LONG TAIL - WALKING THE EXTRA MILE ON RURAL BROADBAND BUSINESS

SATYA N GUPTA,
NGNguru

LONG TAIL - WALKING THE EXTRA MILE ON RURAL BROADBAND BUSINESS
SATYA N GUPTA, NGNguru

LONG TAIL – WALKING THE EXTRA MILE ON RURAL BROADBAND BUSINESS

SATYA N GUPTA,
NGNguru

notionpress.com
INDIA • SINGAPORE • MALAYSIA

Notion Press

Old No. 38, New No. 6
McNichols Road, Chetpet
Chennai - 600 031

First Published by Notion Press 2019

ISBN 978-1-68466-584-6

SATYASPEAK

BLUETOWN Broadband Diary

Long Tail – Walking the Extra Mile on Rural Broadband Business

Satya N. Gupta

NGNguru

Chairman – BLUETOWN, India & BIMSTEC

Table of Contents

Preface – 'Moving the Boat Faster'

Rural broadband has been the most talked about buzz word for last 5 years in all quarters of Govt., Industry and Civil Society but has not delivered on ground and so called **'Digital – Divide'** between Urban and Rural areas still persists as ever. I will term it as **inclusive failure of conventional wisdom.** That's why need for out of box working and **'Walking the Talk.'** Through my discussions with all type of intellectuals who are sensitive to this issue, the ubiquitous reason for this not happening is **'Lack of the Business Case.'**

In this context, I am reminded of a story from Australia, just before the Sydney Olympic in early twenties. The Govt. there decided that, when the games happen in their own country, as a natural prestige issue, the country should aim for the 'Rowing Gold.' A renowned consultant was hired to achieve this deliverable. He analyzed the issue and crafted a one liner questionnaire to clear any action related to preparation for "Gold" which was, **"Will it move the Boat Faster?."** So, while deciding about the Captain, Team composition, make of Oars, Boat, and everything was tested against this. As a result, they were successful in their endeavour of winning the **'Rowing Gold.'**

This incident is similar to what is known as a **Wood-Pecker behavior,** which indicates by ones consistent, focused and never-giving up approach, any goal, howsoever unsurmountable, can be achieved.

In this study, I propose to use the same analogy for **making the Rural Broadband happen in India.** For anything we do in that direction, we should get the affirmative answer to the question

of **"Will it make the Business Case for Rural Broadband?."** Hence all the players need to collaborate and strive only with a single point agenda of making the Business Case for Rural Broadband. That's why **"Extra Mile…. Walking the Talk."** Hope you take the extra trouble of walking this "Extra Mile" together in **People – Panchayat-Public-Private-Partnership.**

Hoping for a great success towards **"Bharat Broadband Gold,"** I mean rural Broadband.

Satya N. Gupta

NGNguru

Conclusion – Beginning from End to Make It Happen

From this study, it has become obvious that business of rural Broadband needs an ecosystem jointly created by multi stakeholders from Public, Industry as well as Society. The major investment for the infrastructure needs to be funded by Government/Public as is the case for any other infrastructural project. The Industry has to pitch for the last mile access network making use of the existing infrastructure created by Public funding.

On the issue of constraints, most of these are on supply side and very few on the demand side which is not that significant. Therefore, the business model has been suggested from the point of view of **"Build it and they will come"** thus emphasizing the need of rural Broadband ecosystem for overall societal benefits. The main challenge is to hand-deliver the Broadband to the rural masses at the affordability levels which is of the order of 3 to 6% of the per capita monthly income translating into the monthly charges of 1 to 3 USD in the developing countries. For India, it averages out to Rs. 125 per month (USD 2) and any revenue requirement over and above this level is required to be guaranteed through Govt. agencies as **Affordability Deficit Funding (ADF).** Actually, during the initial phase of roll-outs, guaranteed revenue from **Anchor Beneficiaries** is more important than Capex funding, as **it is all about the Opex (ROI).**

Most of the studied models have resorted to **Government/ USO funding** for the national Broadband backbone network (NBN) and Public Private Partnership **(PPP)** for the Access networks. Innovative technology solution mostly based on unlicensed spectrum, Wi-Fi system are becoming more and

more popular due to cost advantage and ubiquity of the Wi-Fi enabled access devices.

In addition to funding of the NBN by Government/USO, the regulatory bodies are required to play a facilitating role towards the cost reduction as well as **light-handed licensing regime (VNO, Class licensing)** for service provision in rural area. The regulatory levies/taxes which eat out a fourth of the revenue, have to be **forborne** in the initial period to make the services more affordable.

There is also need for more spectrum to be unlicensed for Wi-Fi Access for rural areas in line with best international best practices. The various implementable recommendations have been provided as way forward for the various players to make the business case for rural Broadband implementable and sustainable.

The urgent need for **People – Panchayat – Public – Private Partnership** calling for each player to move **Extra-Mile** is the starting step to this **Long Tail**.

Foreword

A. N. Rai, ITS (R)
Hon. Advisor to
Minister of Communications &
Minister of State for Railways,
Govt. of India

Straight and simple, he has always aired his views on the sector to resolve the teething and complex problems. When I saw the title of the booklet – **"Extra Mile – Walking the Talk on Rural Broadband,"** I felt it was **"the idea whose time has come."**

Satyen Gupta, fondly and very rightly known as NGNguru, is the Chief Harbinger of NGN era in India and now fully engrossed in taking the Broadband into the hands of rural masses in India. Someone has aptly named him **"Walking Encyclopedia of Telecom in India"** on his Linked-in profile.

Under the Digital India mission of Govt., there is an urgent need for taking the Broadband access to the homes/hands of rural masses to work as the Backbone for digitally empowered society. In that context, the ideas and recommendations provided by NGNguru appear to be very appropriate and implementable. His concept of **"Everything on Tower"–** creating green public hotspot on a rural tower by putting all the systems including power supply, BTS and content in a box is a very innovative idea with great promise.

Also, the making use of existing infrastructure of BSNL and other Telcos to fill the connectivity gap through **"Managed Hotspot Service Provider"** is a win-win formula to enable the

delivery of Broadband services to rural masses in cost effective, timely and affordable manner.

Another Out-of-Box idea of **"Gaon Job Factory-Converting unemployment into entrepreneurship,"** a social-enterprise concept by availing support from various missions of Govt. like Digital India, Make in India, Skill India and Start up India is marvelous one and has potential to create 1 Million jobs in rural India. And last-but-not-least **"Extra-Mile, People-Panchayat-Public-Private-Partnership,"** Walking the Talk together, is what Govt. is encouraging and will like it to happen it sooner than later.

I really hope, all the stake holders will derive guidance and motivation from the suggestions and recommendations of this report and help nation to move forward toward what the author has termed **"Bharat Broadband Gold."**

God bless us all.

A.N. Rai

Gratitudes – Just a Part List

Many great people motivated me to create this work by compiling various learnings and experiences to **"Make it Happen."** Mr. **E. Sreedharan, the Metroman,** with whom I worked in my early days in Railways, 30 years back taught me how to achieve **excellence and timely completion** of a project. **Mr. P. Baijal, Ex TRAI Chairman,** inculcated in me the habit of **'Bias toward Action'** and also **Productivity-in-Anything** we do. Late **Mr. RRN Prasad, Ex-Member TRAI,** who was my Fellow, Friend and Philosopher taught me how to **"Keep it Simple & Straight."**

I am really grateful to **Honourable Dr. Jitender Singh Jee, Minister of State, PMO** for honouring us to release this report during **Graham Bell Award** event courtesy **Aegis Education Foundation.** My special thanks to **Shri N. Sivasailam, IAS, Special Secretary, Department of Telecommunications, Govt. of India** and also the **Govt. of Jharkhand** for their support in making this happen.

I am highly indebted to management team at **BLUETOWN, Brian, Peter, Carsten,** who demonstrated a supreme faith in me by not only by putting their **all eggs in my basket,** also allowed me full flexibility to continue with my passion for **speaking-tourism,** public speaking and writing as well as nurturing my active involvement with ITU, CTO, APT, EBG, PTCIF and other Industry bodies. In addition, they pitched in with some valuable suggestions regarding UN SDGs.

Thanks, are also due to **BSNL** management **(CMD Mr. Anupam Srivastava, Director Mr. N. K. Gupta)** and **RailTel CMD Mr. Bahuguna** who presented us the initial opportunity to try the Bluetown innovative solution in their network to prove the concept. **Mr. A. N. Rai, Ex CMD BSNL, Advisor**

to Honorable Minister of Communications deserves special mention for support and also to very kindly agree to pen down the apt Foreword. **Mr. R. R. Yadava,** who is considered as the **Chief Evangelist of NOFN,** deserves credit for contributing a new **Vision 2.0 for Rural Broadband,** as well as **Mr. K. K. Thakur,** CGM Jharkhand, BSNL, for contributing an article, which is annexed. I am thankful to our fellow, **Mr. TV Ramachandran, President, BIF India and Chairman, telecom committee, EBG India,** which I Co-Chair, for the kind words and putting the perspective of this work in place. I am also grateful to **Mr. Anil Mittal, GOIP Chief** who partnered Bluetown to established in India through unconditional support. Thanks are also due to **Mr. C. S. Goyal of CSG,** who contributed some great ideas to facilitate **"Make in India"** of some of our critical parts. Thanks are also due to my Bluetown collegues **Carsten, Troels, Line** and **Keshav** for contributing the innovative **BLUETOWN Story** and **Prof. Skouby, Alborg** University, Denmark for providing initial thought about the business model. I will also like to thank **Mr. V. K. Agarwal, my ex-colleague at TRAI,** who contributed the International case studies.

Other deservant of hearty gratitudes is my better-half **Madhu,** who not only tolerated my early hours wake ups and workout, kept me energised with hot Chai early mornings and supporting my venturing into **10% Entrepreneurship**. Also, I will like to thank **Vinay Kishore**, my **Globe Trotter** nephew who eagerly volunteered for proof-reading the manuscript and my son **Aniket** who provided some valuable suggestions. And last-but-not-the-least **Monisha,** our **Multi-tasking executive at SAAM,** who did a great job of putting it together.

I will also like to extend advance thanks to all the perspective readers, who may join the **"Walk the Talk"** with me on this exciting path of **Rural Broadband** to **connect the unconnected**.

Satya N. Gupta

Introducing NGNguru – As We Know SNG

India presents tremendous opportunities in the area of Broadband penetration. While today barely 160 Mn people are connected to Broadband, a large market of close to one Billion people is waiting to be provided Broadband connectivity with 700–800 Mn of them living in rural & remote areas which are both difficult and expensive to reach. So, while clearly there is a huge scope for growth of Broadband, this opportunity is also fraught with challenges. One would surely need top class guidance and mentoring to be able to tap the potential.

It is in this context that the entry of Mr. Satya N. Gupta (Satyen) with his Study Report entitled "Extra Mile-Walking the Talk on Rural Broadband" is extremely timely and relevant. This excellent report focuses on various issues before deployment of sustainable rural broadband, various technological alternatives, the relevant broadband services, different business models as well as funding options etc. All these are discussed keeping in mind the fact that rural ARPUs are typically quite low.

This compilation has innovatively attempted to examine the above issues through the practical lens of extensive case studies of various relevant networks and using the wealth of information available in many ITU/World Bank/OECD/Broadband Commission/TRAI reports on the subject. In addition, ideas from some innovations in the new cost effective Access technologies have been illustrated.

SNG is very rightly known as NGNguru started bringing awareness about NGN way back in 2005 wherein he authored a comprehensive consultation paper on NGN which was called the "Magna Carta" in some quarters. In fact, around then, I happened to be the Chairman of the ITU Regional Working

Group for Asia-Pacific and was privileged to have SNG's excellent presentation on the subject at a Bangkok RWG Meeting and the entire audience was enthralled to listen to his perspectives.

SNG has also served as the Member of the ITU Expert Group on their International publication on NGN in 2007.

His concept of Everything-on-Tower (EoT), is a truly great concept, which could definitely yield wonderful results when implemented on large scale in rural areas. It has the potential to be a game changer in the real sense.

An International expert in NGN technologies, SNG is a Regulation, Interconnection and Broadband policy expert with over 35 years experience in all aspects of Telecom, including 25 years with the Govt. and Regulator (TRAI).

SNG is also Founder of NGN Forum in India with the mission to spread awareness about NGN all across. Presently he is heading Bluetown's India operation with overall responsibility to deliver its vision of "Connecting People in Rural Areas of World." one could not ask for a better Mentor for the Indian Broadband Journey to Bharat

Since over 1 Billion out of approx. 4 Billion people in the world who are outside the ambit of broadband connectivity happen to be in India, SNG's treatise on Rural Broadband Business is indeed extremely timely and would act as a 'Margdarshak' (guide) to the makers of Policy & Regulation besides Global technology and funding agencies all of whom have single minded focus to 'broadband' Rural India.

I wish SNG, – my Friend, Philosopher & Guide, all the very best in his endeavor to lead us to a new India which will be 'Broadband-enabled' everywhere.

TV Ramachandran,
President,
Broadband India Forum.
Chairman, Telecom Committee,
European Business Group, India.

Executive Summary

Subject of Broadband services in rural and remote areas has been the talking point of all the stakeholders in developing countries, but walking on this talk has been on a very slow pace. The single most ubiquitous reason given for this lukework response to the call has been the so called **"lack of business case."** The main objective of this study is to explore and elaborate implementable business models and bring out recommendations for various players in the ecosystem to make the business of rural broadband happen. The main issues which are identified to be addressed are Technological alternatives, Tariff structure, Broadband services to improve the quality of life, Funding options and Affordability, through a **"Sustainable Business Model."**

This report has attempted to address the above issues through extensive case studies of various relevant networks and wealth of information available in many ITU/World bank/OECD/TRAI/ UN Broadband Commission reports on the subject. In addition, implementable ideas from some innovation in the new cost effective Access technologies have been considered. The salient features of various chapters of the report are as below:

1. **Introduction**

   This chapter brings out the importance of broadband for the masses especially in rural and remote areas treating broadband as an infrastructure required for increasing the productivity as well as enhancing the lifestyle, taking the analogy from Maslow's Pyramid of basic human needs. It also elaborates upon 4 pillars of sustainability as **ABCD (Access, Backhaul, Content, Devices)** of Broadband.

2. **Challenges to the Sustainable Rural Broadband Business**

   This chapter discusses the various challenges for the broadband business like; infrastructure issues, Power availability, local content and applications, CPE cost, lack of awareness and affordability. It brings out the need for an innovative implementable business model for sustainable growth of broadband services in rural areas.

3. **Technology Alternatives for Access, Backhaul & Devices**

   Various technological options available as well as emerging for different segments of broadband networks are analyzed and discussed. The pros and cons of various alternatives are compared. For Access, Wi-Fi based network to support ubiquitous inexpensive Access CPEs is recommended. For Backhaul in the long run it is optical fiber-based system but in some difficult geographic areas satellite based/Radio Backhaul is also relevant. On the CPE front in addition to smart phones, SIM-less mobiles and converting a TV set as a broadband terminal has been identified.

4. **Broadband for Enhancing Productivity and Quality | of Life**

   This chapter discusses various conventional services of broadband as well as emerging services like e-government, e-learning and e-health. In addition, examples of some community-based ICT services from Thailand, India and Bangladesh have been elaborated. A specific find is the **"Info-lady"** in Bangladesh taking Broadband to people on a pedal bike.

5. **Tariff Plans and Affordability for Broadband Services**

   This chapter deliberates on the affordability issue and brings out the need for the Broadband tariff to be within 3–6% of the monthly per capita income which comes down to 2–3 USD for the developing countries.

6. **Funding Models for Rural Broadband and International Case Studies**

   In this chapter, various investment options have been discussed including Full Public funding, Community + Public Funding, PPP (Public Private Partnership). The various international case studies making use of Public Funding as well as PPP model have been summarized. Finally, the 5P model appears to be way forward where in backbone infrastructure in funded by Government or USO/ Public fund and Access infrastructure is funded by Private Operators/Local communities/Panchayats and managed by local Peoples (VLE), powered by a new breed of players in the form of **"Managed Hotspot Service Providers" (MHSP).**

7. **Recommendations for Way forward for Implementable Business Models**

   In this main chapter, an implementable business model for development of rural Broadband has been suggested, taking into consideration various challenges, technology choices and funding options. A model business plan taking into account the 5Ps model of funding, innovative Access technology architecture and involvement of local entrepreneurs for managing the business has been suggested as a sample which can be adapted for the different scenarios.

The recommendations for various stakeholders are summarized below:

a. Government and Public Agencies

i. Need to prepare **'National Digital Grid'** setting clear targets and timelines for spread of Broadband in rural and remote areas of the country and getting it implemented timely.

ii. Arrange **"Funding and Build"** of National Broadband Network to take the Broadband connectivity to rural and remote areas through infrastructure budget/USO funding.

iii. Provide the Backhaul connectivity to the Access Service Providers/VNOs/MHSPs in rural areas on **Open Access** basis at nominal Incremental charges, through revenue share.

iv. Provide tax breaks/concessions incentives, subsidies for the **MHSP (Managed Hotspot Service providers)** as well as Service Providers in rural areas.

v. Establish the **'Content Delivery Network'** as a backend/ Cloud platform for the delivery of government services and applications to citizens.

vi. Provide **Affordability-Deficit-Funding (ADF)** as guaranteed revenue or financial incentive (benefit) for the procurement of Broadband access to public institutions and individuals in rural areas.

vii. Create a light-regulated **PDOA (Public Data Office Regulator)** class through registration process as is done for OSPs/VAS players.

b. Local Government Bodies

i. Provide free/low cost Access to real estate as well as **"Right of Way"** for creation of Broadband access network (Hotspots).

ii. Provide exemption/reduce levies for the local taxes including **GST** for the Broadband equipments and services in rural areas.

iii. Provide initial funding/grant to **Village Local Entrepreneurs** (VLE) to start Broadband services business.

iv. Assist in awareness creation about Broadband services and applications among the rural masses.

c. Regulatory Bodies

i. Facilitate **'Open Access,' 'Wholesale pricing'** and **"infrastructure sharing"** for the government/public sector owned facilities to enable the local Internet Service Providers/ VNO's to provide Broadband services fast and within affordable level.

ii. Permit franchising arrangements between the 'Operator' and the Local Entrepreneur (VLE) and to create a light-handed, **"Class"** license/rural **VNO** category for niche rural areas by automatic registration process like **OSP (Other Service Providers)** without any conditions or obligations.

iii. Have **'Technology-neutral'** and **"Service-agnostic"** approach to enable the Players to innovate on the technology front to reduce costs.

iv. Make more spectrum **'license-exempt'** for use of Wi-Fi for Broadband access as well as **"Middle Mile"** in rural areas.

d. Operators/Service Providers

i. Partner with **Managed Hotspot Service Provider (MHSP)** to build access network in rural areas using innovative low cost solutions to run on revenue share basis.

ii. Provide interconnectivity to the **"Class"** licensed local access providers/**VNO's** in rural areas on revenue share basis.

e. MHSPs/Local Communities/NGOs

i. Bring awareness and provide training to the local masses to become digital-literate.

ii. Appoint and train the local entrepreneurs (VLE) to take up and manage the Broadband service provisioning.

iii. Facilitate initial funding for the business requirements of Local entrepreneurs (VLE).

iv. Help in identifying the local Content and Applications requirements.

In the conclusion, it is reiterated that the business of rural broadband cannot be handled by a single entity alone, neither by Government nor by Market place. It needs to be a joint effort by all the players in the game, thus, the need for **5P (People-Panchayat-Public-Private Partnership)** mode of deployment and operation.

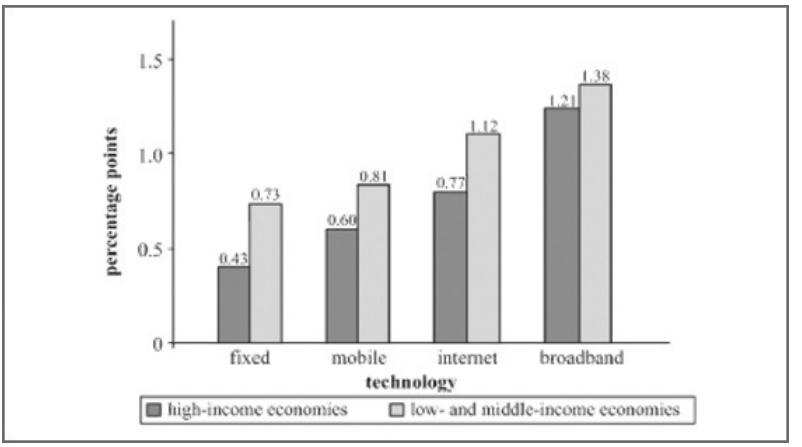
1. Introduction – Broadband as Basic Human Need

The power of Internet has brought greater awareness, skills and knowledge to the citizens and helping markets to encompass a diverse global audience, in all-inclusive manner. Broadband provides the opportunity to work differently & efficiently to achieve higher productivity for people & countries and to ensure continuous growth of economy and create social development. The proliferation of the Broadband infrastructure enables growth of Information and Communication Technologies (ICT), Content, Applications and Services which can help a nation to become a truly competitive knowledge based economy and enable citizens to become more productive, better educated and more engaged in their community & society at large.

Providing Broadband infrastructure in sparsely populated, geographically challenged, remote & rural areas, underserved by profit-driven service providers has become a daunting task & challenge for Governments specially in developing world. By creating Broadband infrastructure in underserved regions, governments can protect remote communities from "digital divide," and can create a climate for economic development, help startups to grow, bring new businesses thus resulting in a conducive climate for economic development & Social upliftment. Broadband penetration is a crucial factor which is increasingly becoming the benchmark used to ascertain the health of a nation's economy & social wellbeing.

Availability of Broadband services at affordable price can contribute to higher GDP growth rates, provide for a larger & more skilled labor force and increased working efficiency. There is a clear correlation between the Broadband adoption rate and the

Gross Domestic Product (GDP) for various countries. As can be seen these growth effects are significant and stronger in developing countries than in developed ones (Figure 1).



Y axis represents the percentage point increase in economic growth per ten percentage point increase in telecommunication penetration.

Figure 1: Impact of Broadband penetration on GDP growth
Source: Qiang (2010)

Broadband has become essential part of the basic infrastructure for economic and social development, along with conventional systems such as railways, roads and electricity. Broadband is not just another telecommunications service or a faster Internet connection, it is the central element of a new ecosystem that offers key structural complementarities for economic and social development[1].

Presently Broadband is being considered as an "Ecosystem" that comprises different elements such as high-speed connectivity to interact in different ways (Figure 4)[2]. Broadband users have the ability to create and share multimedia content in a variety of formats. This interactivity is an important factor that differentiates the Broadband ecosystem from other high-bandwidth, but essentially one way networks such as multi-channel TV. It

also creates various new opportunities for value creation and innovation.

Table 1: The Effects of Broadband on Economic Growth and Social Inclusion

Economic Growth	Social Inclusion
Increased rate of productivity gains	Access to public goods (information and knowledge) free of charge over the Internet
Greater innovation in production and organizational processes through the development of applications that meet the needs of different types of organizations	Access to online public services: education, health, government, citizen participation and others
Job creation	Innovation in social networking applications
Development of technological and production capacities by individuals and companies	Increased well-being due to positive externalities relating to consumption
Greater environmental sustainability due to the use of intelligent tools for managing transport and energy resources	Impact in terms of disaster response and communications

Source: Valeria Jordán, Wilson Peres and Fernando Rojas, "Broadband: an urgent need for Latin America and the Caribbean," ECLAC, United Nations, 2010.

The Figure 2 below depicts the importance of Broadband just above the basic survival needs of human being, as an analogy from Maslow's pyramid. It indicates that Broadband infrastructure is as vital as other public infrastructure like Roads, Railways, Power and Housing for the well being of the society.

(Broadband as Critical Social Infrastructure)

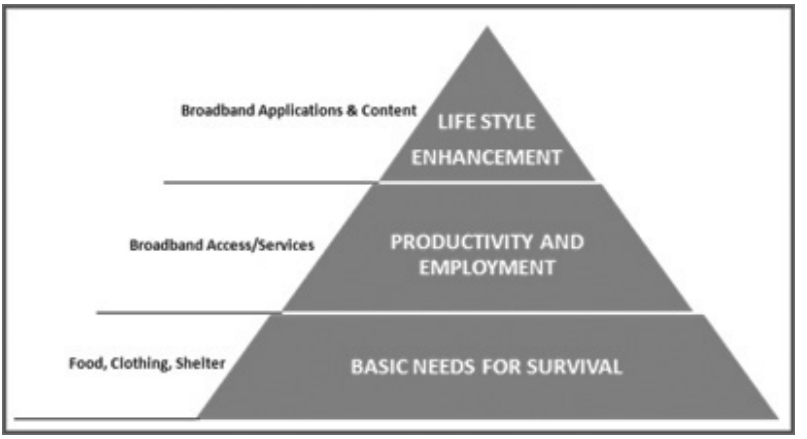


Figure 2: Analogy with MASLOW's Pyramid: Role of Broadband for Basic Human Needs

Growth of Broadband, especially in rural areas, driven by perceived utility to user, relevant applications/content, affordability and availability etc. as depicted in Figure 3:

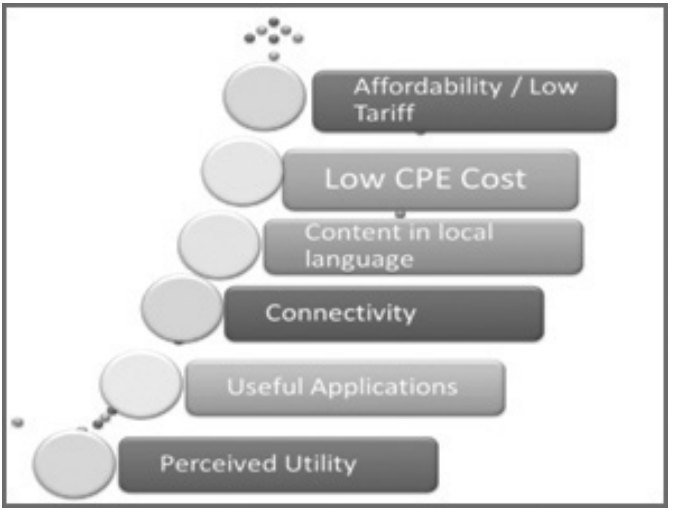


Figure 3: Factors Driving the Growth of Broadband

There are several factors driving Broadband growth. Figure 4 indicates various drivers and advantages of Broadband.

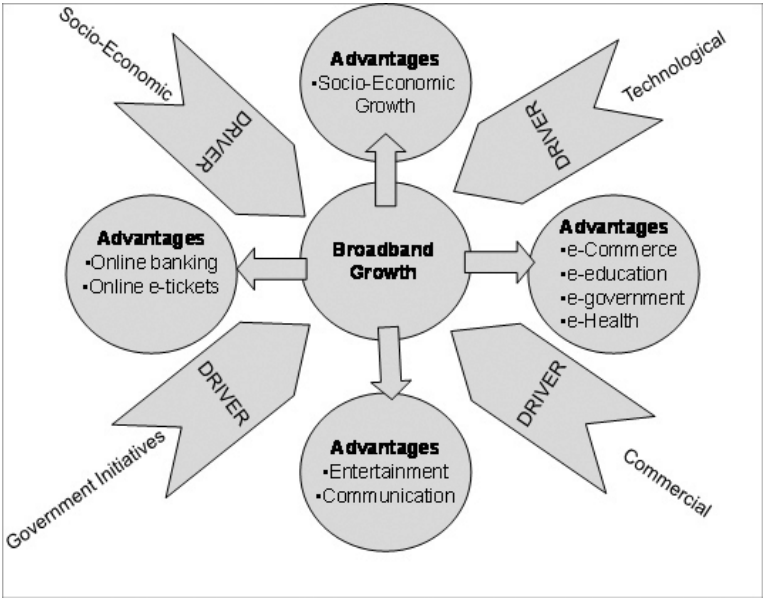


Figure 4: Drivers and Advantages of Broadband

Broadband growth drivers can be categorized as following:

- *Technological Drivers*
- *Economic Drivers*
- *Social and behavioral Drivers*
- *Government Initiatives*

TECHNOLOGICAL DRIVERS

Liberalization and competition in the telecommunications market have brought new and innovative technologies in the market place.The convergence of technologies and ubiquitous use of IP based technologies is making the Broadband networks more efficient & less costly.

