



Bharat Broadband Network Limited
A Government of India Undertaking

Report on Pilot Project

National Optical Fiber Network (NOFN)



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1 Introduction

The Government of India has set up Bharat Broadband Network Limited (BBNL), a Special Purpose Vehicle (SPV), for the Establishment, Management and Operation of National Optical Fiber Network (NOFN) to provide 100 mbps connectivity to all the 250000 Gram Panchayats (GPs) spread over 6590 Blocks and 637 Districts in the country. It was estimated that, the project shall entail laying of 500000 Km of incremental OFC at an estimated cost of Rs 20,000 Cr which will be funded through USOF.

NOFN has the potential to transform many aspects of rural scenario by providing services such as voice, video and data. This project will facilitate Information and communication Technologies (ICT) applications such as e-Commerce, e-Banking, e-Governance, e-Education and Tele-medicine etc. which require high speed Internet connectivity.

At conceptual level, NOFN is envisaged to bridge the connectivity gap between Block and GP through an Optical Fiber Network. To this network, TSP/ISP/MSO will provide vertical and horizontal connectivity to deliver various services. A conceptual diagram and connectivity schematic of the NOFN is given at [Annexure-I](#). Thus, while the actual services (e.g. G2C, B2B, P2P, B2C etc. covering E-education, Remote Health Monitoring, E-Governance, Weather, Agriculture etc,) to the end users will be offered by Telecom / Internet Service providers, Bharat Broadband Network Limited will provide non-discriminatory access to all categories of Service providers by way of providing wholesale bandwidth using NOFN.

It is evident that NOFN is a mammoth and complex project. Therefore, before embarking on a large scale implementation, it was thought prudent to carry out pilot projects at different geographical locations. As discussed in the 8th HLC meeting, held on 16-3-2012 and Advisory Board meeting on 29-3-2012, the pilot trials were to be carried out in 3 Blocks. Accordingly, BBNL embarked upon Pilot projects in three blocks covering 59 Gram Panchayats in three different states. These blocks are Arain in Ajmer District (Rajasthan), Parvada in Vishakhapatnam (Andhra Pradesh) and Panisagar in North Tripura district (Tripura). Target for completion of the Pilot was 15-10-2012. The work in all the three Blocks under the Pilot project was completed on 15-10-2012 as per the target. As a further follow up, DEITY also enabled the delivery of G2C services under a counter funding program in all these Gram Panchayats.

This report is prepared for the three Pilot Sites of NOFN at Arain in Rajasthan, Parvada in Andhra Pradesh and Panisagar in Tripura. The Pilot work was allocated to the three CPSUs namely BSNL, POWERGRID and RAILTEL. BSNL has laid the underground incremental fibre at Arain, POWERGRID has



laid the incremental underground OFC at Parvada where as Railtel has executed the pilot at Panisagar by laying Aerial OFC.GPON technology has been adopted for the roll out of these pilot sites. The equipments namely OLTs, ONTs as well as all the accessories like SPV, Battery etc has been supplied by CDOT. CDOT has also implemented the EMS/NMS solution for the pilot sites. A total of 59 GPs have been provided with 100Mbps connectivity with the commissioning of this pilot project. The pilot sites were commissioned on 15/10/2012.

2 Pilot Project Objective

The broad objectives of the pilots were set out as follows:

- i. The learning on technology choice and network architecture.
- ii. Experience gained in addressing ground realities in rural domain.
- iii. NOFN NOC related issues being developed by C-DOT- its integration and its testing at pilot locations.
- iv. Experience gained by participation of TSPs, ISPs, MSOs and application providers in utilizing bandwidth created by NOFN with respect to deliverables committed by NOFN/BBNL.
- v. Synergisation by DIT/DoT to work together for pilots and plan the Template for pilot testing of G2C services.
- vi. Integration of NOFN pilots with existing networks from Blocks upwards. Also address the interfacing of NOFN with access operators at GPs.
- vii. Synthesis of learning from the pilots and cross learning amongst 3 CPSUs in execution strategy.

3 Pilot Project Execution

The execution of Pilot project in these three Blocks was assigned to the three CPSUs as follows:

Block	State	CPSU entrusted with the Pilot.
Arain	Rajasthan	BSNL
Parvada	Andhra Pradesh	Powergrid
Panisagar	Tripura	Railtel

The scope was to lay only the incremental cable and utilize existing OFC of BSNL, PGCIL and Railtel to the extent possible.

The CPSUs namely BSNL, POWERGRID and RAILTEL have since executed the pilot sites of Arain, Parvada and Panisagar. The essential elements of execution are mentioned below:

3.1 Pilot Scope

BBNL selected three blocks covering 59 Gram Panchayats in three different states for the pilot trials. These blocks are Arain in Ajmer District (Rajasthan), Parvada in Vishakhapatnam (Andhra Pradesh) and Panisagar in North Tripura district (Tripura) which represents diverse conditions and topology. This meant covering 30 Gram Panchayats in Arain Block, 15 in Parvada Block and 14 in Panisagar. A list of these Panchayats is at [Annexure-II](#).

3.2 Technology

As per the minutes of the 9th HLC held on 31.05.2012 (OM dated 14.06.2012) the following was agreed and recorded under para 7.0 which reads as “GPON be the Technology of choice owing to architecture and ground conditions of minimal power consumption etc.” Accordingly, GPON (Gigabit Passive Optical Network) technology has been used for the implementation of NOFN Project. The main components of GPON technology are OLT, ONT/ONU, Splitters, OF cables etc. An OLT equipment is placed at each block headquarter and ONTs are placed at each of the Gram Panchayats (GPs). Technology supports various interfaces such as 1000Base Sx/LX/Zx at the SNI of OLT and 10 base T/100 Base T/1000 Base T for UNI of ONT. The specification for these interfaces complies with TEC Gr No Gr/EMC-01/ 01.Jun.2006 or latest amendments if any.

The Tender for GPON equipment and solar power panel are broadly based on TEC GR with latest modifications. The experience gained in pilot has influenced the formulation of Technical specification of the GPON equipment during tender.

The Block schematic of NOFN architecture is shown in [Annexure-I](#).

3.3 Survey

A detailed survey was conducted by the 3 CPSUs. Whereas underground OFC have been used in Parvada and Arain, Overhead OFC has been used at Panisagar. The survey reports as well as the L14 diagrams for these pilot projects are enclosed in the [Annexure-III](#). A summary of the survey conducted is as follows:

S. No.	Block	Total GP	Existing OFC (km)	Incr. OFC (Km)	Average Existing OFC Per GP (Km)	Average incr. OFC per GP(Km)
1	Arain	30	133	97.6	4.43	3.25
2	Panisagar	14	16.57	38.24	1.10	2.73
3	Parvada	15	18	30	1.2	2
Total		59	167.57	165.84	2.84	2.81

It is observed from the above that the average incremental cable is more than 2km .This has also been verified from the survey done so far. The increased length of incremental cable shall, have cost implications on the capex and opex of the NOFN Project.

3.4 Material

The OFC used are as per the following specification:

Sl. No.	Name of Pilot Sites	Name of Executing Agency	Cable Type (F)	Specification
1	Arain	BSNL	Double HDPE sheathed 24F OF cable	CA/CNP/OFC/T-406/2011-12

Sl. No.	Name of Pilot Sites	Name of Executing Agency	Cable Type (F)	Specification
2	Panisagar	RAILTEL	ADSS 24F OF cable	GR/OFC/03/03/June 2005. with latest amendment
3	Parvada	POWERGRID	Nylon Based 24F OF cable	GR/OFC-17/01/June 2007(with amendment No.1 on 28.08.2008

The OFC for the NOFN has been standardized as Double HDPE based 24F OF cable and the procurement has been initiated accordingly.

The OLTs, ONTs, Accessories, EMS/NMS were supplied by CDOT based on Purchase order from the CPSUs. The details of the equipment supplied to each pilot site are given an [Annexure IV](#).

3.5 Estimate and Costing

The Project Estimates sanctioned is annexed in [Annexure V](#). On the analysis of the PEs following observation evolves:

Summary of Cost Estimate of Pilots:

The estimated cost includes the cost of PLB duct and accessories, OFC and accessories, GPON Equipment and accessories, Trenching and laying cost, supervision and maintenance cost etc.

Sl. No.	Name of Block	Estimated Cost (Rs.)	Increment al OFC in Kms	No. of GPs	Increment al OFC per GP	Est. Cost/ GP (in Rs.)	Est Cost Per Km
1	Parvada	27,221,543	33.5	15	2.233	1,814,769.53	812.6
2	Arain		97.6	30	3.253		

Sl. No.	Name of Block	Estimated Cost (Rs.)	Incremental OFC in Kms	No. of GPs	Incremental OFC per GP	Est. Cost/ GP (in Rs.)	Est Cost Per Km
		37,689,159				1,256,305.33	386.2
3	Panisagar	16,419,710	38.24	14	2.249	1094647.30	429.4

The costing of various parameters have been worked out for the project based on the Pilot project in Ajmer district. However it can be seen that the estimated cost varies widely in the pilot sites and there is a need to standardize the same in order to exercise control over the Project.

3.6 Testing

All the Projects were completed on 15/10/2012. As the CPSUs had placed P.O on CDOT, they have carried out the acceptance testing (A/T) of the optical fibre cable as well as the OLT equipment, accessories including the EMS. The A/T reports are available in this office as per the schedule available with the respective CPSUs at the time of Installation. The Equipments have been loaded with traffic. However the A/T cell of BBNL had made their own assessment based on reports available and has since been following with the CPSUs. BBNL has also issued a standard acceptance testing (A/T) schedule for adoption by the CPSUs in future.

The major observations during the pilot trials are broadly divided in to the following categories:

- i. Acceptance Testing (AT) as per CPSUs AT schedule
- ii. Testing of throughput and End to End QOS based on RFC 2544.
- iii. AT of EMS and NMS.

BBNL decided to carry out the End to End QOS along with throughput of all the pilot sites. Department of Electronics and Information Technology (DeitY) was also of the view to conduct End to End QOS with throughput at the pilot sites. This testing was arranged through JDSU who arranged testers and expert personnel. JDSU carried out testing at Arain, Panisagar block as well as Parvada pilot sites for checking end to end throughput as well as QOS. Results and recommendations of JDSU are annexed at [Annexure VII](#). Various test measurements like End to End throughput, QOS etc were taken at some of the vertical as well as horizontal sites also.

Summary of Observations related to general AT, Throughput & RFC 2544 End to End QOS are as follows:

- i. Optical connectors at both OLT and at NIC were found to be dirty and were failing the IEC standard for optical connector quality. Being a new link with new fibres connectivity, after proper cleaning, the connectors passed the IEC standard quality check.
- ii. It was observed that the frame losses occur in the OLT – ONT segment of the network although 100% throughput is achieved. Even the frame loss rate is also small (less than 1%).
- iii. Majorly of the problem occurs for smaller frame lengths between 64 and 128 byte where the impact of frame loss is more at 100% load.
- iv. Bigger frames are much more stable and efficient.
- v. Though the latency increases as the frame length increases but in this case the variation in latency from smaller to larger frame is significantly low and well within the permissible limits.
- vi. The magnitude of frame loss rate was very high in case of ONT to End Location link with RF connectivity (Wi-Fi link) in-between. The frame loss rate went up to more than 70% in case of small frame length and was still under check at bigger frame lengths.
- vii. Video conference call was working fine with single call bandwidth consumption at around 1.45 Mbps and using a range of frame length, especially bigger than 256 bytes.
- viii. Voice Quality tested on the link provided good results with Mean Opinion Score (MOS) achieved at 4.2 and 3.98 at two different Codecs.

3.7 NMS

This Pilot network is managed through the NOFN-NMS product developed by C-DOT. NOFN NMS is planned in four phases with first phase in pilot being conducted at Parvada Block (Vishakhapatnam, AP) Arian block (Ajmer, in Rajasthan) and Panisagar block (North Tripura district in Tripura). Presently, the NMS manages and monitors the end to end NOFN network comprising of Optical Network Elements like GPON OLT, ONT, and fiber.

3.7.1 NMS Hardware and Software

The NOFN NMS is a software solution and can work in any general purpose computer. The NMS for the Pilot is being hosted in hardware with specifications as follows:-

- i. Application server-Intel ,2cpu with 10 core each

- ii. Data base server – 2 numbers , Intel , 1 having 2 cpu with 4 core each and 2 having 1 cpu with 4 core

NOFN-NMS Software for the piloting version uses custom built NMS software and 3rd party software with specifications as follows:-

- i. OS –Fedora core 14
- ii. Database server –oracle 11g
- iii. web server –Apache Tomcat
- iv. web browser –Firefox

CDOT will scale both H/W and S/W appropriately.

3.7.2 NMS infrastructure and DCN

- i. Application server –available at CDOT Delhi – GPON validation lab
- ii. Database servers – available at CDOT Bangalore NMS lab
- iii. Connectivity between servers – established by lease lines between CDOT Bangalore and Delhi
- iv. Connectivity with pilot locations – pilot locations connect to the EMS located at CDOT through a 2 mbps MPLS VPN taken from BSNL The connectivity is shown in the diagram given in [Annexure VIII](#).

During connectivity of DCN, issue of IP address schema came up and was resolved by adopting BSNL schema which may not be ideal in the main implementation. CDOT has analyzed and submitted recommendation regarding DCN and BBNL is taking action accordingly.

3.7.3 Features

The following features have been identified as key functions of NOFN NMS at Pilot locations:

- i. **Provisioning of service** (service creation and modification of service bandwidth) for the following service types -
 - a. HSI(High speed internet)
 - b. PPPoE(Point to Point Protocol over Ethernet)
 - c. VOIP(Voice over IP)
 - d. IPTV

- e. VBES(VLAN for Business Enterprise Service)
- f. Video phone service
- ii. **Fault management** including
 - a. View all alarms
 - b. View alarms for all service providers
 - c. View alarms of a service provider
 - d. View alarm by category and severity

iii. **Dashboard**

Dashboard presents the overall view of NOFN NMS Features. Presently, it implements specific dashboards for the pilot showing the details of service availability, current network alarms, bar chart showing alarms etc. This however needs to be corroborated with the EMS under alarms /current alarms as many times, it has been found to be out of sync.

iv. **Network element reports**

Reports display services, ONT status and Use log report. It was observed that reports provided were not adequate and accurate in some cases. CDOT has been apprised and next version of software release will take care of these issues.

v. **Generation and notification of trouble tickets**

Provides a feature to raise and notify network issues to the field personnel and also allows escalation of pending tickets. However, there is presently no Root Cause analysis (RCA), co-relation, event masking, diagnostics possible. CDOT has been asked to develop these capabilities as this form the `brain` of any NMS system.

vi. **Fibre management system** (fibre status reporting)

Fiber management system provides a feature to configure and view the provisioned fiber details and map the fiber related alarms to the provisioned fiber.

3.7.4 NMS Testing Observations

In a recently concluded testing of the features of Pilot NMS, carried out by GM, BBNL in Bangalore. In addition, CDOT has also been told to offer the following functionalities/features in the pilot NMS:-

- i. Capability to monitor SLAs
- ii. Port level inventory management reports for ONTs
- iii. Traffic/throughput reports ONT Port wise

-
- iv. Detailed breakup /reasons for ONT unavailability

3.7.5 NMS Roadmap

In the current Pilot scenario, the GPON network elements, the EMS and the NMS modules are all initial basic versions. We see a lot of synchronization problems, a lot of features are not possible in the NMS due to non-availability of these functionalities either in the network elements or in the EMS that is currently deployed in the pilot. In a multi-vendor environment, with at least 4 different GPON technology vendors with their respective EMSs CDOT has to take the responsibility of integrating these EMSs to the NMS. BBNL business processes and the data flow between the various modules for completion of business processes need to be in place for NMS to evolve fully.

Centralized automated fault localization is not demonstrated in the pilot as it is under development stage and CDOT will study and submit the report shortly.

3.8 Tariff

NOFN is a national asset and non-discriminatory access to its bandwidth is the basic tenet while working out the tariff. As such we need to treat G2G and G2C services differently. We also need to ensure that even for B2C services tariff is affordable. At the same time, tariff should be viable for BBNL to generate sufficient revenue. Accordingly a tariff for Pilot was worked out by applying discount on TRAI base rates. This is valid for one year and learning will be applied while determining tariff for the main project. Tariff plan thus worked out is as follows:

BANDWIDTH CHARGES (B2B AND B2C):

- i. BBNL Tariff for 2 Mbps per GP: Rs.4000/- pa
 - ii. For total bandwidth more than 2 Mbps & up to 10 Mbps per GP :
 - iii. For each stream of 2 Mbps including first stream: Rs.3590/- pa
 - iv. For 10 Mbps per GP: Rs.15900/- pa
 - v. PORT CHARGES :
 - vi. Nil charges: where the planned bandwidth of 100 mbps per GP is taken at OLT covering at least 80% of the ONT's in that block.
 - vii. Rs.10000/- per port of 100 mbps port at OLT per annum.
 - viii. Rs.20000/- per port at OLT for 1 Gbps port at OLT per annum.
- ONT port charges: NIL.

BANDWIDTH FOR GOVERNMENT CUG (INCLUDING G2G & G2C)

- I. 100 mbps Rs.66667/- per annum
- II. Bandwidth at OLT as 10 mbps per GP and above but below 100 mbps per GP
 - a. 10 mbps: Rs.7500/- per 10 mbps per annum
 - b. More than 10 mbps but below 100 mbps: Rs.7000/- per each 10 mbps pa
Including first 10 Mbps
 - c. Bandwidth at OLT as 2 mbps per GP and above but below 10 mbps per GP
 - i) 2 mbps: Rs.2000/- per 2 mbps per annum
 - ii) More than 2 Mbps but below 10 Mbps: Rs.1800/- per each 2 Mbps
pa including first 2 Mbps.

4 Service Delivery initiatives in Pilot

The Broad categories of services are B2B, B2C, G2G and G2C. Accordingly, government, industry and public users were pursued. For the government sector, need was felt to coordinate the efforts amongst various ministries and an Advisory Committee headed by Secretary (T) is looking into this aspect. In order to involve industry, meetings/dialogues with Industry associations and TSPs/ISPs were held. Meeting with MSOs were also held to explore the cable TV demand. In addition, officers were deputed in the field to generate leads. Following is a brief status on G2G/G2C and B2B/B2C services in the pilot.

