidth allocation for this pilot project. With this, a single Base Station (BS) per GP can provision up to a maximum of 8 villages with an omnidirectional (omni) antenna. The number of CPEs per BS can be configured depending on the wireless user contention ratio and the actual bandwidth required at each village. Outdoor WiFi access point will be connected to each CPE to provide wireless connectivity to users in the village. A Wireless LAN Controller (WLC) will be deployed in the cloud which helps provide control functions to each WiFi Access Point.

## B.3.6.2 Base Station setup at Gram Panchayat (GP)

At each GP, Internet Leased Lines are terminated. These provide a Point-of-Presence on an electrical or an optical port. A CAT6 cable from this port will be connected to the Base Station Equipment mounted on a tower up to a height of 30-50 ft. above ground level (AGL). The height of the tower is determined by inputs received from Radio planning activity. A Base Station will be connected to its antenna, mounted at the same point on the tower. In some cases, multiple sectors may be required if the number of villages to be served are more than the capacity of the Base Station depending on data rate. A Directional/Sector or Omni Antenna may be used, depending on the angular spread of the target villages around the Base Station. Directional/Sector antenna may also be used to ensure low interference with other Base Stations that are either co-

located or at an adjacent location.

### B.3.6.3 CPE setup at Village

Base Station will communicate with the CPE installed in the villages using UHF spectrum. The CPE will feed a WiFi Access Point creating a WiFi Hotspot within its neighboring area of 100-200m. End-users can then connect to the internet through these hotspots using their WiFi enabled smartphones or using tablets/laptops installed at the Common Service Centers/Schools, etc. We can connect a maximum of 8 CPEs to each BS. Assuming there are 25 simultaneous users, each user can get 1Mbps. Assuming a contention ratio of 1:10, at least 250 users per GP will be online. In order to provide greater coverage within a village, a WiFi mesh network can be setup. A light weight Yagi antenna will be used for the CPE equipment.
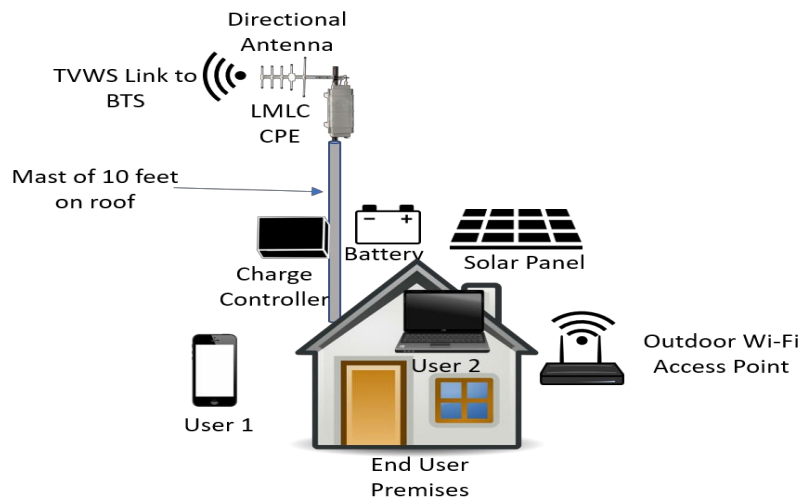


*Figure 6 CPE Modem side User Connectivity*

### B.3.6.4 Provisioning and Management of Fixed Wireless Access Equipment

The Element Management System can be operated from a Network Operations Center (NOC) or a data center on the internet to monitor, diagnose or configure the Base Station and CPEs.

### B.3.6.5 Power Supply

Power is supplied to the Base Station and CPE Modem over Ethernet cable using a PoE (Power Over Ethernet) Injector from an SMPS power supply unit. The CPE and Base Station can be powered entirely by an adequate solar power system. The typical power consumption of Base Station and CPE is 25W.