The capabilities of smart phones bundled with pre-loaded features and inbuilt applications permit access to new Applications using Internet. Data cards and Wireless Broadband CPEs facilitate availability of Broadband anytime, anywhere further fueling Broadband demand. In addition, doubling up of smart TV sets as Internet Access Devices is increasing the Broadband CPE populations in homes.

Technological innovation permits new ways of creating, distributing, preserving, sharing and accessing digital content. As economies move to become more knowledge-intensive, information-rich activities will increase; new content will be created, collected, managed, processed, stored, delivered, and accessed. This spread will contribute to further innovation, growth and enhanced utilization of Broadband.

ECONOMIC DRIVERS

Service Providers are continuously upgrading their network to introduce new services (Value Added Services & OTT applications) in order to meet the diverse demands of users. To make a business case for Broadband services in less remunerative rural areas they need to cut down the capex & opex to recover cost. The convergence of networks (IP based network to provide all services) helps in reducing operational cost to the service providers and support different applications irrespective of platform or format for their transmission. The convergence of Telecom, IT, Broadcasting and Entertainment segments increases business volume with no significant increase in network cost due to use of converged carrier network (IP based network). As a result, provision of bundled services along with Broadband access to end user makes business case for the Service Providers.

SOCIAL AND BEHAVIORAL DRIVERS

The lifestyle and social norms are fast changing which is driving the need for bundled services. People prefer to be in touch

with each other through e-mail, telephone, Internet, chat/ instant messaging etc. There are several social networking sites like Facebook on Internet and millions of users use them for exchanging information. This generates requirement for high speed access to the Internet. The concept of entertainment is also changing. Users want entertainment such as music, video etc. anytime, anywhere with enormous choice and low cost.

GOVERNMENT INITIATIVES

Broadband access can be used to deliver government services directly to citizens which reduces the cost of providing services to citizens with much ease. Such services can range from information services, administration documentation, renewal of a range of licenses, tax submissions, etc. In geographic areas where no government offices are available such services allow interactive dialogue between citizens and administrative officials at low cost. In addition, e-health, tele-education and e-banking are other services which are enabled by Broadband access.

Main Issue – Supply Side Factors

Despite high perceived utility and considerable demand, Broadband services are not available to majority of people in rural areas due to non-availability of required Access infrastructure. Most of the operators have created networks only in lucrative urban areas. Where business case is proven. Due to high initial investment and perceived low returns, operators are reluctant to invest in small cities/villages or remote areas. As a result, citizens of these areas are deprived of access to Broadband services, generally known as "Digital Divide."

Broadband supply mainly depends on four critical elements, namely Access, Backhaul, Content and Customer Premises Equipment (CPE). This is illustrated below in the **Figure 5 as ABCD (Access, Backhaul, Content, Devices) of Broadband.**

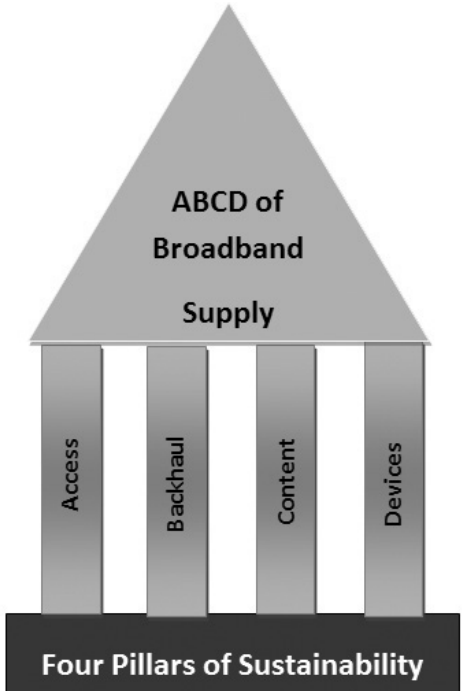


Figure 5: 4 Pillars of Sustainability–ABCD of Broadband Supply

Specially, in rural areas Broadband development can be facilitated by affordable Broadband access, availability of Backhaul, relevant Content and Services & inexpensive Devices at customer premises. In addition, a facilitating & supportive regulatory framework is a must. For this each stakeholder in the ecosystem like Government, Regulators, Municipalities, Operators, startups, NGOs and entrepreneurs have to play their own significant roles.

The main objective of this study is to explore and highlight the challenges for Broadband access in underserved rural areas, identify the technological options, study the international best practices and suggest the way forward for different stakeholders to create implementable and sustainable business models, together.

2. Challenges to the Sustainable Business for Rural Broadband

Recognizing the widening Broadband-Deficit in rural areas in developing countries and the risk of major part of society missing out on the economic and social benefits of Broadband access and usage, Governments and Regulators in a growing number of developing countries are scrambling for the implementable ideas & way forward to **"Make it Happen."**

Policymakers have also realized that success for Broadband access is harder to achieve than with mobile telephony, the spread of which was driven by huge consumer demand and falling ownership costs. Especially in rural areas, Broadband has both supply and demand side considerations though major issue still remains the supply side. For instance, while the usefulness of a telephone is obvious even to illiterate or poor individuals, the same cannot be always said of Broadband—especially if the opportunity to try it is inhibited by cost considerations. Access to Broadband requires owning an intelligent device (computer, PDA or smart phone) and having a connection, making total cost of ownership (TCO) relatively higher (even with falling prices for hardware and subscriptions). In addition, using Broadband also requires some level of digital literacy. Consequently, Broadband access and usage remain incipient in the developing world especially in rural and remote areas. The various challenges for the sustainable business case for rural Broadband are discussed below:

INFRASTRUCTURE (ACCESS & BACKHAUL) ISSUE

One of the major challenges for proliferation of Broadband in rural and remote areas is inadequate infrastructure both for access as well as Backhaul which is a prerequisite.

Setting up a Broadband network in and to rural areas has its special challenges. Having to haul traffic over long distances, the profit-motivated operators often find it hard to justify network setup CAPEX for reaching remote communities with low population density. Moreover, these networks sometimes have to bridge over geographical barriers such as mountains, forests, lakes, swamps or deserts, a fact that drives up deployment costs for traditional terrestrial wired (fiber/copper) solutions [3].

The financial viability for low density rural areas requires selecting a Broadband technology and network infrastructure that can support each subscriber's bandwidth requirements and be sustainable over time. Different Broadband technologies may be deployed in rural areas such as: Fiber (Point-to-Point, GPON), Digital Subscribers Line (DSL), Satellite, and Fixed Wireless. Each of these Broadband technologies has its own economic benefits and drawbacks. As a result, no single Broadband technology can be considered ideal for every rural location due to diverse requirements as "one size does not fit all." The technology chosen to provide Broadband access to a rural location should be based on near-term economic considerations. It should support a sustainable Return-On-Investment (ROI) for a three to five years' period.

An appropriate selection of full or mix alternative technology options such as, centralized verses distributed radio capacity, uniform verses non-uniform radio capacity deployment, static verses dynamic bandwidth utilization of the Backhaul connecting various network elements, mix of cabled (optical fiber/co-axial copper) verses wireless (terrestrial/satellite) Backhaul options, Licensed v/s Unlicensed spectrum are main technical factors for defining a deployment architecture for rural areas. This in turn will determine the total cost of the infrastructure, power consumption, amount of radiated power, total subscriber/traffic handling capacity/subscriber and spectrum requirement. Need for such type of balancing act in an uncertain environment is a complex challenge.

Another infrastructure related challenge is the availability of reliable grid power supply required for the system in rural areas which is discussed below;

Non-Availability of Reliable Grid Power Supply

The growth of reliable grid electric supply particularly in the developing world has not kept pace with the spread of Telecom infrastructure. As a result, the deployment of Broadband and telecom infrastructure (and regular charging of the mobile handsets and Broadband customer premises equipments) particularly in the rural areas of the developing countries used to depend upon the DG sets as primary source of energy for 24 × 7 operation of the networks. The use of DG sets increase OPEX and carbon footprint to a very great extent and makes the business case unviable.

The problem can be solved by deploying energy efficient, self-sustainable, near maintenance free distributed Broadband and telecom infrastructure capable of operating on renewable sources of energy like solar power. This may increase CAPEX marginally but reduce OPEX dramatically. Studies conducted by experts have indicated that such solar energy operated distributed system provide much improved return on investment (ROI) in comparison to DG set operated conventional wireless systems.

Affordability

Affordability of Broadband access to masses is another factor impacting the growth of Broadband services and is a significant barrier to rural households going online as the level of disposable income of rural masses for this service is very low (3–6% of per capita income).

The price of Broadband access plays a critical role in driving Broadband diffusion and is a key barrier to extending access to Broadband in developing countries. While Broadband is becoming more affordable around the world – prices have fallen by over 50%

over the last two years in some countries – it nonetheless remains unaffordable in many parts of the developing world [4].

It is estimated that there are 700 million people in the world without access to Broadband services due to cost barrier alone leading to unaffordability [5].

Content Availability

Content is the key component of the Broadband service, especially the local content that meets the demand & requirement of the local users. Content and Broadband-enabled services in local languages, as well as the capacities of local communities to create and share content, are important drivers of the usage of Broadband infrastructure by local population.

The Internet (WWW) on the other hand, is dominated by English-language content; the fundamental reason for a consumer to access internet is for the content. In rural and remote areas, absence of locally relevant content in native languages inhibits users to go online.

Services entail much more than access to hardware; they encompass affordable access to locally relevant rural content through connectivity providers, content creators and disseminators, information intermediaries, social facilitators, information literacy educators, and the governance channels steering the performance of these services.

Devices Cost

The availability of affordable CPE (Customer Premises Devices) such as PC, laptops and smart mobile phones which serve as an access device for the price sensitive consumer remains another barrier for the uptake of Broadband. In rural areas, there is a great need of innovation in CPE domain to make such devices available at affordable prices.

One such development is the recent availability of low cost Wi-Fi enabled, SIMless smartphones (Bluetown Case). Other innovation is the usage of home TV set as an access device for Broadband, through TV interface (Tata Trust Case). These innovations are discussed later in the report.

Lack of Awareness & Digital Capability

The creation of a high-capacity infrastructure alone is not sufficient to make rural population embrace Broadband services. Many people with the possibility of using Broadband in these areas lack the skills to take advantage of the technology, or do not realize the benefits that they could obtain by properly using the Broadband for personal use at home & at work.

Awareness of the benefits of Broadband and the capability to use Broadband are critical initial steps in building demand for Broadband services. In order for people to use Broadband successfully, they must have the necessary interest and skills. This is sometimes referred to as "digital literacy," which has been defined as "using digital technology, communications tools, and/or networks to access, manage, integrate, evaluate, and create information in order to function in a knowledge society" (Educational Testing Service 2002). Digital literacy ideally makes users aware of and capable of accessing Broadband applications and services. This, in turn, widens the information available to them, provides new ways of learning, and increases their productivity thus creating new employment opportunities [6].

There is a limited end-user awareness and insufficient digital literacy amongst most of the segments of the rural population. For the adoption of Internet and Broadband in such areas, awareness regarding the benefits of Broadband is of utmost importance. Both governments and the private sector should play an active role in promoting the awareness about benefits of Broadband usage.

NEED FOR IMPLEMENTABLE BUSINESS MODEL

Main reason for low availability of Broadband in rural and remote areas is absence of a commercial business model, as main operators are not sure about the Return on Investment (ROI) & perceive lots of risk on demand side.

A viable business case is the prime motivation behind designing, building, and operating communication networks by operators. The revenue generated from the operation of the network must exceed the network's initial CAPEX recovery and the ongoing OPEX. The financial success of any communication network is based on the Average Revenue Per User (ARPU) & the number of users. Urban areas with high density have more opportunity to generate higher revenues than low density rural areas.

The economics of the deployment of Broadband for universal access are daunting. Deploying Broadband has involved investments of tens of billions of dollars annually, and will ultimately require capital and operating expenditures in the hundreds of billions of dollars to provide full universal service. The resulting trend in private sector investment has been to focus the initial wave of investments in high density, low cost urban areas.

Considering the multi-faceted nature of the problem in ensuring affordable rural access to Broadband infrastructure, devices and content, partnerships among organizations with different vision, expertise, capacities and profit goals appear to be a key to improve access and affordability. Collaborations serving as critical mechanisms for improving rural Broadband access can take the form of partnerships within the public sector, negotiated public-private partnerships (PPP), private agreements among stakeholders in the telecommunications sector, and extending it further to stakeholders at the community and village level, 5Ps **(People-Panchayat-Public-Private Partnership).**

The traditional business case to provide Broadband services does not sustain in rural areas where the population densities

are lower and the cost of deploying and managing a Broadband access network exceeds potential revenues. To provide affordable Broadband service in rural areas, it is necessary to carve out a sustainable model that makes the business case viable in the long run.

For deploying telecommunication networks especially those supporting Broadband access, to the geographically large rural areas with the same architecture as in urban areas, per user cost of the infrastructure (CAPEX) and the additionally increased operating cost (OPEX) makes it economically unviable. Therefore, the penetration of the Broadband networks in such remote and rural areas demands new thinking and methods to make the Broadband network operations economically viable. Suitably modified deployment architecture needs to be explored to address the rural Broadband requirements and innovative business model developed to operate in a sustainable mode. This calls for innovative partnerships between various stakeholders and balancing between various judicious mix of technologies & tariff plans.

The subsequent chapters of this report illustrates such models, which has been tried and tested in some of the emerging markets like Africa, Asia-Pacific and India.

3. Technology Alternatives for Access, Backhaul & Devices

Technology options are always a function of type of locations, geography & terrains. Though there are various geographies that may exist, the terrains in most likely scenarios are likely to be the following:

i. Flat Open Space

ii. Valley

iii. Rugged Mountain Terrain

iv. Deserts

v. Islands

The technology choice for a Broadband network in rural areas has to be made mainly keeping into account the type of terrains which generally are difficult geographically, to select the most appropriate solution while keeping the cost low.

Normally, a Broadband network can be divided in two main components namely Access network & Backhaul network as shown in Figure 6 below:

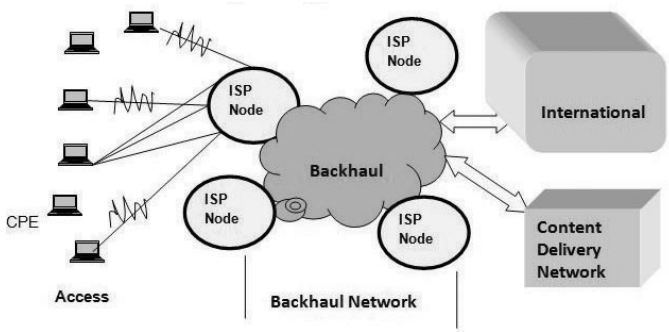


Figure 6: A Typical Broadband Network

Access network provides last mile connectivity between subscriber/ premises and nearest node of the service provider or point of presence (POP), whereas the Backhaul network connects all POPs of the service provider for carrying aggregated traffic of subscribers to other service providers, International Gateway/content delivery network (CDN). Different technologies both based on Wireline and wireless are available for Access and Backhaul networks to provide end to end Broadband services. Some of the technologies can be used both for Access as well as Backhaul.

Generally, the Access network is deployed by the licensed service providers or their franchises (MHSP) using various Wireline and wireless technologies. This network extends right up to subscriber premises/handset and must be designed and dimensioned on the basis of the services and applications that each customer may require, today & in future.

While selecting a particular technology option both speed and availability are important considerations. It is important to increase through put (Data rate) by deploying efficient IP based next-generation networks so that emerging applications and services that will play important roles in improving quality of life and boosting economic growth are not precluded supported.

OPTIONS FOR ACCESS NETWORK

A. Wireline Technologies

i. Wireline technologies are capable to support high speed data transfer with reliability. Some of these technologies are:

- xDSL (Digital Subscriber line) over copper
- Passive Optical Network (PON) over Fibre (FTTX)
- Data Over Cable Service Interface Specification (DOCSIS)
- Ethernet – over-Coax (EoC)
- Power Line Communication (PLC)

ii. **Digital Subscriber Line (xDSL):** DSL or xDSL is a family of technologies which uses the conventional telephone lines (copper cable) for transmitting the digital data at higher frequency than the frequency used for voice communication. Different type of DSL technologies are describe in subsequent paras.

iii. **HDSL:** High bit rate Digital Subscriber Line (HDSL) is a bidirectional and symmetrical transmission system that allows the transport of signals with a bit rate of 1544 Kbit/s or 2048 Kbit/s on the copper twisted pairs. In this type of DSL bandwidth allocation in upstream and downstream is same. It works upto about 3 km delivering maximum speed upto 4 Mbps in each direction.

iv. **Asymmetric DSL:** ADSL is a form of DSL where more bandwidth can be allocated to download than to upload. It provides maximum speed of 8–10 Mbps downstream and about 1 Mbps upstream. ADSL can provide satisfactory services upto about 3–4 km from the local exchange depending on quality of copper pair. It is suited to residential use as it shares a single twisted copper pair with voice, allowing users to use the telephone and surf the Internet simultaneously on the same physical copper pair line.

v. **ADSL2, ADSL2 Plus:** ADSL2 is the sequel to the original ADSL recommendation, enabling improved speed, longer reach and low power consumption. ADSL2 can deliver 8–12 Mbps download speed while further extending the distance coverage. Further, the voice channels are realigned and often provide the ability to combine multiple ADSL2 lines for higher bandwidth to certain customers. ADSL2 plus (ADSL2+) builds further on ADSL2 by increasing the bandwidth through put extending the usable frequencies on the line. These increases download speed from 8 Mbps with ADSL2 to 16 Mbps with ADSL2 plus, on cost of coverage which is reduced to approximately 1.5 km.

vi. Very-High-Data-Rate DSL (Very high speed Digital Subscriber Line) permits the transmission of asymmetric and symmetric aggregate data rates up to tens of Mbit/s on twisted pairs. VDSL2 is an enhancement that supports asymmetric and symmetric transmission at a bidirectional net data rate up to 200 Mbit/s on twisted pairs using a bandwidth up to 30 MHz. VDSL connects to neighborhood optical network units (FTTN), which then extends connectivity to the telephone company's central office (CO) main fiber network backbone.

vii. Despite of continuous technological progress, physical limitations inherent to DSL technologies make them unusable in scarcely populated areas with long distances between the end users and the nearest telephone exchanges, or in regions where most houses are not connected to the telephone infrastructure. Therefore, these are not considered for a business case for rural Broadband.

Passive Optical Network (PON) Over Fiber

i. PON is an Optical Access Network (OAN) with the capability of transporting various services between the customer premises and the Service provides node over optical fibber.

ii. The optical section of a local Access network system could be either an active point-to-point or passive point-to-multipoint architecture. Figure below shows the architectures which range from Fibre to the Home (FTTH), Fibre to the Building/Curb (FTTB/C) and Fibre to the Cabinet (FTTCab). The Optical Access Network (OAN) is common to all architectures shown in Figure 7; hence commonality to support various options in this system has the potential to generate large world-wide volumes. The FTTB/C and FTTCab network options are predominantly different from point of view of implementation.

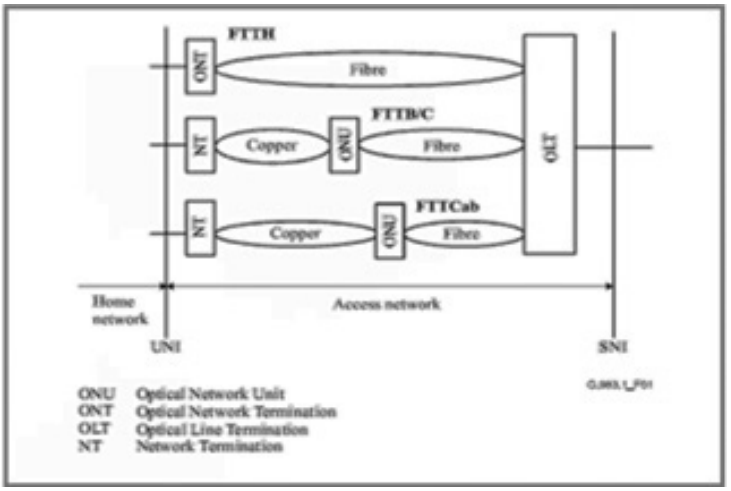


Figure 7: Network Architecture of Access Optical Network
(*Source:* ITU-T G.983.1)

Data Over Cable Service Interface Specification (DOCSIS)

Data over Cable Service Interface Specification (DOCSIS) defines interface requirements for cable modems involved in high-speed data distribution over cable television system networks which enable provision for bidirectional data over coaxial and hybrid fibre-coax cables for interactive services.

Ethernet–Over-Coax (EoC)

Another technology used over cable TV networks is Ethernet–over-Coax (EoC). Standards used in this technology are Multimedia over Cable Alliance (MoCA) and Home Phone Networking Alliance (HPNA). MoCA has been designed for local in-building distribution using frequency range above 862 MHz, which limits its use mainly in HFC plants. HPNA in its latest version 3.1 uses the frequency range of 4 to 52 MHz and can therefore bridge greater distance due to low loss in coaxial cables in this frequency range.

Power Line Communication (PLC)

Power line communication (PLC) is the term used to describe several systems using electric power lines to carry radio signals for communication purposes. Power line communication technology can use the household electrical power wiring as a transmission medium. Telecommunications services can be provided over power line through the modems and injectors. Access to Internet or other telecommunication services can then be provided by a leased line/wireless/satellite link attached at the Broadband over Power Line (BPL) devices as shown in figure 8 below. In future, it is expected that systems will be capable to offer upto 200 mbps speed commercially.

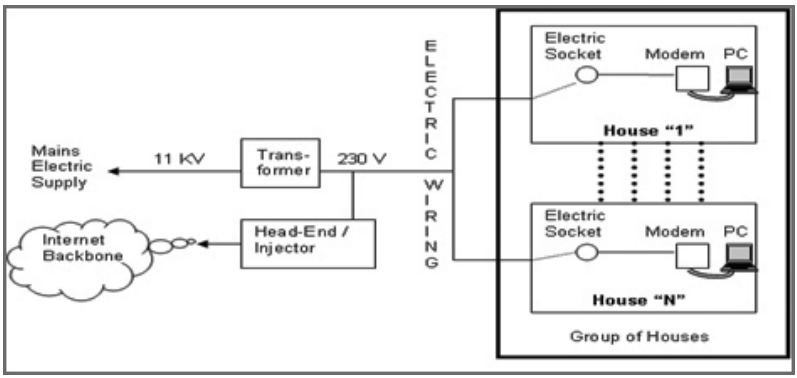


Figure 8: Broadband Over Power Line

B. Wireless Access Technologies

Wireless based technologies for Broadband access are emerging rapidly due to technological innovations. Various wireless technologies capable of providing Broadband are described below:

i. **The Unlicensed Spectrum Based Wi-Fi:** The unlicensed spectrum in sub 6 GHz bands like 2.4 Ghz, 5.1 Ghz & 5.7 Ghz can be utilized in rural areas where interferences are unlikely to occur. This technology is a low cost option for

creating the Access Points (Hotspot) in limited coverage areas. In addition; mid capacity radio links (50 Mbps) can serve as access connections to businesses, school campuses and government facilities. This option is low-cost, easy to install and can be used to provide adequate capacity for supporting Broadband services with a mix of legacy and Ethernet traffic. Due to its affordability, scalability and versatility, Wi-Fi Hotspot are spreading beyond urban to rural areas. Wi-Fi technologies can be configured into point-to-point and point-to-multipoint networks in order to improve their range and provide last mile access for Broadband (refer Figure 9).

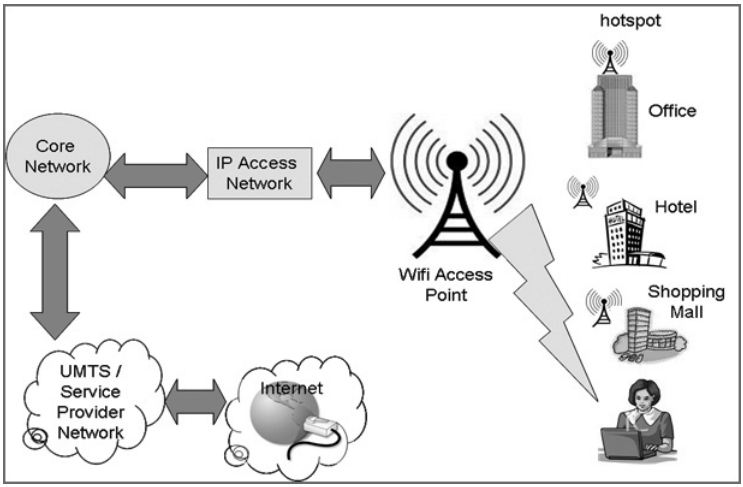


Figure 9: Wi-Fi Based Broadband Access

ii. IMT Standard Based Cellular Access Technologies Using Licensed Spectrum

New wireless technologies are capable to provide faster data communications services along with voice. These are based on the International Telecommunication Union (ITU) family of

standards under the International Mobile Telecommunications (IMT) programme and commonly known as 4G and beyond (5G) technologies.

However due to cost considerations for network which works in licensed spectrum band as well as high smart devices costs these are yet to proliferate in rural areas and are not likely support the business case for rural and remote areas yet.

Both Wireline and wireless technologies are having their advantages and disadvantages. One fact is very vital that Wireline technologies are having much greater capacity as compared to wireless technologies. However, there are many developments in wireless technologies based on Wi-Fi and players have started using this technology for access in a very cost effective manner.

C. Satellite Based Communication for Broadband Access

Satellite technologies specially VSAT (Very Small Aperture Terminal) offer opportunities for achieving universal Broadband coverage through the large areas achievable via a single footprint, and the fact that satellite technologies can be deployed as soon as the satellite is operational, regardless of terrain, distance or any availability of 'last mile' infrastructure.

Use of satellite technology for Broadband access offers significant advantages in terms of ubiquitous coverage, simplicity in network design, reliability and rapid deployment and is very effective to serve rural and inaccessible hilly areas where wired Access as well as terrestrial wireless is cumbersome to install and maintain.

Though the perception is that today's satellite solutions lag behind fiber and wireless technologies in latency, mass throughput, and cost per bit, however, in future satellites are becoming very

advanced in terms of reliability, speed of deployment, and security. Indeed, the next generation of satellites have started delivering higher transmission speeds, potentially competing with other types of Broadband connectivity both in terms of speeds and costs. **(Broadband Commission, ITU)**

Advantages of Using VSAT (Very Small Aperture Terminal) for Broadband Access

- VSAT based services can be deployed anywhere. It provides Broadband access independent of the local terrestrial/wireline infrastructure, which is particularly important for backup or disaster recovery services as well as in Accessible areas.
- The services can be deployed quickly – within a few hours.
- VSAT enables customers to get the same speeds and SLAs at all locations across their entire network regardless of location.
- Current VSAT systems use a broadcast download scheme which enables them to deliver the same content to tens or thousands of locations simultaneously at no additional cost.

Disadvantages of VSAT Based Access

- Latency (delayed response) is generally experienced by VSAT links. As in case of GSO signals relay from a satellite 22,300 miles above the Earth, a minimum latency of approximately 500 milliseconds for a roundtrip appears.
- They are subject to signal disturbances due to the weather; the effect is typically far less than that experienced by one-way TV systems that use smaller dishes.