4.1 G2G/G2C

While many government departments, ministries etc. were interested, concrete plans were missing. After some discussions, DEITY came up with a counter funding program to utilize NOFN bandwidth in pilot projects. This is discussed in detail in subsequent para. In addition, a proposal to extend e-services through Ministry of Rural Development (MoRD) as anchor customer has been worked out which is also discussed in subsequent Para.

4.1.1 DEITY IT overlay counter funding program

G2C services in Pilot Blocks and Gram Panchayat are getting extended by NIC, under a counter-funding program of DEITY. Objective of this program is as follows

- i. Provision for Broadband Connectivity
- ii. 100 Mbps/1Gbps vertical connectivity from District to Block
- iii. 10 Mbps Horizontal Connectivity from Panchayat to user institutions
- iv. Infrastructure Gap Filling
- v. Identify Connectivity Gaps; Hardware requirements, Service portfolio
- vi. Design Strategy for National rollout
- vii. Applications and Services
- viii. Identification and Delivery of selected G2G & G2C services
- ix. Capacity Building and Awareness
- x. Strengthening institutional capacity Building

Accordingly, 195 institutions in these 3 Blocks have been provided connectivity through BSNL on wireless access equipment of CDOT. Vertical connectivity of 1 Gbps has been provided by BSNL through its own transmission media available on commercial terms. For BBNL bandwidth, G2C tariff has been charged through BSNL. NIC has provided Hardware like PC, printer, UPS etc. at each location identified by NIC. List of these institutions is as follows:

Institutions Covered

Rajasthan- Arain			Andhra Pradesh- Panwada			Tripura- Panisagar		
Sr. No	Type of Institution	No. of Institutions	Sr. No	Type of Institution	No. of Institutions	Sr. No	Type of Institution	No. of Institutions
1	BDO Office	1	1	Educational	21	1	Educational	12
2	Gram Panchayat	30	2	Health	4	2	Dept of Animal Resource Dvlp (ARDD)	8
3	Rajiv Gandhi Seva Kendra (RGSK)	31	3	Police Station	1	3	Govt. Office	8
4	PHC/ CHC	8	4	Govt Office	4	4	Health	2
5	Police Station	1	5	Govt Bank	1	5	Agriculture Dept.	2
6	Arian Sub Tehsil	1	6	Gram Panchayats	15	6	Bank	2
7	Digital Knowledge Centres (DKCs)	5	7	Digital Knowledge Centres (DKCs)	15	7	Police	2
8	Tele-medicine Centre	1	8	BDO	1	8	Administrative	2
	Total	78	9	Tele-medicine Centre	1	9	Post Office	1
				Total	63	10	Digital Knowledge Centres (DKCs)	1
						11	GPs	14
						12	BDO	1
						13	Tele-medicine Centre	1
						Total	54	

Applications and services have also been identified and deployed. List of these applications is given below -

Portfolio of Services Planned

Rajasthan- Arain	Andhra Pradesh- Panwada	Tripura- Panisagar
<ul style="list-style-type: none"> • PRIYASOFT software package • E-Sugam, Telemedicine • Mandi Bhav, Cause List • Arogya-Online and e-Aushadi modules • CCTNS Services • G2C related services: <ul style="list-style-type: none"> ▪ RPSC fee collection and application filling ▪ Digital Bonafide Residence Certificate ▪ Digital Caste Certificate ▪ Copy of record of rights ▪ tility Bills Payment • B2C related services: <ul style="list-style-type: none"> ▪ BSNL, IDEA, Airtel ▪ Tata Indicom and Vodafone mobile bill ▪ BSNL & MTS Telephone bill ▪ DISH TV Services 	<ul style="list-style-type: none"> • Mee Seva Services • eHealth Services • Animal Husbandry Services • Veterinary Hospital • Telemedicine Services • ePanchayat Agricultural Services • Computer Literacy, eLearning 	<ul style="list-style-type: none"> • Tele-education • e-Book, e-Journals • National Animal Disease Reporting System (NADRS) • Records of Rights/Land Mutation Status • Integrated Child Development System (ICDS) • Electricity Billing • Mother and Child Tracking System (MCTS) • Agmarket • Electronic Fund Management/Direct Cash Transfer • CCTNS • e-Subidha service, Birth Certificate • Copy of Register of Ordinary Residence etc. • e-MO, Speedpost etc

These applications are already live and transactions have started happening. NIC has also deputed manpower (one person in each GP and a supervisor in the Block HQ) for one year (up to 31-3-2014). The IT overlay provided by NIC is now ready to be formally launched.

4.1.2 E Services extension

Discussions took place between BBNL, DEITY and MoRD with a view to work out a techno-commercial model for extending e-Services in all the GPs so that substantial usage of NOFN is realized enabling enough G2G/G2C/B2B/B2C applications and services that can trigger the Broadband eco-system in the rural areas. The proposal has two components from a project implementation perspective – (a) e-service to GP connectivity platform (b) community Wi-Fi platform. BBNL will provide this platform and be the single front-end as well as be responsible for the back-end. BBNL will provide a POP at District HQ IT location. This POP will be connected by a dark fiber to the OLT in the Block. MoRD will be the Anchor Institution which will use the connectivity provided to deliver e-services to the citizen in coordination with DEITY and state governments. Tenure of the project is envisaged as 10 years to ensure viability and sustainability. The Capex of the project is proposed to be funded by USOF and the Opex by the MoRD. Executive summary of the DPR submitted for the proposed Government user network is attached in [Annexure IX](#).

4.2 B2B

It is assumed that B2B and B2C shall be the main stay of revenue for NOFN. However in the pilot, the response in this segment has been lukewarm. The TSPs/ISPs were expected to be the main users. All the service providers were approached. While all were enthusiastic, no concrete proposals came forward. A conditional response was received from the cable operators. Interest was shown by some NGOs and institutions for some CSR activities and few did mature. A brief description of efforts towards B2B and B2C business is summarized below:

Following initiatives were taken:

- i. All the major TSPs namely BSNL, AIRTEL, IDEA, Reliance Communications, Reliance Jio have been approached for utilising the bandwidth for free of cost for a few months.
- ii. BSNL has been approached to open Hot spots at GPs to offer internet services on prepaid basis.
- iii. ISP Association has been approached to utilise the bandwidth. They have agreed to come back with a business case but never showed any interest.
- iv. Contacts made with IAMAI and other app vendors to show case their products but there were no response.
- v. A meeting organised with the MSOs for utilising the NOFN for triple play services at BBNL premises besides a few meetings organised by Ministry of information and Broadcasting.

- vi. A tripartite agreement was proposed with Indian Bankers Association and BBNL which is under discussion.

CGM/GMs were deputed to all the three sites for Marketing efforts and doing the field work. Some of the major findings were the following:

- i. Identification of Broadband customers.
- ii. Identification of Schools/Educational Institutions.
- iii. Identification of potential customers.
- iv. Understanding the socio economic conditions. Detailed market research was carried out on the basis of a Questionnaire and interview with a few persons during the visit of CGM Tech to Panisagar. Findings are detailed in the [Annexure X](#).

4.2.1 CISCO's Inclusive Growth Initiative in Arain:

The Cisco Inclusive Growth Business Unit is working towards delivering on Cisco's vision of "Changing the way we live, work, learn and play" in the context of rural India. The idea is to empower and enable the rural masses through technology – for a better tomorrow. As a part of Inclusive Growth, the Cisco team has been focusing over on deploying technology for delivering benefits in 3 key areas: Education, Skills and Healthcare. BSNL and Cisco are working with Bharat Broadband Networks Ltd. (BBNL), in Arain block in Rajasthan on showcasing all the solutions listed in the [Annexure XI](#) for the NoFN project.

4.2.2 Digital Literacy programme

Digital Literacy programme by Digital Empowerment Foundation in collaboration with the Intel's follow the fibre programme in providing digital literacy in one Gram Panchayat of each of the Pilot blocks.

Impact of Follow The Fibre (FTF) mission: 'One digitally literate per household'

Location	Block/District /State	Total House hold	House-hold covered	Digital Literacy beneficiaries. One per household.
Arain Panchayat	Arain/Ajmer/Rajasthan	1036	1036	1036
Noagang Panchayat	Noagang/North	353	353	353

Location	Block/District /State	Total House hold	House-hold covered	Digital Literacy beneficiaries. One per household.
Muthayalampalem	Tripura/Tripura. Pravada/Vishakhapatnam ./Andhra Pradesh	280	280	280
Total		1669	1669	1669

4.2.3 MSOs

M/S ORTEL has shown initiative to start triple play services in Parvada block by carrying RF from Vizag. BSNL has provided 1Gb bandwidth from Vizag to Parvada free of cost for the Proof of Concept for a period of two months. M/s Ortel has already provided Triple play services at Thannum GP as well as five other connections. But provision of cable TV services are met with resistance from local Cable TV operators.

4.2.4 Efforts from M/s Sterilite

M/s Sterilite had shown inclination to start e-School programme in at least two schools in each of the Pilot Blocks. Nothing concrete has happened till date. This is being pursued.

4.2.5 IPTV from AKS

Efforts were made to rope in M/s AKSH to extend IPTV to a few GPs and to carry out demand survey to extend the same to retail customers. But the same did not materialize.

4.2.6 ISP/ Uclix

Discussions were held with Uclix /Bharat Synch Ltd for provision of internet bandwidth in Arain Block but it did not yield any result.

4.2.7 Tablet

Efforts are on to have reverse bundling with a few Tablet vendors to offer Wi-Fi based Tablet at special prices in rural schools where Wi-Fi internet service is available. Various Business models are being explored for the same. Talks are on with M/s Amtrak and M/s PTPL.



Further efforts are on to facilitate triggering of B2B and B2C services. It is felt that both B2C and G2C services are interlinked therefore the proposal made for community Wi-Fi service as part of G2C will help trigger B2C services.

5 Observation and Analysis with respect to pilot project objectives

A number of difficulties, issues and observations accumulated since the start of pilot project have been discussed above. These have been either corrected or suitable action initiated to mitigate or correct them. Moreover, 100 mbps connectivity has been available in these 59 locations which have generated various usage and results. In that sense, it has been successful in meeting its objectives.

Many important observations were made during the pilot trial. They can be categorized as Technical, Commercial, environmental and related to eco-system. Learning from these observations is important for planning, scaling and course correction. The summary of the learning /feedback, as per the objectives set out for the Pilot Project is as follows:

5.1 Technology choice and network architecture

GPON technology has been deployed in all the pilot Blocks and tested for its performance as per laid down procedure. Detailed comments on Technology choices and network architecture are as follows –

5.1.1 Related to Linear Architecture

The architecture between Block and GP is linear. Therefore any cut in the fiber (existing or incremental) affects the uptime. Since no protection is available; higher SLAs cannot be provided. However this is a decision which is given and linear architecture cannot be changed to ring architecture. Hence SLA will have to be in line with the linear architecture only.

5.1.2 Related to solar power back up/ Battery

Availability of power is the most important issue as discovered in the pilot. Detailed observations in this respect are as follows:

- i. Power supply situation is bad in all the blocks. In Panisagar, the power availability was told to be better than 20 hours but it is practically down to 4 hours during monsoon season. Power outage is reported to be more than 8 hours everywhere.
- ii. In Arain block, backup solar power is available in Rajiv Gandhi Seva Kendras where ONTs have been installed. Many of these were non-functional and regular power connections were also not available. But the situation has improved now. No backup for ONTs has been provided by BBNL in Arain.
- iii. In Parvada, CDOT has provided 4 Hour Solar back-up. As reported by NIC/ PGCIL officials, the SPV back up have become faulty in majority of the locations in Parvada. CDOT has

installed Li-Ion batteries of 7.8 Volt and 8800 mAH capacity designed for 4 hrs backup. Because of prolonged power failure the CCUs as well as Batteries at most of the ONT locations have become faulty. The ONTs are working on the UPS available with the respective offices.

CDOT was asked to replace the faulty power pack with Batteries and suitable CCUs for 12 hour backup which has not been done till date. As an alternative arrangement PGCIL is going ahead with provisioning of UPS with 12 hours battery back up at all the ONT locations.

- iv. In Panisagar, solar backup of 4 hours has been recently installed. But owing to non-availability of main power for more than 12 hours often, the batteries have got discharged and power situation is precarious.
- v. There are almost 8 hrs power failures on daily basis in Parvada Block. In the Panisagar Block the Power situation is very erratic during Monsoon.
- vi. During the visit it was opined that considering the power situation in Andhra Pradesh and Tripura as well as similar situations in other states, the power back up of 12 Hrs shall be necessary
- vii. It is reported that GP officials while leaving office switch off main supply resulting in non-charging of the batteries

Learning:

- a. Keeping in view the power situation in rural areas the power back up needs to be at least twelve hours.
- b. There should be separate power connection for each ONT. Wherever existing power connection is used the Mains switch/MCB for the ONTs should be separate.

5.1.3 Related to OLT

PGCIL has reported that they are unable to obtain the alarm log from the OLT. They have stated that the solar Power fail/cable fail alarms etc. are not observed at the OLT.

Learning:

- a) The alarm log has since been taken care of by CDOT.

5.1.4 Related to ONT

- i. It is reported that it is not possible to configure the GP name in the OLT/ONT. Numbers are given for GPs instead of names. It shall be cumbersome to correlate the GP numbers with GP names manually.
- ii. The configuration by GP name has been taken care of by CDOT. ONTs were reported to be rebooting frequently. Mal functioning of ONTs have been reported at Panisagar GP, Rowa, Bilthui and Deochera.
- iii. Wrong AC/DC adaptors 230/19Volt adapters are being used to power up the ONTs instead of 12 volt adaptors. Adaptor and ONT both are changed with new ones at Panisagar GP ONT site. The Wrong AC/DC adapters 19Volt were used to connect ONTs instead of 12 volt AC/DC adaptors. Major cause of ONT failures may be use of wrong adaptors.
- iv. It is difficult to differentiate faults at ONT between OFC failure and Power failure.

Learning:

- a) Minimum of 12 hours of power back up is required at ONT level.
- b) Training of the persons at ONT level is necessary to avoid wrong connections of adaptors which resulted in rebooting etc.
- c) It was observed that Dying GASP features were not available with ONTs. CDOT has implemented the same in one of the ONTs namely Fategarh ONT in the Sarwar OLT. The same is to be implemented in all the ONTs of pilot sites.

5.1.5 Related to EMS.

- I. Service Level Agreement (SLA) is to be monitored for every operator/every connection in the EMS.
- II. Customized reports are to be made for monitoring the traffic, connections, performance parameters etc.
- III. The security management done in EMS is to be tested. Support for multi-level passwords and the use of fire wall server for this purpose is to be examined
- IV. EMS to NMS interfaces to be tested.
- V. EMS GUI is not matured. Most of the configuration options and reports are task based. Tree based structure, graphical view and “point and click” provisioning are not yet available.

Learning:

- a) As the EMS is being designed by the CDOT, the same has been escalated to them for appropriate action and is being co-ordinated by QA cell of BBNL.

- b) Some of the observations have been taken care of by CDOT like EMS to NMS interface, Security management etc.
- c) The latest status of EMS is annexed at [Annexure VI](#)

5.1.6 Related to Triple play services

Video services through IPTV, Data services and VOIP was successfully tested in Arain. However IPTV has not been tested in Parvada and Panisagar because of non-availability of IPTV feed. The video conferencing facility has been tested in all the three pilot sites.

The RF Video testing in the field has been done with the help of M/s Ortel in the Parvada OLT. The RF video overlay accessories required in the OLT equipment were installed by CDOT. The triple play services were extended by Ortel to Thanam GP utilizing free bandwidth of 1 Gbps of BSNL from Vizag to Parvada.

Learning:

RF electronics is neither part of the Pilot nor that of GPON Tender. However these can be added to the equipment on need basis at a later stage, but this shall require capital expenditure.

5.1.7 Related to Connectivity in Access network

- i. Problems were noticed in the Wireless connectivity provided by BSNL using BBWT equipment of CDOT at certain locations in Parvada as well as panisagar Block.
- ii. However the Broadband Wireless Terminals were supplied to BSNL by CDOT. BSNL has taken up the issues with CDOT and the same has been attended to.
- iii. Wi-Fi Trial:

BBNL had placed PO to M/s Ozone and M/s Cadenceworth to do the Proof of Concept of Wi-Fi Access point based community internet in Arain, GP. The testing was carried for M/s Ozone and the testing in respect of Ms Cadenceworth is still in progress. Wi-Fi coverage test was carried out in the Arain GP premises using 10-12mtr existing MARR mast. The login process was working fine without delay in GP premises and the internet Wi-Fi connectivity was working satisfactorily using prepaid vouchers. The Wi-Fi Coverage was tested beyond the GP premises and the Wi-Fi coverage was available up to 100 mtrs. M/s Ozone has distributed free vouchers to the villagers which are being utilized as per the reports being sent by M/s Ozone.

Learning:

The horizontal connectivity could be a mix of aerial OFC and wireless depending on terrain conditions, bandwidth requirement, distance and cost. The service provider can access the OFC from the splitter located near the ONTs.

5.1.8 Related to Cost/Incremental OFC

- i. Variation in cost observed across pilot sites. Similarly there are variations in incremental OFC per GP from Block to Block.

Learning:

- a) Following uniform costing across different sites may not be possible.
- b) The variation from the projected incremental OFC of 2km/GP shall have impact on the Capex as well as the Opex of the project.

5.2 Experiences gained in addressing ground realities in rural domain

5.2.1 User Observations

- i. NIC reported that ONT will be required at the Block headquarters also. Accordingly, extra ONTs were installed in all the three block HQs.
- ii. NIC also requested that keeping a Wi-Fi port in the ONT is very useful since it provides immediate connection without any cabling.
- iii. Most users found going to TSP/ISP and BBNL inconvenient and impractical. They wanted a single window service which is not available even now for the retail as well as enterprise customer

Learning:

- a) Additional ONTs have to be procured for Block Headquarters.
- b) Wi-Fi port has since been provisioned at the pilot sites and is being taken care of for the future procurement.
- c) A Government user network is being proposed to provide POI at the District level to provide single window service.

5.2.2 Operational Observations

While looking into the O&M issues involving pilot sites, it is imperative to look at the downtime of ONTs, Cause of down time, the OFC failures and time taken to repair the same. This helps us to find out the network availability of the Pilot sites.