### B.3.6.6 Special Requirements to execute the project

Permission is required from WPC (Wireless Planning and Coordination) for use of UHF spectrum (between 470-698 MHz) within the geographical area of this project. For the present requirement, it is recommended to use a single band of 8-MHz per radio link (For Higher Bandwidth requirements we will need additional multiples of 8MHz channel to provide incremental 25 Mbps links). With 1:3 frequency reuse the setup needs 24MHz of bandwidth allocation for this pilot project.

## B.4.  Work Plan

The project plan shown below is a high-level project plan. A detailed project plan with all the milestones will be made after the USOF Project approval.

## B.5.  Outcome of the Pilot Deployment

1.  Ability to connect more villages which are otherwise not connected to the internet.
2.  More users on BharatNet.
3.  Our Fixed Wireless Access solution can facilitate Online Classes to enable distance & safe learning, which is extremely important post Covid-19 lockdown.
4.  Benefits of wireless connectivity to the selected Schools, Primary Health Centers, Community Health Centers, Post Offices, Anganwadis & Police Stations.

## B.6.  Likely Impact (Social / Economic)

As per Government of India study- "every 10% usage of Internet in India drives up GDP by 3.3%"

## B.7. Parameters for Monitoring Effectiveness of Pilot Deployment

1. Number of villages connected.
2. Traffic Utilization on BharatNet
3. Increase in use cases (Modern Farming, Tele Medicine, Smart Classes, etc)

## B.8. Suggested Post Pilot Deployment Activities

These activities are suggested for future scope of the Pilot Project -

a. Operations & Maintenance of the sites.
b. Annual Maintenance Contracts for all equipment for Fixed Wireless Access Equipment, solar plant, EMS, Leased Lines, etc. beyond 1 year.
c. Customer support.
d. Service delivery – Addition of new sites, etc…
e. Government of India should certify the effectiveness of the Indigenous technology for rural applications and recommend this technology/solution for Large scale deployments by bulk manufacturing in India.
f. Addition of 5G Broadcast solution to Fixed Wireless Access for improved Social Messaging, Digital Schools, Modern Farming programs, etc…