- VSAT services require an outdoor antenna installation with a clear view. This may make installation in skyscraper urban environments or locations where a customer does not have roof rights problematic.

Selection of Technology for Broadband Access

A host of many factors influence the optimal choice of technologies[8]. Among the most important are:

- Type of terrain;
- Speed of deployment
- Data handling capability to the customer;
- The existing footprint and quality of the fixed telephone network;
- The availability of spectrum suitable for fixed and mobile voice and data services.
- Cost of service provision
- Capacity of the masses to pay

The technology options for delivering wired local loop Broadband connectivity include the rollout of xDSL, DOCSIS cable, and fiber to the home infrastructure. All these suffer from the high cost of deployment as well as cumbersome & time consuming process for installation. Wireless options include the rollout of mobile (2G, 3G, 4G), wireless Broadband (Wi-Fi, WLAN), and satellite's very small aperture terminal (VSAT) infrastructure. Within cell-based (mobile) wireless standards, all users connect to a single base station, and the transmission bandwidth has to be shared among all users in the cell's coverage area. Most of these technologies suffer from the high cost of deployment except those making use of unlicensed spectrum to avoid high spectrum oriented costs.

Wi-Fi is proving to be an ideal option for Broadband access in rural areas because of its cost advantage & ubiquity of the Wi-Fi compatible access devices. The strengths and weaknesses of Wi-Fi based wireless versus Wireline Broadband access have been analyzed and summarized in Figure 12 below:

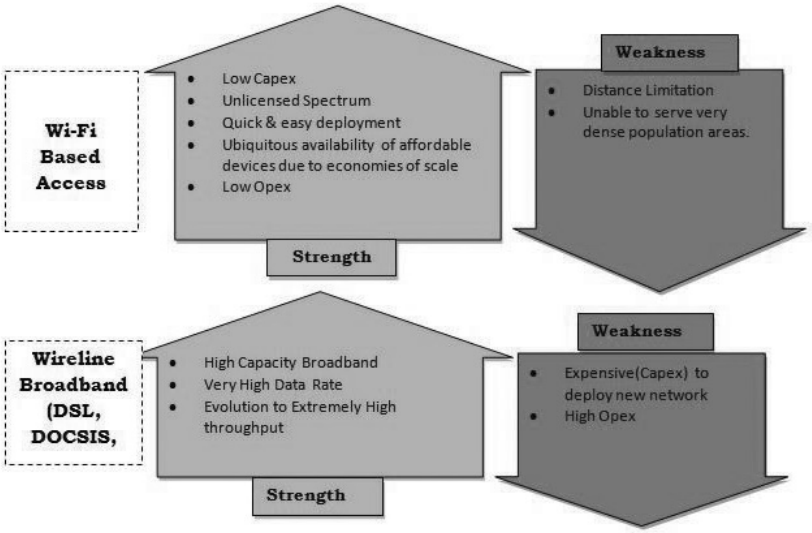


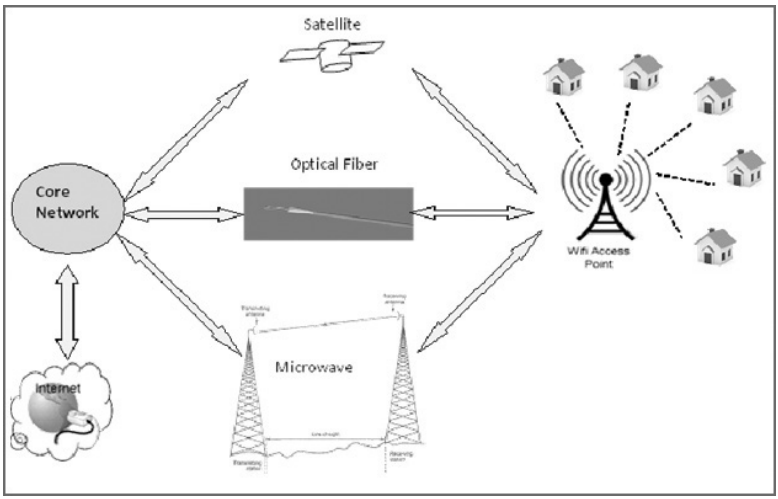
Figure 12: Strengths & Weaknesses – Wi-Fi Vs Wireline

Considering the lower cost of deployment & also its usage in unlicensed band, Wi-Fi emerges as a compelling technology sweetspot for access in rural areas, especially when the inexpensive devices which are Wi-Fi enabled for widely available.

OPTIONS FOR BACKHAUL TECHNOLOGIES

Another pillar for Broadband network infrastructure is the Backhaul Network. Regardless of the technology selected for the Access, the main requirement of Broadband services in rural areas is how to transport data capacity to and from the Access node &

centralized node of core network. This Backhaul connection to the Access node should be able to carry at least to the order of 100 Mbps to the nearby point of presence (PoP), and sometime even more.



Backhaul Network

Figure 13: Technology Options for Backhaul Network

A. Terrestrial Microwave Based Backhaul

The microwave transmission in licensed spectrum band is separated into two low and high frequency groups. The low frequency group uses the spectrum between 6 and 11 GHz and is more focused on long haul, high capacity transport to rural Access nodes. The high frequency group utilizes the 13–38 GHz spectrum and is more oriented towards medium and short haul applications.

Taking advantage of low frequency group radios operators can easily build long haul links that span over 20 Miles/30 Km per hop and may reach up to 80 Miles/130 km with more sophisticated planning. Such high capacity links can be cascaded together to

create radio trunks for networks spanning thousands miles over virtually any terrain. Long haul radio technology is already tested and proven having been in service for years carrying real-time traffic in applications ranging from broadcast TV, to controlling and monitor of gas pipes, water systems and power grids, to military applications.

Today, radio solutions offer operators a reliable technology for long haul transport. Accompanied by new high capacity techniques, microwave radios can now be utilized as a cost-efficient alternative to fiber, and serve the growing need for Broadband services in rural communities.

B. Satellite Based Backhaul

Satellites have been successfully serving the traditional markets i.e. telephony and broadcasting, covering large geographical areas using single beam/transmission. For satellite operators, their footprint is virtually limitless. Demand for two-way Broadband Access over large geographical areas not served by telecommunication infrastructure is ever increasing.

Satellite telecommunications technology has the potential to accelerate the availability of high-speed Internet services in developing countries, including the least-developed countries, the land-locked and island nations, and economies in transition.

Although satellites are generally designed for a 15-year life they often provide service for periods of 18 years or longer. Satellites are inherently highly reliable and provide a very high availability (up-time) compared with terrestrial solutions like fiber/copper cable or terrestrial wireless – particularly in developing countries where long sparse distances need to be covered.

Meanwhile, there are inherent latency (the time it takes to send and receive a message, 540 ms to 800 ms for a geostationary satellite in a typical environment) issues associated with the delivery of Broadband using geostationary satellites. Latency is however not a problem for many applications like basic email Access and web browsing. Since latency is due to the distance between the satellites and the earth, satellites in lower earth orbits have less latency than geostationary satellite networks.

Besides there are frequency dependent atmospheric/rain-attenuation problems for satellite signals especially in tropical areas – which creates issues primarily for higher frequencies like Ka-band. However, with improved technology in place to mitigate latency and attenuation issues, the underlying advantage of true global Broadband Access availability of satellite Broadband (i.e. data and web-based applications) is unmatched. One issue is that of the data capacities of the satellite bases Backhaul, which is not up to the mark yet [9].

C. Optical Fiber Based Backhaul

As the optical fiber based transmission system has enormous capacity these are ideally suited for the Backhaul segment for Broadband specially taking into account the futuristic high speed Broadband applications. Even though wireless is accepted as an economical option for delivering "last mile" connectivity, Backhaul traffic is usually carried via fiber-optic networks because of their high capacity. That is why optical fiber systems are forming the integral part of National Broadband Backbones. The main issue with optical fiber systems is that related to high CAPEX which needs funding from the Government or public agencies and also the time it takes to create the network.

Selection of Technology for Backhaul Network

The comparison of 3 dominant technologies discussed above is given in the Table 3 below:

Table 3: Technologies for Backhaul in Rural Areas

	Terrestrial Microwave	Fiber	Satellite
Capacity	Limited	No limit	Limited
Distance	Cost per link. Some incremental cost with the distance	Directly dependent	No Dependence
Terrain	Any line of sight required	Becomes costly when trenched in mountains, desert, rocky plains or jungles	Any. Ideal for remote and difficult to Access terrain
Climate	Sometime might need to select protected all indoor installation for the active equipment	Limits on Aerial fiber optic cable installation	Suffers from rain attenuation/ atmospheric conditions
Accessibility	Need Access only to the end points – two base stations for example	Trenching can be tricky if there is no Access for vehicles along the path	No issue
Time frame	Time taken in site acquisitions & towers erections	Right of way, and construction works may take a while and increase linearly with distance	Instant

While fiber has an obvious advantage in terms of capacity, it often does not fit the bill for rural deployment being too costly and too time consuming to deploy. Microwave on the other hand offers shorter setup cycles after obtaining the spectrum license. Satellite is suitable for providing Backhaul connectivity to remote and hilly areas which are difficult to access, otherwise.

Backhaul connectivity is often limited by the availability of the fiber based network. The delivery of Backhaul connectivity to rural areas lacking fiber based network involves balancing of concerns about Broadband access, connection quality, and the expenditures and delays entailed in rolling out supporting infrastructure. The benefits of terrestrial wireless Backhaul technologies specially in unlicensed spectrum bands are worth considering in such cases.

Wireless Backhaul is increasingly recognized as an option for combating the expenditures involved in providing Fiber based backbone for rural connectivity. Wireless Backhaul solutions can take the form of point-to-point or point-to-multipoint wireless Ethernet bridges or wireless mesh networks. They can use licensed or unlicensed spectrum band. With throughput from as low as 10 Mbps up to GigE, full duplex (with gigabit wireless), a licensed microwave link or wireless bridge can provide sufficient capacity for many rural applications [10].

OPTIONS FOR DEVICES (CPE) FOR BROADBAND ACCESS

End user devices or the CPEs form another pillar for Broadband supply chain as this is what makes the Broadband applications and content available to the users. The diagram below indicates different locations which are used in a typical developing country for accessing the Broadband, which determines the type of access device i.e. whether shared or personal.

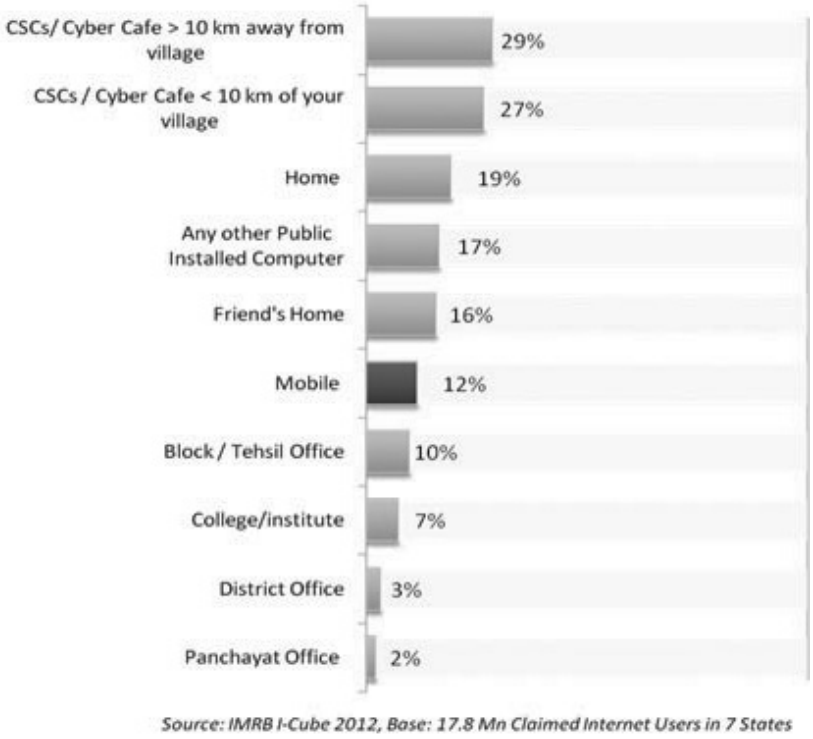


Figure 15: Point of Accessing Internet in Rural India

To make Broadband access to reach each individual it needs to be accessed through a personal device. It is generally observed that the cost of conventional devices for Broadband access like PC, Laptop and smart phones are on the higher side making it unaffordable for the rural masses and hence, proving to be a hindrance to the growth of Broadband in the rural areas. Some innovations are taking place in various part of the world towards making the Broadband access devices less expensive and affordable. Two examples of this are development of low cost and TVT box in Israel which enables a household TV set to double up as a Broadband Access device. These are shown in the boxes below:

BOX 1

Bringing Broadband to Home TV – Project Dhruv By Tata Trusts & Prodea

DRUV is an all new community development programme that serves to use innovative technology to help transform the lives of rural and remote populations in India. The project has been launched in Rajasthan and will be expanded to other states in the country soon. DRUV is about internet connectivity and its mission aims to create accessibility to affordable and informative content by bringing digital connectivity to television screens with a view to make a difference to the quality of life of the underprivileged and underserved populations. Project DRUV is an initiative of the Tata Trusts in association with Prodea Systems. The respective state governments will play a lead role in supporting this effort with the Govt. of Rajasthan (already partnering the process extensively in the launch state). Project DRUV is a part of the 'Digital India' initiative created by the Government of Rajasthan and serves to help gain access to important information and benefits entitled that the community is entitled to. Project DRUV is an innovative technology that is very easy to set up and works through a television screen, turning it into a Smartscreen and enabling one to access information and communicate with important Government and Non-Government organisations for availing of important and beneficial services. By simply setting up a set-top box to one's television, one can instantly get online and gain access to information that can positively affect the family's

(Continued)

health and well-being. Rajasthan is a geography of focus for several Tata Trusts initiatives which gives an added advantage in project planning and implementation.

BOX 2

Need for Broadband Connectivity at Bottom of Pyramid (Rural India)

To become a cashless economy, India must reach out to those at the bottom of the digital divide

The Real Social Network

Kris Gopalakrishnan & N Dayasindhu

Harvard University's Kennedy School published a working paper by Peter Sands in February 2016, 'Making it Harder for the Bad Guys: The Case for Eliminating High Denomination Notes' (goo.gl/Vqr9Ev). It posited that eliminating €500, $100, CHF1,000 and ₹500 notes would make the 'bad guys' face higher costs and higher risks of detection.

Sands said that one of the reasons demonetisation is easier to implement today is the accessibility and cost-effectiveness of digital payment alternatives. Post-demonetisation in India, we have witnessed ministers, bureaucrats and RBI officials exhort citizens to adopt digital payments.

The government has set up a committee of chief ministers to identify best practices to promote an economy based on digital payments, and provide a roadmap for implementation. GoI has roped in Nandan Nilekani as its digital adviser in this effort. It is important to assess and debate how we can quickly move from a predominantly cash-based economy to one where digital payments predominate.

Bhaskar Chakravorti, Ravi Shankar Chaturvedi and Benjamin Mazzotta of Fletcher School, Tufts University, assessed the Indian context in a May 2016 Harvard Business Review paper, 'The Countries That Would Profit Most From a Cashless World' (goo.gl/97bQQ). India has a high absolute cost of cash. This includes banks' cost of reaching cash to citizens, total cost borne by citizens to access the cash, and costs of having a shadow tax-evading economy.

Prima facie, there is potential for India to adopt digital payments as they reduce overall cost of cash. However, India's digital inclusiveness score is below global average. Only about 30% of the over one billion mobile phones in India are smartphones. It is imperative that digital payments cater to the lowest common denominator of those at the bottom of the digital divide and have only a feature phone.

Disrupting Digital Divide

The highest mindshare among those at the top of Indian digital divide is for the Unified Payments Interface (UPI) from the National Payments Corporation of India (NPCI). The focus to start minimising the digital divide barrier should lie in the NPCI's *99#, a GSM (Global System for Mobile)-based USSD (Unstructured Supplementary Service Data) for feature phones.

This has the potential to have a bigger impact in minimising the immediate disruptions caused by demonetisation and including a larger proportion of Indians under the umbrella of digital payments. After all, more than 70% of India's mobile users still have a feature phone with no internet capability. The *99# service provides functionality to transfer and receive up to ₹5,000, and supports multiple Indian languages.

Banks do not charge for the *99# service, but telcos charge 50p per transaction. While this telco fee is about a fifth of what is charged by the National Electronic Funds Transfer (Neft), it is still high enough to act as a disincentive for small payments. The *99# service is a good beginning to go cashless. But it is important to also provide a presence-less Aadhaar-based identity authentication-driven product like the UPI to make higher-value cashless digital payments more trustworthy and cost-effective.

Upward mobility can't be contained

Based on GSM Association projections, smartphone penetration in India is set to increase from about 275 million in 2016 to 670 million by 2020. Even after four years, it is estimated that only about 50% Indians will have a smartphone. A shortcut approach to pull more Indians into higher-value Aadhaar-authenticated digital payments like UPI is probably to share a smartphone among multiple residents in a village.

Taking a cue from the original use case of the Simputer — an Indian hand-held computer for bottom-of-the-pyramid users in the early 2000s — it may be beneficial to provide each village with a 3G or 4G smartphone capable of capturing biometric information. The custody of the village smartphone can be with a trusted person like a panchayat functionary or a postman.

Each resident gets a secure digital (SD) card that holds her information on identity and financial transactions. While the government or government-authorised telco can own the smartphone, they can recover a nominal monthly fee from every user for using the smartphone and SD card. The custodian of the smartphone can be trained to operate the device and UPI-based financial payments apps.

Once a resident's SD card is inserted, a presence-less identity authentication is done leveraging the India Stack and Aadhaar infrastructure. The custodian then helps the resident to make digital payments, confirm receipts, check bank account balance, etc.

Managing Mobile Money

The revised information of financial transactions is then updated on the resident's SD card. Currently, there are no bank charges for transacting using UPI, and it has a daily limit of 20 transactions and ₹1 lakh. Only data consumption is charged by the telco.

An important assumption is that grid and backup power together will be sufficient to ensure uninterrupted digital payment operations. The recent cyclone in Chennai is an eye-opener on how things can go awry. The government needs to ensure that telcos provide more than the customary few hours of power backup they provide for cell towers now.

Gopalakrishnan is chairman and Dayasindhu is CEO, Infosys Research and Digital, respectively

Taking a cue from the Simputer, it may be beneficial to provide each village with a 3G or 4G smartphone capable of capturing biometric information

BOX 3

Innovation – Telephony through SIMless Mobile Using Wi-Fi as Access by Bluetown

BLUETOWN has developed a handset especially designed for easy and quick interfacing with the Wi-Fi Hotspot and providing Broadband and voice connections without need for a SIM.

- **In some remote & rural villages India (35,000) even the Telephony access is not available**
- **In case a public wi-fi 'HotSpot' is created in a village, in addition to broadband access it can also provide voice services as a value-add/Apps (OTT)**
- **Last mile access of Wi-Fi can be used by NGN core to deliver IP based voice as a Fixed Mobile Convergence (FMC) application also known as Unlicensed Mobile Access (UMA)**
- **This can make voice calls in rural areas very cost-effective (almost free) as it will use License-free Spectrum and the All-IP cost efficient infrastructure.**

It is expected that SIMless Wi-Fi enabled phones will be used for voice and Broadband applications to startwith as is being tried in some parts of Africa's. In addition, it is worthwhile to promote use of existing Television sets as a means to access Broadband by individual households in the rural areas to start with. In such systems, a setup box is attached to the TV sets that provide access to Broadband/internet for accessing email, browsing, file downloads and small video clips in compressed IP format. This promising technology is reported to have undergone a successful pilot.

4. Broadband for Enhancing Productivity and Quality of Life

Economic consideration for urban and rural areas would be different and need to be appropriately factored in while making tactical and strategic plans. Also, it is important to take into consideration is the service set suitable for different types of user population. In addition to basic access to World Wide Web (WWW) & citizen services though e-governance; there are many lifestyle improving applications which Broadband can support. An application set that is important for society and can be greatly facilitated by Broadband delivery to the users includes applications and services falling into the broad categories of e-learning, e-health, e-commerce and e-government.

The ability to deliver education, health and government services to citizens over the Internet makes it possible to optimize the provisioning of these services and overcome geographic and financial barriers that have made it difficult to reach poor and marginalized segments of the population (Jordan, Peres and Rojas, 2010). In education, Broadband services not only make distance learning possible, but they also provide access to the broader range of cultural information and applications available online, facilitating the development of new teaching and learning models. Broadband also enables the remote delivery of medical diagnostic and monitoring services. In the area of government, streamlining service delivery (the online payment of taxes, for example) increases the transparency of administrative processes and facilitates public participation and access to government information. These services are discussed in the following paras;

A. E-GOVERNMENT APPLICATIONS

During the last decade, the emergence of the Internet and related technologies led to the development of e-government, or electronic government services. Broadband technology can be used to deliver government services directly to citizens and can reduce the cost of providing such services with much ease. These services can range from information services, administration documentation, renewal of a range of licenses, tax payments, etc. In remote geographic areas where no government offices are available such services allow real-time dialogue between citizens and administrative officials at nominal cost. Examples of such services being provided in a developing country is shown in the Box 4 below:

BOX 4

Rural ICT Projects in India

ITC e-Choupal

This is a profit-driven project run by Indian Tobacco Company (ITC). ITC has initiated an e-Choupal effort that places computers with Internet Access in rural farming villages. The e-Choupals serve as a social gathering place for exchange of information and an e-commerce hub. Mittal et al. (2010) find that farmers experienced 10 to 40 per cent productivity gains by using ITC services and benefited from being able to sell locally and getting local costs reimbursed.

DakNet11

DakNet uses wireless technology to provide Broadband connectivity. Developed by MIT Media Lab researchers, DakNet has been successfully deployed in remote parts of both India and Cambodia at a cost much less than that of traditional landline solutions.

Bhoomi

The Bhoomi project of Karnataka state government has revolutionized the way people Access information of land

records. Several of the 7,00,000 land records are available online for banks, judicial courts and hundreds of village kiosks all across the State.

Gyandoot

The Gyandoot project was started with the installation of a low-cost rural Intranet covering 31 village information kiosks in five Blocks of the Dhar district. Villages that function as Block headquarters or hold the weekly markets in tribal areas or are located on major roads (e.g., bus stops) were chosen for establishing the kiosks. Each kiosk caters to about 25 to 30 villages. Each kiosk was expected to earn a gross income of Rs. 4,000 per month.

Rural "e-Seva"

The project is a tool to bridge the digital divide in the rural areas and has used information technology for providing Access to various services to the people living in rural areas. Under this project web enabled rural kiosks termed e-Seva centres have been established at the mandal (a sub-district unit of administration) level. The project is based on BOOT (Build Operate Own Transfer) Model.

BOX 5

India-The Government of Rajasthan Develops E-Mitra

A project to provide people with Access to e-government in urban and rural areas at kiosks and service centres, known as common service centres. The regional government is responsible for providing the front-end e-government services to customers, whilst the back-end systems are supported by a technology partner (but owned by the government of Rajasthan). As of June 2012, over 2100 kiosks were operational across 33 districts and supported over 370000 transactions during that

(Continued)

month. Services supported include registration of births and deaths, payment of local government bills, and purchase of train tickets and stamps.

Source: Developing successful Public-Private Partnerships to foster investment in universal Broadband networks, ITU September, 2012.

B. E-HEALTH (TELEMEDICINE)

Healthcare is potentially one of the most important areas where Broadband can make an impact especially in rural areas. It has been estimated that at least USD 5 trillion is spent worldwide on providing healthcare and savings of between 10% and 20% could be achieved by the use of telemedicine delivered through Broadband. A World Health Organization report revealed an estimated shortage of almost 4.3 million medical staff worldwide, with the situation being most severe in the under developed countries & rural areas. Medical advice, monitoring, diagnosis and training delivered through Broadband can help a great deal to overcome these gaps. Training of professionals in all sectors can be delivered through Broadband video and other applications[11].

In order to make progress in achieving the targets of MDGs (Millennium Development Goals) which include reducing child mortality, improving maternal health, combating HIV/AIDS, malaria and other diseases, etc. by the target date of 2015, it is essential that countries and communities everywhere are enabled to take advantage of ICT revolution.[12] ICT applications in the health sector can bring efficiency gains, much as they can for education, employment and other priorities of the MDGs. ICT technologies offer the potential to empower citizens with medical information and knowledge that can facilitate improved decision-making and care. ICT in health care can reduce costs and help to mitigate the impact of the crisis[13].

Broadband can be leveraged to achieve higher capacity and quality in health care segment. Many e-health applications require various video based applications and high-bandwidth networks are essential for these services to function properly. Broadband Connectivity will enable medical care providers to share data

throughout their geographically dispersed clinical delivery sites, and to a lesser degree, reach the patient at home or at least at a central place in the village. To the extent that health care becomes dependent on access to computer networks, policymakers need to pay special attention to the needs of the medically underserved population to ensure that lack of network access does not further impede their access to health care[14].

The Broadband connectivity has started making impact by improved dissemination of public health information; enabled remote consultation, diagnosis and treatment through telemedicine; facilitated collaboration and cooperation among health workers, including sharing of learning and training approaches; supported more effective health research and the dissemination and access to research findings; strengthened the ability to monitor the incidence of public health threats and respond in a more timely and effective manner; and improved the efficiency of administrative systems in health care facilities. This translates into savings in lives and resources, and direct improvements in people's health[15]. Some examples of use of Broadband access to deliver health applications are given in the Box 6 & 7 below.

BOX 6

E-health Applications in India

Gramjyoti:

In early 2007, the "Gramjyoti" project was formed to demonstrate the improvement in productivity and quality of life resulting from the use of HSPA mobile Broadband. With focus on providing telemedicine services, Ericsson partnered with Apollo Hospitals, a leading healthcare provider in India. Under the program, doctors based in Chennai, Tamil Nadu held surgery with patients in village citizen centers and the Gramjyoti Broadband van through video conferencing. The patients were supported by paramedics, who administered ECG tests, blood pressure and injections. Post the success of the

(Continued)

program, Ericsson and Apollo Hospitals have partnered to form the Apollo Telemedicine Networking Foundation that aims to provide improved mobile healthcare services to rural areas around Chennai.

eSanjeevani:

eSanjeevani is a web-based comprehensive telemedicine solution, modeled on Centre for Development of Advanced Computing (C-DAC) Mohali's flagship integrated telemedicine solution. It was launched in June 2009, with the aim of providing healthcare services to masses in both rural areas and isolated communities. The application has the potential to provide healthcare services to 100,000 common service centers (CSCs) in rural India, which have been setup as part of the country's National eGovernance Plan (NeGP). eSanjeevani can also be used to provide medical education to interns across various CSCs. The combination of CSCs across the country along with the potential offered by 'eSanjeevani' is expected to enhance the reach of healthcare services across rural India.

Source: Huawei India whitepaper on Broadband: Connected Possibilities-Innovation, Integration & Inclusiveness (2012).

BOX 7

Malawi, Baobab e-health Project (www.baobabhealth.org)

A project between a non-governmental organization and the Ministry of Health. The project provides nurses and clinicians with touch screen devices and applications to help them treat patients. The applications were developed by the government and clinicians. In the period from launch in 2002 until July 2012, over one million consultations had taken place and 800 000 patients have been registered at five sites. Information collected using the touch screen devices is shared with the Ministry of Health.

Source: Developing successful public-Private Partnerships to foster investment in Universal Broadband Networks, ITU September, 2012.