From the data available from the pilot blocks the average end to end availability of NOFN could be as follows:

Pilot Blocks	OLT Availability	ONT Availability	OFC Availability	Power Availability	End to end Availability
Arain	99.99	99.42	99.65	94.06	93.1
Sarwar	99.99	99.14	99.92	88.48	87.5
Panisagar	99.99	99.69	98.57	58.77	57.7
Parvada	99.99	99.85	98.77	70.68	69.7

The detailed data pertaining to underlying factors that impact the overall availability is provided in [annexure XII](#)

The reasons of poor availability have been because of the following reasons:

- Poor Power availability and in adequate back up.
- OFC failures and long time to repair
- Linear architecture.

There were also other operational issues reported which can be summarized as follows:

- i. Dust in connectors results in low speed which was observed during testing.
- ii. Many times hard re-booting of ONTs is required necessitating dispatch of maintenance personnel.
- iii. BBWT related problems were reported by Customers at Panisagar and Parvada.
- iv. A few cases of Battery theft were reported, therefore there is a need for arranging proper security of Battery, SPV and ONTs.
- v. There were cases of shifting of the OLT /ONT sites at Arain as well as Parvada, which resulted in downtime. As most of the sites are located in rented premises similar situations could recur and need to be accounted for.
- vi. There were demand of provisioning of ONTs in the Block headquarters and the same need to be kept in mind during procurement.
- vii. Switching off the Main power is resulting in the power shutdown of ONTs.

Learning:

- a) There is a need to provide fibre protection at places depending on SLA desired. Linear architecture may not suit all. Additional investment is needed at those places.
- b) Higher power back up to take care of power failure.

- c) It is necessary to have a separate MCB for commercial supply to the CCU of the ONT so that it is kept on during night hours. Preferably there should be separate commercial supply for the ONTs wherever techno economically feasible.
- d) A formal O&M procedure needs to be in place for Equipment as well as OFC which is getting finalised by BBNL. The draft has been circulated to stake holders for comments. The O&M process has taken into account the in-ordinate MTTR for OFC. There is an imperative need to keep fibre maintenance team with tools, instruments and transportation to attend to cable faults.
- e) Proper arrangement of Custodian at GP level needs to be worked out to avoid theft etc.
- f) A standard operating procedure needs to be in place for shifting of OLTs/ONTs whenever there is a need.
- g) Due to lack of dying gasp feature it has not been possible to segregate power and OFC failure accurately.

5.2.3 Eco-System Observations

- i. TSP/ISP/MSOs are not willing to offer services due to commercial considerations and lack of regular power supply.
- ii. Digital literacy level is very poor.
- iii. Lack of access devices in rural areas namely Smart phones, tablets, laptops and PCs.
- iv. Lack of trained man power in rural areas for operation and maintenance works.
- v. DKC or CSC business model viability needs to be established for proliferation.
- vi. Main issue is related to Power supply.

Learning:

- a. Based on the trials, solar power back-up has been standardised in the tender for a 12 hour backup. In the Pilot sites the backup was designed for 4-8 hours.
- b. It is also observed that the digital literacy is very low and there is a need to include digital literacy as a mission.
- c. Considering that the ISPs may not come forward to provide broadband connection to retail customers at an affordable price, there shall be a need to provide Wi-Fi hot spots in GPs, Schools and hospitals as well as Police stations, where common man can come to access the broad band using cheap prepaid coupons. There shall be need for public Kiosks where persons without access devices can avail the broadband facility.

- d. There are also issues relating to access devices. Computer density is very poor. The Tablets loaded with application in regional languages could be the answer for bandwidth consumption. Such initiatives have to be initiated in PPP model.
- e. There is a need for basic skill development relating to basic O&M at ONT level like rebooting, checking health of power back up, Cleaning of solar panel, OFC splicing etc.

5.3 NOFN NOC related issues being developed by C-DOT- its integration and its testing at pilot locations

C-DoT developed NMS has been Tested and being used for monitoring the pilot locations. Experience gained has been incorporated in SRS. Many modules and functionalities need to be developed which has been discussed with CDOT. There are certain issues with the NMS which need to be resolved in the coming months.

Learnings:

- i. As the Tender envisages EMS by four vendors, the issue of interconnection need to be addressed once the vendors are finalized.
- ii. In the current Pilot scenario, the GPON network elements, the EMS and the NMS modules are all initial basic versions. We see a lot of synchronization problems, a lot of features are not possible in the NMS due to non-availability of these functionalities either in the network elements or in the EMS that is currently deployed in the pilot.
- iii. Centralized automated fault localization is not demonstrated in the pilot as it is under development stage and CDOT shall do the needful.

5.4 Experiences gained for participation of TSPs, ISPs and application providers in utilizing bandwidth created by NOFN with respect to deliverables committed by NOFN/BBNL

A number of initiatives were taken with respect to delivery of services on pilot sites. Key experiences gained from these initiatives are listed below -

- i. There is lack of interest by the corporate houses to invest in the GP for broadband infrastructure. Certain policy regulatory intervention may be needed.

- ii. The existing NOFN at around 59 GPs is too small a market to attract TSP/ISPs to take commercial interest.
- iii. The response of TSPs/ISPs/application providers has been lukewarm so far. IN case of ISPs there are issues of bandwidth availability at District level for the ISPs. It is difficult to conclude any reasons for TSPs keeping in view the availability of NOFN bandwidth in a limited geographical location. Expansion of NOFN project to certain critical number may prompt TSPs to consider NOFN as a potential option..
- iv. The MSOs are reluctant to lease bandwidth at commercial rates. They are looking at a different business model keeping in view the return on investment in rural areas. Keeping in view the availability of bandwidth on non-discriminatory basis from the District up to Block level, a concept paper has been floated to create POI at District level by BBNL.
- v. Similarly plan has been mooted to provide a few Wi-Fi hotspots at a few GPs as well as providing a few horizontal connectivity by Aerial OFC as the last mile. Various business models are being worked out to enable the ISPs.

Overall following can be cited as the key reasons for lukewarm response –

- a. Due to overall poor adoption of digital technology amongst rural population business case for TSPs/ISPs does not materialize.
- b. No viable ROI for service providers at the commercial price of bandwidth resulting in SPs asking for free bandwidth.
- c. TSP/ISPs are not in a position to commit investment unless there is reasonable roll out of NOFN which shall enable them to have enough critical mass in terms of demand.
- d. Lack of availability of rural applications/regional language content etc.
- e. Lack on trained manpower for O&M

5.5 Synergisation by DIT/DoT to work together for pilots and plan the Template for pilot testing of G2C services

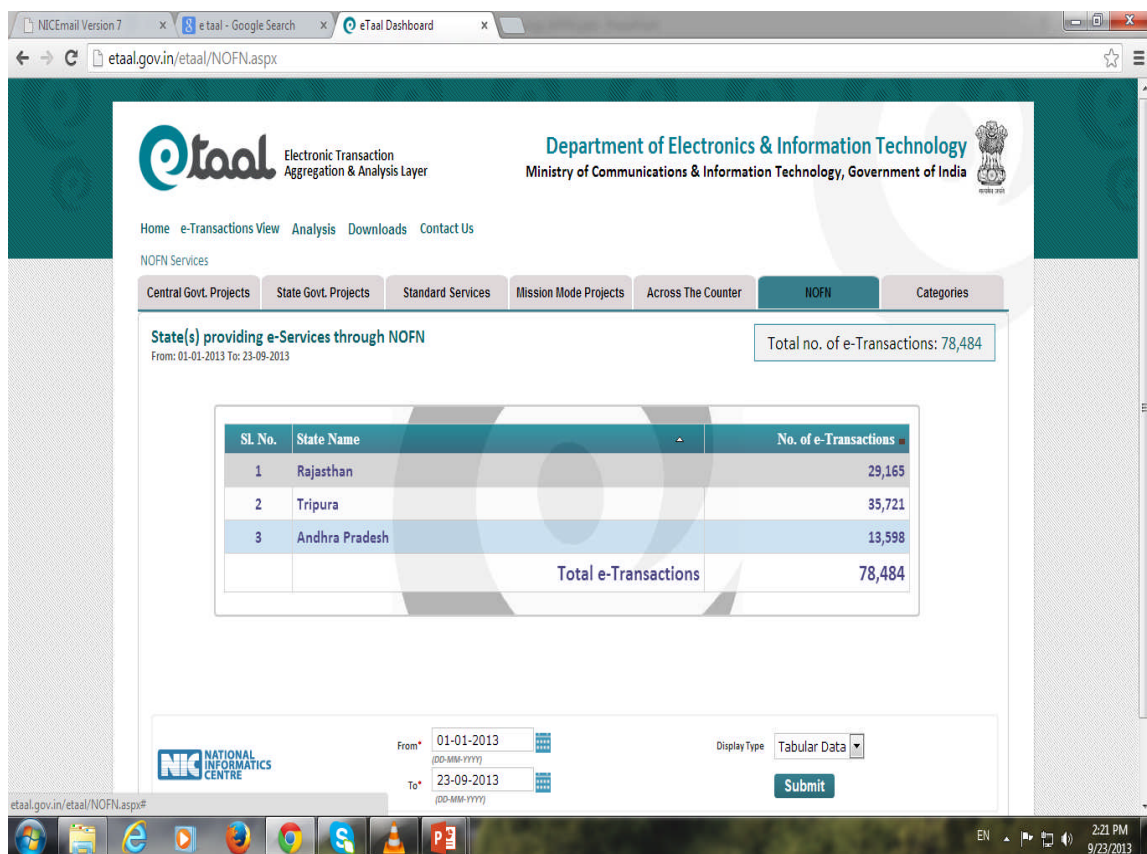
A counter-funding program has been prepared and got approved by DEITY. Work under this program has started and the G2G/G2C services have been delivered in all the pilot locations. DIT is regularly monitoring the services of G2G as well as G2C which has been launched in these pilot blocks. Various committees have been constituted for this purpose.

NIC is carrying out project monitoring by:

- Real time monitoring of devices in NOFN (<http://10.203.1.29:8088/default.asp>) including
 - ROUTER & REPEATER
 - BBWT-PC
 - ONT-PC
 - BBWT HZ & BBWT VT

End to end throughput testing was done and found to be as per ITUT standards. Results and recommendations of JDSU testing are annexed at [Annexure VII](#)

A web based monitoring tool has been developed named as e-taal.



The screenshot displays the e-taal web dashboard. The header includes the 'e-taal' logo and the text 'Electronic Transaction Aggregation & Analysis Layer'. The page is titled 'Department of Electronics & Information Technology, Ministry of Communications & Information Technology, Government of India'. The main content area shows 'NOFN Services' with a table of 'State(s) providing e-Services through NOFN' for the period from 01-01-2013 to 23-09-2013. The total number of e-Transactions is 78,484. The table lists the following data:

Sl. No.	State Name	No. of e-Transactions
1	Rajasthan	29,165
2	Tripura	35,721
3	Andhra Pradesh	13,598
Total e-Transactions		78,484

At the bottom of the dashboard, there are input fields for 'From' (01-01-2013) and 'To' (23-09-2013), a 'Display Type' dropdown set to 'Tabular Data', and a 'Submit' button. The footer shows the NIC National Informatics Centre logo and the date 9/23/2013.

DeitY has also constituted a committee on “Beyond NOFN” which will address the issues on scaling up the Government usage. Pilot project learnings will also be useful input in the report. The committee will work with the applications, technical and commercial aspects.

5.6 Integration of NOFN pilots with existing networks from Blocks upwards.

Also address the interfacing of NOFN with access operators at GPs.

Listed below are the key outcomes with respect to integration of NOFN with existing networks at Block level as well as the access operators at GPs -

- a) Most users (especially NGOs and companies doing CSR activity) wanted the Bandwidth free from BSNL and BBNL
- b) Those who were willing to pay for the Bandwidth found the charges on the high side when they added up the vertical, horizontal and NOFN charges
- c) Users wanted a composite tariff
- d) Considering poor commercial considerations Service providers desired a revenue sharing model with the bandwidth providers.
- e) Some individuals wanted Broadband connections which could not be addressed by BSNL as yet due to tariff, commercial and technical issues.
- f) Reliance Jio wanted dark fiber instead of bandwidth from Block to the GP. This was not possible.
- g) Cost of Bandwidth for MSOs from their Head end (at limited locations in the country like state capitals and major cities) was prohibitive for rolling out business in rural areas.
- h) BBNL has not provided for RF interface and MSOs are not willing to invest in the same.
- i) TSPs merely indicated that they will keep in mind NOFN while planning their roll out for new BTS. No TSPs including BSNL was interested in shifting their existing BTS backhaul through NOFN.
- j) BSNL shall charge for active equipment interface at Block level. Commercial rates are not clear and are seen as a deterrent. Thus only passive interface is possible.
- k) TSP/ISPs have to extend connectivity from his POP at Block (if it is available) to BSNL exchange which is seen as additional investment.

5.7 Synthesis of learning from the pilots and cross learning amongst 3 CPSUs in execution strategy

Ground level implementation at rural areas by the 3 CPSUs provided a number of key learnings that are listed below -

- i. There is no formal O&M process in place with any of the PSUs for the Pilot sites. Thus there are issues relating to Fault management and escalation matrix which is getting streamlined.
- ii. Various PSUs have followed different layout in the wiring and commissioning practices. The practices are widely different across PSUs and across GPs. This necessitates the need for a uniform design which shall be mandatory across the GPS in terms of layout, signage etc.
- iii. No OFC has been offered for leasing by either Railtel or PGCIL thus defeating the premise that the existing cables of these PSUs shall be available.
- iv. Survey based planning is an important pre-requisite for execution. Execution strategy through the 3 PSUs also needs to be based on solid MOUs and Agreements. Inputs for these have emerged from the Pilot project.
- v. There is a difference in costing between different CPSUs for executing the Project. There is a need to standardise the same.
- vi. The Acceptance Test Schedule of CPSUs was different and therefore a standard AT Test schedule was finalised for adherence by all the CPSUs.
- vii. It is necessary to carry out the infrastructure audit at OLT locations in terms Battery capacity, Air conditioners, Engine Alternators as infrastructural constraints were observed at Pilot sites.
- viii. There are ROW issues relating to RINL at Vijag .The situation could be similar in other Industrial Townships as well as Railway crossings. This needs to be resolved.
- ix. Gap in NMS Vision and its implementation.
- x. NOFN has been implemented on linear structure. This is leading to higher downtime.
- xi. BBNL has been mandated to lay only incremental cable thus leading to dumping of a lot of fibres at a short distance from the block. The OFC resource of the country could be greatly benefitted if the OFC is laid from the Block to the GP. This can help the TSPs/MSOs/SPs to take leased fibres, which is not possible now due to paucity of fibres from Block onwards.

Horizontal and vertical connectivity has been provided by BSNL in all the three Blocks. The present NOFN architecture provides for a last but one mile connectivity as a wholesale bandwidth provider. This architecture needs to be supplemented to make it more valuable and viable on account of following reasons:

- i. Enter Network anywhere, exit anywhere: It should be possible for a customer to reach the number of locations he targets conveniently and economically. At present this

means he has to choose from 10,000 entry points (OLT locations) which creates the problem of diseconomy of scale. While it was consciously decided not to create a core network, providing interconnect at District HQ shall widen the scope for service providers to utilize NOFN.

- ii. POI at Demand Point: Connectivity of TSP/ISP at Block level is limited mostly to BSNL. POI at District HQ addresses this problem of connectivity from District to Block.
- iii. Bharat Broadband Network – without Broadband service delivery: BBNL is mandated to be wholesaler and does not provide end user service. Without any service to begin with, no benefit as envisaged in the NOFN project would accrue. It is therefore necessary to create a “wholesale” service across all the GPs to fulfill the promise of Broadband service delivery. Community Wi-Fi service in all the GPs shall provide the users access to the technology.
- iv. Single window: In order to reach out to an end user in the GP, horizontal and vertical connectivity is needed, involving multiple operators. Thus no direct and convenient business proposition is available for the user. This proposal solves this problem, with BBNL presenting a single window to any prospective customer.
- v. Network Effect & Virtuous Cycle: Value of a network increase exponentially with increase in number of users leading to a virtuous cycle. If users are below a critical mass, it enters into a vicious cycle.

Thus there is an imperative need to address the issue of vertical connectivity up to District level.

6 Key issues and proposed action

This section outlines the summary of key issues identified during the pilot and the proposed action taken/planned to resolve those issues.

S.No.	Issue	Action taken/planned
1.	Inadequate power supply and backup in rural areas	Specifications for national rollout have been revised to provide a power backup of 12 hours.
2.	Not able to configure the GP name in the OLT/ONT	CDOT has already complied to.
3.	ONTs were reported to be rebooting frequently	May be due to connection of wrong adaptors by field persons in ONT site. Same was intimated to CDOT
4.	NMS functionality Issues	Has been taken up with C-DOT
5.	Wireless connectivity issues	BSNL has taken up the issue with CDOT and it is reported that CDOT has upgraded their BBWTs.
6.	ONT requirement at Block HQs	Additional ONTs were provided
7.	Wi-Fi port needed in ONT	WiFi ports provided at Pilot sites and in the GPON Procurement the same has been taken into account.
8.	Single window service required by users	Proposal to provide end to end connectivity between District and GP is under consideration
9.	Fiber cuts of long durations	Suitable O&M procedure is being finalized with the CPSUs to formalize the restoration process. Suitable trained staff along with tools and instruments need to be deployed at suitable locations for timely restoration of faults.
10.	Low speed due to dust in connectors	This shall be attended to by the maintenance staff and form the part of O&M procedure.
11.	Equipment theft	Suitable custodian has to be arranged.

S.No.	Issue	Action taken/planned
12.	Low digital literacy in rural areas	Digital literacy mission has to be taken up by the Government and NGOs.
13.	Lack of access devices with rural population	In the initial stage support of Government /Corporates may be necessary to provide the same either free of cost or at subsidized price.
14.	Lack of trained manpower for O&M work	Endeavor is being made to design the O&M mechanism so that least human intervention is required. A suitable O&M strategy to be worked out for the same.
15.	No service providers to provide broadband access at affordable price.	Proposal to provide low cost community based Wi-Fi service in under consideration.
16.	General lack of interest from corporate houses to invest in the GP for broadband infrastructure	The anticipated ROI is low. However subsidizing bandwidth cost for initial years may prompt various corporate to look into rural areas for investment.
17.	Reluctance of MSOs to lease bandwidth at commercial rates	Business model that would enable provisioning of low cost bandwidth is under consideration. Alternate business models have to be examined.
18.	Availability of MSO's head end at limited locations in the country	Proposal to provide end to end connectivity between District and GP is under consideration. This should enable MSOs to connect to network from District level
19.	Service Level Agreement (SLA) is to be monitored for every operator/every connection in the EMS. Customized reports are to be made for monitoring the traffic, connections, performance parameters etc.	CDOT has been intimated to take appropriate action.