## Part C – Pilot Project Estimates Summary

| S. N. | Item | Per Unit Rate (INR) | Quantity | Item Cost | GST 18 | Tolat Cost Including GST (INR) |
|---|---|---|---|---|---|---|
| **A. Equipment cost** | | | | | | |
| **A.** | **Base-Station side** | **# of GPs** | **60** | | | |
| A.1 1 | UHF Wireless Base Station (BS), one for every 4* villages | 163,000 | 60 | 9,780,000 | 1,760,400 | 11,540,400 |
| **A. 2** | **CPE side** | **# of villages (assumed** | **240** | | | |
| A.2 | UHF Wireless CPE Modem (CPE) | 75,500 | 240 | 18,120,000 | 3,261,600 | 21,381,600 |
| **A.** | **Monitoring and Management Tool** | | | | | |
| A.3 1 | Saankhya Element Management System (License fee, hosting, maintenance Fee) | 2,100,000 | 1 | 2,100,000 | 378,000 | 2,478,000 |
| **A.** | **Training, Installation support** | | | | | |
| A.4 1 | Training for Installation & Commissioning, Project Management and Remote Support | 3,900,000 | 1 | 3,900,000 | 702,000 | 4,602,000 |
| **A.** | **Antenna, Cables and Accessories** | | | | | |
| A.5 | Antenna (Omni) | 14,000 | 60 | 840,000 | 151,200 | 991,200 |
| A.5 | Antenna (Low power Yagi) | 9,500 | 240 | 2,280,000 | 410,400 | 2,690,400 |
| A.5 | Cables and Accessories | 2,500 | 300 | 750,000 | 135,000 | 885,000 |
| **A.** | **Annual Maintenance Contract** | | | | | |
| A.6 | RF Survey, RF Plan and Remote Support | 4,000,000 | 1 | 4,000,000 | 720,000 | 4,720,000 |
| | The above costs include warranty for 1 year. Any additional support & maintenance required for beyond the Warranty period of 1 year will be charged additionally as AMC at 12%. | | | | | |
| | **Total Budget for Saankhya Labs** | | | **41,770,0** | **7,518,6** | **49,288,6** |
| | **OTHER Equipments to be Sourced** | | | | | |
| **B.** | **WiFi Access related** | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Wireless LAN Controller (WLAN) | 30,000 | 5 | 150,000 | 27,000 | 177,000 |
| | Outdoor WiFi Access Points | 20,000 | 300 | 6,000,000 | 1,080,000 | 7,080,000 |
| B. | **Poles/ Masta** | | | | | |
| B.2 | Poles for BS per GP (6m) ** | 10,000 | 45 | 450,000 | 81,000 | 531,000 |
| B.2 | Mast for GP (30m) ** | 200,000 | 15 | 3,000,000 | 540,000 | 3,540,000 |
| B.2 | Poles for CPE (2-3m) ** | 5,000 | 240 | 1,200,000 | 216,000 | 1,416,000 |
| B. | **Solar Power Supply** | | | | | |
| B.3 | Solar power For BS (50W) | 5,000 | 60 | 300,000 | 54,000 | 354,000 |
| B.3 | UPS (Without Battery) - 800VA | 12,500 | 60 | 750,000 | 135,000 | 885,000 |
| B.3 | Battery For UPS (50W for 4H Backup) | 7,500 | 60 | 450,000 | 81,000 | 531,000 |
| B.3 | CCU (100W) | 5,000 | 60 | 300,000 | 54,000 | 354,000 |
| B.3 | Solar power For CPE (50W) | 5,000 | 240 | 1,200,000 | 216,000 | 1,416,000 |
| B.3 | UPS (Without Battery) - 500VA | 10,000 | 240 | 2,400,000 | 432,000 | 2,832,000 |
| B.3 | Battery For UPS (50W for 4H Backup) | 7,500 | 240 | 1,800,000 | 324,000 | 2,124,000 |
| B.3 | CCU (100W) | 5,000 | 240 | 1,200,000 | 216,000 | 1,416,000 |
| B. | **Miscellaneous** | | | | | |
| B.4 | Misc Wiring & other Materials | 9,500 | 300 | 2,850,000 | 513,000 | 3,363,000 |
| B.4 | Earth Pit | 5,000 | 300 | 1,500,000 | 270,000 | 1,770,000 |
| B. | **Installation and Commissioning** | | | | | |
| B.5 | For Base Station | 23000 | 60 | 1,380,000 | 248,400 | 1,628,400 |
| B.5 | For CPE | 10000 | 240 | 2,400,000 | 432,000 | 2,832,000 |
| C. | **Operations and Maintenance (OPEX)** | | | | | |
| C.1 | Operation & Maintenance cost per year (50% to be generated using revenue from wireless service) per village | 22,500 | 300 | 6,750,000 | 1,215,000 | 7,965,000 |
| D. | **Leased line connectivity for annum** | | | | | |
| D.1 | 100Mbps leased line for internet connectivity (Approximately) | 600,000 | 0 | 0 | 0 | 0 |
| | ** The exact height of the poles will be dependent on a detailed RF plan. | | | | | |
| | **Total Budget for ITI** | | | **34,080,0** | **6,134,4** | **40,214,4** |
| | TOTAL FOR PILOT PROJECT | | | 75,850, | 13,653, | 89,503,0 |
| | Project Management & Supervision Cost of ITI | 10% | 1 | 7,585, | 1,365, | 8,950,3 |
| | Total including Project Management & Supervision Cost of ITI | | | 83,435,000 | 15,018,300 | 98,453,300 |
| | Independent Agency Evaluation Cost | 1.5% | 1 | 1,251, | 225,274 | 1,476,8 |
| | **Grand Total of the Pilot Project** | | | **84,686,5** | **15,243,5** | **99,930,1** |
| | Shipping and transportaion of equipments not included | | | | | |