C. TELE-EDUCATION (E-LEARNING)

E-learning is a powerful application that has started to change the conventional education system. Broadband has the capabilities to enable distance learning applications, which deliver optimum real-time audio and video in a simulated classroom environment. In addition to many public schools which are, or will be, connected via Broadband networks, there is a growing commercial market for education services offered by private companies. Broadband can also enable online learning systems via public libraries and provide improved access to information for rural and remote areas.

The non-availability of educational materials and books which are handicaps for rural unprivileged children can easily be provided using Broadband connectivity and e-education platform. The flexibility of timing and pace are the added features which make e-education more popular. On top of it, one can repeat and read as per the individuals pace. Some of the e-education modules provide option to give examination as and when one desires. Such features are extremely suitable to rural environment where students may have no time in day to attend conventional classes.

One innovative example of e-learning initiative in a developing country is given in Box 8 below.

BOX 8

E-Learning Initiative in Africa

The e-schools initiative of the New Partnership for Africa's Development (NEPAD) equips primary and secondary schools with ICT equipment (for example, PCs, phones, scanners and network Access) and trains students and teachers in ICT skills. The initial phase of the project in 2004 consisted of trial deployments, to schools in 11 countries (including Kenya, Mauritius and Uganda), funded by consortia made up of the public sector (the participating governments) and private-sector organizations (led by AMD, Cisco, HP, Microsoft and Oracle). Other participants included the ITU, the South African

(Continued)

Department of Communications, and the African Development Bank. The ultimate aim of the project is to deliver a minimum of 20 PCs and other ICT equipment to each of a total of 600000 schools throughout Africa. The project is due for completion in 2014.

Source: ITU Report – Developing successful Public-Private Partnerships to foster investment in universal Broadand network (September 2012).

D. BROADBAND BASED COMMUNITY SERVICES CENTERS

In addition to individual consumers, to start with it makes business sense to provide the services though community based Access mechanism, wherein the infrastructure & devices are shared to reduce the cost. Some examples of common delivery centers for various E-Services through Broadband are provided in Boxes below:

BOX 9

Community ICT Learning Centers in Thailand

Ministry of Information and Communication Technology initiated "ICT Community Learning Centers" project for establishing ICT community learning centers that are suitable to the needs of the local communities, so that they can Access the Internet to search for data, enhance their body of knowledge, and facilitate life-long learning. This project aims to train community specialists to be knowledgeable and proficient in ICT so that they can operate the centers by themselves. The centers are to be the reservoirs for local wisdoms and information that are useful for everyday life and job creation, helpful to the community decision-making, supportive to the philosophy of sufficiency economy, and provide Access to the e-services, which would help reducing the digital divide. As of 2010, 872 ICT community centers have been established. The ICT community centers use ADSL at a speed 2 Mbps. and IP STAR at a speed 1 Mbps.

Source: World Bank Thailand MICT Broadband Study (April 2011).

BOX 10

Community Service Centers (CSC) in India

Department of Electronics and Information Technology (DEITY) in 2006 initiated a plan to deploy 104881 Community Service Centers (CSC) with PPP model in rural areas all over the country under National e-Governance Plan (NeGP) in order to deliver e-governance services in the rural areas. The Scheme envisions CSCs as the front-end delivery points for Government, private and social sector services to rural citizens of India, in an integrated manner. CSCs are managed by local Village Level Entrepreneur (VLE – loosely analogous to a franchisee).

The various G2C services offered at CSCs are; Agricultural services, RTI Services, NREGA MIS Data Entry service, Postal Products, Land Records, Issuance of Birth and Death Certificates, Utility Services, Electoral Services, Transport Services, Grievances, e-District Services etc.

The B2C Services like e-Learning, Financial services, Telecom – Mobile Charging/DTH Recharge, Utility services, Employment services, Railway -Ticketing, Matrimony Services, UTI-Pan Card Processing etc. are being offered/identified through the CSCs. State Bank of India, Punjab National Bank and other commercial banks have started using CSCs for delivery of financial products and services including banking and insurance. Basic computer course, digital photography, photocopying, CD writing etc. services are also provided by some successful VLEs.

Source: www.deity.gov.in.

A live case of Smartphone connected with internet being used to run the business by a rural woman is depicted in a latest stories as copied below:

Smartphones are helping rural women get better at business

Self-help groups and small farmers are using apps and social networks to sell everything from cattle to homemade chocolate

Rachel Chitra, Ranjani Ayyar & Sharmila Ganesan | TNN

Soundaram Ramasamy, the only female bull-keeper in the farmlands of western Tamil Nadu, breeds Kangeyam bulls, an indigenous cattle breed named after the region and used for rural sports like jallikattu, bull racing and farming. Despite the Supreme Court ban on bull sport, interest in the Kangeyam breed is alive because of mass adoption of technology by her customer base to whom she Whatsapps pictures of the bulls along with price quotes and milk yield at her dairy unit in Kathasamipalayam village.

Ramasamy is just one among many women using mobile apps like Kongu-Madu (an online marketplace for jallikattu breeds) and social networks to increase their earnings.

And this impact of smartphones on agrarian women-driven businesses is being felt across sectors. In Kotagiri in the Nilgiris, women self-help group (SHG) members are using social media to market their chocolates, pastries, tea and spice goody bags in urban centres, and some of their posts have more than 3,000 likes. Darmona Tea Estate owner Dinesh Raju, who's helped a lot of his female tea workers get part-time jobs with SHGs, says social media is helping them tap hitherto unexplored markets at no extra cost. Since the Nilgris has a high number of tourists, the gift hampers of candles/chocolates/fruit/fir cones that these women make prove popular for online sales.

Despite growing use, rural women are still far less mobile-savvy than urban counterparts. Internet and Mobile Association of India (IAMAI) data shows that in rural India, male-to-female internet use is far more skewed at 88:12 as compared to 62:38 in urban India. But among the few who bridged the divide are women entrepreneurs using mobile solutions like Vodafone Foundation's RUDI Sandesha Vyavhar to sell farm produce to local communities.

RUDI Sandesha Vyavhar has benefited over 3,500 RUDIbens in Gujarat by helping them increase monthly sales and incomes, sometimes four-fold, according to a report by the Vodafone Foundation which has tied up with the Self Employed Women's Association (SEWA) to develop a mobile app for rural women entrepreneurs to sell farm produce like pulses, wheat, and turmeric. Using this mobile app, women are able to place orders real-time, record sales and maintain sales reports and customer ledgers.

These small-scale businesswomen are catching up with the menfolk. IAMAI says internet penetration among rural females is growing at 61% and 79% among males Unlike urban centres, internet use in rural areas is largely synonymous with mobiles and not so much with laptops, PCs, tablets and other devices.

Using a mobile app created by the Vodafone Foundation, female entrepreneurs in Gujarat can not only sell farm produce but maintain sales reports and customer ledgers

For nearly a decade now, social dogma has restricted women's access to mobile telephony. In some parts, khaps have issued decrees barring unmarried women from owning cellphones, seen as a symbol of promiscuity. Research conducted by GSMA, a trade body of mobile operators, shows that women in India are 36% less likely to own a mobile than men. The findings show that lack of address and ID proof among women, particularly migrant workers, is one of the many reasons they do not own mobiles. Cost is also a barrier because many are financially dependent on male-earning members of the household, and often have to borrow handsets.

In a 2014 Telenor India study in UP's Aligarh district, a majority of men were found to have smartphones while women made do with basic phones. "While we associate mobiles with progress, a patriarchal mindset often associates cellphones in the hands of women with 'evils' in society," says Sharad Mehrotra, CEO, Telenor India Communications. Telenor has been working to bridge this gap under Project Sampark: through street plays and door-to-door contact with families, female promoters explain the benefits of mobile connectivity to people. Currently running in parts of Western Uttar Pradesh, the project has helped provide livelihood opportunities to local women who work as promoters and brought over 75,000 rural subscribers into the mobile network.

Shrutam Desai, co-founder of Onlymobiles.com, which sells mobile phones to over 17,000 pin codes in India, says lack of education and familiarity with English has prevented mobile phones from reaching the last mile in the female segment. "However, more and more handset makers are coming up with local language-enabled handsets which should help," says Desai.

Getty Images

STILL A LONG WAY TO GO

209m urban Indians use internet		108m rural Indians use internet	
62% urban users are male	38% urban users are female	88% rural users are male	12% rural users are female

Source: IAMAI

Internet Saathis: Unlikeliest 'Power Users'

BE checks in to see if Google and Tata Trusts' Internet Saathi program is working or not

Delshad Irani | ETBrandEquity | Updated: March 08, 2017, 08:25 IST

Last year, 23-year-old Laxmi Rani from Patahensal in West Bengal held a smartphone for the first time when she became an Internet Saathi and embarked on her maiden voyage into the Web. Fifteen months later, Rani tells us she's trained over 700 women in how to use the Internet and now she wants to learn netbanking and how to use Paytm.

This is the story of women like Laxmi Rani who have never held or not been allowed to use a smartphone in their lives. Nor have they ever had access to the Net. However, a few months of learning the Internet ropes through Google and Tata Trusts' 'Internet Saathi' program and women in rural India are charting a new course for themselves and others. Saathis are using, and helping other women use the Internet to find information about health, government programs and agriculture, how to make *jalebis* and sew *saree* blouses and to see what Mumbai and America look like.

Armed with a smartphone or tablet, the newborn army of Google's unlikeliest "power users" is shutting down spurious liquor bars in villages, finding jobs for unemployed husbands and looking up test scores and answers even their 14 year old daughter's school

teacher doesn't know. One Saathi helped reduce the number of female foeticide in her village by showing men and pregnant women photos of formed fetuses to raise awareness and empathy.

Alphabet-owned Google partnered with Tata Trusts to kick off the program last year, after years of trying to find the right model to increase digital literacy in the country. Now they are building a legion of female trainers in rural India who ply dusty roads on retrofitted bicycles, go from village to village and train women in how to use smartphones and the Internet. Currently, over 2.5 million women in 60,000 villages across 10 states have been trained by 18,000 Saathis travelling the countryside on their branded bicycles. Sapna Chadha, marketing head for India and South East Asia at Google, says even there they had a curious learning. Not many women knew how to ride a bike. So, while they learnt how to take a selfie they also picked up another skill – riding a bicycle that gives them not just mobility but also establishes a sense of identity and status in the community.

Chadha tells us watching these women access the Net for the first time is a sight to behold. "It's a source of power they've never had," or not allowed to have by a father or husband who thinks she'd "break the phone." One Saathi has been curious her whole life and now that she has the answers to all her questions a few swipes away, she can't sleep at night.

Many Saathis don't want their journey to end because it gives them a sense of purpose. Like Parvati Khushwa from Dholpur in Rajasthan. One of her greatest achievements as a Saathi she says is helping a disabled couple find a source of income by teaching them how to make pakodas via online videos. Khushwa wants to learn how to work a laptop next.

For now, women who wish to continue to be Saathis are encouraged to do so by Google. However, connectivity is one of the biggest hurdles in remote Indian villages. The workaround: target areas that are reasonably well connected. On the user front, for some women having access to Internet enabled devices for just a few hours in a week remains an impediment in picking up real skills.

Nevertheless, in a world awash with "purpose-driven initiatives" by brands, 'Internet Saathi' stands out as one that's likely to have the most direct and immediate impact on a new power consumer group – women in rural India. "This isn't a marketing program," says Chadha. It's Google's mission (naturally) to reduce one of the worst digital gender gaps anywhere in the world, this in a country with the second largest internet population.

Innovative Wi-Fi based Broadband in a remote area to achieve SDGs "Giga Island" in Bangladesh:

Viewpoint 9: Global 'GiGA Island' Project Helps Transform Bangladesh into Digital Bangladesh

In an effort to bring 'broadband empowerment' to an unconnected part of the world, KT has been collaborating with the Government of Bangladesh, IOM and NGOs. This initiative is dedicated to enhancing quality of life through the high-speed GiGA network by improving public services and enhancing access to information in Moheshikhali Island, Bangladesh. KT and IOM with the Government of Bangladesh plan to provide ICT services to implement the success of the GiGA Island. The project aims to provide the benefits of high-speed Internet and to build a replicable national development model for developing countries.

The government-supported Bangladesh 'GiGA Island' Project, labelled 'Digital Island', is distinctive from the case of Rep. of Korea because: (1) It is a multi-party collaboration model involving numerous public and private sector stakeholders from both countries; (2) It is aligned with a national development strategy, 'Digital Bangladesh', which is a part of Bangladesh's 'Vision 2021'.

Vision 2021 is a national initiative to transform Bangladesh into a middle-income country by 2021. As part of this strategic vision, Bangladesh has committed itself to build a 'Digital Bangladesh' that is poverty-free, has healthy citizens and skilled human resources, all enabled by ICT. Among its key pillars, a contribution of at least 2% led by ICTs is expected to be achieved by 2017, calling for large-scale investment support and elevating the skillset of the young workforce.

The demographic profile of Bangladesh embodies a high propensity to achieve 'Digital Bangladesh': the younger generation (18-35) accounts for 65% of the population, while internet penetration and mobile penetration currently stand at 34% and 83%, respectively. Taking all this into consideration, the country is concentrating its efforts on developing a highly skilled IT workforce and building the supporting network infrastructure.

For choosing a site in Bangladesh, KT considered network feasibility, investment effectiveness, and societal value to satisfy relevant socio-economic needs and selected Moheshikhali Island, with a total population of 321,218 and population density of 900 people per kilometre squared. The average literacy rate is 30%, below the national average of 50%.

Beginning in November, KT plans to roll out network infrastructure; GiGA Wire (through existing copper lines), GiGA Microwave (over legacy microwave equipment) and GiGA WiFi in three districts in Moheshikhali Island. Each has high population density, concentrated public institutions and low access to network infrastructure, an ideal environment for expanding connectivity and maximizing the use of ICT solutions. Gradually, KT plans to expand the coverage to overall islands in cooperation with development organizations.

The 'GiGA Island' Project aims to empower residents of rural communities, using ICT technology. In collaboration with the Government of Bangladesh, KT identified four major social priorities in Moheshikhali: Education, Health, Information, and Agricultural Resilience Service. For each area, KT has assigned initiatives: A21, Teachers Portal, Learning & Earning, and Agricultural Centre. By facilitating these policies, the viability and sustainability of the project is to be achieved. Once the network is built, the project will start introducing relevant ICT solutions to the targeted government facilities and provide training to the service providers to ensure they can utilize the services.

The 'Digital Island' promotes the achievement of a number of the SDGs and shows how ICT can contribute to

achieving the SDGs, including: Goal 1 (End Poverty), Goal 2 (No Hunger), Goal 3 (Good Health and Well-Being), Goal 4 (Quality Education) and Goal 9 (Good Jobs and Economic Growth).

For instance, to combat poverty and hunger, 'Digital Island' provides IoT solutions, which help farmers by sensing and analysing salinity information to boost agricultural productivity, and enable efficient use of farming resources. To promote good health and well-being, the project provides access to health education, as well as diagnosis tools for early and remote detection and prevention of diseases. By providing distance learning programmes to students, the project expects to improve digital literacy, which ultimately acts as a powerful lever for achieving broader goals of good jobs and economic growth.

Source: Korea Telecom (KT).

'Info Ladies' take Internet on cycles to Bangladeshi villages

Associated Press
letters@hindustantimes.com

JHARABARSHA: Amina Begum had never seen a computer until a few years ago, but now she's on Skype with her husband. A woman on a bicycle brings the Internet to her.

Dozens of 'Info Ladies' bike into remote Bangladeshi villages with laptops and Internet connections, helping tens of thousands of people — especially women — get everything from government services to chats with distant loved ones.

The Info Ladies project, created in 2008 by local development group D.Net and other community organisations, is modelled after a programme that helped make cell phones widespread in Bangladesh.

D.Net recruits the women and trains them for three months to use a computer, the Internet, a printer and a camera. It arranges bank loans for the women to buy bicycles and equipment.

"This way we are providing jobs to jobless women and at the same time empowering villagers with critical information," says Ananya Raihan, D.Net's executive director.

The women — usually undergraduates from middle-class rural families — aren't doling out charity. Begum pays 200 takas ($2.40) for an hour of Skype with her husband, who works in Saudi Arabia.

"We prefer using Skype to mobile phones because this way we can see him on the screen," Begum says, beam-

Info Lady Sathi Akhtar shows a 15-minute video on a laptop to women in Saghata, a village 200 km north of Dhaka. AP PHOTO

These examples are worth emulating in the rural areas wherein the availability of Broadband services is taking off.

5. Tariff Plans and Affordability for Broadband

Tariff has been identified the key factor in determining affordability, adoption and usage of a service by ITU. Pricing at both retail and wholesale levels can influence the Broadband investment and product decisions of network operators and service providers. The two most important factors contributing to the overall demand for Broadband, especially among rural users, are perceived utility and cost of service and both these factors are highly interrelated.

Despite the emergence of new technologies and market conditions, the delivery of Broadband services to rural and remote areas still continue to be difficult. The distinctive features of these areas, such as low population and revenue base are a significant disadvantage for a service supply industry based on economies of scale. Invariably the cost per customer of supplying Broadband services in these areas remains significantly higher than in densely populated areas.

The price of Broadband access plays a critical role driving its diffusion and is a key barrier to extending access to Broadband in developing countries. While Broadband is becoming more affordable around the world – prices have fallen by over 50% over the last two years in some countries – it nonetheless remains unaffordable in many parts of the developing world. In 2011, the price of fixed Broadband access cost less than 2% of average monthly income in 49 economies in the world, mostly in the industrialized world. Meanwhile, Broadband access cost more than half of average national income in 30 economies; in 19 of the LDCs, the price of Broadband exceeds average monthly income (ITU, 2012). By 2011, there were 48 developing economies where

entry-level Broadband access cost less than 5% of average monthly income, up from just 35 the year before[16].

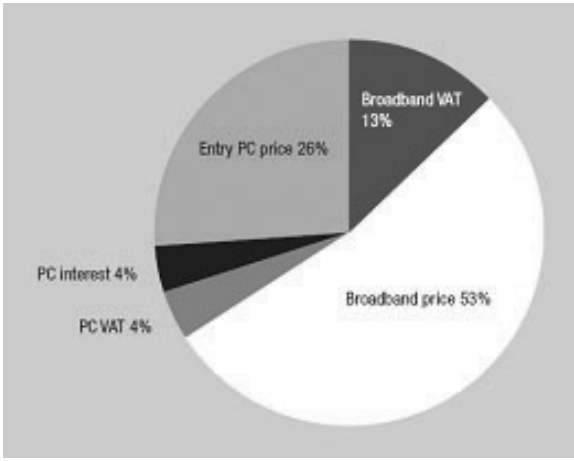
To reach the rural Broadband users, a new innovative approach is needed. Example of one such approach is from India, Sri Lanka and Bangladesh, where 300 MB of mobile Broadband is offered at extremely low prices of ~$0.45 USD through inexpensive mobile Broadband prepaid vouchers. The value proposition for customers has been compelling, resulting in many new sales. These countries utilizing the "prepaid miracle" and "sachet approach" that has helped make mobile phones ubiquitous around the world[17].

Regarding affordability of Broadband access in rural areas of developing nations it is worth noting the learnings from World Economic Forum (WEF) report – Global information Technology Report 2012 reproduced as below:

"Affordability: Making the Expensive Affordable To the Next Wave of Users"

Recent studies published by ITU reveal that Broadband penetration is directly related to its cost, relative to an average family income, as well as to the availability of products and services that accommodate the general population's purchasing ability. For example, as the annual cost of Broadband drops below 3 percent of a family's annual income, its use begins to increase dramatically. For developed countries, this relative cost has already been achieved, but for at least 34 countries worldwide, the cost of Broadband remains higher than the average annual family income and thus it remains entirely out of reach. Of the approximately 5 billion people world-wide who remain without Broadband access, the three billion represents those poised or preparing to achieve an income level capable of technology consumption. The challenge becomes one of establishing viable models that make this possible. Affordable Broadband programs are starting to emerge in countries such as Sri Lanka and India, with service providers offering connectivity solutions starting as

low as US $2 per month. This level of affordability is making it possible for people to step up their learning, skills preparation, and service delivery levels by opening up their Access to a larger quantity of Internet services and PC applications. Many of the offerings are linked to financing options that further reduce the entry barriers to lower-income Internet entrants. Significant focus is put on the cost of specific Internet Access devices, especially PCs, but looking into the total cost of ownership for a citizen of the rapidly developing economies—BRIC+TIM countries11—(Figure 16) shows that most of the family/individual income in-vested in getting connected to the Internet is actually spent on connectivity.



Source: ITU, 2010a.
Note: Data projected for next four years (based on current day).

Figure 16: Average personal computer plus Broadband solution costs, BRIC+TIM countries

It advocates that incentivizing technology options is much more lucrative than taxing the initial technology purchase leading to reducing the cost of devices through subsidies or reducing the taxes such as import duties and VAT.

This report has also brought out that Broadband Services becomes affordable to a large percentage of population when

its tariff approaches 3% of annual family income as shown in Figure 17 below:

Figure 17: Three percent of family income: Entry point for Broadband adoption *(Source: Intel)*

This report also brings out a useful conclusion about the affordability levels for the BRIC + TIM countries as given in the Box 11 below:

BOX 11

Affordability Levels in BRIC + TIM Nations

Brazil, Russia, India, China, Turkey, Indonesia, and Mexico (BRIC+TIM countries) could grow their available market by 860 mil-lion people by reducing the cost of entry for Broadband by about 50 percent. Short of dropping prices, lower – cost and lower-speed or prepaid data packages can allow Broadband providers to find new avenues to new customers by reducing the barrier to Broadband adoption.

Broadband as a percent of GNI PPP per capita	Population that can afford (millions)	Percent of population
< 3	731,911	22.38
>3 – <6	860,138	26.30
> 6 – < 10	533,277	16.31
> 10 – < 40	1,145,132	35.01
	3,270,458*	

Source: Intel calculations based on Euro monitor statistical data and Intel field intelligence.

Affordable connectivity bundled with computers, software, and content are being offered by several service providers around the world. Government-sponsored programs to equip educators, students, and lower-income families are also becoming a priority for many countries. To take the example of Kenya, family income levels mean that only about 7 percent of the population can af-ford a service that offers uncapped monthly Broadband Access for US $20 per month. A prepaid Broadband Access service capped at 200 MB of data for US $5, how-ever, could within the reach of more than 60 percent of the Kenyan population with most new Broadband users also need to acquire a PC; the PC market grew in the country as well. In Egypt the telecommunications provider Mobinil is currently offering a net book with six months of Internet Access for US $300. The Broadband service is capped at 110 MB per month, at which time the high-speed service degrades.

From the above, it can be concluded that the tariff for a minimum Broadband access package with reasonable download should be in the range of 2 to 5 USD & in the percentage range of 3% to 6% of the monthly income, which are in the affordability threshold as per the reports.

6. Funding Models for Rural Broadband and International Case Studies

A. INVESTMENT MODELS FOR RURAL BROADBAND

From previous discussions, it has become obvious that the business of Broadband in rural and remote areas is not a normal case but it is a complex ecosystem which needs to balance out the conflicting requirements of higher cost of deployment and the lower revenue potential because of low paying capacity of the targetted customers. Therefore, it does not provide an attractive preposition to the conventional telecom operators who are driven by profit and ROI motives. To make it an implementable preposition which is sustainable, all the stakeholders specially the Government, Regulators, Service Providers, Local Bodies, NGOs and Entrepreneurs have to play the role in the ecosystem jointly. The most important task is the creation of Broadband infrastructure in the rural areas which needs CAPEX more than that required in urban areas having concentration of the users, and this cannot be expected to be achieved through market forces alone.

For instance, of the four quadrants of variable population density and demand set out in Table 4 below, market forces are least likely to enter adequately where a region has low density as well as low demand, thus, the problems of providing Broadband access becoming most challenging. This has led to calls for government intervention to enable Broadband deployment, lower connection and data access prices and improved quality/reliability

of service, particularly in rural and remote areas. The resort to universal service obligation as one of the compelling options[18].

Table 4: Density and Demand Factors and Prospective Broadband Availability

	High Density	Low Density
High Demand	Competition/market Solutions adequate	Universal service mechanisms, availability of new technology enabling declining incremental cost, demand aggregation initiatives
Low Demand	Economic and community development approaches, publicizing Broadband benefits	Most challenging, universal service obligations, government financial support, government ownership

Source: OECD

Public participation alongwith Private entities in PPP (Public Private Partnership) mode in building Broadband infrastructure and fostering the development of Broadband services can be a viable option for several reasons. First, there are rural, sparsely populated or geographically challenged areas where it is not possible to build telecommunications solely based on market conditions. A for-profit telecom company is not interested in, or more simply cannot afford, building an infrastructure as the Return On Investment (ROI) is too low. Therefore, to meet the needs of rural areas, a great degree of public involvement in investment needed. In addition to owning networks, there are several other models of how the public can participate in telecommunication development, thus bridging the 'digital divide.'

The choice of investment model depends on local circumstances, the economic situation of the country concerned,

and also, to a large extent, on the wish of the local or regional community. As mentioned above, no single stakeholder whether it is public entity or market player is capable of funding the Broadband infrastructure in rural and remote areas and therefore this is the fit case for public private partnership (PPP) or some other innovative financing model.

The various investment models which can be considered for different elements of Broadband infrastructure are shown in Figure 18 below:

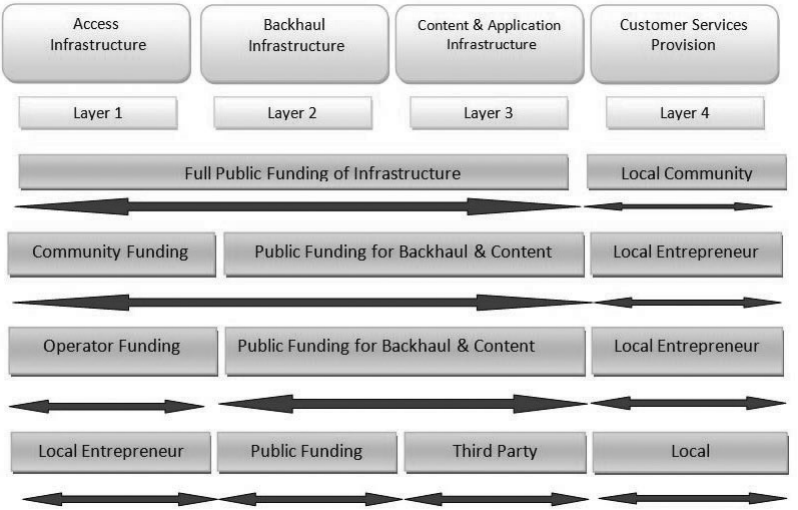


Figure 18: Funding Options for Rural Broadband Infrastructure

Based on Analogy from Alberto Emerging models of Public-Private Interplay

The various options from above Figure are discussed as following:

I. Full Public Funding

This is resorted to when there is a situation of market failure due to inability of any of the market entity to have any interest in any of the element of rural Broadband network and hence the

only option remains that of Government funding or through the USO (Universal Service Obligation) fund. Of course, the service provision to the customers will be required to be handled at the local level either through the local community or through VLE (Village Local Entrepreneur). In this model though the investment and the ownership of the network remains with Government/its agency, the design build and operate is generally outsourced to a non-government entity who has the expertise in implementing such projects. Examples of such arrangements are Argentina, Malaysia, Mongolia, Pakistan, and Qatar as described at **Annex-I (listing the Broadband projects in developing countries).**

II. Public Funding of Backhaul and Content, Community Funding of Access Network

In this Model, Government and USO funding is limited to Backhaul and content infrastructure which forms the major Capex, whereas the Access network is funded by the local bodies and community from their sources (Local Community Model). The customer service provision can be entrusted to a community representative or an independent VLE. The example of such arrangements is Dominic Republic as described at **Annex-I**.