S.No.	Issue	Action taken/planned
20.	There is no formal O&M process in place with any of the PSUs for the Pilot sites.	The same is being worked out to have a formal process in place.
21.	The incremental fibre exceeds 2km/GP	The same has to be guided by actual survey. However increased incremental fibre per GP shall result in increased Capex and Opex.

7 Conclusion

Given the complexities and unknown factors involved in implementation of NOFN, it was imperative that the pilot project was carried out before the full blown implementation of NOFN is undertaken. This section summarizes the details provided in this report, specifically with respect to performance of pilot project vis-à-vis its objectives and the key learning derived from it.

7.1 Pilot Objectives

The endeavor to do pilot project has been largely successful in meeting its goal of early detection of important issues that could have potentially prevented successful implementation of NOFN project.

All the objectives set out for the of the pilot project have been met as listed below –

S. No.	Objective	How met
1.	The learning on technology choice and network architecture.	The pilot unearthed a number of issues with respect to technical choices made for NOFN project and overall network architecture. Same are detailed in section 5.1 and corresponding actions taken/proposed are listed in section 6
2.	Experience gained in addressing ground realities in rural domain.	The specific issues pertaining to implementation in rural domain are detailed in section 5.2 and corresponding actions taken/proposed are listed in section 6
3.	NOFN NOC related issues being developed by C-DOT- its integration and its testing at pilot locations.	The NMS SRS is being suitably modified to address the gaps identified during the pilot as detailed in section 5.3 and corresponding actions taken/proposed are listed in section 6
4.	Experience gained by participation of TSPs, ISPs, MSOs and application providers in utilizing bandwidth created by NOFN with respect to	The issues have been addressed in 5.4. Extensions to NOFN project are under consideration in order to

S. No.	Objective	How met
	deliverables committed by NOFN/BBNL.	address some of the issues pertaining to delivery of B2B/B2C services as detailed in section 5.4 and corresponding actions taken/proposed are listed in section 6
5.	Synergisation by DeitY/DoT to work together for pilots and plan the Template for pilot testing of G2C services.	Counter funding program run by DeitY to deliver G2C services at pilot stage has provided valuable insights into G2C service delivery model as detailed in section 5.5. The proposed actions based on the insights are listed in section 6
6.	Integration of NOFN pilots with existing networks from Blocks upwards. Also address the interfacing of NOFN with access operators at GPs.	Issues pertaining to interconnectivity, costs etc at Block level have been listed in sections 5.6 and corresponding actions taken/proposed are listed in section 6
7.	Synthesis of learning from the pilots and cross learning amongst 3 CPSUs in execution strategy.	Key lessons are listed in section 5.7

7.2 Key Learnings

The NOFN Project in general and pilot projects in particular has created both a national and international buzz as a unique project for inclusive growth. Connecting the unconnected in the bottom of the pyramid shall have a far reaching impact in improving the socio economic condition of the majority of country's population. The major learning from the pilot implementation which shall influence the Project implementation can be summarized as follows:

- i. Unstable power supply position leading to revisiting the power back up to 12 hours.
- ii. Need to devise a suitable O&M procedure which shall be binding to all the PSUs. There is no formal mechanism in place.
- iii. No OFC has been offered for leasing by either Railtel or PGCIL thus defeating the premise that the existing cables of these PSUs shall be available.

- iv. Various PSUs have followed different layout in the wiring and commissioning practices. The practices are widely different across PSUs and across GPs. This necessitates the need for a uniform design which shall be mandatory across the GPS in terms of layout, signage etc.
- v. No commercial enterprises have come forward to utilise the bandwidth thus leading to the over dependence on the Government as the main user.
- vi. Presence of TSPs/ISPs/MSOs is missing at Block level other than BSNL.
- vii. Need to extend the reach of NOFN to the District level for making the project sustainable in the long run and making the goal of NOFN successful.
- viii. Need to make the ROW binding on various Industrial Estates of PSUs and other corporate houses.
- ix. Possibility of utilising the Aerial OFC in inaccessible and hilly terrain.
- x. Provision of Wi-Fi in all the ONTs.
- xi. Provision of Dying Gasp feature.
- xii. Linear implementation of GPON may lead to higher downtime.

7.3 Service Delivery

7.3.1 G2C Service Delivery

Government Departments led by DEITY is exploring all possible ways in expanding the reach of NEGP as well as NKN.NIC is playing a key role in reaching the GPs, Educational Institutions, Police Stations, and Hospitals etc. Various committees have been constituted for the effective utilization of the NOFN bandwidth and they are working towards facilitating various stake holders. Various business models are being worked out.

7.3.2 B2B/B2C Service Delivery

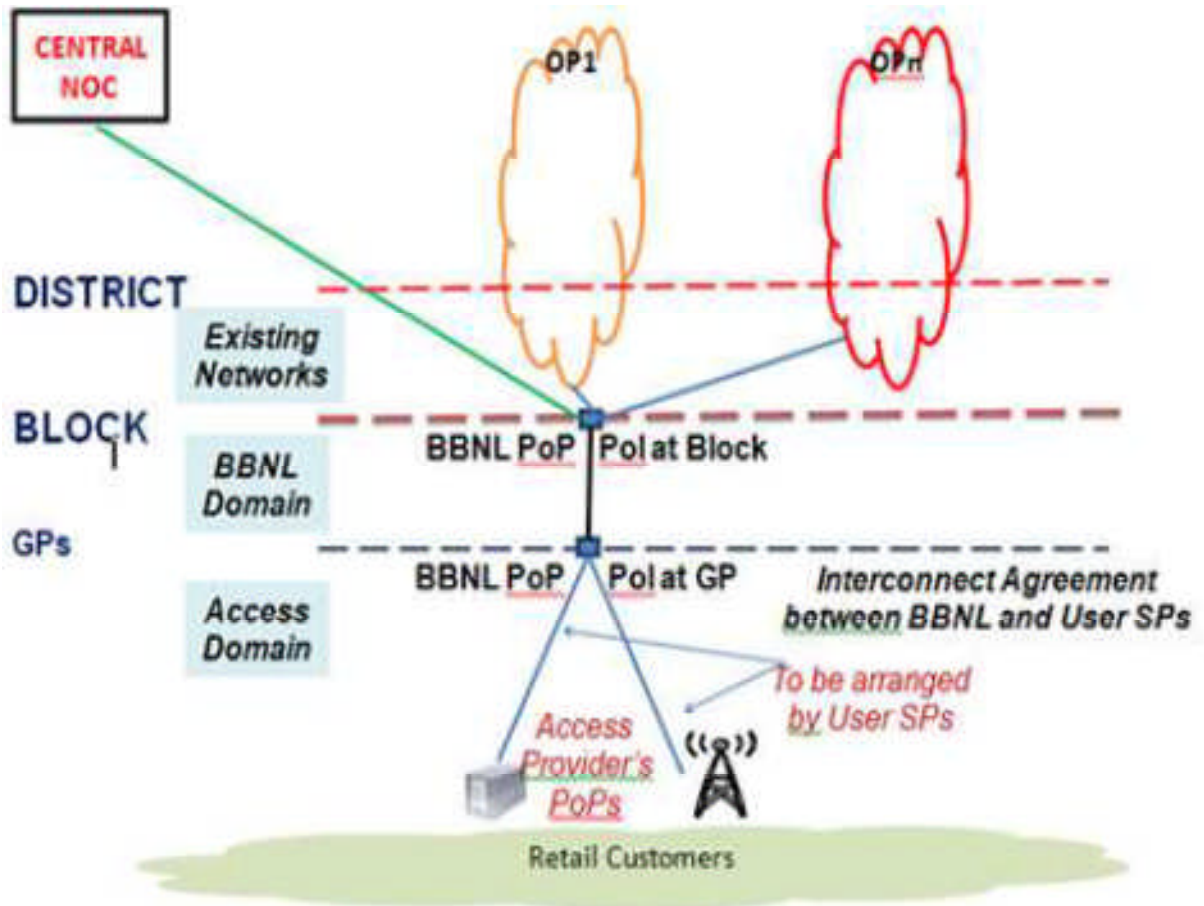
Industry must explore as to how effectively it can monetize the window of opportunity offered by the NOFN. The key could be mobile data offloading, creation of a national Wi-Fi corridor where broadband could be made available at a very affordable price. There may be regulatory and statutory provision for such obligations from the TSPs and other corporate. A PPP model could ideally serve this purpose. Similar initiatives have been operational elsewhere in the globe and we need to replicate some of the success stories in India.

7.4 Next Steps

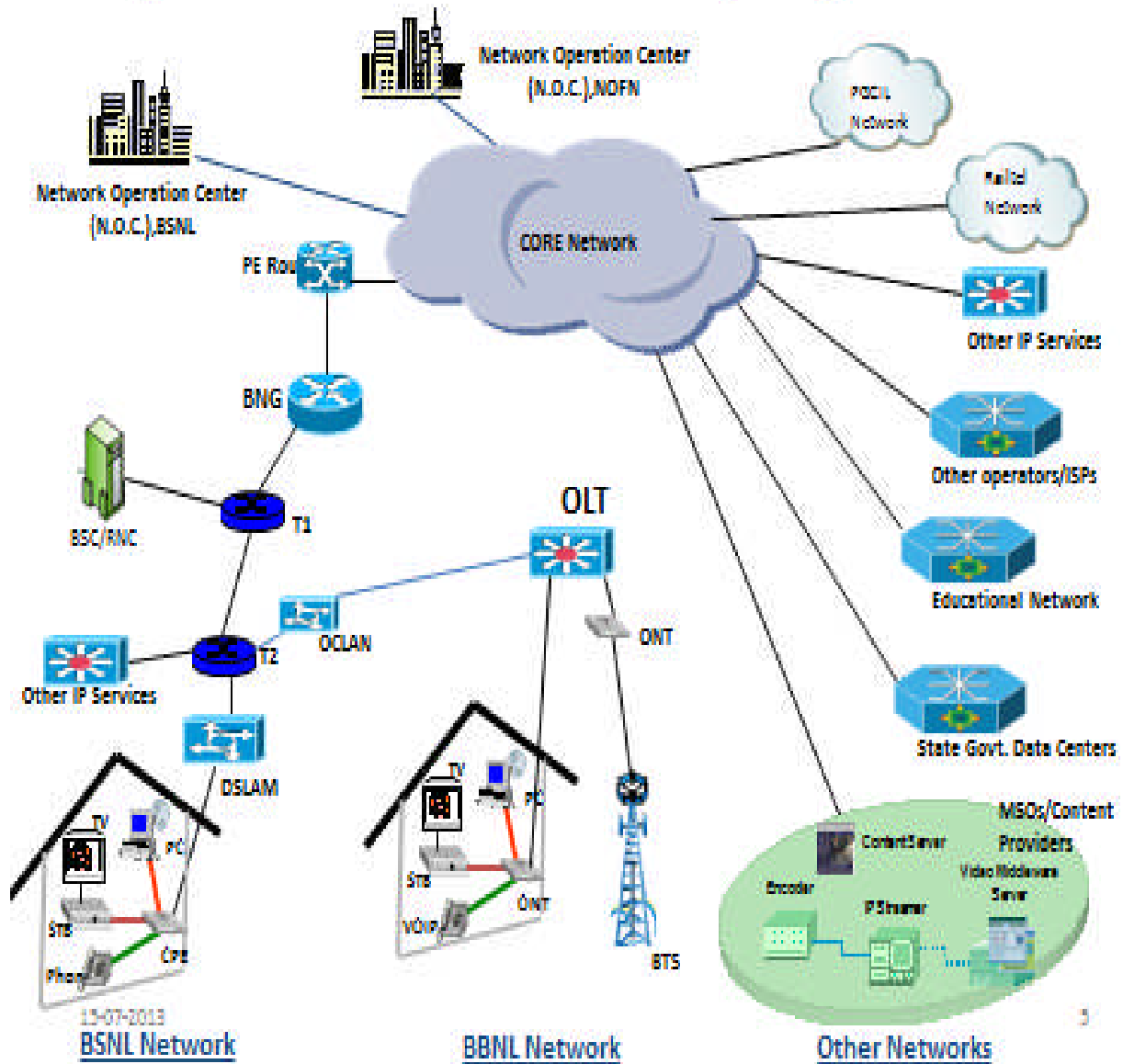
The outcomes from implementation done at pilot sites have produced a number of issues and corresponding learnings. It is imperative that these learnings be incorporated in various facets of NOFN implementation including technical, service delivery, project execution, coordination etc. This report summarizes all the key learnings from various activities undertaken in order to successfully achieve the objectives listed down for Pilot implementation. BBNL on its part has incorporated a number of changes that were derived from outcomes and learning of the pilot project. Going forward BBNL shall implement the necessary course correction in Project Management, Operation and Maintenance in order to successfully meet the larger objectives of NOFN implementation.

8 Annexures

8.1 Annexure I: Conceptual Diagram of NOFN



Proposed Network Connectivity diagram for NOFN



8.2 Annexure II: List of Gram Panchayats.

GRAM PANCHAYATS COVERED IN ARAIN

<u>S.No</u>	<u>V P name</u>
1	AJGARA
2	ANKAURIYA
3	ARAIN
4	BHAGWANPURA
5	BHAMBHOLAO
6	BHOGADEET
7	BIRLA
8	BORADA
9	DADIYA
10	DEOPURI
11	DHASOOK
12	FATEHGARH
13	GOTHIYANA
14	HARPURA
15	HINGONIYAN
16	JHEEROTA
17	KALANADA
18	KASHEER
19	KATSOORA
20	KHEERIYA
21	LALLAI
22	LAMBA
23	MANDAWARIYA
24	MANOHARPURA
25	RAMPALI
26	SANDOLIYA
27	SAPLA
28	SIRONJ
29	SOONPA
30	SYAR

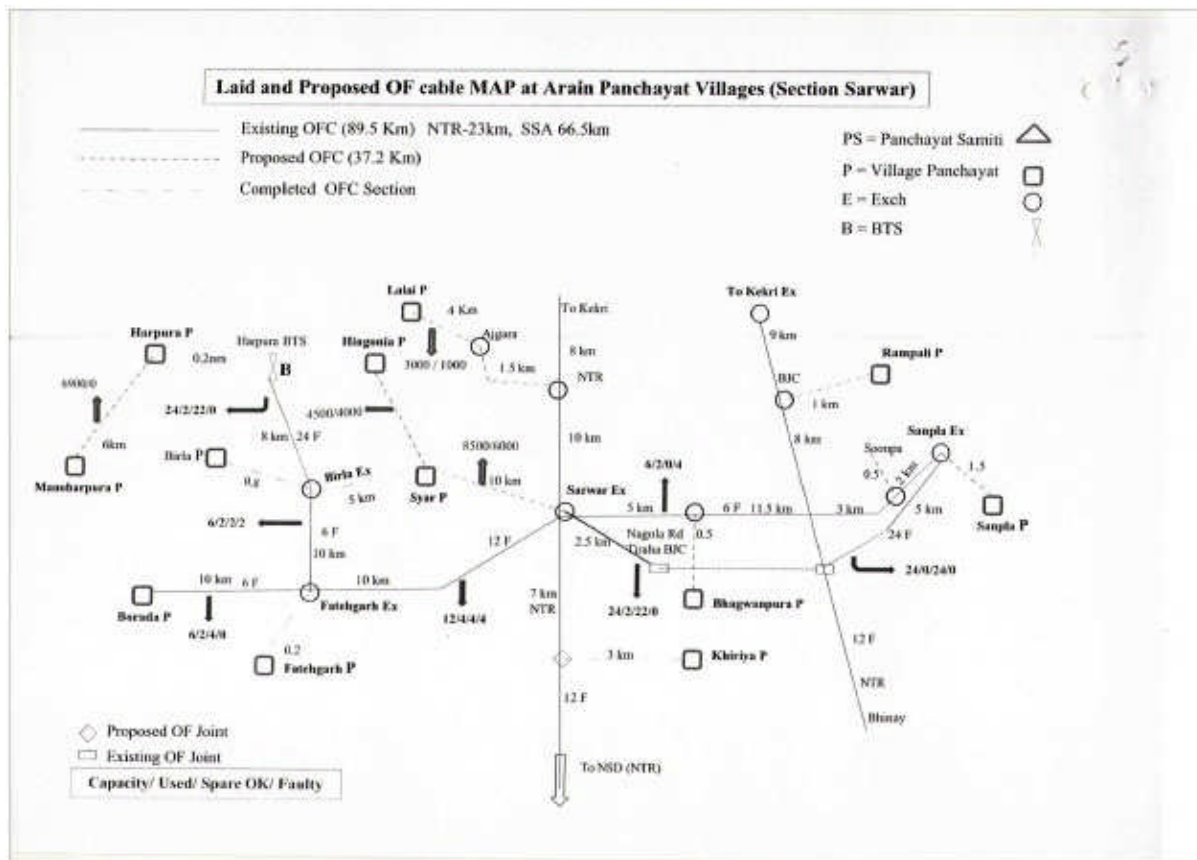
GRAM PANCHAYATS COVERED IN PARVADA

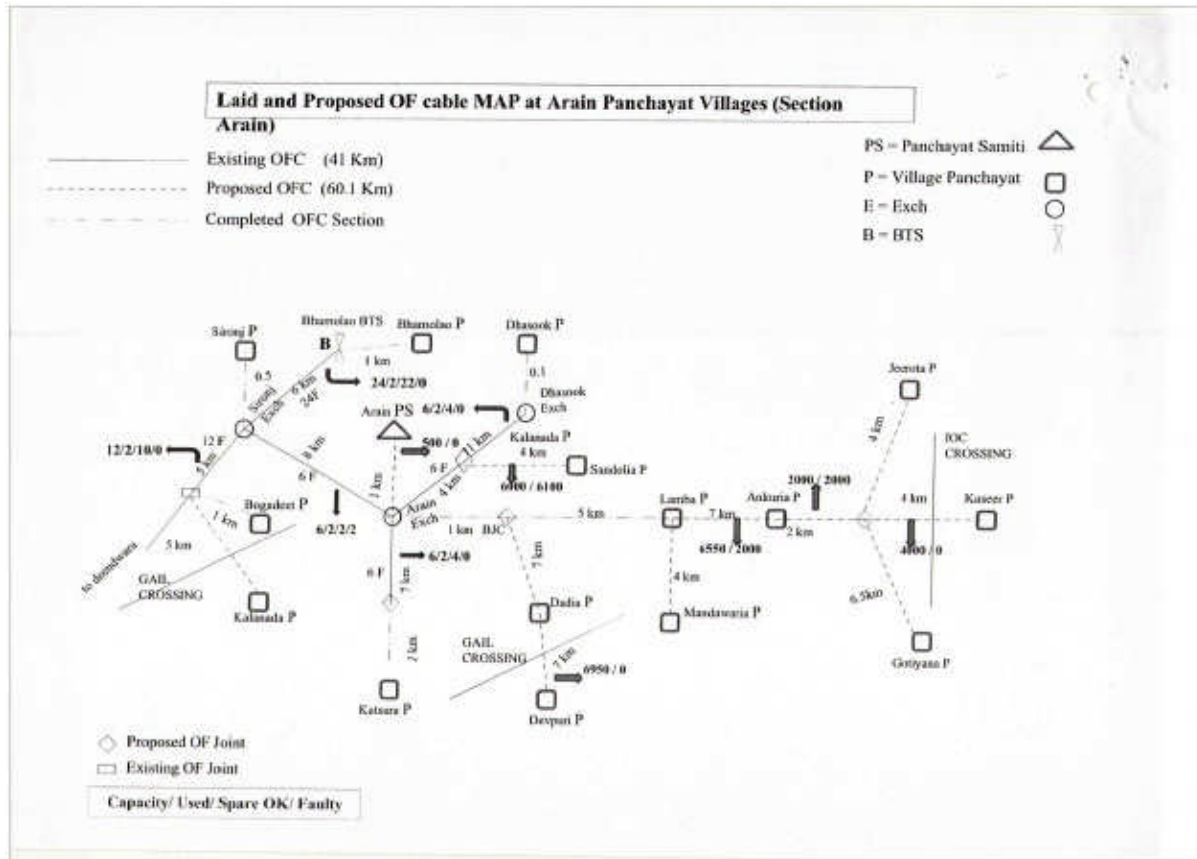
S.No.	Gram Panchayat
1	BHARINIKAM
2	CHEEPURUPALLE(WEST)
3	EDULAPAKA BONANGI
4	GORLIVANI PALEM
5	KALAPAKA
6	KANNURU
7	MUTYALAMMAPALEM
8	NAIDUPALEM
9	PARVADA
10	PEDAMUSIDIVADA
11	RAVADA
12	SALAPUVANIPALEM
13	P BONANGI
14	THANAM
15	VENNELAPALEM

GRAM PANCHAYATS COVERED IN PANISAGAR

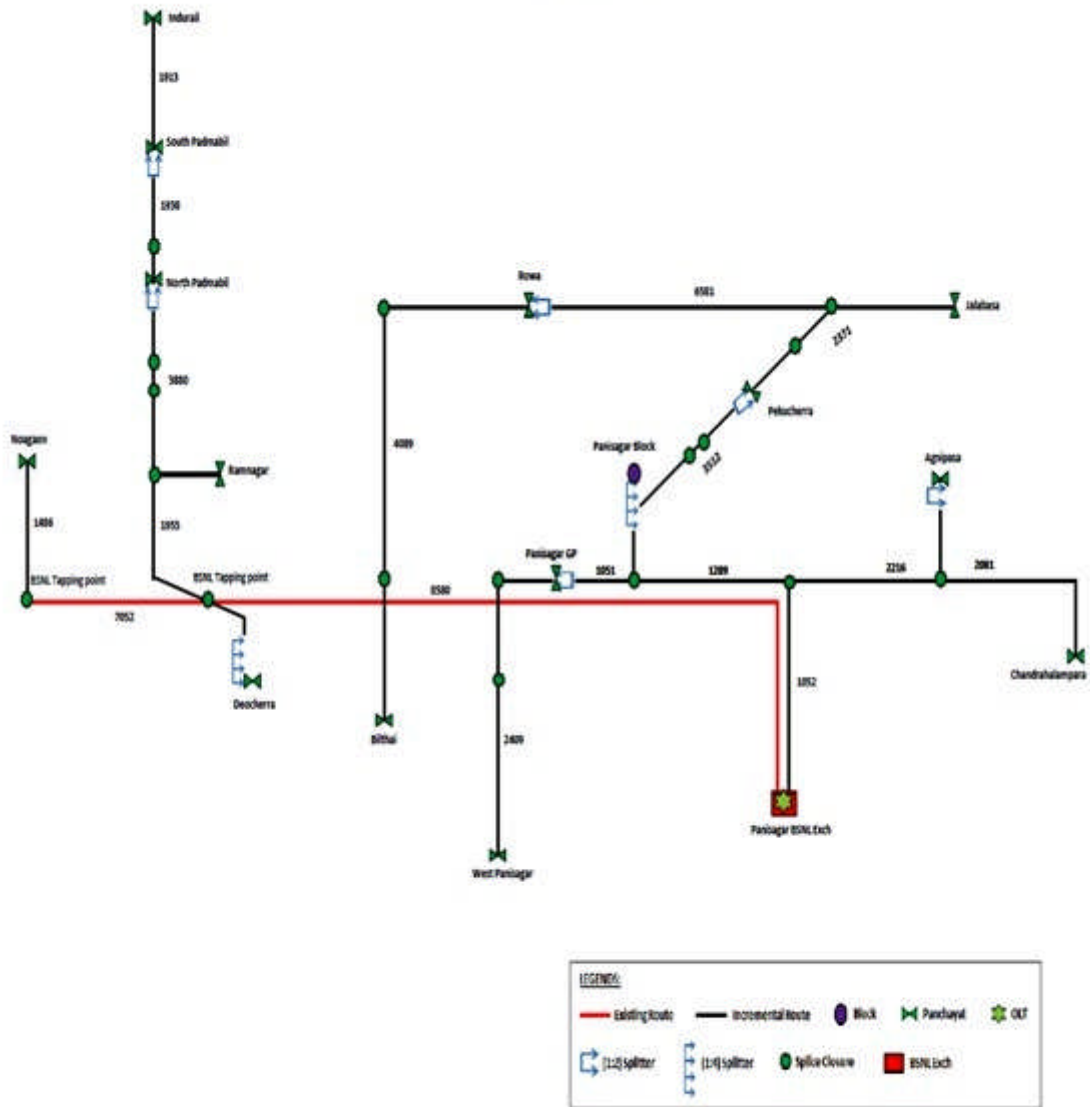
S. No.	Name of the Gram Panchayat
1	AGNI PASA
2	CHANDRA HALAM PARA
3	WEST PANISAGAR
4	BILTHAI
5	DEOCHERRA
6	RAMNAGAR
7	SOUTH PADMBIL
8	ROWA
9	JALABASA
10	PEKUCHRRA
11	INDURAIL
12	NORTH PADMBIL
13	NOAGANG
14	PANISAGAR

8.3 Annexure III: L14 Diagrams as per Survey





L-14 DIAGRAM OF PANISAGAR NOFN PILOT



8.4 Annexure IV: TECHNICAL SPECS

Details of C-DOT GPON Equipment Commissioned at NOFN Pilot Locations:

A) ATCA Chassis based GPON OLT System commissioned at following locations:

1. Sarwar, Ajmer, Rajasthan
2. Parvada, Vishakapatnam
3. Panisagar, North Tripura

Specifications: The equipment meets specifications defined in TEC GR and on broad level these specs are described as follows:

- Compliant with ITU-T G.984.x & TEC GR
- 2.5 Gbps Data Rate for downstream at 1490 nm wavelength
- 1.25 Gbps Data Rate for upstream at 1310 nm wavelength
- Cards are housed in standard 19", 12U high telecom grade ATCA chassis
- It can house up to 12 numbers of PON interfaces cards (PIC Cards) each with 4 PON Ports or 8 PON ports, thus it supports 48 PON in protection and 96 unprotected PON ports per shelf
- PON Protection support of 1:1 protection towards ODN on same card or different cards.
- One PON can support up to 128 ONTs per port (1x128 Splitter)
- Maximum number of customers (No of ONTs) can be served Up to 12288 per shelf
- Typical distance supported is 20 Km (depends upon the split ratio) and can serve up to 59km.
- 10 Gb and 1 Gb Ethernet uplinks (4 numbers each) for SNI connectivity towards core network with support of ZX / LX and SX reach configurations
- SNI Protection support; 1:1 protection on SNI uplinks
- Network Synchronization through network clock or internal clock
- Operates at -48V DC.
- Inbuilt cooling mechanism
- Management of entire GPON system through LCT/EMS
- Power consumption when fully equipped is 500 Watts approx.
- Can be populated for providing cable TV services through RF video overlay at 1550nm wavelength through Video transmitter and WDM Couplers

- Optics class supported on PON level can be Class B+ and Class C+ with 28dB and 31dB optical power budgets respectively
- Rack supplied to Panisagar and Parvada are of 24U height and 50U height at Sarwar

Requirements / Parameters		GPON OLT Specifications
Optical interface (Towards PON side)	Transmission	ITU-T G.984
	Line rate	D/S - 2.488 Gbps, U/S – 1.244 Gbps
	Fiber	Single mode fiber (G.652)

GPON OLT Specs at glance are given below:

	Connector	SC/APC
	Wavelength	1490 nm downstream, 1310 nm upstream, 1550 nm video
	Distance	Up to 20 km depending upon the split ratio
	Link budget	28 dB (class B+) / 31 dB (Class C)
	Ports per shelf	96 max.
	ONTs per port	Up to 128

**B) GPON OLT System based on single card (Pizza Box GPON Solution),
commissioned at Arain Block, Ajmer (Rajasthan):**

Requirements / Parameters		GPON OLT Specifications	
Network uplinks	Protocol	10 GbE	1 GbE
	Interface	Optical (through XFP)	Optical / Electrical (through SFP)
	Connector	SC/APC	LC/UPC or RJ45
	Ports	4	4
Management interface	Protocol	SNMP v2c	
	Interface	10/100BaseT	
	Port	1	
Power supply		-40 V to -59 V DC	
Cooling		Fan Cooling	
Dimensions		Standard 19" rack of 2200mm height or 1065mm height	
Environmental Compliance		QM 333 'B2' category.	



Specifications: The equipment meets specifications defined in TEC GR and on broad level these specs are described as follows:

- Scaled down version of OLT
- Nominal Input Power Supply : -48V DC
- Input Voltage Range : -40VDC to -59VDC, can be feed through AC/DC Adapter also
- The system works in non AC environment also
- The estimated power consumption of the system is approximately 150W maximum when fully equipped and serving full capacity of customers.
- Forced cooling is provided through fans
- Can be a central office equipment or may be housed in residential building premises
- Compliant with ITU-T G.984
- 2.5 Gbps Data Rate for downstream at 1490 nm wavelength
- 1.25 Gbps Data Rate for upstream at 1310 nm wavelength
- Pizza box type with 1U height and Table top or 19" rack mountable
- Supports up to 8 PON interfaces towards PON can serve up to 1024 customers (128 customers per PON)
- PONs can also be configured in 1:1 protection
- Typical distance supported is 20 Km and can support up to 59 Km (depends upon the split ratio)
- 1Gb /10Gb (Optional) Ethernet uplink for SNI network with 24GbE capacity and can be configured in protection also
- Management of entire GPON system/network through LCT/EMS
- No rack is supplied to site and can be mounted in any telecom standard rack with 590mm depth

Unit Name	No. of cards	SNI Interfaces		PON Ports	Management Interfaces
		1G	10G		
Mini OLT	1	4 (Optical or Electrical)	2 (Optical)	8	3

Pizza-box OLT Configuration:

C) GPON ONT (Customer Premises Equipment) installed at all the NOFN Pilot locations:

Specifications: The equipment meets specifications defined in TEC GR and on broad level these specs are described as follows:

- Single card system designed to serve a single residential unit
- Compliant with ITU-T G.984 & TEC-GR
- Class B+ (28dB) optics
- Works on 12V DC supply
- Can work on 159-270V AC \pm 50 Hz with external AC-DC adaptor
- Approx. power consumption is 18W
- No forced cooling is required and working in non AC environment
- Attractive metallic and plastic packaging
- Interfaces supported:
 - ❖ 1 RF video port
 - ❖ 2 POTS ports
 - ❖ 1 port of Gigabit Ethernet (10/100/1000 BaseT)
 - ❖ 4 ports of Fast Ethernet (10/100 BaseT)
 - ❖ 2 USB ports
 - ❖ Wi-Fi IEEE 802.11n
- Card size : 220 x 180 x 1.6 mm
- Box Size: 220 x 188.9 x 48.6 mm

8.5 Annexure V: Project estimates.

1.0 Project Estimate of Pilot Sites: Arain

(A)

S. No.	ITEM	QTY(M)	RATE	Value
1	OF cable 24F	100000	50/- (per meter)	5000000
2	PLP Pipe	98000	31.22 (per meter)	3059559
3	Straigh joint/ Branch Joint	55	2480	13590
4	WSC	30	1950	59500
5	OF jumper patch cord	0	510	0
6	Pig tail	359	375	135000
7	Spare cable chamber	30	1590	48000
8	Cable tool kit	2	3000	5900
9	Half round RCC pipe	0	27 (per meter)	0
10	GI 65 mm	300	200 (per meter)	59000
11	Stone route indicator	500	100	50000
12	Nylone rope	0	2 (per meter)	0
13	Push fit coupler	500	34	17000
14	Cable selling plug	100	18	1800
15	End plug	100	15	1500
16	Local Handling Charges	1	2500	2500
17	Full round RCC/DWC pipe	30000	59 (per meter)	1800000
	Total			10376259

(B) Labour calculation

S. No.	ITEM	QTY(m)	RATE	VALUE
1	Distance	97590		
2	Digging Trench 1.65 m Depth	77590		
3	Digging of Soft soil	57550	61	3510550
4	Digging of soft rock	0	73.50	0
5	Hard Rock	20050 m	300	4972400
6	HDD/ Boring	20000 m	350	7000000

S. No.	ITEM	QTY(m)	RATE	VALUE
7	Laying of half round pipe	0	0	0
8	Laying of PLP pipe	77590	2	155200
9	Pulling of OF cable	100000	3	300000
10	Laying OFC by CC work	200 cubic meter	2597	517400
11	Installation of Route indicator & Painting and sign writing etc	500	176	88000
12	Construction of Brick chamber for joint	55	2000	110000
13	Laying of full round RCC/ DWC pipe	30000 m	7.8	234000
14	Laying GI pipe 65 mm	300 m	11	3300
15	Road cutting charges		Lump sum	2000000
16	Reopen old chamber for joint	10	800	8000
17	Joint & Termination	95	8000	759000
		Total		19659850

(C) Cost to company: Staff Expenditure Recurring for one year :

Sl. No.	Staff	Numbers	Emolument to staff including all allowance		Total
			Per Month	Annual	
1	SDE	1	113850	1366200	3515759
2	JTO	1	94030	1128359	
3	TM	2	85110	1021200	

(C) Cost of company (Staff) = 3515759/-

(D) Vehicle for 4 month @ 22000/- Per month = Rs. 88000/-

(E) Cost of two OLTs, installation and testing =Rs4050000/-

Total Expenditure A+B+C+D = 10376259+19659850+3515759+88000+4050000 = 37688870/-

2. PANISAGAR Estimate

Statement of Accounts for Panisagar NOFN pilot project up to 31.03.2013

Sl. No.	Item Description	Amount (Rs)
1	Detail Survey of the Route to cover all the GPs of Panisagar, Preparation and acceptance of ROW Drawing	149933.00
2	Supply of ADDS OFC and construction of OFC network for connecting all the GPs with Block at Panisagar	7959217.00
3	Supply and installation of 01 set of 50 A charger 300AH battery at block	180870.00
4	Maintenance of OFC network for the period from 19-10-2012 to 18-3-2013	240625.00
5	Supply and installation of OLT , ONT, Solar Panel, Splitter etc. with all accessories by CDOT	4172364.00
6	Total expenditure on a/c of salary manpower engaged , T.A. , Vehicle bill., hotel Bills, Travelling Expenses, Administrative Expenses in Dharmanagar office etc. spent for the project	2225000.00
	Total	14927009.00
	Add 10% cent age on above	1492700.90
	Grand Total (r/o)	16419710.00

*Excluding taxes payable extra.

3.Parvada Estimate Cost

			Original Based on GIS Planning	Revised based on Field Survey			
	Total No. of GPs	Nos.	17	16	15		
	Increment Fibre Length	Kms	22	35.7	33.5 (executed)		
Sr No.	DESCRIPTION	RATE	AMOUNT (Rs.)	AMOUNT (Rs)		Amount (Rs)	Taxes
A	Equipment cost with spillter, Power Supply and Accessories		3,849,500	3849500	Note 1	3728825	Plus taxes @ 12.36% ST at Present
B	Cost of fiber including Supply and installation		7,146,147	11985649	Note 2	9429443	incl.taxes
C	Total cost of Equipment and Fiber		10,995,647	15935149		13159268	
D	Incidental Expenses During Construction (IEDC)	10.75% of C	1,182,032	1702279	Note 3	1414514	
E	Contingencies	3% of C	329,869	475054	Note 4	394748	

F	Sub Total (F=C+D+E)		12,507,549	18012482		14967530	
G	Cost of 5 year maintenance of Network		5,962,090	8703377	Note 5	8703377	Plus taxes @ 12.36% ST at Present
H	Total Cost of the Project (H=F+G)		18,469,639	26715959		23670907	
I	Centage of Powergrid	15% of H	2,770,446	4007379	Note 6	3550636	
K	GRAND TOATL		21,240,084	30723237		27221543	

1. The above estimate does not include :	
(i) Internet leased line Bandwidth (2 Mbps) from Block HQ (PoP) to central NOC	
(ii) 100 Mbps bandwidth to each GP	
(iii) Cost fo leased dark fiber from POWERGRID/BSNL/RAILTEL	
(iv) Cost toward OLT co-location & Power Supply charges at BSNL exchange.	
(v) Cost towards electricity bill at Gram Panchayat	
(vi) Provision for Power Supply for Power backup to SP's equipment at PoP/GPs	
2. Equipment cost and OFC length are taken as provided by C-DOT.	
3. The network topology is planned on the basis of GIS map provided by NIC.	
4. Above estimate is subject to availability of Dark Fiber in BSNL/ POWERGRIG/RAILTEL networks.	
5.Requirement of spares for OFC Network is included under maintenance	

Note to costing provided under s partially executed / to be executed	
Note1	Cost as per LOA for 17 GPs. 15 GPs executed, 1 GP (Thadi) put on hold by district administration and 1 GP (L. Agarharam) has been denotified and deleted. Further, out of 15 GPs one is to be relocated (already intimated)
Note2	As executed cost for 33.5 kms Does not include cost for 1 GP relocation (already intimated) and 1 GP is on hold (Thadi)
Note3	POWERGRIG's Standard Cost towards execution of he project as a % of the project cost.
Note4	Contigencies Provision is kept.
Note5	Estimated cost for 5 years gas not been revised, will be done after final completion.
Note6	% as been kept as per our standard requirement.