III. Public Private Partnership (PPP) – Backhaul and Content Public Funded, Access Network Private Funded

This model is the most successful example of development of rural Broadband networks. In this while the Backhaul infrastructure is funded by Government/USO/Public Sector, the access network is funded by the service provider/operators themselves. The VLE is employed as the franchisee of the service providers to manage the customer service provision. Examples of such arrangements are Kenya (TEAMS Project), Latvia, Lithuania, Paraguay, Saudi Arabia, Slovak Republic as discussed at **Annex-I**.

IV. Public Private Partnership (PPP) – Backhaul Public Funded, Content and Access Private Funded

This is emerging model in cases where operators have no interest in any investment but there are 3rd party entrepreneurs, who are willing to invest and manage the access network and service provision. Such models though are not very prevalent yet but there is a compelling case for these to be used to create rural Broadband infrastructure and content. This model can be implemented as a consortium approach whereas ownership of the complete network is divided between the Public and Private sector players, including local entrepreneurs. This is being tried on India by some innovative **"Managed Hotspot Service Providers"** like Bluetown as at **Annex-II**.

B. INTERNATIONAL CASE STUDIES FOR RURAL BROADBAND

Recognizing the importance of Broadband, many national governments all over the world have launched Broadband initiatives, programs and projects, considering national Broadband networks as the main component of Broadband access.

Therefore, National Broadband Network (NBN) rollout has started becoming social compulsion attractive and economically viable option for the Government for following reasons. Firstly, research consistently shows that investment in any ICT project similar to basic infrastructure has a direct positive effect on GDP growth. Secondly, Broadband networks have potential to very quickly pay for themselves through the benefits that get delivered across society in many multiple ways. In addition, Broadband networks can effectively be financed by innovation and cost-savings in sectors such as health, education, energy and transport; this makes them further cost effective. This concept is very much relevant for the national Broadband backbone constituting the Backhaul part of the Broadband infrastructure connecting the rural

areas. The latest, say it all, observation by an expert who appears to be filling the pinch for lack of digital infrastructure is very well depicted in the newspaper article reproduce below.

ET By Invite

We need to invest in digital infrastructure

India Can Bank on the Unbanked with Better Network

Madhur Deora

Digitisation and universal access to financial services that have the potential to transform lives of millions of citizens in a short span of time, should get prominence in this budget. A large share of India's population is either unbanked or under-banked. The percolation of formal financial services needs to happen the way it did in telecom services.

NOFN (National Optical Fiber Network) project and other initiatives that can ensure high-speed, reliable internet access in every corner of the country, should be fast-tracked.

This is at least as important, if not more, than the physical infrastructure projects. Sustaining focus on smart-city projects is another area while initiatives like WiFi at Railway Stations, bus stations, and community centres have the potential to increase digital inclusion for millions of Indians.

There is a large amount of unutilised funds with USOF (Universal Service Obligation Fund) and this can be used to subsidise the cost of data for select customers.

This can be capped at a certain limit of about ₹50 per month for every customer. Access to digital services can also be improved by making smartphones available at economical prices and promoting devices supporting multilingual interfaces. Benefits in terms of tax rebates should be defined for such category of phones.

An ecosystem that supports financial inclusion must also be developed, to begin with increasing the reach of digital payments. Disbursal of government benefits in bank account is just the first step, it is important that such funds also be used digitally instead of being withdrawn in the form of cash. Ubiquitous acceptance of digital payments is essential in transforming India from a cash to a cash-less society.

Transaction fee needs to be minimised especially on low-ticket transactions.

Tax rebates can also be given to merchants clocking a significant share of sales through any digital method.

Access to credit must also be increased. Financial institutions can be mandated to disburse a certain portion of loans only to merchants who have embraced digital payments beyond a certain threshold. Also, an institution similar to Deposit Insurance and Credit Guarantee Corporation (DICGC) can be set up to insure credits up to a fixed amount, so that small loans can be disbursed with minimum hassles.

Schools, colleges and NGOs can be given incentives to conduct training programmes for consumers and merchants to encourage them to avail digital

THINKSTOCK

NEED OF THE HOUR

The annual budget must hasten digital inclusion with initiatives that make it easier for Indians to transact without cash

services. The corporate sector can also be encouraged to promote digital literacy. Conducive policies that invest in digital infrastructure, and create a level-playing field between traditional financial institutions and innovative financial technology companies, could lead to significant improvement in financial inclusion for hundreds of millions of Indians.

(The writer is the chief financial officer of Paytm)

Some of the International examples in respect of Broadband backbone initiatives in developing countries are summerised at **Annex-I.**

Also, an innovative technology solution company from Denmark, namely BLUETOWN has dared to create a business model to fill the rural broadband divide for developing countries, some information about the same is depicted below (www.bluetown.com):

BLUETOWN: Connecting the Unconnected Through Innovative Business Model

BLUETOWN is an investor-founded startup company within the Telco Operator, Internet Service Provider (ISP), Managed Hotspot Service Provider (MHSP) business segment. BLUETOWN's mission is "Connecting the unconnected," referring to our potential customer base being the 3.9 billion people in the world without internet access, most of whom live in rural areas in developing and emerging economies.

Internet access is a self-enforcing enabler for wealth and higher standards of living as it enables education, provides access to life-saving information for health-clinic personnel, helps farmers get a fair price for their crops, enables political and financial inclusion of people in remote areas, etc. By "Connecting the un-connected" BLUETOWN wants to support improved livelihood of those who are currently not connected – and through that BLUETOWN targets becoming the operator of the rural world!

BLUETOWNs to have a solution that overcomes the main challenges that other, established telecommunication operators face in semi-urban and rural areas: lack of grid power, high cost of standard telecommunication equipment and prohibitive cost of backhaul (data traffic from a remote site to the central

backbone). BLUETOWN aims to overcome the business challenge by generating revenue from 3 streams:

A core element of the BLUETOWN business is corporation with local CSCs and VLEs who are responsible for light service of the installation, selling internet access, and onboarding new users who are new to the internet.

BLUETOWN's product portfolio consists of low-cost, sustainable Wi-Fi solutions, adapted to fit a variety of market characteristics:

Semi-Urban	Rural	Remote
Typical characteristics:	**Typical characteristics:**	**Typical characteristics:**
Population: >500.000 **Density:** >15.000/ km^2	**Population:** <500.000 **Density:** <15.000/ km^2	• Refugee camps and disaster relief • Exploration • Lodges and farms • CSR

(Continued)

Targeting the world's 3.9 billion unconnected means working with a low Average Revenue Per User (ARPU) and consequently, the time for Return on Investment (ROI) is often longer than in traditional telecommunication deployments. BLUETOWN mitigates this via its Local Content Platform which allows BLUETOWN to establish a revenue stream from content providers interested in utilizing BLUETOWN's infrastructure to make their content available to the 3.9 billion end-users who can otherwise only be reached by physical presence or one-way communication like radio spots.

To do this, a local cloud solution is installed in villages or at hotspots when deploying a network. It allows users to access content – stored locally on the village network – via a Local Content Platform without the need for internet access and costly data usage. This unique combination of online and offline content is what is anticipated to make BLUETOWN the preferred choice for the currently un-connected or underserved population. And for any partner with a need of reaching this population.

Two more examples from developing countries are also depicted in the Box – 12 & Box – 13 below:

BOX 12

Enabling Rural Areas with Broadband Coverage

The village of Ta Van is located in the Lào Cai province, 300 km northwest of Hanoi, in Vietnam. It has 150 households (700 inhabitants), with each resident earning $13 a month from farming activities. The town also has some guest houses for tourists which generate approximately $50 a month.

In 2007, a public-private partnership formed by Intel, USAID, and the Vietnam Data Communication Company

(VDC), implemented a project to provide Broadband Access to the Ta Van village. The project used WiMAX technology for local coverage and a satellite Backhaul connection through IPSTAR.

Basically, after implementation of the network all households in the town could Access Broadband applications. Additionally, telephony functionality was introduced through VoIP (though limited to calls within the province at first). Soon after implementation, guest houses' tourists were using the Internet and VoIP applications. Public entities such as the local health center use the Internet to search for medical and pharmaceutical information. Internet Access has become the main source for news and information in the village, and now many villagers can communicate with relatives living in urban areas of the province.

According to Intel, the cost of a similar network supporting 40 subscribers would add up to approximately $20,000 ($12,000 in base station equipment and around $200 per user), which implies a cost of approximately $29 per inhabitant (assuming all inhabitants benefit from the project). If we assume a subsidy for 50 percent of the capital expenditure, total public resources required would still be somewhat high compared to other subsidy ratios. Besides, operation expenses are expected to be high due to the satellite Backhaul.

It is clear that the wealth of services, applications, and opportunities that the project has introduced to the village far exceed those of public telephony projects. Additional estimations of development impact in the village would support replication of the project in other areas. However, the challenge in this case, more than the size of a one-time subsidy, is to guarantee the sustainability of the operation.

Source: Taken from "Cost-Effective Rural Broadband: A Vietnam Case Study," Intel Corporation, 2007.

BOX 13

National Optical Fiber Network (NOFN) in India

Government of India in October 2011 approved creation of National Optical Fibre Network (NOFN) for providing Broadband connectivity to all Gram (Village) Panchayats. The existing core OFC network in the country deployed by different service providers covers State/District/Block head quarters but does not extend to most the Panchayats. The plan envisages to connect all the 2,50,000 Gram Panchayats in India through optical fiber utilizing existing fibers of Public Sector Units (PSUs) viz. Bharat Sanchar Nigam Limited (BSNL), RailTel and Power Grid and laying incremental fiber wherever necessary. The project will be funded by Universal Service Obligation fund (USOF) and initial estimated cost of project is US $4 billion in 2 years. For management and operation of the NOFN and ensuring non discriminatory Access to all service providers a Special Purpose Vehicle (SPV) namely Bharat Broadband Network Limited (BBNL) has been incorporated recently. Tripartite agreements are being signed by Government of India, BBNL and State Governments/Union Territories for free Right of Way (RoW) for establishment of NOFN. The Backbone network thus created will be available to various service providers, to provide Broadband services in rural area on Open Access basis at nominal lease charges, just to recover O&M costs, the Capex funded by USO absorbed as a sunk cost.

Source: www.usof.gov.in.

7. Recommendations for Way Forward for Implementable Business Models

From the previous discussion, it has become very obvious that all the stakeholders of the Broadband ecosystem like Governments regulators, Local bodies, operators, service providers, NGOs, vendors and other entrepreneurs need to play their role in making the rural Broadband deployment a sustainable business case. There are examples of some innovative business models in some scattered areas but there is no evidence of any sustainable rural Broadband deployment in large regions. This chapter aims at providing recommendations for guidelines to these stakeholders to play their much-needed role in the growth of Broadband in the rural and remote areas and also brings out a case study from India.

To start with salient requirements of a generic business models for the same is discussed below:

A. CHALLENGES FOR RURAL BROADBAND DEPLOYMENT

Deployment of Broadband in rural areas is constrained by a multiple number of infrastructure, economic and social factors. The special type of challenges for rural Broadband deployment and their solutions are discussed below:

i. Nonexistent or Unreliable Electric Grid Supply

For operation of Broadband infrastructure, availability of reliable electric supply is must, but, most of the rural areas, all across the world, still do not have reliable grid supply. As an alternate, fossil

fuel based DG sets are extensively used. Due to high operational cost, logistics and spillages etc., this does not provide a sustainable solution to the power requirement. More over the use of diesel in the DG contributes in increasing the carbon foot print.

One solution appears to be in using efficient and low power wireless based architecture for Broadband network that can work on renewable/non-conventional sources of energy without depending upon the grid power supply/DG sets.

ii. Unavailability of Backbone Network Access the Country

Providing fiber based backbone in sparsely populated remote and inaccessible rural areas is a daunting task. Planning and laying fiber in such areas is time consuming and capital intensive activity and it does not make a business case in terms of return on investment on capital employed. In many developed countries, this activity is undertaken by the government by its own funding or through USO support, treating the Broadband Backbone as a National infrastructure. The same strategy is required for the developing countries as well as there are no alternatives.

Till such time fiber network comes into existence through the Government/USO funding, it is advisable to use terrestrial microwave or satellite based Backhaul in in-accessible areas as backbone for connectivity to the service provider's core network. The OPEX of satellite based backbone is much higher in comparison to terrestrial microwave based backbone and hence satellite based Backhaul is recommended only in locations where terrestrial types of backbone systems are technically-not-feasible (TNF).

iii. Computer Literacy and Access Devices Issues

A major part of rural population, by and large, are habitual of remaining the passive users of any technology without using the facility of interaction with the technology. They generally are not

confident to work with any interactive digital device to start with. The computer is a new device which most of the rural masses are unable to use without some training and supervision. Also, computer literacy without any immediate purpose related to day to day lifestyle of the rural masses does not become interesting. Hence, it is advisable to get these masses a comfort of familiar devices and applications to start with, followed by hands on training on interactive devices such as computer. Mobile phones with Wi-Fi connectivity or TV sets with Broadband connectivity appears to be an attractive starting option in such instances.

iv. Different Operation and Maintenance (O&M) Need

Requirement of network operation and maintenance in rural areas is entirely different from the densely populated high ARPU urban areas. Hence the retrofit of urban centralized and remote controlled network and business models of present day telecoms cannot serve the purpose.

For rural Broadband networks it is essential to use simplified and easy to maintain architecture with involvement of local communities/entrepreneurs to take care of operation and basic maintenance of Broadband system with some initial training in operation as well as service provisioning.

v. Non-Availability of Relevant Applications and Services

The rural masses are required to be provided with the solutions for their day to day problems to enhance their quality of life as well as opportunities for new businesses and employment in their own ambiance. The application and the services over Broadband are required to be tailored to meet their current and latent needs. This can only be achieved with the proper support and encouragement for local content and application development in their own languages. The Governments, the NGOs and local bodies should take the responsibility to support such activities and popularise relevant applications and contents in other similar communities/markets.

B. THE IMPLEMENTABLE SOLUTION FOR DEVELOPMENT OF RURAL BROADBAND NETWORK

For early adoption and deep penetration of Broadband in rural areas it is necessary to have technical solution that is low cost & easy to be managed and operated by the local communities/ entrepreneur and making use of existing backbone connectivity of main national/regional networks of telecom operators. The local communities/entrepreneur needs to be involved in the whole gamut of operation, maintenance, marketing, sales support and application etc. to take the overall responsibility for the business at local level.

For the Broadband backbone network, optic fiber is the best and future proof solution for Broadband connectivity with long term perspective. However, laying fiber cables is a time consuming and capital intensive activity. It needs to be funded by Government/USO agency and investment treated as sunk cost for the purpose of societal return on investment like any other national infrastructure such as highways, Railroads, Power and other public utilities, as discussed in previous chapter. To start with existing infrastructure of public sector telecom operators can be used on Revenue share basis.

For the access network, it is advisable and cost effective to go for wireless based Access system with different Backhaul solutions depending upon the terrain, geography and existing infrastructure, availability of conventional telecom system and backbone network etc.

Following Table depicts the suitability of different technological solutions depending upon the terrain, geography and basic infrastructures such as availability of grid power supply, backbone connectivity, population density, clustering of villages etc.

Table 5: Suitability of Technology Options for Broadband in Rural Areas

Technology Options / Local Conditions	Distributed Wireless Based Backhaul + Wi-Fi Access Working on Renewable Energy	Distributed Wireless Based Backhaul +Wi-Fi Access + Voice Working on Renewable Energy	Satellite Backhaul + Wi-Fi Based Broadband Access Working on Renewable Energy	Wireless Broadband Access Through Telecom Network Using Tv Set as Access Device	Wi-Fi Based Broadband Access With Fiber Backhaul
Rural and Remote areas with no grid supply and no telecom network	Yes Good for low OPEX and CAPEX	Yes Good for low OPEX and CAPEX	Yes Good for high OPEX and low CAPEX	NA	NA
Rural and Remote areas with no reliable grid supply but with mobile network	Yes Good for low OPEX and CAPEX	NA	Yes Good for high OPEX and CAPEX	NA	NA
Rural and Remote areas with no grid supply but with fiber Backhaul	Yes Good for low OPEX and CAPEX	Yes	NA	NA	Yes
Rural and remote area with grid power and mobile network	NA	NA	NA	Yes Ideal for TV owning households	Yes

In recent past, some of the innovative technology solutions specifically designed to cater for the special needs of rural areas have emerged. One such setup which is recommended is non-conventional energy based, Wi-Fi based distributed architecture type system which has potential to provide cost effective

Broadband access to the rural masses. One of such solution, discussed in the later part of report, at present, is capable of providing 100 Mbps capacity at each village with Wi-Fi Hotspot for Broadband access to customers. The whole system does operate on solar energy and does not fully depend upon grid supply or DG sets). The additional feature of such system is that it is easy to operate and maintain with minimum technical training.

C. MODEL BUSINESS CASE – IT IS ALL ABOUT OPEX (ROI)

In the absence of any possibility of needed ROI (Return on Investment) on the CAPEX, as well as restricted potential for revenue due to affordability constraint, the success of rural Broadband business will depend upon the Government's policy and regulatory environment, investment support and incentives provided by the local governments in creating underlying infrastructure as well as making use of the existing infrastructure of operators. Also, involvement of a local entrepreneur or community under public private partnership (PPP) model with an opportunity to create a business case through Government/Public funded backbone infrastructure is the key for sustainability of Broadband business in the rural areas. One option for this scheme can be involvement of an independent infrastructure provider, who creates the access node as "Managed Hotspot Service Provider" (MHSP).

Involving the local community/village local entrepreneur (VLE) which could be used in MHSP will require selection and basic training to a local entrepreneur in a village or a cluster of villages through schemes like "Skill India." Government/local bodies will be required to provide majority financial support for initial setting up of the infrastructure for Village Level Entrepreneur (VLE) and help this entrepreneur to get funding from the bank/financial institutions under the plans like "Startup India."

The VLE will become Franchisee/agent of an Internet Service Provider/Telecom Service Provider and will operate and manage Wi-Fi Access infrastructure, and work as single point of contact for

rural Broadband services, billing and customer support etc. VLE will also use this infrastructure to generate extra revenue scheme by providing various content, value added services and application services in addition to providing basic Broadband access at an affordable price point.

The Internet Service Provider (ISP)/Telecom Service Provider will provide the interconnectivity to the MHSPs access network through available Backhaul network to be created through Government/USO/Public funding in PPP mode. In absence of the existing backbone the operators may need to arrange for the satellite based Backhaul to the MHSPs network. Since the ISP/Telecom operators will get the rural franchisee/ VLE with established access network by MHSP and new market, at no cost to them, they could be motivated to provide services to the rural masses at incremental cost basis and share the revenue with MHSPs & VLEs based on the work done.

It is worth mentioning that some of the innovative rural Broadband network solutions are based on self contained, maintenance free, low OPEX, renewable energy based systems involving local entrepreneurs for basic maintenance and operation including managing the Backhaul connectivity and service provisioning. These solutions need to be emulated in the developing countries for the spread of Broadband in rural areas. Salient features of one of such solutions are depicted as **Annex-IV**.

Regarding regulatory intervention, the role of Regulator for growth of rural Broadband is tailor-made to be that of a promoter, to play a facilitating role and have to adopt a light-touch/hands-off approach to encourage innovation as well as cost efficiency. Also, the franchisee arrangement between the Telecom Service Providers and MHSP/VLEs has to be permissible without any onerous conditions or regulatory levy/tax. As an option which may be required for some of the developing countries, the regulator may create a category of "Class License" or VNO/PDOA for local players with simple registration process and with very light regulatory conditions

and obligations. One such example captured from a World Bank report is shown in Box 14 below:

BOX 14

Licensing Local Operators

Niche licenses for local operators allow specific solutions targeted for small towns. By this, Governments support local entrepreneurs and increase their sustainability by allowing revenues from on-net communications.

Vendors are developing solutions for such local-oriented models. Nokia Siemens, for instance, is currently testing its "Village Connection" model in India. This model allows entrepreneurs to manage a GSM Access point in their community. The Access point can manage call completion within each village (supporting up to 80 subscribers) with a standard personal computer, reducing investment and the need for communication with regional Access points (done in IP and only for long-distance calls). However, this model may not require the establishment of a local license regime if a franchise or reselling approach is adopted.

In the Dominican Republic, the Dominican Telecommunications Institute (Indotel), the regulatory agency, launched in 2007 a rural Broadband tender aimed at installing Broadband connections for 500 communities under an output-based aid (OBA) scheme. These points of presence have allowed local entrepreneurs that already were operating telecenters (known as "Informatics Training Centers") to work as local ISPs within their communities, offering Broadband Internet Access to private users and VoIP.

The main characteristic of this approach is that it gives the opportunity for local entrepreneurs to serve their communities with tailor-made solutions in a self sustainable manner, leveraging low-cost technical solutions and minimizing public funds requirements.

In India, recently heralded VNO regime is a timely step in that direction but falls short on making the process light handed and less expensive. Hence further liberalization is requires towards that.

To create a Business Model for Managed Hotspot Service Provider analogy has been taken Strategyzer Canvas having Nine Building Blocks which is shown in the Box 15.

BOX 15

The Business Model Canvas – Managed Rural Broadband Service Provider

<table>
<tr>
<td rowspan="2">Key Partners
• PSU Telcos
• Private Companies
• ISPs/TSPs
• Social Networking/ Content companies
• Investors, VCs
• NGOs
• Academic Institutions
• System Integrators</td>
<td>Key Activities
• Local Manufacturing & Sourcing
• Alliances & Partnership formation
• Proposal & Responses to EOI/Tenders
• Sales & Promotions</td>
<td rowspan="2">Value Proposition
• Low cost, Low power & Low maintenance (3L)
• High QOS & Coverage
• Multi-faced system
• Rugged, Rural, Outdoor fit
• Open platform (Standard Wi-Fi APs)
• Environment friendly green-solution DG-less)
• End-to-End IP platform
• Cloud server for localized content</td>
<td>Customer Relationships
• 24*7 Customer Care Centre
• Micro Operators/ VLEs
• Regional Sales Executives</td>
<td rowspan="2">Customer Segments
• Rural Retail Market
• Govt. users in villages
• Institutional users
• SOHO (Small Office Home Office)</td>
</tr>
<tr>
<td>Key Resources
• Investors & Venture funding
• Proven Technical Solution
• Innovative Business Model
• Passionate Management</td>
<td>Channels
• Micro Operators/ VLEs
• Co-branded outlets
• Partnership Telcos/ISPs
• CSC (Common Services Centers)
• Direct Sales</td>
</tr>
</table>

(Continued)

Cost Structure	*Revenue Streams*
• Manufacturing & Sourcing • Wi-Fi hotspot integration, funding, deployment, operation & maintenance • Employees & office • R&D & Training • Sales & Marketing	• Sales of Prepaid Vouchers to retail customers • Content/Application services revenue share • Postpaid Connections to institutions/ SOHO • Govt. Anchor usage payments receipts • Mobile Data offload revenues

Diagram based on template sourced from STRATEGYZER (https://strategyzer.com/):

Taking into account the learnings from previous chapters and the discussion above a sample business case has been prepared for a typical rural area to demonstrate how a Broadband network infrastructure can be commercially deployed and sustained as a business through joint efforts of stakeholders. This sample model with varying options and assumptions is described below:

Sample Business Model for a Typical Rural Locality of Developing Country

For successful deployment of the Broadband in the rural areas it is necessary for the respective government agencies/public institutions/ Telecom service provider to support local Village Level Entrepreneurs (VLE) and provide the backhaul connectivity at a subsidised cost Revenue Share.

(The technical solutions and business models for different rural areas will have to be selected depending upon the availability of existing infrastructure to reduce the cost of deployment with a sustainable business model for MHSP/Village Local Entrepreneur (franchisee) ISP/Telecom Service Provider (franchisor))

Case 1: Rural Areas with Telecom Infrastructure But No Broadband Connectivity

In such cases, it is recommended to use terrestrial microwave middle mile in unlicensed band (5.1 to 5.8 GHz) with Wi-Fi (2.4 GHz)

as Access node capable of working on alternate source of energy. Such solar energy based systems along with Li-Ion batteries are in use in some developing countries.

Managed Hotspot Service Provider (MHSP) Model

For provisioning of Broadband in such rural areas a MHSP in partnership with Telco/ISP, installs a 5 meter high pole/mast mounted microwave backhaul radio and Wi-Fi hotspot with solar panel and Li-Ion batteries along with BTS all in a box mounted on this mast. MHSP will appoint a VLE from Local folks for managing Hotspot. This VLE will be given basic training by the MHSP for regular maintenance and operation of Hotspot infrastructure and to provide Wi-Fi of assisted Broadband services to the villagers.

The VLE working as franchisee of MHSP, acts as single point of contact for all Broadband related products and services. VLE also takes the responsibility of digital literacy and assisted Broadband services (such as e-governance) to the rural masses. VLE will also use this WI-FI infrastructure for generating revenue through other activities (such as mobile charging providing rail-road ticketing, getting market prices of crops and assisting in doing business transactions, rural e-banking, help in getting medical facilities from urban health centres etc. to name a few).

Following Is the Gist of a Typical Business Model for Such Case

Different possible modes of funding for establishing rural Broadband business:

- *MHSP funded through Managed Services (CAPEX)/Revenue share (OPEX) route.*
- *Investment by VLE through microfinancing/startup fund.*
- *Subsidy by Government/Local bodies Contribution/Direct benefit to users through USO fund, Guarranted Revenue by the Anchor Users (Govt.).*

Key Benefits of MHSP Model Are:

VLE

- *Opportunity to become an Entrepreneur.*
- *Contributing to the village community for improving the quality of life, in addition to generate employment and livelihood for self.*

Village People

- *Assisted Broadband services at doorstep/hands.*
- *24/7 connectivity to the world wide web.*
- *Improved productivity efficiency and life study enhanced.*

A Typical Business Case for Broadband Access in a Village in India:

1.	**Assumptions**			
	Village Population (Typical)		2500	
	No. of Public Institutions/ SOHO		10	
	Backhaul Internet Bandwidth		10	Mbps
	Expected Broadband subscribers		150	in the first year to 300 in the 3rd year
	Initial Average Basic Revenue (ARPU)	INR	100	per month
	Revenue from other application services/Content	INR	50	per month
	Revenue from Institution/ SOHO Clients	INR	750	per month
	Typical Revenue/Month during first year	INR	30000	
	Annual Revenue	**INR**	**360000**	
	Capex per village Hotspot	**INR**	**300000**	**for additional equipments on existing Public/Telco infra**

2.	**Operating Cost per year (OPEX)**	**INR**		**Must be recovered (ROI)**
	Govt. levies & taxes	82800	23%	of Revenue
	Bandwidth Cost (existing infra)	90000	25%	of Revenue
	O&M & Depreciation	30000	10%	of CAPEX
	VLE Commission	36000	10%	of Revenue
	Financing Cost	30000	10%	of CAPEX
	Miscellaneous Cost	7200	2%	of Revenue
3.	**Total OPEX**	276000		
4.	**Annual Margin**	84000	23%	of revenue
5.	**IRR**	28	%	Margin/Capex
6.	**Payback Period**	3.6	Years	

By taking into consideration the depreciation, interest on the capital employed and taxes the cash flow and Earnings after tax becomes positive in the 4th year of the operation with IRR of 28%. Off-course during initial period, the revenue-deficit may need to be guarranted by some Govt. agency, acting as ***Anchor User*** *to de-risk the investment of MHSP, thus making it a compelling proposition.*

The business case gets improved further in case the regulatory levies & taxes can be forborne in the initial period or there can be some kind of support from USO fund/Govt. by way of guaranteed revenue initially. One such innovative model which makes use of the availability of VGF from USOF to compensate for ***affordability-deficit*** *through direct benefit to users to guarantee minimum revenue is illustrated in paper* ***Vision 2.0 for Rural Broadband by Mr. R. R. Yadava, ITS, who is a renowned expert on the subject (Annex III).***

D. PUBLIC DATA OFFICE (PDO) – AN INNOVATIVE LIGHTLY REGULATED BUSINESS MODEL

As, in India, the existing service providers are unable to reach and have no incentive to deliver public Wi-Fi in remote areas, a new breed of players specially the smaller local enterprenuers are

required to be facilitated to be part of the Public Wi-Fi ecosystem in remote and rural areas.