Absract Cost Estimte for PARVADA Block

Sr. No.	Description	Rate	Amount (Rs. In Crs.)
A	Equipment cost with spillter, Power Supply and Accessories		3,849,500
B	Cost of fiber including Supply and installation		7,146,147
C	Total cost of Equipment and Fiber		10,995,647

D	Incidental Expenses During Construction (IEDC)	1.75% of C	1,182,032
E	Contingencies	3% of C	329,869
F	Sub Total (F=C+D+E)		12,507,549
G	Cost of 5 year maintenance of Network		5,962,090
H	Total Cost of the Project (H=F+G)		18,469,639
I	Centage of Powergrid	15 % of h	2,770,446
K	GRAND TOATL		21,240,084

1. The above estimate does not include :

- i. Internet leased line Bandwidth (2 Mbps) from Block HQ (PoP) to central NOC
- ii. 100 Mbps bandwidth to each GP
- iii. Cost fo leased dark fiber from POWERGRID/BSNL/RAILTEL
- iv. Cost toward OLT co-location & Power Supply charges at BSNL exchange.
- v. Cost towards electricity bill at Gram Panchayat
- vi. Provision for Power Supply for Power backup to SP's equipment at PoP/GPs

2. Equipment cost and OFC length are taken as provided by C-DOT.



8.6 Annexure VI: EMS AT Pending Points Test Report



EMS AT Pending Points Test Report

For NOFN Project

OLT Site Name : Sarwar

Testing Period: From 16/01/2014 to 21/01/2014

21.	Addition and Deletion of ONT in the GPON network	
	4. Activate and deactivate any one of the services namely VoIP, IPTV & HSI (The services available and configured on ONT)	Verified & Found Ok (For PIC:2 PON:2, ONT:1, OLT= Sarwar)
23.	Testing of FEC Feature for Enable and Disable through EMS	
	3 Verify the FEC enable/disable functionality changes as per the settings	Verified & Found Ok
24.	Verification of Alarm reporting for LoS of i^{th} ONT on EMS	
	1. Add and activate ONT's	Verified & Found Ok
	2. Pull out the fiber at the ONT	Verified & Found Ok
	3. LoS ONT will be reported at the EMS	Verified & Found Ok
	4. Insert the fiber back into the ONT	Verified & Found Ok
	5. LoS ONT Clear alarm will be reported at the EMS	Verified & Found Ok
25.	Verification of Alarm reporting for LoS of PON on EMS	
	1. Add and activate ONT	Verified & Found Ok
	2. Pull out the fiber from PON port at OLT	Verified & Found Ok
	3. LoS Alarm will be reported to EMS	Verified & Found Ok
	4. Insert the fiber back into the PON port	Verified & Found Ok
	5. LoS alarm gets Clear and will be reported to EMS	Verified & Found Ok

<p>26.</p>	<p>Verification of Dying Gasp (Electric Power Failure) for ONT</p>	<p>(Feature supported at PIC:2 PON:1, ONT:1 Fatehgarh Only)</p>
	<p>1. Add and activate ONT</p>	<p>Verified & Found Ok</p>
	<p>2. Check the ONT is up</p>	<p>Verified & Found Ok</p>
	<p>3. Check in the EMS the green color for the ONT since it is up</p>	<p>Verified & Found Ok</p>
	<p>4. Power off the ONT</p>	<p>Verified & Found Ok</p>
	<p>5. The EMS should show a DGI (Dying Gasp Indication Event for the ONT).</p>	<p>Verified & Found Ok</p>
<p>28.</p>	<p>Configuration Management Support on EMS</p>	
	<p>3. IGMP enable/disable</p>	<p>Feature not demonstrated</p>
	<p>4. Naming of the ONT</p>	<p>Verified & Found Ok. ONT name can be set and seen from ONT details reports. However, ONT details gives list of only those ONT where name has been configured. Needs to be corrected. Also, the location is not appearing in other reports.</p>
	<p>5. Card reset / Reboot</p>	<p>Verified & Found Ok (PIC:2 PON:2, ONT:1 rebooted PIC: 2 rebooted)</p>

	6. Creation of VOIP , DHCP service enabling	VOIP service configured with Static IP only for Sarwar DHCP Not demonstrated for Sarwar. However, DHCP enabling was demonstrated in Lab.
	9. IP Configuration	Not possible in EMS. At Lab LCT demonstrated.
	12. Software Remote Down load	Verified & Found Ok
29.	Remote Management of ONT and Services	
	4.Check the triple play service (Voice , video and Data)	Configuration done. Services are running in the field. Verified in lab setup.
	5.Check the system status from EMS	Verified & Found Ok
	12 Down loading a Software	Verified & Found Ok
30.	Verifying Performance Features in EMS GUI	
	2.Error performance for optical link – OLT to ONT	Verified & Found Ok
33.	Messaging feature in the EMS system (If messaging server installed)	
	6.Email to be seen at the configured email account	Verified & Found OK for internal mails of CDOT. Not working for external mail ids.
	7.Automatically downloading the new software to upgrade ONT software	Not demonstrated
34.	Customized report of fault log on EMS	
	8.Export to Excel Sheet	Verified & Found OK
35.	Operations Log for the EMS operations carried out	

	3.Backup/restoration	Verified & Found OK
36.	Data Base Backup and Restoration testing	Verified & Found OK
	1. From the EMS issue a command to back up the configuration	Verified & Found OK. On some occasions backup command took a very long time and had to be killed at the back end.
	2. Delete the configuration at the OLT and reboot the system	Verified & Found OK
	3. Re-login and Restore the configuration from the EMS to the OLT and reboot the system	Verified & Found OK
	4. System should come up with previous configuration	Verified & Found OK
	5. Services should get restored	Verified & Found OK
	6. Check the configuration back up to and restoration from external storage like CD drive	There is no provision in the front end for backup/restoration from external storage. Demonstrated in the Lab by copying and restoring the CD through the back end.
37.	Check for the following compliance:	
	1. Provision of Disaster Recovery of EMS and the DR switches over to standby server.	Not available
	2. EMS to NMS (North bound) interface is to be tested.	Verified & Found OK
	3. Service Level Agreement (SLA) is to be monitored for every operator/every connection in the EMS.	Not implemented
	4. Customized reports are to be tested for monitoring the traffic, connections, performance parameters etc.	Verified & Found OK

	5. Configure the GP name in the OLT/ONT.	Verified & Found OK
	6. Obtain the alarm log from the OLT. They including the solar Power fail/cable fail alarms.	Does not distinguish between ONT power failure & cable cut. Infra- alarms not available.
	7. Alarms are to be sent as SMS for instant action by the maintenance personnel. Escalation of alarms is to be done through SMS to higher authorities for monitoring. If SMS server is installed.	Not implemented at EMS including its escalation to higher level
	8. The IPV6 implementation issues and existing IPV4 network and GPON IPV6 interworking are to be verified.	Demonstrated between EMS and OLT at Lab

General Observations:

Only Sarwar OLT is offered and the tests were carried out only for Sarwar. The other NOFN pilot OLTs- Arain, Parvada & Panisagar are yet to be offered.

EMS GUI is not yet matured. Most of the configuration options and reports are task based. Tree based structure, graphical view and 'Point & Click' provisioning are not yet available.



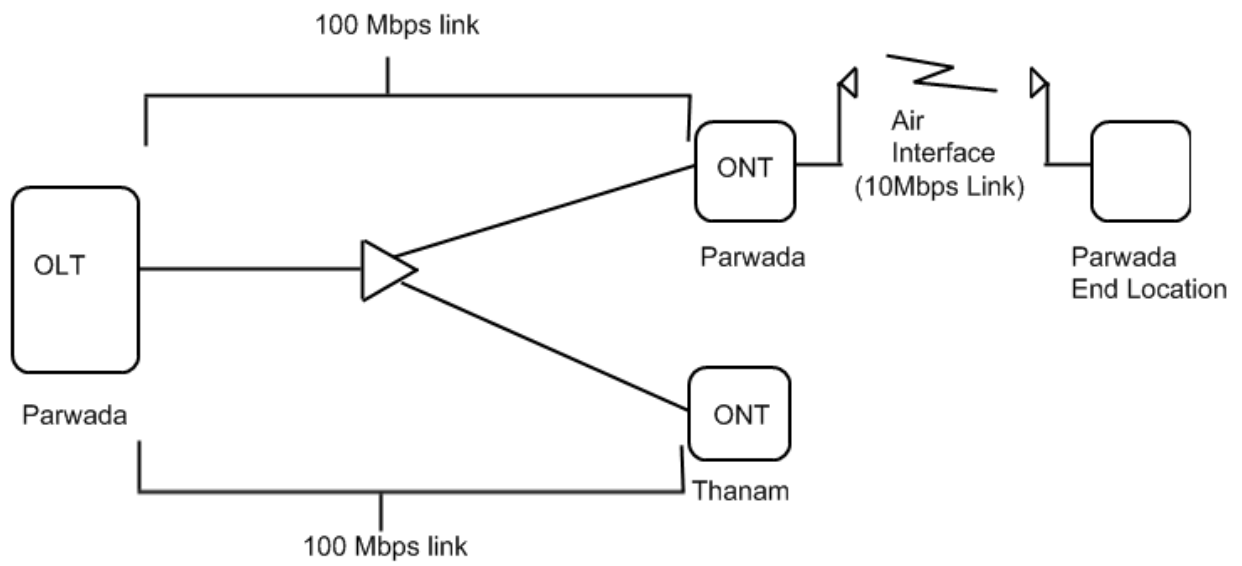
8.7 Annexure VII: JDSU Test Reports on end to end QOS..

BBNL Network Testing Report

Parvada, Visakhapatnam

Conducted by : JDSU India Pvt Ltd

Network Setup



Day 1 – 20th May 2013

Testing Scenario 1

Testers were connected on OLT (Parvada) and on ONT (Parvada) to check the 100 Mbps bandwidth.

Result

The link was able to work on a throughput of 100 Mbps with a minimal frame loss rate of 0.5% max.

Testing Scenario 2

Testers were connected on OLT (Parvada) and at the Parvada End Location. This link was tested for 10 Mbps as the ONT (Parvada) to End Location (Parvada) is a 10 Mbps link.

Result

A very high frame loss rate for lower frames was detected, which reduced down to 8as the frame length increases. The throughput of the link was achieved at 10 Mbps for 512 byte and bigger frames but was 4.37 Mbps for 68 bytes and 9.27 Mbps for 128 byte frame lengths with a very high frame loss rate (ranging from 13% to 76%).

Testing Scenario 3

Testers were connected on ONT (Parvada) and at the Parvada End Location. This link was tested for 10 Mbps as the ONT (Parvada) to End Location (Parvada) is a 10 Mbps link.

Results

The results reported were same as **Testing Scenario 2** above.

Testing Scenario 4

Testers were connected on OLT (Parvada) and on ONT (Thanam) to check the 100 Mbps bandwidth.

Results

The results reported were same as **Testing Scenario 1** above.

Testing Scenario 5

Master tester was connected at OLT (Parvada) and one tester each was connected at ONT (Parvada) and ONT (Thanam). 100 Mbps throughput was generated from master tester at OLT (Parvada) simultaneously to both the testers connected at ONT (Parvada) and ONT (Thanam).

Results

In this scenario, the total link capacity being tested for 200 Mbps and both the links were reporting throughput of 100 Mbps each and a cumulative (aggregated) throughput of 200 Mbps at OLT. The test was run a period for around 2hrs 45 min and the link was stable.



Day 2 – 21st May 2013

Testing Scenario 6

Testers were on the link between NIC (Vishakhapatnam) and OLT (Parvada) to check the 1000 Mbps throughput. OLT was eliminated in this case and the optical patch cords that terminate on OLT were terminated on tester.

Result

The link was able to work on a throughput of 1000 Mbps without any errors successfully.

Testing Scenario 7

Testers were on the link between NIC (Vishakhapatnam) and ONT (Parvada) to check the 100 Mbps throughput. ONT is configured for a maximum throughput for 100 Mbps.

Result

The link was able to work on a throughput of 100 Mbps with a frame loss rate of less than 0.7%.

Testing Scenario 8

Testers were on the link between NIC (Vishakhapatnam) and ONT (Thanam) to check the 100 Mbps throughput. ONT is configured for a maximum throughput for 100 Mbps.

Result

The link was able to work on a throughput of 100 Mbps with a frame loss rate of less than 4%.

Testing Scenario 9

A video conference was conducted between **ONTs** at **Parvada** and **Kalpaka**. The tester was kept in a Through Mode at the Parvada ONT connected to the live Video conferencing equipment. While the Video conferencing was live, tester captured the link quality information.

Result

The video conference was conducted successfully without any issue. Even the tester reported a consumption of around 1.45 Mbps of Bandwidth for the Video conferencing and the frames used for these were majorly the big frame of size more than 256 bytes. No frame losses were reported.

Testing Scenario 10

VoIP calls were placed between NIC (Visakhapatnam) and OLT (Parvada) & also between NIC (Visakhapatnam) and ONT (Thanam). Since, the SIP server was not available to place SIP calls the testers generated the H.323 (fast connect) calls with Codec **G.711 μ -Law 64k** and **G.729A**.

Result

In both cases, the VoIP quality was good and was at a **MOS quality score** of **4.2** (for G.711 μ -Law 64k) and **3.98** (for G.729A) on a scale of **5**.

CONCLUSION

Through the various testing conducted on different sections of the network following observations are made

1. Optical connectors at both OLT and at NIC were found to be dirty and were failing the IEC standard for optical connector quality. Being a new link with new fiber connectivity, after proper cleaning, the connectors passed the IEC standard quality check.
2. It was observed that the frame losses occur in the OLT – ONT segment of the network although 100% throughput is achieved. Even the frame loss rate is also small (less than 1%).
3. Majorly the problem occurs for smaller frame lengths between 64 and 128 byte where the impact of frame loss is more at 100% load.
4. Bigger frames are much more stable and efficient.
5. Though the latency increases as the frame length increases but in this case the variation in latency from smaller to larger frame is significantly low and well within the permissible limits.
6. The magnitude of frame loss rate was very high in case of ONT to End Location link with RF connectivity (WiFi link) in-between. The frame loss rate went up to more than 70% in case of small frame length and was still under check at bigger frame lengths.
7. Video conference call was working fine with single call bandwidth consumption at around 1.45 Mbps and using a range of frame length, especially bigger than 256 bytes.
8. Voice Quality tested on the link provided good results with MOS score achieved at 4.2 and 3.98 at two different Codecs.

RECOMMENDATION

Following recommendations should be considered.

1. Dirty connectors can slowly result in damage of the fiber connectors, ports on the equipment where they are connected and ultimately resulting in a malfunctioning of the network which will affect the running services. The 1G link between NIC and OLT optical which is further providing connectivity to no. of ONT and other end locations. Any performance issue in the optical link will result in the affect the services and degrade the performance of the services running at all connected ONTs and the end locations.

It is advised to clean the optical connectors every time they are pulled-out and connected back to the network.

2. Though the impact on running applications in the network is less due to small frame lengths but to further improve the quality and reliability of the network the last mile (link between ONT and End Location) is recommended to be with Fiber connectivity.

BBNL Network Testing Report

Panisagar, Tripura

Conducted by : JDSU India Pvt Ltd

Network Setup

JDSU CONFIDENTIAL 3 of 5

Day 1 – 6th Aug 2013

Testing Scenario 1



Testers were on the link between NIC (Unokoti) and OLT (Panisagar BSNL Exch) to check the 1000 Mbps throughput on 1GE optical link. OLT was eliminated in this case and the optical patch cords that terminate on OLT were terminated on tester.

Result

The link testing resulted in a complete failure as no Ethernet traffic was being received at either end of the 1GE optical link. Initially, the doubts were on the local connectivity in Unokoti between the BSNL and NIC location but on testing from Panisagar BSNL Exch to Unokoti BSNL the result remained same.

We tried to attempt the MUX to MUX testing between BSNL locations by eliminating the fiber from BSNL MUX to OLT but even that resulted in a failure.

It was also observed that the SFP's used at BSNL MUX are of 1550nm wavelength but the SFPs used at NIC and at OLT are of 1310nm wavelength. Even after changing the SFPs on the tester from 1310nm to 1550nm to check between the BSNL MUX's there was no throughput achieved.

Further, before starting the testing the optical connectors were inspected and found to be dirty which were cleaned before the testing.

JDSU CONFIDENTIAL 4 of 5

Day 2 – 7th Aug 2013

Testing Scenario 2

Testers were connected on OLT (Panisagar BSNL Exch) and on ONT (Panisagar GP) to check the 100 Mbps bandwidth.

Result

The link was able to work on a throughput of 100 Mbps with a minimal frame loss rate of 0.06% max.

Testing Scenario 3

Testers were connected on OLT (Panisagar BSNL Exch) and on ONT (Panisagar Block) to check the 100 Mbps bandwidth.

Result

The link was able to work on a throughput of 100 Mbps with a minimal frame loss rate of 0.06% max.

Testing Scenario 4

Testers were connected on ONT (Panisagar Block) and at the Panisagar (Hospital) Horizontal Location. This link was tested for 10 Mbps as the ONT (Panisagar Block) to Horizontal Location (Panisagar Hospital) is a 10 Mbps link.

Results

A very high frame loss rate for lower frames was detected, which reduced as the frame length increases. The throughput of the link varied between 3.5 Mbps to 9.5 Mbps as the frame length increases with a varying high frame loss rate (ranging from 6.6% to 77%).

JDSU CONFIDENTIAL 5 of 5

CONCLUSION

Through the various testing conducted on different sections of the network following observations were made

1. Optical connectors at both OLT and at NIC were found to be dirty and were failing the IEC standard for optical connector quality. Being a new link with new fiber connectivity, after proper cleaning, the connectors passed the IEC standard quality check.
2. It was observed that the frame losses occur in the OLT – ONT segment of the network although 100% throughput is achieved. Even the frame loss rate is also small (less than 1%).
3. Majorly the problem occurs for smaller frame lengths between 64 and 128 byte where the impact of frame loss is more at 100% load.
4. Bigger frames are much more stable and efficient.
5. Though the latency increases as the frame length increases but in this case the variation in latency from smaller to larger frame is significantly low and well within the permissible limits.

6. The magnitude of frame loss rate was very high in case of ONT to End Location link with RF connectivity (WiFi link) in-between. The frame loss rate went up to more than 70% in case of small frame length and was poor for big frames also.

JDSU CONFIDENTIAL 6 of 5

RECOMMENDATION

Following recommendations should be considered.

1. Dirty connectors can slowly result in damage of the fiber connectors, ports on the equipment where they are connected and ultimately resulting in a malfunctioning of the network which will affect the running services. The 1G link between NIC and OLT optical which is further providing connectivity to no. of ONT and other end locations. Any performance issue in the optical link will result in the affect the services and degrade the performance of the services running at all connected ONTs and the end locations.

It is advised to clean the optical connectors every time they are pulled-out and connected back to the network.

2. Though the impact on running applications in the network is less due to small frame lengths but to further improve the quality and reliability of the network the last mile (link between ONT and End Location) is recommended to be with Fiber connectivity.

3. During the link testing failure of the NIC – OLT link, it was observed that there are no Ethernet testers available at the BSNL location to test these links before deploying. Such deployment of link without proper testing puts the entire n/w at risk as this link being the most critical one for network connectivity. It is recommended to test these links before being commissioned for a live network.



CDOT GPON Network

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2

CDoT – GPON :: OLT – ONT Setup

From / To NIC From/To Voice, Video & Data Services 1G Optical Ethernet pipe

100Mbps Electrical Ethernet Connection towards Users

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3

OLT ONT

In this test scenario,

1. Two testers were connected, as shown in the figure above. 2. The tester connected to ONT was setup on a loopback mode so that any traffic coming from tester connected at OLT will be send back to OLT tester. 3. 100Mbps traffic was generated at various frame lengths – 70, 128, 256, 512, 1024, 1280 and 1518 bytes.

Optical Ethernet Connection

Electrical Ethernet Connection

Testing Scenario 1

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Observation – Testing Scenario 1

OLT ONT

The following observations were made



1. The traffic with frame lengths 70 and 128 bytes generated more than 95% bandwidth but with frame losses / bit errors. 2. The traffic with frame lengths 256, 512, 1024, 1280 and 1518 bytes generated 100% bandwidth without any frame losses / bit errors.

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6

OLT ONT

RFC 2544 testing was conducted from OLT towards ONT with Throughput, latency and frame loss settings. 1. The test passed for 256, 512, 1024, 1280 and 1518 byte frame lengths. 2. The test failed to achieve 100% throughput at 70 and 128 bytes frame lengths and also generated frame losses at these frame lengths. 3. RFC 2544 works on 0% frame loss tolerance, hence, at 70 byte frame length around 32% and at 128 bytes around 53% of bandwidth was achieved with no frame losses.

Observation - Testing Scenario 1 – RFC 2544

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Further, to isolate the cause of the issue we changed our test scenario to perform in-depth analysis on the link

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8

OLT ONT

In this test scenario,

1. Two testers were connected, as shown in the figure above. 2. The traffic was generated from both the testers so that the traffic generated from OLT tester terminates at ONT tester and vice-versa. 3. 100Mbps traffic was generated at various frame lengths – 70, 128, 256, 512, 1024, 1280 and 1518 bytes from both the testers.

Optical Ethernet Connection



Electrical Ethernet Connection

Testing Scenario 2

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9

Observation – Testing Scenario 2

OLT ONT

The following observations were made

1. All the traffic transmitted from OLT towards ONT achieves 100% throughput at all frame lengths (70, 128, 256, 512, 1024, 1280 and 1518 bytes) without any error. 2. All the traffic transmitted from ONT towards OLT achieves 100% throughput at all frame lengths without any error except 70 and 128 bytes, which achieve more than 95% throughput but generates frame losses / bit errors.

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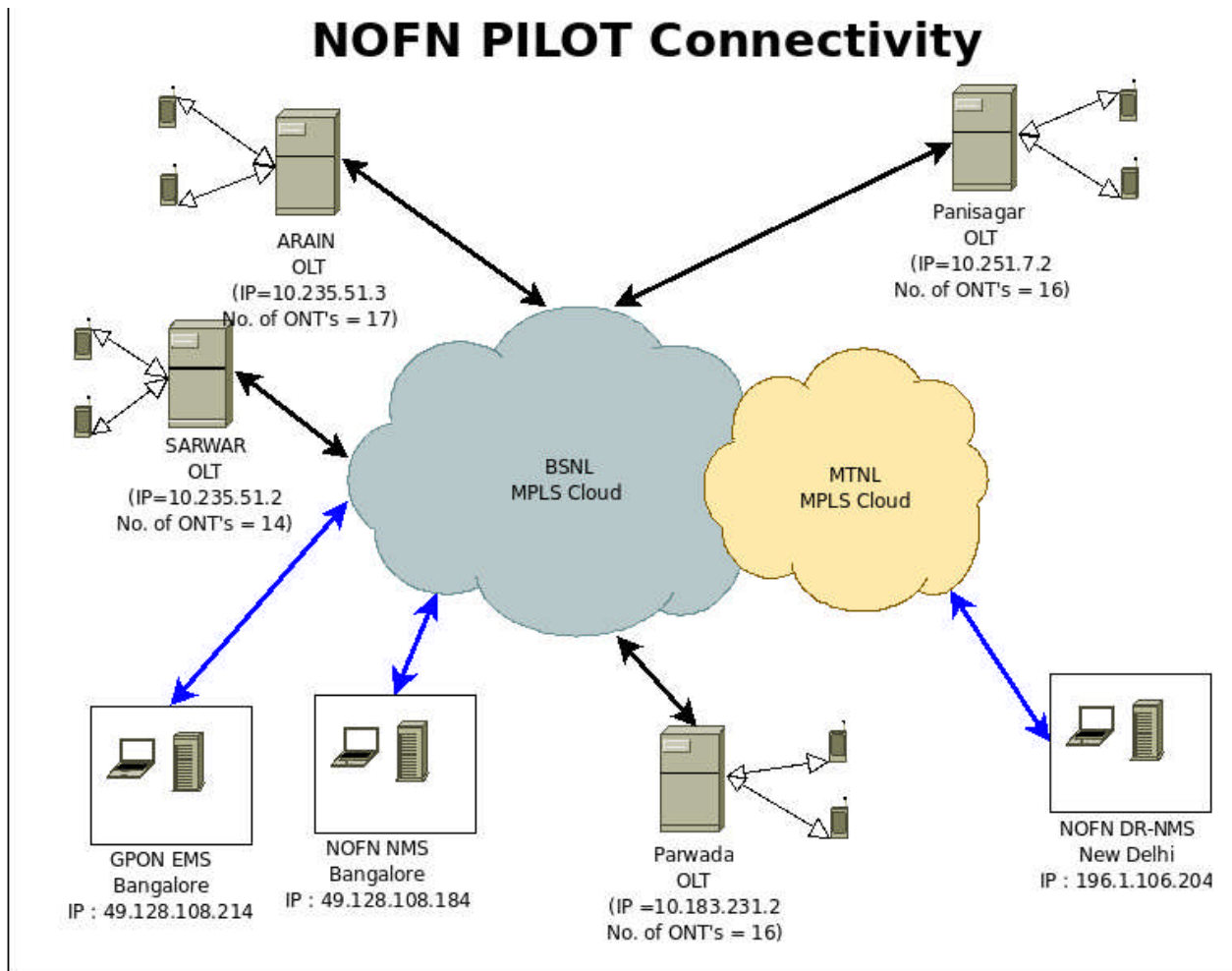
Conclusion

1. Frame loss / bit error were observed at a smaller frame lengths for the traffic going from ONT to OLT. For bigger frame lengths no frame loss / bit error was reported. 2. No frame losses / bit errors were reported in the traffic from OLT to ONT on all frame lengths. 3. Frame loss ratio for the errored frame lengths were max. 0.13% on a throughput of 100 Mbps. 4. Latency observed was well within the permissible limits. 5. Packet jitter observed was well within the permissible limits.

Ethernet traffic is busy in nature and in a live n/w all types of frame lengths are used based on the applications running.

Such low % of frame loss ratio should not be impacting the quality of the network drastically and the applications running on such network should provide high quality output with minor glitches.

8.8 Annexure VIII: The connectivity diagram of NOFN NMS.-



8.9 Annexure IX: Executive Summary of Government User Network DPR

Report Background

Bharat Broadband Network Ltd (BBNL) is the agency entrusted with the task of spreading Broadband connectivity in the country with an objective of enabling delivery of broadband based services from Government and other agencies to the rural population. BBNL has already launched a program to create **National Optical Fiber Network (NOFN)**. NOFN aims to set up OFC connectivity from 10,000 Blocks to their respective 250,000 Gram Panchayats (GP).

While the connectivity between Blocks and their respective GPs is being set up by NOFN, The prospective users, both in Government sector and other Telecom Service Providers, perceive viability, feasibility and technology concern since mounting a service for rural sector on NOFN would require a large number of interconnects. BBNL has observed a low level of interest from the prospective service providers. The 'Government User Network (GUN)' has been envisaged as an extension over NOFN in order to address the above concern and greatly ease mounting of services for delivery to rural population. GUN envisages that the connectivity would be aggregated at district level from where it can be connected to the National Knowledge Network and the Internet as well as other State Wide / Nation Wide Networks as required.

About GUN over NOFN

As explained above, while NOFN aims to connect Blocks to Gram Panchayats (GP), BBNL is planning to extend the connectivity created by NOFN on both ends as below:

- i. **Backward Aggregation:** Establish connectivity between Block and District Headquarters and aggregate the network at District level.
- ii. **Forward Extension:** Extend the connectivity from GP PoP to 2 selected Government institutions and provide low cost Wi-Fi internet services within the vicinity of GP

The above extensions would enable end to end connectivity till the GP level and would be used to provide Government services at village level and is labeled as "**Government User Network (GUN) over NOFN**". In addition, the District PoP of GUN would have the option to be connected to the National Knowledge Network (NKN) PoP at each district, this would allow for end to end closed user group connectivity upto the State Data Center and National Data Centers. Others networks can

interconnect with this network at the District, State or National level. The GUN would also be connected to Internet at district level.

The project aims at making available the required connectivity and bandwidth for rural service delivery across the nation. Accordingly, consultations and discussions have been done with DeitY, MoHRD, USOF and DoT. Going forward and prior to implementation it may be necessary to interact with a larger set of users and that an inter-ministerial/departmental committee may be formed for better coordination of inputs.

This DPR focuses on GUN over NOFN with the objective to assess the feasibility of its implementation from following perspectives –

- As-is, gap and stakeholders analysis
- Technical Solution
- Project Implementation Strategy
- Operations and Management of Infrastructure
- Legal and Regulatory environment
- Risk Analysis
- Budgetary Estimation

Source of Funds

Capital Expenditure: The capital investment for the project is envisaged from USOF

Operating Expenditure: BBNL is planning to engage **Ministry of Rural Development (MoRD)**, as “**Anchor Customer**”¹, to support the operating cost for a period of 10 years. In lieu GUN over NOFN will provide MoRD with 50 Mbps of broadband connectivity across all GPs in the country with an assured Quality of Service (QoS).

MoRD will utilize the 50 Mbps connectivity as below:

- i. 10 Mbps for delivery of community Wi-Fi internet services at GP
- ii. 10 Mbps for delivery of services at GP

¹ MoRD is being referred to as the Anchor Customer since this network primarily is being envisaged to cater to MoRD requirements.

-
- iii. 20 Mbps for 2 government institutes at GP (10 Mbps each). The institutes could be School and health center or any other government institute such as Police Station, Post office etc
 - iv. 10 Mbps reserved for future use

In order to provide above mentioned capabilities to MoRD, GUN scope includes the following:

- i. Backward aggregation of NOFN so that CUG service provider can interconnect at District level
- ii. Setting up infrastructure at GP level and providing community Wi-Fi internet services to rural population within a vicinity of approx 300 to 500 meters
- iii. Extending network from GP to minimum two government institutes – one School, one PHC/ Police Station/ or any other Government institution.

Beyond the “Anchor Customer”

The NOFN would provide a capacity of 100 MBPS from GP to Block Level. Further, GUN extension would have a capacity of 1 GBPS from Block to District level. The District aggregation point of Gun would have 4 X 10 GBPS ports for upward connectivity. Therefore, it can be seen that GUN over NOFN would actually create much higher bandwidth capacity than the 50 Mbps assured to the MoRD. This additional capacity is envisaged to be offered to other service providers, on a non-discriminatory basis, to enable them to deliver their services to rural population. This additional capacity can be offered at economical rates to other service providers, since the project would already be completely funded. Low cost bandwidth can potentially enable service providers to create a viable business model for delivery of services at rural level. Refer to section **Error! Reference source not found.** for estimates on potential bandwidth demand.

The guiding principle for arriving at tariffs, for providing bandwidth to service providers, would be to encourage them to provide their services to rural population at affordable cost. Exact methodology to determine the tariffs will be decided by the BBNL board from time to time.

The incremental revenue, if any, generated from customers other than the ‘Anchor Customer’ can be utilized for technology refresh and reducing the OPEX burden of the “Anchor Customer”.

Project Implementation



GUN over NOFN aims to

- i. Backward aggregate around 5900 Blocks (10,000 OLTs) of NOFN with their respective 590 Districts. Connect with NKN and Internet at District level.
- ii. Forward extend around 2,50,000 GP PoPs of NOFN to
 - a. Connect to two Government institutes
 - b. Provide community Wi-Fi services at around 2,50,000 GPs

Project is envisaged to take around 3 years to implement. A high level implementation plan is provided in section **Error! Reference source not found.:Error! Reference source not found..**

The implementation approach envisages that BBNL would need to deploy a team of around 200 staff at implementation units spread across the country. During Operations and Management phase the required staff number is expected to be around 700. Primary function of this staff would be to manage the on field vendors who will provide the implementation and O&M services to BBNL.

In order to effectively meet the implementation objectives, this DPR outlines the strategic aspects of implementation approach across the following key implementation areas -

- i. Dark Fiber leasing
- ii. District, GP and Institute level implementation

Below are the key highlights of the suggested implementation approach -

Dark Fiber Leasing

- For leasing of Dark Fiber, tendering process needs to be followed for discovering the availability of dark fiber and its price.
- Based upon received responses, categories for dark fiber leasing and rate card for each category shall be created.
- Dark fiber providers to sign contract against the published rate card. This rate card to be used on an on-going basis to enhance the reach in areas where dark fiber may not be available as yet.

District, GP and Institute level implementation

- Detailed design with Bill of Material with item specifications to be created for the entire solution.
- Through an open RFQ process, centralized empanelment of OEMs to be done for all key equipments. For each of the equipment, at least 4 to 5 vendors who meet the specification requirements shall be empanelled based on lowest quote.
- States to be grouped together into clusters based upon geographical proximity, size of State, number of Districts, average number of Block per District in State so that an average of around 100 Districts are grouped in cluster. This will result in formation of around 6 to 8 clusters.
- Through tendering process identify an SI for each cluster who would undertake implementation in all Districts and GPs in that selected cluster.
- SIs to bid with equipment specifications from empanelled vendors only. The equipment prices in SI bids to be less than or equal to the prices quoted by the empanelled OEMs.
- Maintenance for 5 years (with layered SLAs) to be part of post implementation tender to be extended at the discretion of BBNL.

Operations and Management Approach

As in case of project implementation, the lean structure of BBNL poses a challenge to Operations and Maintenance of the network of the scale of GUN over NOFN. Below mentioned key strategic aspects of O&M approach are designed to address this challenge.

- The implementing agency to be responsible for overall maintenance (referred as O&M agency) of the network. Maintenance contract to be integral part of the implementation contract.
- The expected SLAs to be defined in the tender itself. The Agency shall be responsible to maintain the SLA for whole network *excluding*:
 - i) NOFN Network
 - ii) Dark fiber between Block-District and PoP
 - iii) ISP Bandwidth
- SLA of NOFN network will be managed separately by BBNL as per NOFN O&M strategy and SLA of other two components (Dark fiber and ISP link) will be negotiated back to back from respective provider.
- BBNL would establish a central performance monitoring and SLA audit team to carry out overall performance monitoring and SLA audit for each of the individual agencies viz;

- System Integrators
 - Dark Fiber Providers
 - ISP Bandwidth provider
 - NOFN maintenance agency
 - POP providers
- As part of its services the performance monitoring and SLA audit team shall administer the SLA with above entities on behalf of BBNL. All breaches, compliances and escalations shall be compiled and reported by to BBNL. BBNL shall undertake the centralized payment based on report submitted by the team.
 - BBNL will deploy State Managers (GM) and Area Managers (SDE) for administrative management of NoFN. This report factors in the additional resources that will be required to manage GUN over NOFN.
 - Additional resources required for NOC and service desk have been taken into consideration. These resource may required to be increased over time as the customer base expands.
 - New additional NMS has been considered to manage backward aggregated network between Block-District and Wi-Fi access points.

Budgetary Estimation

Estimated budget for implementation of GUN over NOFN is as below:

CAPEX	INR 4942 Cr
OPEX / Annum	INR 2472 Cr

Refer to section **Error! Reference source not found.:Error! Reference source not found.** for details on project budget and related assumptions.