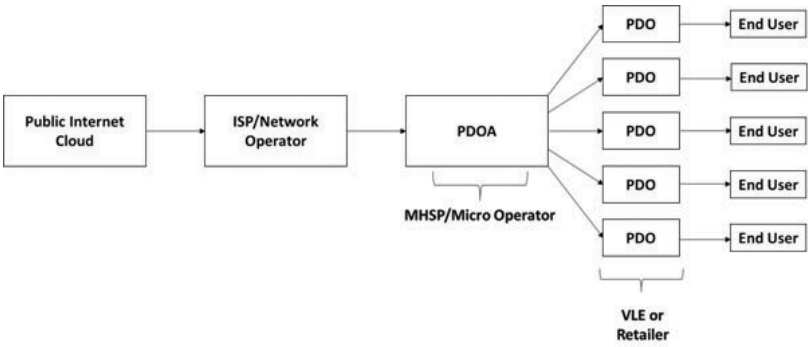
In this direction, the telecom regulator, TRAI has recommended a model which is quite innovative as well as unique to our requirements wherein an aggregator (may be termed as **Pubic Data Office Aggregator-PDOA**) can provide last mile Wi-Fi infrastructure and small entrepreneurs would set up **Public Data Offices (PDOs)** in local areas for customer access. The PDOA will facilitate multiple PDOs to provide public Wi-Fi services, without requiring a telecom license, as they will work mainly as the reseller for ISPs. PDOs will be venue owners and may not own or deploy any infrastructure and may not have the means or resources to actually implement a seamless interoperable system on their own. This is where the role of a PDOA comes in, PDOAs will be registered with the DoT and there will be no limit on the number of PDOs that such a PDOA can register[19].

Salient features of recommendation from TRAI are summarised as below:

- PDO owners will need to take care of user registration, but they can outsource payments, authentications and Wi-Fi equipment to "neutral" third parties.
- For payments, a PDO can use "national open Application Program Interfaces implemented for Aadhaar, eKYC (e-Know Your Customer), and Unified Payment Interface (UPI)."
- PDO owners need not get a license from the authority for providing Wi-Fi, instead, PDOAs can be mandated to register with the DoT.
- PDOAs will have to maintain a list of PDOs registered under it and share this information with the DoT.
- **A Wi-Fi hotspot device owned by a PDO could be pre-designed to perform eKYC, authentication, and record-keeping.**

- "As a user moves from one PDOA to the other, he should be able to use the Wi-Fi provided by the PDO of the new PDOA without having to go through the registration/ authentication process once again. Similarly, payment information setup with the first PDOA should be sufficient to make payment to the second PDOA."
- **In order to ensure seamless connectivity between hotspots, PDOAs can be allowed to store a device's MAC ID.** The PDOA must ensure privacy and secrecy of information shared with it by its subscribers and ensure that private data is collected with user consent.

PDOA-PDO Flow Diagram



TRAI recommended for implementation of this whole model using an innovative **Wireless Access Network Interface (WANI)** Architecture, which is basically an **Open Architecture** based concept, such that;

- Any entity (company, proprietorship, societies, non-profits, etc.) should easily be able to setup a chargeable public Wi-Fi Access Point.
- Users should be able to easily discover WANI compliant SSIDs, do one click authentication and payment, and connect one or more devices in single session.

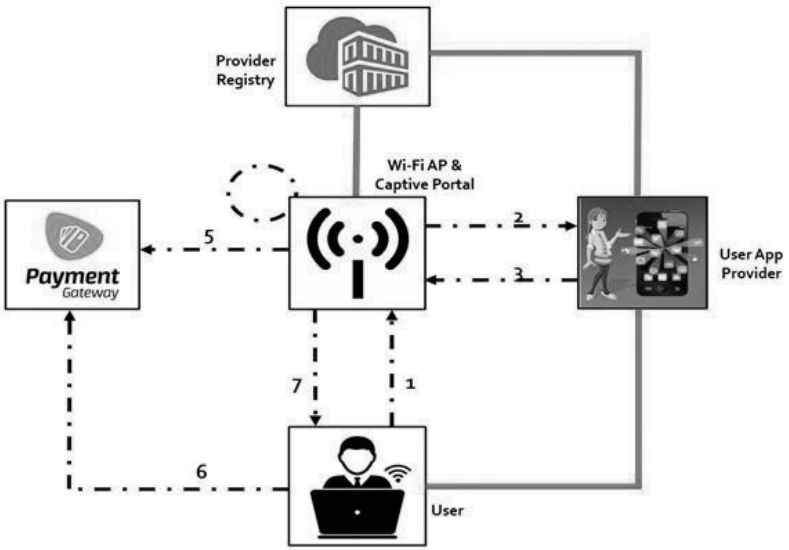
- The Experience for a small entrepreneur to purchase, self-register, set-up and operate a PDO must be simple, low-touch and maintenance-free.
- The products available for consumption should begin from "sachet-sized," i.e. low denominations ranging from INR 2 to INR 20, etc.
- Providers (PDO provider, Access Point hardware/software, user authentication and KYC provider, and payment provider) are unbundled to eliminate silos and closed systems. This allows multiple parties in the ecosystem to come together and enable large scale adoption.

Players in the Ecosystem of WANI Architecture

- **PDO/PDOA:** Any Indian entity (companies, associations, small merchants, etc.) having a PAN number wanting to provide one or more WANI compliant Wi-Fi hotspots to public using either free or paid model. They conform to the governing rules laid out by TRAI under this framework.
- **Hotspot Hardware/Software/Service Provider:** Any software or service provider who is providing necessary software, hardware, services, and support for PDOs to setup WANI compliant Wi-Fi hotspot. These can be any software/service provider, either Indian or global. It is expected that these providers will offer a Wi-Fi-in-a-box solution for PDOs. Their software will need to be compliant to specifications laid out in this document. They will also integrate with a bank or a payment gateway for collecting payment from user.
- **User App Provider:** Any company providing a software application and backend authentication infrastructure for users to signup, discover WANI compliant Wi-Fi hotspots, and do single-click connect from within the app. This

app allow users to create a profile, do their KYC (mobile verification), and allow setting up preferences for MAC-IDs for various accessing devices and payment methods. This app should allow users to discover WANI compliant hotspots and connect to it. In addition, App Provider must offer a backend user authentication service that is called by Wi-Fi Captive Portal software whenever user connects to obtain a signed user profile.

- **Central Registry of Providers (or Simply Provider Registry):** A central registry managed by DoT/TRAI or an entity approved by DoT/TRAI containing information about the PDOs/PDOAs, and User App providers in a digitally signed XML format. This is a relatively static registry where approved providers can manage their profiles. Actual specification of the registry is provided later in this document.



WANI Architecture

High Level Flows in the WANI Architecture:

One Time Flows

One-time flows are depicted in red lines in above diagram.

- PDO/PDOA completes Self-Registration with Provider Registry using their public certificate (for signature validation). They also register their Wi-Fi Access Points, SSIDs, and locations.
- User App provider is also registered with Provider Registry along with their authentication URL and public certificate (to validate their digital signature).
- User completes one-time KYC with App Provider through their App. User App caches trusted SSIDs from Provider Registry from time to time.

Usage Flows

Usage flows are depicted in dotted lines in above diagram. Bullet number below corresponds to the number depicted within the diagram above.

- User opens the App in which user has already registered and allows discovery and connection to WANI compliant Wi-Fi access points. Within the app, user browses for nearby WANI compliant SSIDs and then chooses one SSID to connect to
- Wi-Fi Captive Portal of the PDO initiates user authentication with App provider backend using the token passed from the app.
- App provider backend returns a signed user profile token back to Wi-Fi Captive Portal.
- Wi-Fi Captive Portal displays data packs available with their charges. User selects desired data sachet, click to confirm the terms.

- Wi-Fi Captive Portal sends request for payment through their payment gateway.
- User completes payment.
- PDO activates all device MAC-IDs that were part of the signed profile and allows them to connect to the session without additional authentication. Pack is activated, and user can begin browsing.

Access Point Discovery

- User App should allow users to discover nearby WANI compliant Access Points by detecting nearby SSIDs and verifying the MAC-IDs against the SSID Registry.
- In addition, optionally user App can provide location specific searches and allow users to discover "nearby" WiFi hotspots without being the WiFi range. SSID registry can be cached locally by app smartly for doing location level searches.
- App should also optionally allow users to save "favorites," "most recent," etc. for easy selection of regular connections.
- In addition, ideally App may also provide easy sorting and selection of access points based on the "Tag" attributes such as when AP is available, average speed, rating, etc. This allows users to select best AP within available selections.
- App must provide a mechanism for users to rate the access points and providers.

User Sign-Up and Management in WANI Architecture

Users are expected to use some software application (mobile/desktop/etc.) provided by the "App Provider" for user signup, KYC, and profile management. User App should provide

the following key features during user signup and profile management:

- Users install an app from the App Provider.
- App MUST capture user mobile number and does a mobile number verification (via OTP or GSM Mobile Connect or any other mechanisms).
- App also allows creation of mandatory "username" which is unique within the App Provider system. This is shared with Wi-Fi provider during authentication and used for audit and traceability.
- App should allow user to setup profile with additional **optional** attributes:
    i. *Email – user should be able to optionally setup email for getting alerts, etc.*
    ii. *Preferred payment address – This is ONLY for capturing UPI or Wallet address in the form upi://vpa/token (VPA is Virtual Payment Address for UPI collect transaction) or wallet://acc-no@ppi/token. App provider MUST NOT capture or store ANY sensitive information such as credit card number. All other types of payment will be directly handled by Wi-Fi Captive Portal.*
    iii. *If the User App is also a payment app (like UPI/Wallet app), then additional optional token string can be used to provide auto-deduct/offline/other additional payment functionalities.*
- App MUST also allow users to easily add/remove devices (MAC-ID and a name) which they want to connect to various Wi-Fi hotspots.
    i. *This allows the user to have more than one device to be connected to Wi-Fi hotspots within same session.*
    ii. *This is critical to allow IoT devices used by user to also connect using the common app and authentication. For*

example, by connecting the mobile phone to the Wi-Fi network, user may also connect his/her laptops or connected cars or other future devices.

iii. *Optionally app may also provide "device group" profiles to allow users to define named group of devices so that they can choose one group vs another during connecting.*

WANI Compliance Requirements

For Wi-Fi Provider

- Captive portal must allow standard connection and authentication as per this specification.
- Wi-Fi Provider must provide choice to user to select a package with clear details of the package.
- Captive portal should respect and handle preferred payment scheme for users and allow seamless collection of payment once the package is selected.
- Wi-Fi provider must comply and be certified with regulatory and security rules for payment transactions, auditing, and storage/handling of any sensitive payment information.

For App Provider

- App provider must provide an App to user (for any device/OS based on market needs) and comply with user sign up, profile management, and authentication specifications as per this document.
- App provider must ensure user data is strongly protected to ensure user privacy and data security is ensured.
- App provider must have a mechanism to allow regular app update and improvements.

App is encouraged to provide good user interface for consumers to easily discover, search, find best access points, and connect to it with single-click.

A policy change is still expected which will allow the reselling of data without an ISP license. Small businesses will be encouraged to become PDOs through a simple self-registration process in lieu of cumbersome licencing process.

The main objective of this, apart from creating connectivity, and access for all is also job creation. In the new policy, the government has outlined the vision of creating 4 million additional jobs in the telecom sector. And when we look at the kind of potential that WANI platform and the public data office and data office aggregator concepts alone represent. We can, indeed unleash huge employment potential, if we are able to put in place this architecture and make it available for people across the country.

E. RECOMMENDATIONS FOR VARIOUS STAKEHOLDERS

As has clearly come out from the study as well as discussions in the previous chapters the business of rural Broadband calls for creation of an all-inclusive ecosystem through the joint efforts of multiple stakeholders from Government, industry as well as community and NGOs needing more efforts from each player who has to **Walk- Extra Mile** through **PPPPP (People-Panchayat-Public-Private Partnership)** Taking into accounts the various learnings from the study. The action steps for different players are included in the executive summary in the beginning of this report.

Annex I
Public Funded Rural Broadband Projects in Developing Countries

Table: Argentina – Argentina Connected

Project Information	Description
Managing Authority	Strategic Coordination Commission with support from the Ministry of Federal Planning, Public Investment and Services and SECOM (the telecommunications NRA).
Project description and funding used	Project to triple the amount of backbone optical fibre infrastructure across the country, adding 30,000 Km of optical fibre cable (by 2015), funded by government grants. A mixed funding model, consisting of public outsourcing and public DBO. (AR-SAT) has responsibility for deploying and operating a core fibre network. AR-SAT subcontracts deployment via public outsourcing in certain regions where it does not have the capability to deploy fibre, and in large cities.
Broadband Objectives	Use the core and backhaul fibre network to provide regional connectivity and facilitate broadband access in unserved and underserved locations.

Project Information	Description
Other objectives and/or linked projects.	Part of a wider USD 1884 billion project announced in October 2010 to improve access to broadband-Netbooks were provided to 1.9 million students between 2010 and 10 July 2012 (according to Conectar Igualdad), as part of a project to deliver 3 million netbooks. A Digitally Literacy Program has also been implemented to provide PC and Internet training to communities.
Project Progress	The project is ongoing: as of June 2012, and 1000 Km of fibre had been deployed.

Table: Dominican Republic – Rural Broadband Connectivity Project

Project Information	Description
Managing Authority	Indotel (the telecommunications NRA)
Project Description and Funding Used	Provision of broadband access, residential and public telephones to 508 communities, mostly rural. The Tender was issued in August 2007 and the project was awarded in January 2008, with the aim of completing it by September 2009. The Rural Broadband Connectivity Project used its Universal Access Fund to support this project. However, the winning bidder for the project, Codetel, chose to use some unassigned spectrum that was available for no fee instead of opting for available funding
Broadband Objectives	Provision of broadband access, at leat 128 kibt/s, to 508 mostly rural communities using ADSL and Universal Mobile Telecommunication System (UMTS)

Project Information	Description
Other objectives and/or linked projects	In January 2012, Indotel held a public consultation for its Biennial Plan od Development Projects (2012–2013). The consultation included the potential to provide Wi-Fi access in public places and further develop the country's core fibre backbone and broadband access
Project Progress	By March 2011, 440 communities had been connected

Table: Kenya – The East African Marine System (TEAMS) Project

Project Information	Description
Managing Authority	TEAMS, a collaboration between the government of Kenya, Etisalat and other commercial organisations. TEAMS investors (actual stake in TEAMS, not TEAMS Kenya) include: Safaricom (17%), Telecom Kenya Limited (17%), Kenya Data Networks Limited (8.5%), Econet/ Essar Telecom (8.5%), Wananchi Group 4.3%, Jamii Telecom Limited (3.2%), Broadband Access/Access Kenya (1.1%) and Flashcom Limited (1.1%).
Project Description and Funding Used	Deploy a 1.28 Tbit/s submarine optical fibre cable between Fujairah, the UAE and Mombasa (Kenya). Government and private-sector.
Broadband Objectives	Provide International Data and Internet Connectivity.

Project Information	Description
Other Objectives and/or Linked Projects	The Government of Kenya initiated a programme of schemes in 2009/2010 with the aim of promoting availability of broadband services across Kenya: • Provide ISPs with access to the submarine cable over 20-year period, and offset the cost against taxable income • Create and support Digital Villages (in partnership with the World bank) • Provide USD100 million investment in mobile computer laboratories for secondary schools • Enable telecommunication equipment, including cabling, to be depreciated by 20 per cent instead of 12.5 per cent • Exempt all handsets from VAT In May 2012, the government of Kenya announced a plan to deploy an open-access LTE network by 2013 using a PPP, but a definite decision will only be made following the forthcoming elections, due in March 2013. The cost of the project, USD 500 million, needs approval from the Ministry of Finance.
Project Progress	The submarine cable was launched in July 2010.

Table: Latvia – Next-Generation Network for Rural Areas

Project Information	Description
Managing Authority	Latvia State Radio and Television Centre (LVRTC), not for-profit public enterprise (100% A state ownership), managed by the Ministry of Transport.
Project Description and Funding Used	Deploy a regional backhaul/core network, funded entirely by the ERDP.
Broadband Objectives	The roll-out a network to support improved broadband access in rural locations. The network will remain in public ownership, but a private-sector organization is responsible for constructing, maintaining and administering the network. LVRTC is responsible for managing wholesale service provision to service providers.
Other Objectives and/or Linked Projects	Latvia 2030 Sustainable Development Strategy of Latvia 2030 and National Development Plan 2007 to 2013, to increase Latvia's competitiveness through sustainable development including the provision of broadband access, and innovation in R&D.
Project Progress	Project is ongoing, first phase due for completion by 2015.

Table: Lithuania – Rural Area IT Network (RAIN)

Project Information	Description
Managing Authority	Non-profit public enterprise, A 'Joint Activity Partnership Agreement' between the Ministry of Transport and Communications and Public Enterprise Pladajuostis Internetas (PEPI).
Project Description and Funding Used	Deploy a nationwide backhaul and core network, using government grants as well funding from the ERDF.
Broadband Objectives	To provide improved connectivity to existing access infrastructure to support improved broadband access.
Other Objectives and/or Linked Projects	Lithuanian Information Society Development Programme 2011 to 2019, to increase the number of Internet users and ICT usage in Lithuania and development of digital content and services.
Project Progress	Project Ongoing. The network is due to be completed by March 2013.

Table: Malaysia – National Broadband Initiative (NBI)

Project Information	Description
Managing Authority	Malaysian Communications and Multimedia Commission (MCMC) (the telecommunications NRA).
Project Description and Funding Used	The National Broadband Initiative (NBI) to improve broadband access nationally was announced in October 2007, and comprises two projects: The High-Speed Broadband (HSBB) project will deploy FTTH to the main economic areas of the country. The Broadband to the General Population (BBGD) project targets other areas using ADSL and wireless HSPA and WiMAX. HSBB is funded through government grants. BBGP is funded from the USF.
Broadband Objectives	The HSBB aims to deliver download speeds of between 10 Mbit/s and 100 Mbit/s in the major economic areas, and the BBGP aims to provide download speeds of between 256 kbit/s and 10 Mbit/s in other areas. Aiming for 75% penetration by the end of 2015.

Project Information	Description
Other Objectives and/or Linked Projects	The Malaysian government has adopted a national programme, which known as Digital Malaysia, which will assist th ethe country to become a digital economy by 2020. The programme is built on three strategies: one of these strategies is 'supply to demand-focused', which includes the NBI initiative. Other initiatives are designed to stimulate demand for broadband access. USF has also been used for the construction of CBCs and Community Broadband Libraries (CELL which provide communities with access to computers, broadband services and IT training.
Project Progress	HSBB achieved 1.2 million premises passed in 2011, up 53% on 2010, and according to Telekom Malaysia the project was on track.

Table: Mongolia – ICT Infrastructure Development Project

Project Information	Description
Managing Authority	Communications Regulatory Authority (CRC) and Information, Communication Technology and Post Authority (ICTPA).
Project Description and Funding Used	Output-based funding, using a USF and external sources from the government of Japan and The World Bank.
Broadband Objectives	Provision of broadband services using Wi-Fi to provide access in rural communities. Using Wi-Fi to provide access in rural locations, flubbed to Ulaanbaatar by a very small aperture terminal (VSAT) satellite link or other pre-existing core fibre. 34 prime district centres have broadband Internet access for public and private users at the same tariffs as in the capital, Ulaanbaatar; schools are connected at discounted rates, and in all of these 34 communities people are benefitting from access to public Internet cafes.
Other Objectives and/or Linked Projects	e-Mongolia National Programme 2004 to 2012 and ICT Vision 2021, including programmes to develop a knowledge-based economy by improving the availability of broadband access, stimulating demand for broadband access by providing free PCs to rural areas, digitise government and health content and develop e- government services.
Project Progress	Launch initial pilot and provided Internet access to 34 soums in 2010.

Table: Pakistan – USF Broadband Programme

Project Information	Description
Managing Authority	USF company, overseen by Ministry of Communication Technology (NRA).
Project Description and Funding Used	Improve broadband access through the provision of government grants from the country's USF. Broadband defined as 128 Kbit/s download speed Programme commenced in 2007.
Broadband Objectives	To deploy broadband access to unnerved urban areas and rural communities, using ADSL and wireless HSPA and WIMAX, and a nationwide backhaul and core network to provide improved connectivity to all Tehsils (administrative districts).
Other Objectives and/or Linked Projects	The project is also being used to provide telephony and telemedicine in rural areas. Operators that succeed in winning finding to deploy broadband access in unserved and underserved urban and rural areas are obliged to construct EBCs and CBCs, by June 2012 1,000 and 300 had been deployed respectively. These centres provide students and communities with access to computers, which they would be unable to access using their own financial means. Access to these centres is anticipated to provide improved access to e-health, e-government and other services.
Project Progress	As of July 2012, 12 contracts signed by USF for over 430,000 broadband connections (broadband programme) in 44 un-served districts and six contracts for 6,523 km core fibre network to provide access in 102 unserved Tehsils.

Table: Paraguay – National Telecommunications Plan (PNT)

Project Information	Description
Managing Authority	Comision Nacional de Telecomunicaciones (Conatel) (the telecommunications NRA).
Project Description and Funding Used	Use its Universal Service Fund to subsidize network roll-outs to underserved and unserved areas (optical fibre cable, ADM_ and mobile), but also promote sharing of infrastructure (e.g. towers) and collaboration between companies to deploy fibre to municipalities—specifically for fibre, RFP issued in 2011).
Broadband Objectives	Deliver broadband access to unserved and unserved locations, with a minimum speed of 512 Kbit/s.
Other Objectives and/or Linked Projects	Investment part of a wider PPP project to increase mobile teledensity and fixed-line penetration.
Project Progress	In December 2011, an RFP was issued fora core optical fibre network project, but none of the bids was accepted because bidders wanted to use technologies other than fibre. The project is ongoing.

Table: Qatar – Q.NBN Project

Project Information	Description
Managing Authority	Q.NBN (Qatar National Broadband Network), which is part of Qatar National ICT (Information and Communication Technology) Strategy 2015 and Qatar National Vision 2030.
Project Description and Funding Used	Accelerate the deployment of FTTH using government funds.
Broadband Objectives	Deliver coverage in excess of 95 per cent of households and businesses by 2015 (100 Mbit/s). A passive infrastructure deployment using existing operators' or other organizations' infrastructure (for example duct space), providing equal access to all operators. Q.NBN is responsible for setting wholesale prices nationally in order to ensure the retail price of broadband access is minimized.
Other Objectives and/or Linked Projects	Qatar National Vision 2030 and Qatar ICT Strategy 2015. A number of other initiatives are being used to support the take-up of F7-I services, including promoting the adoption of cloud computing and ICY adoption by businesses and the government, as well as running training programmes to provide people with ICT-skills.

Project Information	Description
Project Progress	Since formation in March, 2011 Q.NBN singed a number or agreements with operators to support the roll out of the FTTH network: • in September 2010, signed an agreement to install FTTH using with the Barwa City's project ducts. In March 2012, a total of 6,000 units were connected, enabling operators to use the FTTH infrastructure and provide services, including telephony, broadband Internet access and other data services. • in April 2012, signed an agreement to access Qtel's duct network and other passive infrastructure until 2032. • in May 2012, signed an agreement with Vodafone, providing it with access to wholesale services.

Table: Saudi Arabia – Universal Service Project

Project Information	Description
Managing Authority	Communications and Information Technology Commission (CITC) (the telecommunications NRA).
Project Description and Funding Used	Universal service fund used to provide grants to operators to provide Internet access to unserved and underserved locations.
Broadband Objectives	Deliver a minimum of 512 Kbit/s to unserved and underserved locations.
Other Objectives and/ or Linked Projects	Provide voice access to unserved and underserved locations.

(Continued)

Project Information	Description
Project Progress	Four projects funded to deploy broadband access to underserved locations. Three operators – Mobily, Zain and Saudi Telecom (STC) – have used 3G to provide wireless access.

Table: Slovak Republic – National Broadband Project

Project Information	Description
Managing Authority	The Government Office of the Slovak Republic and the Telecommunications Regulatory Authority. The network is owned and managed by the National Agency for Network and Electronic Services (NASES), a non-profit public enterprise.
Project Description and Funding Used	Deploy a regional backhaul/core network funded by the Slovak government, the ERDF and operators.
Broadband Objectives	To support improved broadband access in white areas, rural and other unserved areas. The network will remain in public ownership under NASES. NASES is responsible for managing wholesale service provision to service providers, with wholesale rates determined in conjunction with the telecommunications NRA.
Other Objectives and/or Linked Projects	Operational Programme Information – Society 2007 to 2013, a programme to develop a knowledge-based economy, including the broadband project above, the implementation of government e-services and digitization of content.
Project Progress	The project is ongoing. The network is due for completion in 2015.

Annex II
Wi-Fi Broadband Solution for Rural and Remote Areas

CASE STUDY – Blue Town– Denmark

RURAL BROADBAND ACCESS INNOVATION-HOTSPOT AS A MANAGED SERVICE

Satya N. Gupta
BlueTown, Denmark

BlueTown
Connecting the next billion
www.bluetown.com

INTRODUCTION

BlueTown is a Denmark based innovative technology company, focused on rural area communication solutions. BlueTown has developed an end-to-end communication platform, specially designed for the needs and conditions in rural villages of the developing nations. The solution provides out-of-the-box access to the Internet, via a low-cost mobile telephone without the need of a SIM card, or any other IP device. The solution is based on cost efficient standard technology with low maintenance, which is easy and fast to deploy, and includes own power supply based on solar panels and rechargeable batteries.

BlueTown has developed an integrated, miniaturized, low-powered low cost Wi-Fi Access Point Controller. It is powered by solar panels and re-chargeable lithium-ion batteries. With the power requirement of the complete setup of less than 20 Watts this setup can provide un-interrupted broadband access for up-to 30 hours without any charging.

Salient Features

The AP controller provides functionalities of power control, charge control, RF control, RF control, bandwidth management, quality, security and authentication management as well as POE for APs. In its functionality it is similar to BSC of a cellular network and facilitates the creation of a managed Wi-Fi Hot-spot, while utilizing off the shelf outdoor Aps.

- BlueTown platform will be connected to existing infrastructure (mast or fiber), and a partnership with local service and infrastructure providers
- Users connect to the BlueTown Base Station via Wi-Fi with more than 1 km in range
- Users connect via traditional handsets or the BlueTown dedicated handset
- BlueTown engages with local micro-operators to take care of the base station, selling prepaid broadband coupons and acts as BlueTown/ISP agent; thereby generating employment opportunities.

Support for Digital India Mission

"To Create an inclusive knowledge society through proliferation of affordable and high quality Broadband services across the Nation"

- Digital India Mission envisages to connect the Rural India on optical fibre; from Block Level to Gram Panchayat Level
- Missing Link is access to "Hand Deliver" the services to rural India (Bharat)
- BlueTown wants to play a major role in "Hand Delivery" of broadband service to Rural masses
- BlueTown with its innovative solution will create public Wi-Fi hotspots and deliver the High Speed Internet Access in the hands of rural countrymen

CASE STUDY – Blue Town– Denmark

BlueTown Business Model and Project Details

BlueTown is focusing on a innovative business model with the ISP/Telco. BlueTown shall partner with the ISP/Telco as a Managed Hotspot Service Provider (MHSP) and provide "Last Mile as a Managed Service" without any CAPEX requirement from ISP/Telco.

With the introduction of such concept the ISP/Telco can focus on their core areas and additionally utilizing their existing infrastructure to provide end to end high speed broadband access for end users in cost effective, timely and affordable manner; whereas BlueTown shall invest in the creating the last mile access for Broadband in the rural parts of the country. The ISP/Telco can ride on BlueTown's last mile and provide broadband services to the end user in a cost effective manner without any CAPEX.

When we talk about the potential of this business case in Rural India; it has got immense potential. About 70% of the population in India resides in the rural part of India and there is no data connectivity option available in rural India.

Pilot Project Description

Last-mile Broadband Access through Wi-Fi based solution in two Gram Panchayats of Ajmer i.e. Arian and Dadiya at NOFN pilot project sites were implemented using innovative solution of BlueTown consisting of miniaturized Access Point Controller powered by Lithium-ion batteries and outdoor Access Points. The existing mobile tower of BSNL which were around 250-500 meter in the vicinity of NOFN fiber termination location were used. The billing and authentication server was installed at the BSNL datacenter at Ajmer. A range of radius around 1 km could be achieved while complying with the transmitted power restriction of WPC. The requisite security and authentication conditions were met in all respects.

Comments on Scalability

Facility of Wi-fi off-loading and Wi-fi roaming(Hotspot 2.0) can also be implemented in the Wi-fi Access Point Controller to de-congest the scarce 2G/3G spectrum.

Challenges Faced

- The NOFN fiber termination room not co-located with BSNL towers and hence needing back-hauling of NOFN connectivity to the BSNL tower (through 5 Ghz Wi-Fi unlicensed link)
- Local power supply very erratic and hence need for solar backup

Best Practices

- Use of miniaturized Lithium-ion batteries in the project having 30 hours capacity without charge.
- Miniaturized, integrated and PCB based Wi-Fi access point controller powered by solar power and supporting the functionality of Web Camera.
- Extremely low voltage (16V) and power consumption (20W) for Access Point Controller and outdoor Access Points.
- Use of existing infrastructure of BSNL/BBNL/CSC to reduce the CAPEX.

Lessons Learned

- As power supply is the major issue and concern in the villages we learned that solar panel is the best solution for powering up our low energy miniaturized solution with Lithium-ion battery backup.
- Need for remote access of Controller to avoid need for local O&M at each Gram Panchayat.

Live Case Study

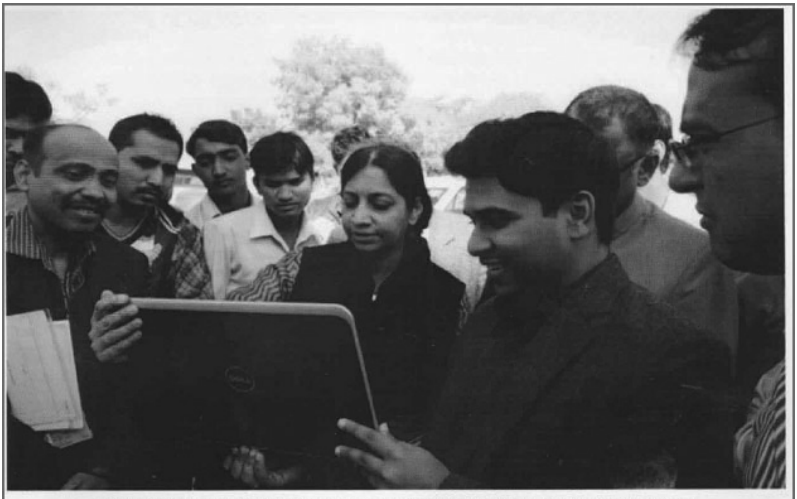
- BlueTown have already successfully conducted trials of this solution in partnership with BSNL & BBNL
- Trials have been running successfully at 3 locations (Arian, Dadiya & Tilonia)

Way forward-Recommendations

- Deploy more and more Managed Hot-spots in Rural areas on Revenue-share basis by using existing infrastructure to provide carrier grade public broadband access.
- Make more Wi-Fi spectrum unlicensed in 5.1-5.3 GHz band.
- Allocate trial spectrum for White-Spaces (Digital-Dividend)

CASE STUDY – Blue Town– Denmark

- Provide VGF (Viability Gap Funding) for rural access network in line with National Backbone Network (NOFN) and mobile telephony in NE/LWE areas.
- Involve local bodies (GPs, Municipalities) as stakeholders.
- Facilitate " Make in India" of Wi-Fi Access Point Controllers and other modules.
- Create a Social Business for " Blue-Collared Job Factory" to train VLE.
- Let us "Make It Happen" together (USOF, PSUs, Industry), PPPP (Panchayat, Public, Private Partnership)



BBNL CMD Mrs. Aruna Sundarajan experiencing the BlueTown Wi-Fi access from rural roadside

Annex III
Vision 2.0 for Rural Broadband

R. R. Yadava, ITS

Mr. R. R. Yadava, *having 17 years experience in the field of telecom is among the conceptualization of the network for BharatNet, having varied knowledge in the field of Optical Fiber Networks, Transport Network and Satellite communications. He inhibits rural background and easily translates his telecommunication skill and rural background into the techno-commercial solutions for the rural requirement. He is well experienced in execution of the various USOF schemes.*

Background

Reach of the broadband connectivity to every citizen is the need of the hour. Government is promoting Digital India by tooth and nail. Promotion of cashless transactions fully depends upon internet connectivity to every citizen irrespective of age and geography. To empower youth through seamless connectivity to everyone irrespective of city, urban, rural, hilly, deserted, etc. Vision 2012 of the Telecom Department envisages, "Right to Broadband for every citizen." The move of the government to build up BharatNet to connecting 250,000 Gram Panchayats with OFC network is a marvelous step towards Right to Broadband. By this approach, nearly 250,000 High Speed Broadband nodes will be created. From this point of Broadband's presence, all Telecom Service Operators based on commercial viability, can setup Outdoor Telecom Access

Infrastructure for providing First Mile connectivity between the customers and networks. This part of Network connectivity from city up to Gram Panchayats can be termed as **Vision 1.0 of the Rural Broadband**.

The expectation of the government that Telecom Service Providers will built outdoor telecom infrastructure to deliver broadband connectivity within each Gram Panchayat, having sufficient commercial potential and viability had not been converted into reality. Even through prosperous villages of Kerala have been connected long back but no operator, evidenced, turned up for roll out of services to the hands/homes of the people. There may be many reasons, one of them most mentioned about is the commercial viability for CAPEX and OPEX. Further it is learnt that there are resentments that one side Government is levying taxes for the facilitation of the rural telecom services and have collected significant amounts in the Universal Service Obligation Fund (USOF) of the Department of Telecommunication which are yet to be utilized for rural broadband services and other side Government is expecting since long that Industry should turn up and set up network without further support except under Vision 1.0 as stated above. They are further stating that USOF is having sufficient funds left even after Ear-marking of Rs. 20,000 Crores to Rs. 30,000 Crores for the completion of Vision 1.0 Broadband Network as it is getting recurring revenue by levy of 5% of the Telecom AGR of the country. This fund can be utilized to trigger the rural Broadband ecosystem of the country. It is to be stated that waiting time of the rural population for getting empowered with Broadband services has extended enough and service roll out is becoming essential now due to recent move on encouraging cashless transaction by the Government. This is essential to provide the broadband connectivity to every citizen, even they are in rural but who will take the first initiative, Government via USOF support to rural or Telecom Service Providers seeing highly viable business and comparable to urban clusters. We can term this as Vision 2.0 for Rural Broadband.

Vision 2.0 for Rural Broadband

Presently Telecom services in India are totally provided on the basis of the commercial viability basis since Government is not directly involved in telecom operation. The two Government Sector PSUs BSNL and MTNL operating on exclusive geographic basis are having mandate to operate the services on self-sustaining basis. That means assessment of viability is applicable to them also before launching any service in any geographical area. No Operators including Government PSU have come forward for rural broadband by their own assessment of viability. This indicates that the voices of the operators as stated above have some tangible reasons. The suggestion of the operators that the funds of USO can be utilized for rural broadband needs to be explored further;

Analysis of USO Fund objectives and utilisations:

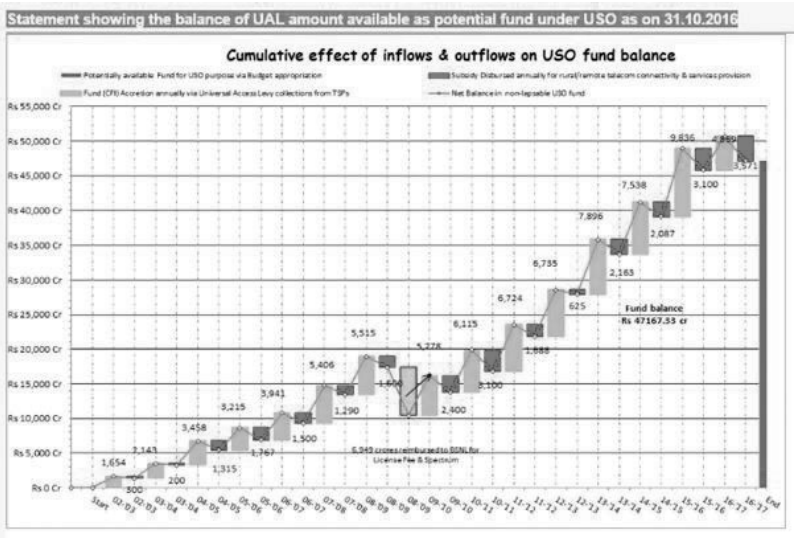
As per the USOF website, under the heading, "What we do," USO claims that they provide widespread and non-discriminatory access to quality ICT services at affordable prices to people in rural and remote areas. They provide an effective and powerful linkage to the hinterland thereby mainstreaming the population of rural and remote parts of the country. They ensure that universal services are provided in an economically efficient manner. They ensure by developing hitherto unconnected areas, the benefits of inclusive growth are reaped by our nation, bringing in its wake rapid socio-economic development and improved standards of living.

Under the heading, "For Whom" they declare that this is for the people in rural and remote areas of the country where ICT services are not available due to commercial non-viability on account of various combinations of reasons such as: Sparse population, Remoteness of areas, Absence of supporting infrastructure (power, road etc.), Low income of inhabitants, Insurgency, difficult terrain. It is here that USOF Administration steps in to provide subsidy support thereby incentivizing Telecom Service Providers to venture forth and provide services to such target beneficiaries. Under the heading, "Why We Do," the steps where there is

market gap or failure at current competition or market is under maturity and ICT Services cannot be provided. They fill the access gap if prohibitive cost of service provision or infeasibility due to society's expectations of 3A's (availability, accessibility & affordability) and 'Beyond 3A's i.e. fairness, equity. They also bridge Rural – Urban digital divide and socio-exclusion & economic-lag of rural citizens due to Market & Access Gap. Lack of a business case for telecom companies due to higher capital cost of providing telecom services in rural and remote areas. The steps in those areas also were generation of lower revenue due to lower population density, low income and lack of commercial activity. Thus, normal market forces alone would not motivate the telecom sector to adequately serve backward and rural areas. This is because of the Government's constitutional obligation to grant Services to every citizen irrespective of socio-economic considerations & geographical location.

From above it clear that the demands of the Telecom Service Providers that USOF should be utilized for rural Broadband are also in the sync of the objective of the USOF as explained by them under the headings of, "What to Do," "For Whom" and "Why to Do." Then question arises that where is the missing link in the system to trigger the rural Broadband, using the BharatNet, a rural Broadband backbone network. Immediate attention comes towards availability of the funds with USOF to deal with this massive rural broadband funds requirements and constraints there in terms of ongoing projects.

The statement showing the balance of UAL amount available as potential fund under USO as on 31.10.2016 is an eye opener to every telecom experts for lagging the rural broadband to the national average while availability of ear-marked funds with the responsive organisation with little spends. The charts, which is reproduced below, states that net balance in non-lapsable USOF is about Rs. 45,000 Crore at this time. They get addition of about Rs. 9,836 Crore in the last financial years while maximum spending is about Rs. 3,571 Crores.



As per data on the USOF website it is stated that the, "Potentially available fund is Rs. 47167.33 Cr." An assessment is required that how these funds can be utilised to meet the crisis like situation in the rural due to cashless imposition by the Government while broadband access infrastructure for first mile is not yet ready through any service providers. the Government needs movement like Jan-Dhan account opening in the record numbers in a limited period by participation of every public and private banks of India. Similar move is required in the telecom sector where Public (BSNL) and all Private operators can be roped in the rural broadband penetration on non-discriminatory basis among operators. Move should also need to consider, so that technological competition can also be achieved. One of such scheme is suggested below which meets the Operator-neutral-technology-neutral; aspects and having potential to rope all bigger, small operators and new innovative companies into the roll out of the rural broadband and move towards the achieving the goal of "Right to Broadband."

Scheme of 100RRB, 100Rs. Per Month Per User of Rural Broadband: We all are aware that Government is providing/ going to provide 100Mbps Broadband backhaul in every 250,000 Gram Panchayat of the country under the BharatNet

project. Now time has come for Government to come forward with a benefit scheme of Rs. 100 per month per rural broadband user. This benefit will be reimbursed to the customer's account/ mobile Wallet/electronic account or any registered eValet service provider linked with Aadhar number and Phone number. The fund of the USOF can be utilized as there is sufficient fund with them for the rural telecom growth as stated and depicted in the chart above.

Target Rural BB Penetration by 50 Million by 2020: Although making a sweeping statement like "Right to Broadband" or targeting of achieving millions of broadband customers without any implementable plan is just a talk but it needs to be delivered. Many previous millions of targets by prominent intellectuals can be seen floating on the internet in the form of presentations, write ups, white papers but without implementation plans and realistic approaches. Here it has been tried best to provide essential aspects of the implementation of the 100Rs. Rural Broadband Scheme (100RRB scheme) as below:

1. **Scheme Funding:** USOF should come forward with the scheme of 100RRB, Rs.100/- per month per rural broadband customer subsidy paid directly to customer Aadhar linked mobile number/broadband connection number/Aadhar linked eValet/Aadhar Linked Paytm account etc. Detail funding support and expected Rural Broadband customer growth is tabulated below. It is expected that it will attract 50 Million rural broadband customers by the end of 2020 with monthly out go of the USOF of Rs. 500 Crores/month. It depicts the expected yearly rural customers' growth and funding subsidy support.
2. **Validity of Scheme:** Five years (2016 to 2020).
3. **Outcome:** 50,000,000 (50 Millions) Rural Broadband customers by 2020 using NOFN.
4. **Eligibility:** All rural Broadband Users.

5. **Assurance of Ruralness:** Address on the Aadhar card. KYC submitted to the Operator and copy pass on to the disbursing agency.

6. **Assurance on Usage of Broadband:** Monthly subsidy will be reimbursed on the start of the second week of the month based on the data received from the respective operator containing mobile number, MAC address of the ONT used under BharatNet and data usage in the month.

7. **Neutrality and Agnosticness:** The Scheme proposed is fully technology-neutral, operator agnostic and complies to the fundamental principles of Net – Neutrality. Customer will choose the operator. Customer is the king. No direct funding to the operator. Any operator, TSP/ISP/telecom licensee can set up network in rural using BharatNet middle mile backhaul to provide Broadband services.

8. **Technical Provisioning:** The backhaul network of the Service Provider can be support by NOFN/BharatNet in aggregation layer from Point of Presence in Panchayat to the Block where the core network of service provider will be terminated on the 1Gbps optical port of the OLT. The location address will be published and updated regularly for new commissioning on the BBNL and USOF websites. Similarly, 100Mbps Ethernet port in the GPs will be used for backhaul to the Outdoor Access Network of the service Provider. The list of corresponding GPs parented to particular OLT with address and lat-long will also be published on the BBNL and USOF websites and updated based on commissioning of new GPs. Actual Bandwidth provisioning will be as per tariff plan of BBNL published on BBNL website and amended time to time.

9. **Monitoring:** Monthly customer, logs containing Aadhar number, data usage, MAC of ONT for surety of usage. Monthly customer detail can also be collected according to the TSP/ISP License agreement.

10. **Monitoring and Verifying Agency:** BBNL should be monitoring and certifying agency. The NOC of the BBNL will provide the used MAC and customer details also.

Annex: Expected Rural Broadband Customers and Fund Analysis for the 100RRB Scheme:

	Mar-16	**Mar-17**	**Mar-18**	**Mar-19**	**Mar-20**
Expected GPs Roll out in all expect including ONT Commissioning under BharatNet	5000	60000	100000	200000	250000
Average No. of Household in the GPs	655				
Corresponding Total average HH covered under NOFN in Lakhs	3.275	39.3	65.5	131	163.75
Outcome: Effective House Hold (HH) in Lakhs (Excluding 40% HH weaker section assuming no Smartphone/laptop)	19.65	23.58	39.3	78.6	98.25
Rural Broadband Take Rate	10%	20%	30%	40%	50%
Expected RBB customers provisioning using BharatNet by all TSPs/ ISPs in Lakhs	1.965	47.16	11.79	31.44	49.125
USOF Subsidy per customer per month (Rs.) under 100RRB Plan	100	100	100	100	100
Total Subsidy disbursed under 100RRBB connection/Month provisioning using NOFN (Rs. Cr)	1.965	47.16	117.9	314.4	491.25
Fund Flow (Rs. Cr)	Mar-16	Mar-17	Mar-18	Mar-19	Mar-20
USOF disbursement to customers under 100RRB Plan (Rs. Cr)	1.965	47.16	117.9	314.4	491.25

(Continued)

	Mar-16	Mar-17	Mar-18	Mar-19	Mar-20
Expected revenue to TSPs/ISPs from rural BB using considering Average Rs. 100/-month additional investment by the individual customer, so for Rs. 200/ARPU	3.93	94.32	235.8	628.8	982.5
5% USOF Levies (Rs. Cr)	0.197	4.716	11.79	31.44	49.125
3% License fee for DOT	0.118	2.83	7.074	18.864	29.475
14.5% Govt for service tax and swatchh Bharat Tax	0.57	13.676	34.191	91.176	142.463
Expected Revenue to BBNL (assuming Rs.7000/per port 10 Mbps and atleast two port for TSPs/ISPs in each GP	7	84	140	280	350
Funding required to BBNL from USOF to sustained the operation of NOFN	14.1	169.2	282	564	705
Total income to USOF from telecom sector					
Total annual telecom sector revenue (Rs. Cr)	125000	126000	127000	128000	130000
5% USOF Levies (Rs. Cr)	6250	6300	6350	6400	6500
Expected Accumulative Funds with USOF (Rs. Cr)	42234.053	48320.523	54277.697	59818.161	65151.386

Annex IV
Everything on Tower (EOT) – Creating Hotspot on Rural Tower

Satya N. Gupta

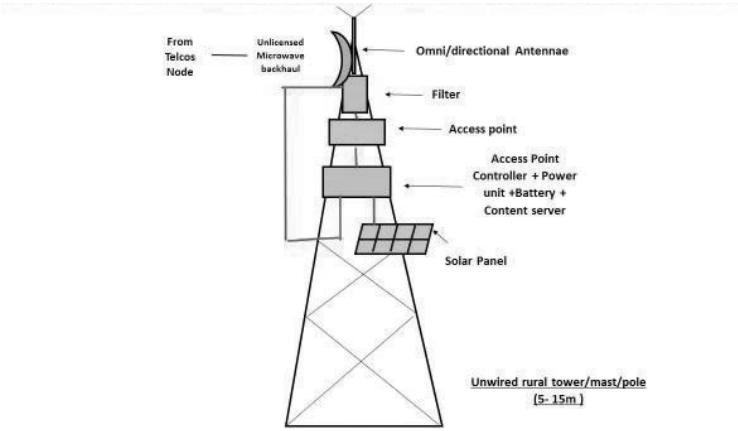
1. ABSTRACT

As a part of Digital India mission of the government to make "Broadband for All" a reality in the near future there is a great buzz about Wi-Fi everywhere specially in urban areas wherein people are expecting free Wi-Fi access in times to come. Though there is not much talk about rural Wi-Fi. EOT concept appears to be the only solution to provide broadband access to rural masses in a cost effective, timely affordable & sustainable manner. For making delivery of high speed broadband access in the hands/homes of rural people some very low cost, low power & low maintenance technical solution is required which can reduce the cost too minimum possible by making use of existing infrastructure and unlicensed spectrum which is free. Also in many villages of rural India there is acute shortage of grid power supply which is also highly unreliable. In addition, there is unavailability of suitable indoor space for installing the network equipment's and keeping it safe and secured. Due to all the above challenges there is a perceived lack of a business case for rural broadband access and that is why not many players are talking about it. This paper brings out an innovative concept which can lead to a sustainable business model of hand delivery of broadband access to rural masses.

2. INTRODUCTION

"Everything On the Tower (EOT)" is an innovative concept which brings out a solution for creation of a public Hotspots for use of the telecom service providers to enable them to provide much needed broadband access to rural masses as a business case without any perpetual subsidy. It is based on the availability of subsidised internet backhaul as a part of NOFN project of Govt. and making use of abandoned/discarded telecom towers of MARR legacy or some other existing structure of around 10–15 metres height. This makes use of an innovative rural access technology 5L principles of value innovation namely; Low cost, Low Power, Low Maintenance, Local Control, Local Content. Normally the installation of a hotspot needs a building space/shelter, a power supply source, a tower on which the access network equipment is to be installed. In addition to the availability of reliable power supply and a backup source, it also requires lot of cabling to carry the bandwidth from the backhaul termination point to the BTS and from BTS to the Antenna. This involves lot of work, cost and maintenance and also creates pollution. Under the concept of "Everything On the Tower," the solution does away with all the above mentioned cumbersome and costly requirements and physically put everything on top of the tower in a secured and safe manner. The various network elements which are mounted on tower are Omni antenna, filter, backhaul dish. BTS (Controller, power unit, battery, local content server) and solar panel. Such installation which will have no cable connected to the tower has the potential to convert a small village into a hotspot to provide Wi-Fi based broadband access in a very cost effective manner. The advantage of such solution is it does not require indoor space, no cabling from building to the tower and no grid power supply connection and more than anything else it is totally Green. Such solution can work for more than 30 hours without charging and free from any requirement of external power supply. It is certain to be a reality in many villages of country during the coming year.

Everything on Tower (EOT) – A Schematic



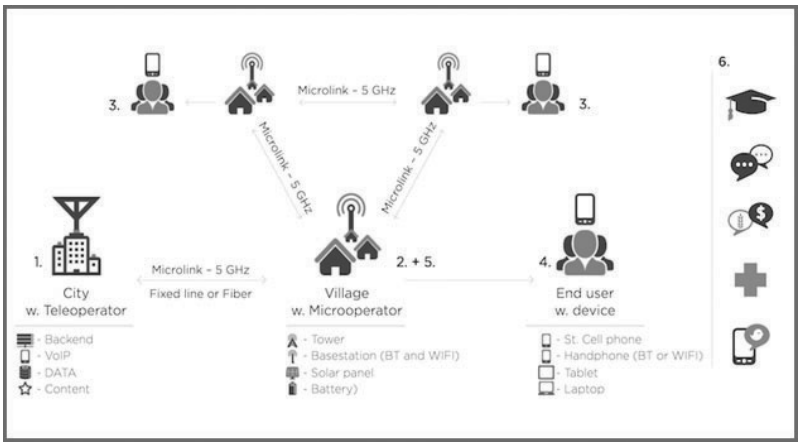
3. THE LIVE CASE STUDY

A Proof – of Concept (POC) conducted at Arian block of Ajmer District (BBNL Pilot site) made use of low-cost solution to provide the last-mile access using unlicensed (Wi-Fi) band of 2.4 GHz, existing infrastructure of public Telco and local Access Point Controller to provide public access through managed Hot-Spot. This pilot has been run by M/S BlueTown, a Denmark based innovative technology company in association with BSNL, the Public sector Telco.

BLUETOWN provided all the Wi-Fi network equipment's such as antennas, Access Points and Controller while utilizing the BSNL towers and Backhaul infrastructure. The special contribution of BlueTown is an integrated, miniaturized, low-powered and low-cost Wi-Fi Access Point Controller powered by solar panel and rechargeable Lithium-ion batteries. The power requirement of 3APs and a Controller being less than 20 Watts only, the system can work up to 30 hrs. Without any charging. The AP Controller provides the functionalities of Power control, Charge control, RF control, Content server, bandwidth management, quality, security and authentication management as well as POE for APs. In its functionality, it is similar to BTS of a cellular network and

facilitates the creation of a managed Wi-Fi Hot-spot, while utilizing off-the – shelf outdoor APs. The backhaul bandwidth of 10 Mbps is provided by BSNL in partnership with BBNL on trial basis. BlueTown has also installed their billing and authentication server at BSNL Broadband NOC at Ajmer which also has the capability of generating pre-paid coupons for distribution to consumers while authenticating their credentials.

The conceptual diagram of such a solution which has also been deployed in rural areas is shown below:



4. SALIENT FEATURES

The salient features of the POC results of such trials at 3 GPs in Ajmer district are following:

1. Range of 0.5 Km radius with 15 meter tower height and 0.3 Km radius with 5 meter (rooftop) mast is achievable, while restricting the APs power to permissible limits.
2. System can sustain for 30 hrs. Without availability of any electricity and can charge itself through solar panel beyond that.
3. All the requirements of Authentication can be achieved through pre-paid coupons or OTP based authentication through mobile connection.

4. Users experience has been better than 3G Data connection.
5. Use of miniaturized Lithium – ion batteries in the project having 30 hrs capacity without charge.
6. Miniaturized, integrated and PCB based Wi-Fi access point controller powered by solar power and supporting the functionality of Web Camera.
7. Extremely low voltage (16V) and power consumption (20W) of access point controller and outdoor access point.
8. Use of existing infrastructure of BSNL/BBNL/CSC to reduce the CAPEX.

5. HOTSPOT – AS – A – MANAGED SERVICE – AN INNOVATIVE BUSINESS APPROACH

National Optical Fiber Network (NOFN) project which constitutes one of the nine pillars of PM's "Digital India" mission aims to connect 250,000 Gram Panchayats (GP) with 100 MPBS backhaul through optical fiber. Though the progress on this mission mode project of national importance is happening in its own style, there is not much talk about the Last-Mile access to end-users which may become a missing-link in end-to-end connectivity. This paper illustrates a technical solution and way forward to plug this gap in a speedy, cost-effective and sustainable manner.

As per the national broadband plan, bandwidth of 100 Mbps will be terminated in every GP of the country at a location working as Common Service Centers (CSC) which provide citizen services like e-mitra, e-seva, birth/death certificate, land – records, computer training, etc. to the people living in the rural areas. This will be a very limited and restricted use of the valuable Internet connectivity reaching the GPs through a capital – intensive NOFN.

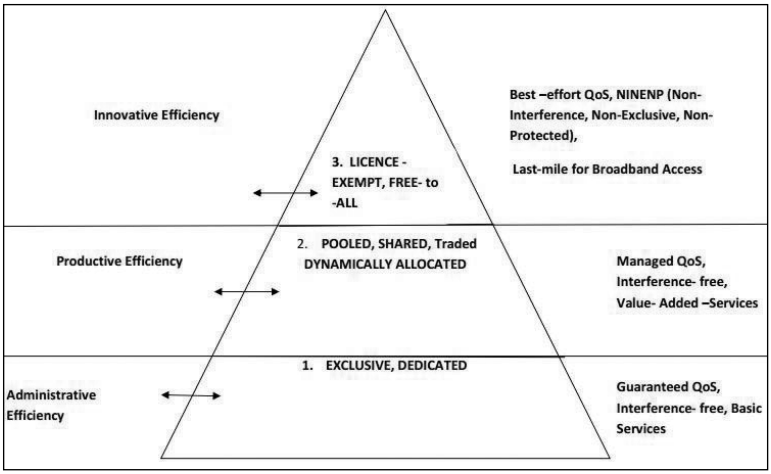
To make the best use of this national infrastructure it needs to be distributed outside CSC for various purposes such as providing

internet access to the government institutions like hospital, post office, schools, etc. as well as to deliver it to homes and the rural masses through Last – Mile access as a sustainable business case.