Key aspects of project budgeting are as below:

- Total project period has been considered as 10 years
- Project will be funded as:
 - CAPEX to be funded by USOF
 - OPEX to be funded by MoRD

-
- Cost of NOFN bandwidth included in GUN OPEX would be considered as revenue for NOFN Project
 - It is considered that that the District-Block and Block-Block incremental fiber pair shall be available on lease from other service providers. An average distance of 33 K.M per Block is considered for the same (Refer to section **Error! Reference source not found..Error! Reference source not found.**)
 - The average distance between Institution and GP PoP of BBNL is considered to be 1 K.M.
 - Existing PoP of BSNL at Blocks and GP are used for over all GUN Project as BBNL collocated PoP. Cost of power for the same is considered.
 - At District the BBNL will create its own PoP that shall be linked to the relevant CUG service provider's PoP

Technology at a glance

The Technical solution proposed for GUN's backward aggregation at District level and forward extension in GP comprises of following key features:

Features of GUN network designed for backward aggregation at District

- The NOFN network designed to work on Layer-2, the new Block to District network is also planned to be deployed to provide L2 services. This will enable end to end GUN over NOFN to deliver services as Packet switched Layer-2 (Transparent IP) Network.
- Underlying architecture of GUN over NOFN is highly secure and completely segregated from the Internet.
- The proposed backward aggregation connectivity between Block and District will have capability to carry 1-2 Gbps traffic from each Block to District. It will further have Minimum 4*10Gbps uplink ports to integrate with Government/OSP network at District. The interconnect link between BBNL DHQ PoP and NKN/SWAN/NII PoP has been considered.
- A Separate NMS/EMS has been proposed to manage this network centrally. This new NMS/EMS shall be integrated with existing CDOT NMS for end to end management.

Features of GUN network designed for forward extension at GP

As a part of GUN project four different connectivity of 10 Mbps each need to be provided, The extension network in GP has been designed to cater the requirement of extension network for individual 10 Mbps connectivity as briefed below:

- It is assumed that GP e-Service delivery center and BBNL GP PoP will be collocated in same premises. A L3 CPE device (Router/Switch) has been considered additionally to terminate the link in GP e-service delivery center. This device will also have inbuilt Wi-fi capability providing Wi-fi access in the center for e-GP services.
- 10 Mbps connectivity to two Institutions at Gram Panchayat (GP): The last mile connectivity will require various options based on geographical situation at GP. Various options for different scenario are detailed in the report. A L3 CPE device (Router/Switch) has been considered additionally to terminate the link in Institution. This device will also have inbuilt Wi-fi capability providing Wi-fi access in the institution.
- LAN accessories i.e. Switch, Computer, LAN cabling, UPS etc. are not part of this project and need to be factored by respective institution/line-ministry.
- Community Wi-Fi service will enable villagers to access broadband internet using their Wi-Fi appliances (i.e. Laptop, Teblet, Mobile Phones, computers using Wi-Fi access point). One access point will be installed at every GP to provide the Wi-Fi internet hot-spot around the installation location at GP. Contention ratio of 1:50 has been considered for aggregated B/W at District Level for Internet from ISP.

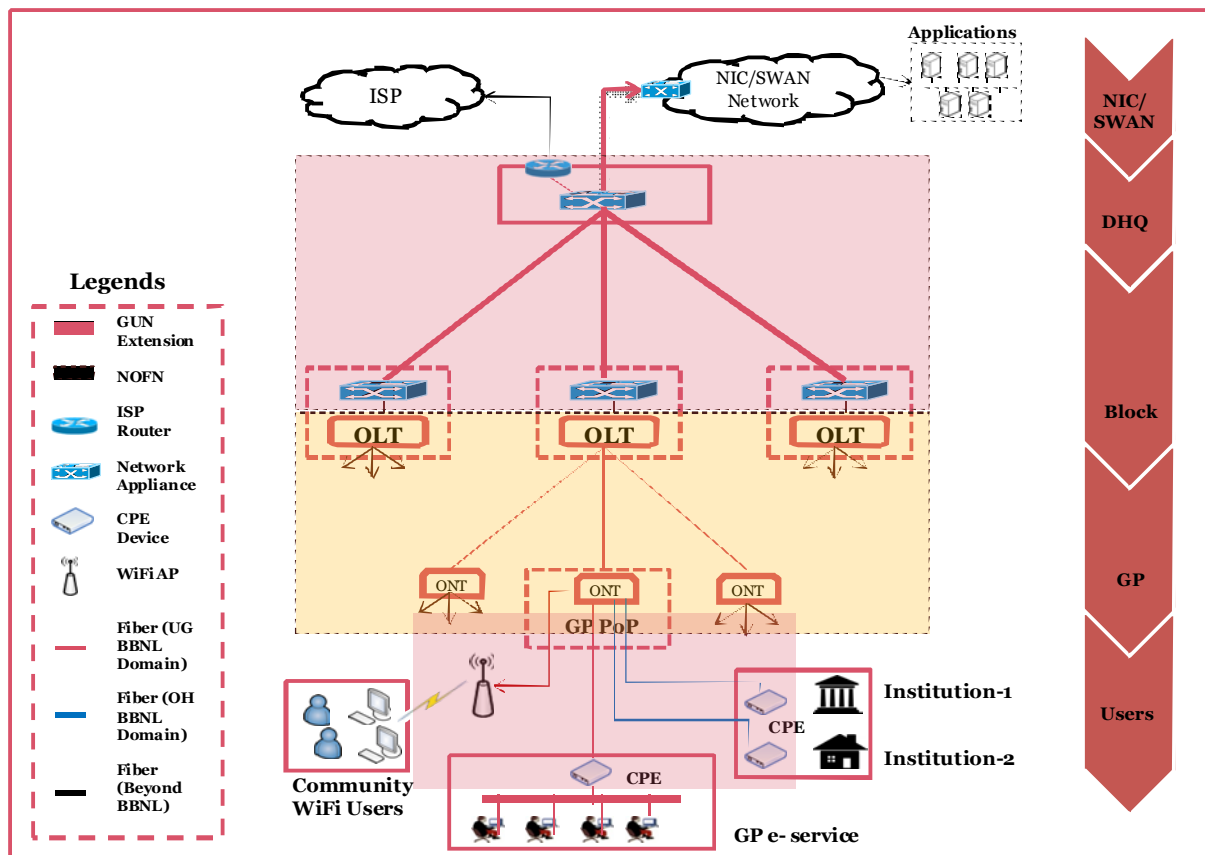


Figure 1: Solution Architecture – GUN overlay on NOFN



Legal and Regulatory Assessment

In order to provide additional services as envisioned under GUN over NOFN project, BBNL will need to make changes to its current legal status. In order to identify the required changes, study of the Memorandum of Association as well as the National Long Distance (NLD) license currently held by BBNL was done.

Key outcomes of the assessment are provided in section **Error! Reference source not found.:Error! Reference source not found.** of this document. Key changes are:

- Current NLD license held by BBNL will suffice the purpose of providing bandwidth services under GUN over NOFN project
- Additionally, BBNL will need to acquire ISP license in order to provide community Wi-Fi services at GP
- Memorandum of Association of company will need to be updated. Suggested changes are detailed in section **Error! Reference source not found.:Error! Reference source not found..**

8.10 Annexure X: Marketing Survey results

- i. Mobile sets used are not GPRS enabled thus indicating most of the usage to voice and SMS. Data usage is yet to pick up.
- ii. Some of the people are aware of social networking sites namely Facebook and Twitter but hardly one was reported to have a Facebook account as he has done his B.Tech.
- iii. People do not have computers at home in general. Detailed survey is needed for the same.
- iv. Young people are interested for using internet for doing their academic project work as well as education purposes.
- v. Everyone prefers to have regional content in the net for ease of adoption.
- vi. There is no awareness with the public about the broadband availability or the cost.
- vii. Some of the customers may take broadband connection and buy their computers if the monthly spend is less than Rs100 towards broadband.
- viii. It is felt that the present services offered need to be reliable to instil a sense of confidence with the customers for subscribing the services. The present service has not been very reliable.
- ix. The customers have to go through this learning phase in order to switch over to their own broadband at home. The ease of usage shall generate the need for the services.

8.11 Annexure XI: Cisco Initiative

1 Education

- Across 3 govt. schools in Ajmer district – children have been remotely taught (Grade 6 – Science and Grade 7 – English) by specialist subject teachers based out of Bangalore – using Cisco’s CEED platform, which enables 2-way interactive video & voice between the teacher and different rural schools. We have so far completed 6 sessions over 2 weeks since July 31st 2013. About 420 student hours of teaching have been concluded.
- The platform allows for a teacher from any location to teach any other location (both of which are connected to the platform with appropriate bandwidth).

2 Healthcare

Cisco Health Presence (CHP) solution has been deployed in 2 Primary Health Care center in Arain Block and 1 Medical College – JLN Medical College at Ajmer. We have connected Primary Healthcare Centers (PHC’s) to a specialty hospital in Bangalore as well.

- In a span of 2 months, as of 12th August, 2013, close to 59+ live general/specialty/super-specialty consultations have been enabled using our solution. Through this solution, which incorporates medical diagnostic tools (such as digital thermometer, stethoscope, BP, ECG etc. from a third party), the patient experiences a consultative session with the remote doctor as if they are sitting face to face. The remote PHC needs only a nurse or a para-medical who can be trained to operate the equipment and serves as the “remote hands” of the doctor.

3 Skills

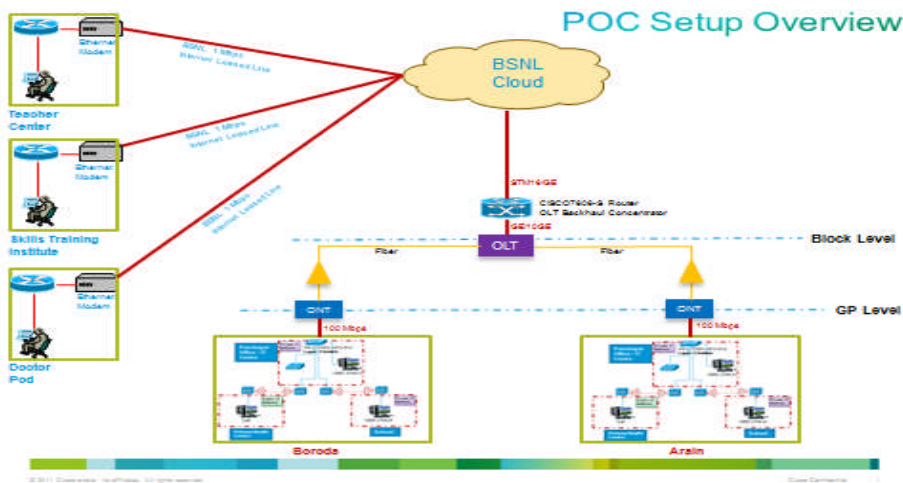
- Samvad Centre at Arain Panchayat office is being proposed to remotely deliver skills training and Community Outreach programs.
- Cisco through its training partners is planning to offer courses in the area of Rural Banking, Agriculture, Mobile Handset Repair, Milk diary management and Animal Husbandry. We are in discussion with the District administration to mobilize the rural youth who can be trained on these livelihood skills.

In all the above instances, Cisco and its partner ecosystem take care of the burning issues in rural areas like establishing & maintaining the network connectivity and power. The Inclusive Growth initiative at Cisco aims to make a sustainable profit so that the overall program can be enhanced and constant & relevant innovation can be supported. These

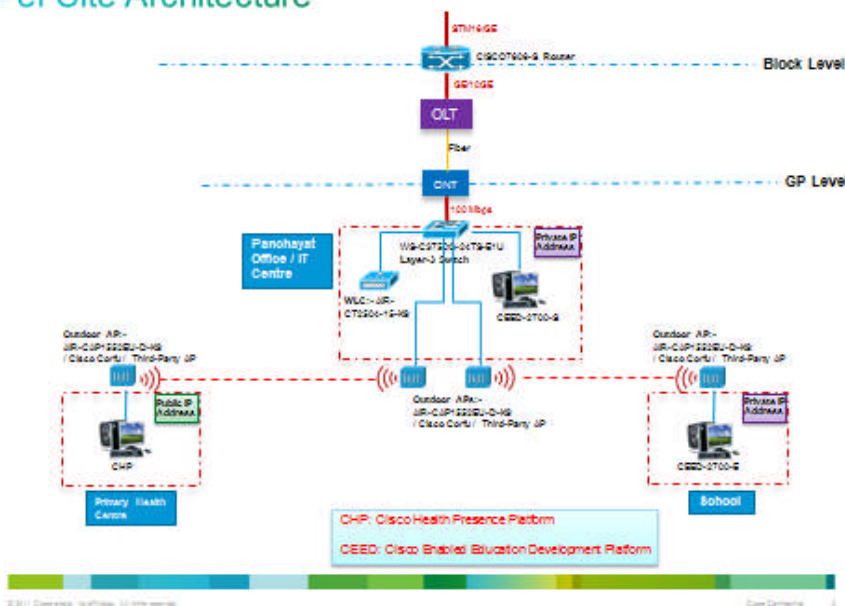
PPP's have successfully demonstrated the efficacy of the use of technology for the betterment of rural masses. And the outcomes have been extremely encouraging.

The last mile and the entire network has been provisioned as per the architecture in the two villages is given below:

NoFN – Ajmer Architecture



Per Site Architecture



8.12 Annexure XII: O&M Data

The table below shows the monthly availability report of ONTs in the pilot project.

Table I: Monthly availability report of ONTs in the Pilot Blocks taking into account the Power as well as OFC:

Pilot Blocks	Aug13	Sept13	Oct13	Nov13	Dec13	Jan14	Average
Arain	82.05%	92.44%	99.02%	97.46%	92.97%	94.90%	93.14%
sarvar	84.52%	82.44%	86.71%	89.85%	93.34%	88.36%	87.54%
Panisagar	47.88%	64.66%	43.33%	61.42%	70.36%	54.94%	57.10%
Parvada	64.59%	72.09%	66.11%	66.22%	67.92%	65.11%	67.01%

The main reasons of non-availability are Power failure/Power switch off during night time, OFC fault and link problems.

The reasons for the last 6 months are as given below for the pilot blocks:

Table II

Pilot Blocks	Reasons of non-availability	Aug13	Sept13	Oct13	Nov13	Dec13	Jan14
Arain (Avg Non-availability in hrs)	Power failure	129.09	54.43	7.06	3.13	44.08	18.63
	OFC cut	0	0	0	14.50	0	0.67
	Link Problem	0.18	0.00	0.00	0.68	6.56	17.41

Table III

Pilot Blocks	Reasons of non-availability	Aug13	Sept13	Oct13	Nov13	Dec13	Jan14
Sarvar (Avg Non-availability in hrs)	Power failure	103.72	126.35	95.67	69.52	45.15	57.26
	OFC cut	0	0	0	3.43	0	0
	Link Problem	7.78	0.11	0.01	0.11	2.82	26.55

Table IV

Pilot Blocks	Reasons of non-availability	Aug13	Sept13	Oct13	Nov13	Dec13	Jan14
Panisagar (Avg Non-availability in hrs)	Power failure	375.24	223.56	408.01	265.30	213.17	296.02
	OFC cut	0	30.06	0	12.25	3.15	16.35
	Link Problem	0.02	0.84	0.00	0.24	0.26	12.06

Table V

Pilot Blocks	Reasons of non-availability	Aug13	Sept13	Oct13	Nov13	Dec13	Jan14
Parvada (Avg Non-availability in hrs)	Power failure	254.88	200.96	244.02	239.98	182.34	144.37
	OFC cut	0	0	0	0	45.3	8.0
	Link Problem	0.02	0.00	0.00	3.21	3.32	0.02

The end to end availability is a function of the availability of each element in the Network. The elements are:

- OLT Equipment.
- ONT Equipment.*

*The availability of ONT is a function of OFC as well as power availability. Thus ONT availability = availability of ONT equipment*availability of Power*availability of OFC

Table VI: The Table below indicates the downtime for different availability:

Downtime Per week Hrs.	Downtime Per month Hrs.	Downtime Per year Days.	Availability In %
16.8	74	36.5	90
8.4	36	18.25	95
3.36	14.4	7.3	98
1.68	7.20	3.65	99
0.84	5.68	1.83	99.5

Table VII: The OFC cuts and time taken to repair the same for the pilot blocks are as follows:

Pilot Blocks	Aug13	Sept13	Oct13	Nov 13	Dec13	Jan14
	No of OFC cuts /Time to repair in hrs	No of OFC cuts /Time to repair in hrs	No of OFC cuts /Time to repair in hrs	No of OFC cuts /Time to repair in hrs	No of OFC cuts /Time to repair in hrs	No of OFC cuts /Time to repair in hrs
Arain	-	-	-	2/145	-	1/12
Sarwar	-	-	-	1/48	-	-
Panisagar	-	1/5	-	3/11	3/2.8	3/14.5
Parvada	-	-	-	-	1/240 (restored on 2 nd Jan)	-

9 Abbreviations Used

Abbreviations	
A/T	Acceptance Testing
B2B	Business to Business
B2C	Business to Consumer
BBNL	Bharat Broadband Network Ltd
BHQ	Block Head Quarter
BSNL	Bharat Sanchar Nigam Ltd
CAPEX	Capital Expenditure
C-DOT	Center for Development of Telematics
CPSU	Central Public Sector Undertaking
CSC	Common Service Center
CSR	Corporate Social Responsibility
CUG	Close User Group
DC	Data Center
DCN	Data Communication Network
DeitY	Department of Electronics and Information Technology
DHQ	District Head Quarter
DoT	Department of Telecommunications
DPR	Detailed Project Report
DR	Disaster Recovery
EMS	Element Management System
G2C	Government to Consumer
G2G	Government to Government
GP	Gram Panchayat
GPON	Gigabit Passive Optical Network
GUN	Government User Network
H/w	Hardware
HIS	High speed internet
ICT	Information and communication Technologies
ISP	Internet Service Provider
Mbps	Megabits per second
MoRD	Ministry of Rural Development
MOS	Mean Opinion Score
MSO	Multiple-System operator
MTTR	Mean Time To Resolve
NeGP	National e Governance Plan
NGO	Non-Governmental Organisation
NIC	National Informatics Centre
NKN	National Knowledge Network
NMS	Network Management System
NOC	Network Operations Center
NOFN	National Optic Fibre Network
O&M	Operations and Maintenance

Abbreviations	
OEM	Original Equipment Manufacturer
OFC	Optical Fiber Cable
OLT	Optical Line Terminal
ONT	Optical Network Terminal
OPEX	Operational Expenditure
OS	Operating System
OSP	Other Service providers
PGCIL	Power Grid Corporation of India Ltd
PoE	Power over Ethernet
Pol	Point of Interconnect
PoP	Point of Presence
PPPoE	Point to Point Protocol over Ethernet
PSU	Public Sector Undertaking
QoS	Quality of Service
RCA	Root Cause Analysis
S/w	Software
SLA	Service Level Agreement
SPV	Special Purpose Vehicle
TSP	Telecom Service Provider
USOF	Universal Service Obligation Fund of India
VBES	VLAN for Business Enterprise Service
VOIP	Voice over IP