To provide such Last-Mile access in speedy, cost effective manner and affordable manner, some innovative technical solution and business proposition is required as the conventional technologies cannot help the conventional ROI based business case.

6. NEED FOR MORE LICENSE-EXEMPT SPECTRUM AND LAYERED APPROACH

The diagram below depicts an innovative solution for next generation spectrum management, in the form of a tiered approach (Divide and Rule) which has been exploited by Internet and NGN to make the network and system efficient. Going by the learning that "One Size does not Fit All" the spectrum management can be done in a Pyramid mode dividing the allocations in separate layers of Exclusive Allocation, Dynamic need-based Allotment and License – Exempt usage to get best of both the worlds. This can result in meeting the QOS requirement of Basic services and super – efficient usage for value added services including Broadband and emerging innovative applications.



Layered Approach for Spectrum Allocation

As per the above structure the spectrum allocation can be divided into 3 distinct layers as following:

1. **Exclusive, Dedicated Allocation –** This layer makes use of conventional way of spectrum allocation which is generally done through auction. This should be used for start-up spectrum to an operator for providing QOS based basic services wherein degraded quality as well as Interference is not tolerated e.g. 2G and 3G voice services Major part of the upfront revenue requirement of Govt. can be met through this chunk, but the optimum utilization of spectrum in this method is not ensured.

2. **Dynamic Spectrum Exchange –** This is the main theme of the paper based on the principals of Spectrum sharing. Any requirement of additional spectrum beyond start-up spectrum by an operator should be met through dynamic allocation from Pooled spectrum which should be demand assigned (remember DAMA, Demand-Assigned Multiple Access, used in space communications). For this use of Public Switched Spectrum Pool (PSSP) could be made on dynamic allocation basis. Generally, a major chunk of popular spectrum at "sweet spots" in 800, 900, 1800, 2100 MHz band amounting to around 300 MHz needs to be allocated through this route. Actually, the most efficient allocation and usage of radio spectrum for QOS – oriented services can be done through dynamic sharing basis by creating a Common Pool of Add-on spectrum, allocated based on need and demand for Add-on spectrum by existing operators and charged based on usage without any upfront payment. As the operators are made to pay per usage based, they are saved of 'Winners Curse" which is countered in Auctions, but eventually the Govt. ends up earning more due to payment linked to usage which becomes multiple time than the dedicated

allocation. Any additional chunks of spectrum, being vacated fully or partially by public, state and defense forces are the ideal candidates for this approach. To start with this concept can be tried for about 100 Mhz chunk coming out of "Digital Dividend" band in 700 MHz.

3. **License-Exempt Spectrum –** This is the top of the pyramid and most efficient way of spectrum utilization. It is ideally suited for "Best-Effort" services like Broadband (Wi-Fi). Though Govt. does not earn any upfront revenue from this, but the societal returns on its wide spread exploitation are immeasurable. In addition to last – meters broadband access powered by FTTX, this can also be used for Data-offload (to spare the dedicated spectrum for Voice) and also the In-Building Solutions for Voice through FMC (Fixed Mobile Convergence). World over around 450 Mhz. of such spectrum in 2.4,5.1 and 5.7 GHz is unlicensed for such applications but in India around 150 Mhz in 2.4 and 5.8 GHz band only is made available under this and that also with lot of technical restrictions. We also have to remember that consistent with what is happening around the world, and also consistent with the need of universal provision of all services to the entire populace the thin layer of delicensed spectrum will be the norm and the dedicated spectrum allocation will be an exception.

7. RECOMMENDATIONS FOR WAY FORWARD

- Deploy more and more managed Hot–Spots in rural areas an revenue – share basis by using existing infrastructure to provide carrier grade public broadband access.
- Make more Wi-Fi spectrum unlicensed in 5.1–5.3 GHZ band
- Provide VGF (Viability Gap Funding) for rural access network in line with National Backbone Network (NOFN) and mobile telephony in NE/LWE areas.

- Involve local bodies (GPs, Municipalities) as stakeholders.
- Facilitate "Make in India" of Wi-Fi access point controllers and other modules.
- Create a social business for "Blue-Collar Job Factory" to train VLE.
- Let us "Make It happen" together (USOF, PSUs, Industry), PPPPP (People, Panchayat, Public, Private Partnership).
- Govt. should make more spectrum unlicensed in ISM bands as well as in other emerging bands for rural broadband access.
- USO Fund should come out with a scheme to fund the Capex or Opex (Direct benefit to users, guarranted revenue to Operators) for Broadband access infrastructure in rural areas.
- 100 Mbps bandwidth at the GP level should be increased to 1 Gbps so that people can access the internet at a faster speed and better quality of service.

8. CONCLUSION

- The availability of a robust and reliable broadband connectivity is most critical for the successful implementation of some of the key social sector schemes and programmes in rural areas by the Central and State governments on e-governance, education, health, employment and financial inclusion.
- The benefits of the broadband connectivity to the rural population are immense with the convergence of voice, data and video.
- As the time and cost are two critical elements for the implementation, the key question is how we can rollout the broadband connectivity to the rural areas in the

quickest and most cost-effective manner. The government is highly dependent on the speedy implementation of broadband connectivity for the success of its 'marquee' Digital India programme. The concept of "Everything on Tower" solution, pioneered by the author, enables, the creation of a public hotspots for use of the telecom service provider to enable them to provide much needed broadband access to rural masses as a business case without any perpetual subsidy. It is based on the availability of the subsidised internet backhaul as a part of NOFN project of government or through PSU telco like BSNL and making use of abandoned/discarded telecom towers of MARR legacy or some other existing structure of around 10–15 meter's height in rural areas.

Annex V
Making the Broadband Access Happen in LWE Areas of JHARKHAND – a BLUETOWN Use Case

Keshav Sharma,
Senior Executive,
Global Business Intelligence & Research,
BLUETOWN.

The Left Wing Extremism (LWE) affected areas are characterized by poor socio-economic indicators. Lack of infrastructure development has been identified as one of the causes for its backwardness. Telecom connectivity (both voice & data) would help in fostering economic development of the region and enable security forces to deal effectively with extremism in their areas.

In recent years, mobile connectivity has emerged as one of the transformational phenomena. Mobile telephony has transformed access to communication in emerging markets. But rural areas have traditionally been no-go for incumbent telecos as far as data connectivity is concerned, due to perceived lack of a business case. Today, almost 90% of the country's population is covered by mobile phone signals, yet there are still two third of the population who don't have access to voice and data connectivity.

Earlier, reaching out to the rural areas presented particular technology and economic challenges. Solutions that worked typically well in urban settings – copper, fiber, cable and mobile – were unreliable in rural areas or prohibitively expensive. For

example, premises near town small towns and villages are often too dispersed to make the rollout of fast fixed-line solutions economically viable. In these, there are limits on asymmetric digital subscriber line (ADSL) speeds and also, the cost per premise for fiber to the node (FTTN) is several thousand dollars. At the same time, rural areas are not remote enough to justify satellite technology's incremental cost per unit of performance. So, we came out with our quite efficient and innovative technological solution which made the use of unlicensed Wi-Fi Technology.

On August 20, 2014, the Union Cabinet approved the extension of mobile telephonic services to 2,199 locations affected by Left Wing Extremism (LWE) in the states of Andhra Pradesh, Bihar, Chhattisgarh, Jharkhand, Maharashtra, Madhya Pradesh, Odisha, Telangana, Uttar Pradesh and West Bengal. The Project was executed by Bharat Sanchar Nigam Limited (BSNL). BSNL has already installed towers at these locations giving a network coverage to many villages as well as camps of security forces.

BSNL have created 782 GSM sites in the un-connected areas of the state of Jharkhand.

The Jharkhand State Government in line with the Digital India Mission is looking to provide Wi-Fi based broadband services around these 782 GSM sites to the its residents.

Jharkhand State Government envisioned to expand digital network in rural areas so that the masses can get benefit of e-services (government/private).

After BSNL with support of USOF started deploying towers in the LWE affected states, the impacted villages have started to show signs of growth, and BLUETOWN – a Danish Technology start-up substantiated that by deploying Wi-Fi Access Points over these towers. Traditionally entering a typical rural area for private telecom operators means not just capex & opex issues but the perception of existing hostility in these regions make the organisation vulnerable and think twice before they enter these areas.

BLUETOWN's initiative to promote an alignment between technology, demand, standards & regulations has enhanced efficiency in network reach into zero data access regions. Now people living in these regions have access to better education, better and timely medical services all because of our efforts as Managed Hotspot Service Provider (MHSP) with BSNL, which complimented the Govt. initiatives to bridge the Digital Access deficit.

BLUETOWN's LWE Wi-Fi Broadband Access Project in Jharkhand

The Government of Jharkhand in line with the Digital India Mission intended to establish Wi-Fi hotspots on around 750 GSM sites in LWE areas. Presently BSNL has installed mobile towers at those GSM sites. There are 48 timeslots for voice and data both. Effective speed of data is only 20 Kbps. This speed was not sufficient for data communication and cashless transaction. As Govt. of Jharkhand is trying to expand digital network in rural areas so that the mass can get benefit of e-Governance services. For effective implementation of Digital India scheme, data speed should be high. Hence, Govt. of Jharkhand decided to install Wi-Fi hotspots in those areas using existing mobile towers.

The objectives of this project were:

a. High speed connectivity to citizens

b. Provisioning of data connectivity to Govt. offices

c. Penetration of Digital India Programme in LWE areas.

BSNL is 100% owned by Govt. of India PSU. BSNL is in business of Telecom Connectivity since long. BSNL has very good connectivity in rural areas.

BSNL issued a Work Order in 2016 for setting up, own and operate Wi-Fi Hotspots at public places through BSNL POP on Revenue Share basis for East Zone (Zone 3 – Bihar and Jharkhand,

Zone 4-Assam & Zone 6-A&N) and BLUETOWN executed that work efficiently and timely.

Project was monitored directly by DoIT (Government of Jharkhand) or the agency authorized by DoIT. DoIT or its authorized agency will inspect working of Wi-Fi system.

The Duties & Responsibility of BSNL-BLUETOWN Partnership for the Project

The duties, roles and responsibilities of BSNL-BLUETOWN consortium and the activities expected to be carried out in the process are summarized below:

1. BSNL ensured Internet Bandwidth of 2 Mbps bandwidth with Public IP Addresses at all the LWE Locations.
2. BLUETOWN Installed, operated and maintained the equipment required to create WiFi hotspots at these LWE sites.
3. **Uptime SLA:** Uptime of 98% is guaranteed, as below:
    i. Avg. annual uptime>=98% full payment.
    ii. Avg. annual uptime>=92% and <98%, 4% shall be deducted.
    iii. Avg. annual uptime <92%, full 10% payment shall be deducted at the end of year.
4. **Revenue Sharing:** BSNL will share the revenue (received from the Jharkhand State Government i.e. Bulk Revenue and any revenue received from Retail Customer Recharges i.e. Retail Revenue) as per the Work Order Referred above.
5. **All DoT Guidelines:** Regarding Wi-Fi Hotspots and user interfaces and records were to be maintained.
6. BLUETOWN have to provide dashboard for monitoring of the function of Wi-Fi system.

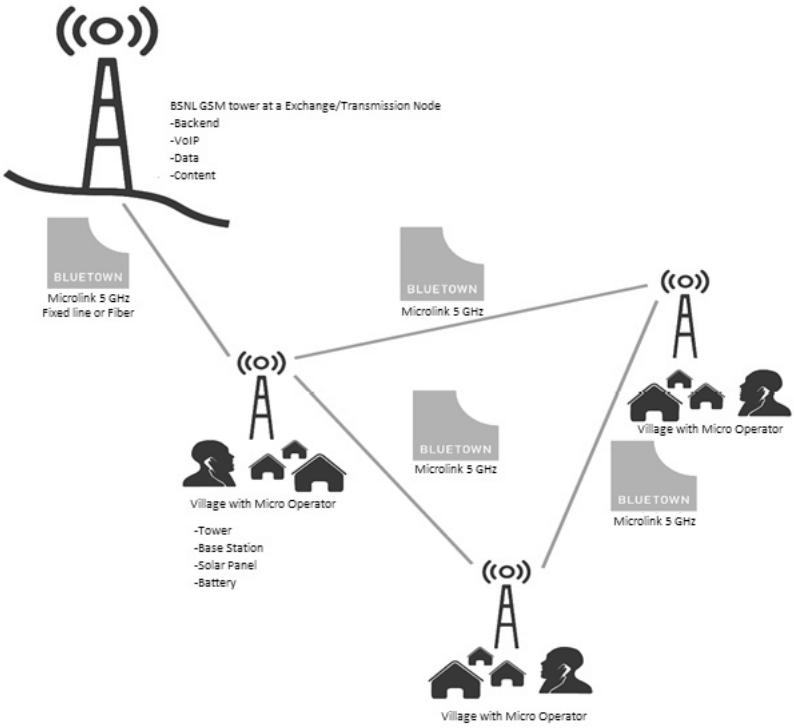
The Solution BLUETOWN Installed in the Project

BLUETOWN provided all the Wi-Fi network equipment's such as antennas, Access Points and Controller while utilizing the BSNL towers and Backhaul infrastructure. The special contribution of BLUETOWN is an integrated, miniaturized, low-powered and low-cost Wi-Fi Access Point Controller powered by solar panel and rechargeable SMF batteries. The power requirement of 3APs and a Controller being less than 20 Watts only, the system can work up to 30 hrs. Without any charging. The AP Controller provides the functionalities of Power control, Charge control, RF control, Content server, bandwidth management, quality, security and authentication management as well as POE for APs. In its functionality, it is similar to BTS of a cellular network and facilitates the creation of a managed Wi-Fi Hot-spot, while utilizing off-the – shelf outdoor APs.

The innovative solution deployed is summarised, as below:

BLUETOWN Outdoor Solution – Everything on Tower

- Access Point Controller (Housed in an IP67 weahter proof outdoor box)
- 3 weather-proof Sector Antenna assembly located on BSNL existing Tower. This includes the following components
  - ➢ 120 Degree Sector Antennae's (3 in Number)
  - ➢ Bandpass filters (3 in Number)
  - ➢ 2.4 Ghz Access Points (3 in Number)
  - ➢ Backplates to support the Antennae assembly (3 in Number)
  - ➢ Antennae Mounts



- Solar Power system including the following
  - ➢ Solar Power Unit with Batteries (Housed in an outdoor IP67 box)
  - ➢ Solar Panel
  - ➢ Solar Cables & Connectors
- 4th Access Point with an OMNI/Sector Antennae (as per requirement) to be installed at a location upto 1 Kms (like a school, PHC or GP etc.) away from the tower
- Internet backhaul was provided by BSNL

Salient Features of the Project

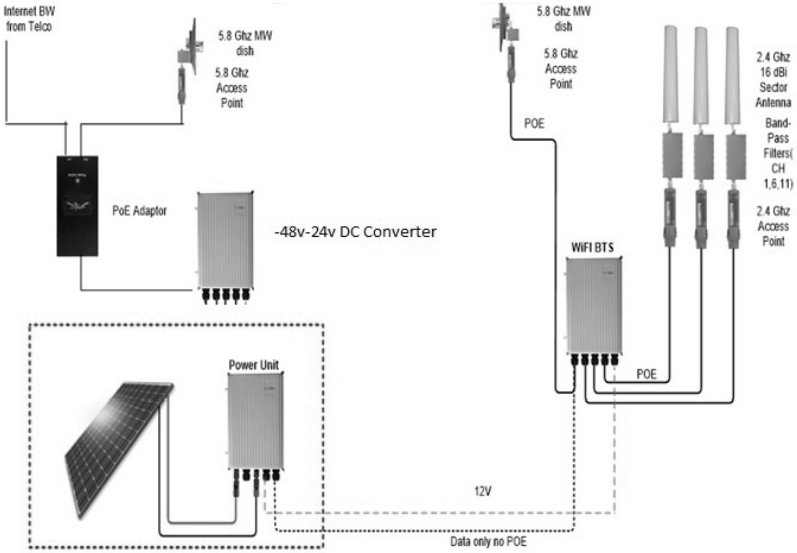
1. Range of 0.5 Km radius with 15 meter tower height and 0.3 Km radius with 5 meter (rooftop) mast was achieved, while restricting the APs power to permissible limits.

2. System can sustain for 30 hrs. Without availability of any electricity and can charge itself through solar panel beyond that.
3. All the requirements of Authentication were achieved through pre-paid coupons or OTP based authentication through mobile connection.

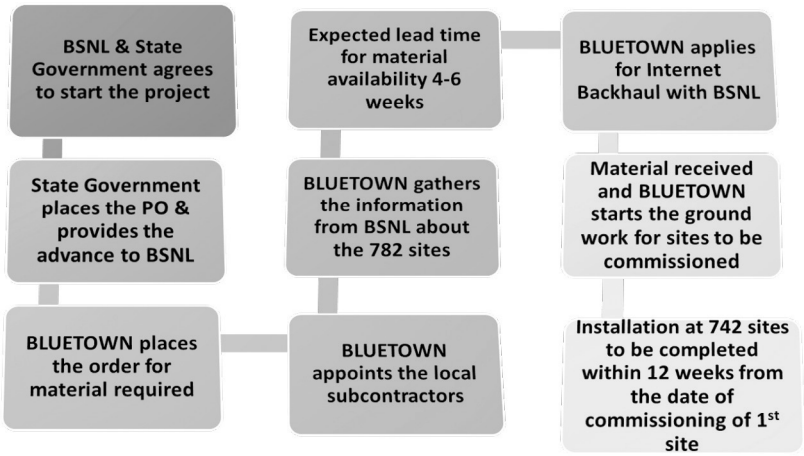
4. Users experience has been better than 3G Data connection.
5. Use of miniaturized SMF batteries in the project having 30 hrs capacity without charge.
6. Miniaturized, integrated Wi-Fi Access Point Controller powered by solar power which were capable of handling:
    - AAA Authentication
    - Bandwidth Management & RF Control
    - Power Control & Battery Management
    - Remote Access for system maintenance
7. Extremely low voltage (16V) and power consumption (20W) of access point controller and outdoor access point.
8. Use of existing infrastructure of BSNL/BBNL/CSC to reduce the CAPEX.

General Network Architecture

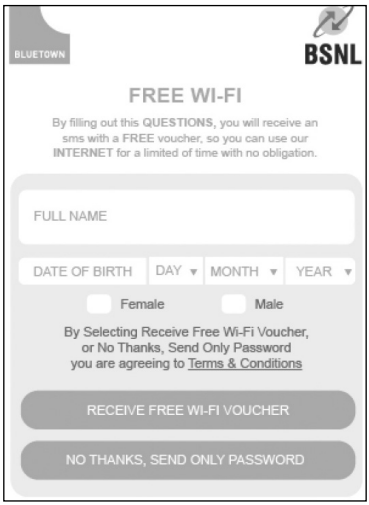
The following network architecture was implemented at the LWE sites most of which are located in remote areas. The Wi-Fi infrastructure was installed at existing BSNL towers where Backhaul was provided by BSNL, through unlicensed radio channel.



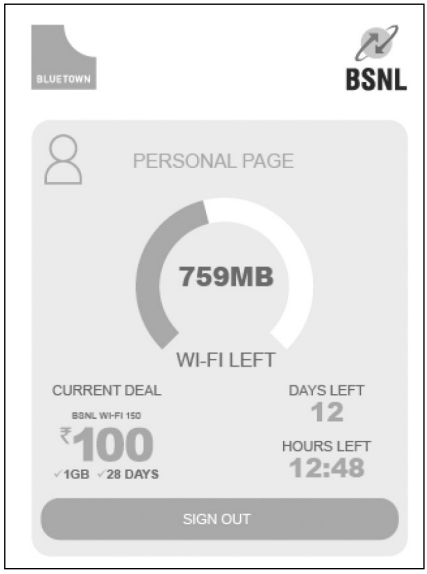
Plan BLUETOWN Followed for the Project Rollout



Some Screenshots of Existing Login Portal (User Interface)


BLUETOWN
BSNL
FREE WI-FI
By filling out this QUESTIONS, you will receive an sms with a FREE voucher, so you can use our INTERNET for a limited of time with no obligation.
FULL NAME
DATE OF BIRTH
DAY
MONTH
YEAR
Female
Male
By Selecting Receive Free Wi-Fi Voucher, or No Thanks, Send Only Password you are agreeing to Terms & Conditions
RECEIVE FREE WI-FI VOUCHER
NO THANKS, SEND ONLY PASSWORD


BLUETOWN
BSNL
OUR MOST POPULAR WI-FI PLANS
₹10
100MB
2Mbps
1 DAY
BUY NOW
BSNL WI-FI 10
₹60
1GB
2Mbps
3 DAYS
BUY NOW
BSNL WI-FI 60
₹100
1GB
2Mbps
28 DAYS
BUY NOW
BSNL WI-FI 150
MORE PLANS
VOUCHER


BLUETOWN
BSNL
PERSONAL PAGE
759MB
WI-FI LEFT
CURRENT DEAL
BSNL WI-FI 150
₹100
1GB
28 DAYS
DAYS LEFT
12
HOURS LEFT
12:48
SIGN OUT

BLUETOWN – bringing smiles on the first time internet users in rural jharkhand

Success of this project has vindicated our belief that there is a sustainable business case for Broadband in Rural parts of the country whereas the incumbent Telco's are not there yet as they are concentrating in the urban areas and it has been showcased that this LWE project, was mainly possible because of our innovative solution (Low cost, Low maintenance, Low power and our "Managed Service" based business model.

BLUETOWN vision & mission would enable the people living in rural areas with no data connectivity to the world of Internet at an affordable price. Also, with each hotspot being created there was one job also, that was created, as a local person would be required to do the sales/marketing & basic maintenance of the Wi-Fi hotspot.

This synergy strategy amongst manufacturers, R&D centres, and service providers for achieving efforts for deployments into the remotest parts of the country would eventually lead to a roadmap for Grand India Dream. Because data connectivity is a citizen right, they say, not a privilege.

Annex VI
Author's Topical Published Articles

Roadmap Ahead

Wi-Fi Outlook – Hotspots Moving Wild and Rural

Satya N Gupta
Secretary General,
NGNguru

As in the beginning of 2016 the country crossed the landmark milestone of 1 billion mobile customers, voice is likely to take a backseat now, and the focus shifts to broadband. In the telecom, both for voice as well as data, the customer access, i.e., the last-mile has always been a challenge, which has already been addressed as far as voice is concerned, but for data and especially in rural areas, the last-mile challenge remains. Wi-Fi is one solution that can help to mitigate the last-mile challenge for data and broadband in a cost-effective and speedy manner. Though everyone has been talking about Wi-Fi in India for the last few years, on ground Wi-Fi is yet to become ubiquitous as we would have liked it to be. But now its time has come, and outlook for 2016 appears to be *Wi-Fi everywhere*, moving to rural areas where it was not even talked about.

Some developments, facts, and predictions pertaining to Wi-Fi Hotspots:

- The first railway station to get Google Wi-Fi facility – Mumbai Central becomes the first railway station in the country to get free high-speed public Wi-Fi connectivity through Google. And after Mumbai Central, railway stations in Allahabad, Patna, Jaipur, and Ranchi will get Google's Wi-Fi coverage. As per the railways minister, Wi-Fi Hotspots are to come up at 400 railway stations in India.
- Techies turn three villages of Madhya Pradesh into free Wi-Fi zone – Inspired by Prime Minister Narendra Modi's *Digital India* initiative, four techies from Madhya Pradesh's Rajgarh district have turned three remote villages into first free Wi-Fi hamlets in the country without government funding.
- First hill station to provide high speed Wi-Fi – Mussoorie has become the first hill station to provide high-speed Wi-Fi service through a private operator.
- First beach in India goes Wi-Fi– Malpe in Udipi district of Karnataka has become the first Indian beach to have Wi-Fi facility for tourists.
- First rural institution to have wide-area outdoor Wi-Fi surfing – Barefoot College, Tilonia, in Ajmer district, was converted into an outdoor Hotspot powered by managed service solution of Bluetown, DK, using existing infrastructure of BSNL.
- Wi-Fi data offloading – Emerging opportunity for public Wi-Fi Hotspots to decongest the precious licensed radio spectrum.
- Li-Fi – A new cousin of Wi-Fi – Li-Fi – or light fidelity – is a wireless technology that makes use of visible light in place of radio waves to transmit data at terabits per second speeds – more than 100 times the speed of Wi-Fi. Li-Fi offers great promise to overcome the existing limitations of Wi-Fi.
- Wi-Fi HaLow – HaLow is a low-power, long-range version of the IEEE 802.11 Wi-Fi standard. HaLow is based on the Wi-Fi Alliance 802.11 ah specification. HaLow extends into the 900 MHz band, a part of the electromagnetic radiation spectrum that is well-suited for small data payloads and low-power devices. This lower part of the spectrum is also able to penetrate walls and other physical barriers and promises better range than the 2.4 and 5-GHz Wi-Fi bands.
- Wi-Fi Hotspot as a managed service– BlueTown, an innovative rural telecom solution start-up is teaming up with PSUs and private telcos having interest in rural India to set up Hotspots on a managed service (OpEx) basis.
- Rural Wi-Fi wishlist of PSU stalwarts – The erstwhile CMDs of BSNL and BBNL are on record about their rural Wi-Fi plans (BSNL – 80,000, BBNL – 2.5 Lakh rural Hotspots)

Way Forward to Rural Wi-Fi – It Is All about Funding?

As an innovative Wi-Fi Hotspot solution having low cost, low power, and low maintenance has already been developed and demonstrated by Bluetown; technical, operational, and maintenance issues have been taken care of. But to make a sustainable business case in rural India, innovation in funding is also required. Managed service route, which is a type of vendor-financing, can meet only the starting demand. Other options can be MP/MLA funds, *panchayats*/corporations funding, micro-credit, and maybe CSR support. All these avenues put together also will still not be able to meet the requirements of 6.5 lakh villages in the country. Hence, the option of last resort, tailor-made for such exigencies, the USO fund needs to be tapped. and a (miniscule) part of this should be gainfully utilized for creating Wi-Fi access network to achieve end-to-end broadband connectivity for rural masses. They say, "*Need support for rural connectivity? USO fund Hai Na (is there).*" ■

Perspective

Extra Mile – Walking the Talk on Rural Broadband with 5Ps of Partnership

Broadband penetration is a crucial factor which is increasingly becoming the benchmark used to ascertain the health of a nation's economy and social well-being.

Broadband access provides the opportunity to do things efficiently to achieve better efficiencies for people and countries and to ensure higher growth of economy and overall social development. Broadband penetration is a crucial factor, which is increasingly becoming the benchmark used to ascertain the health of a nation's economy and social well-being.

Providing broadband connectivity in geographically challenged, remote and rural areas, underserved by profit-driven market players, has become a challenge for governments in the developing world, who are tasked with this role in case of market failure. In situation of such a "double-fault" civil society through various CSR and philanthropy acts is trying to pitch-up but the task is too daunting to be accomplished through such island types of initiatives. This paper brings out an innovative business model to achieve this through 5Ps of partnership of various stakeholders mainly, People, Panchayat, Public, and Private.

Challenges to the Rural Broadband Access and Way Forward

Need for sustainable business model. Main reason for low availability of broadband in rural and remote areas is absence of a commercial business model, as operators are not sure about the return on investment (ROI) and perceive lots of risks on demand side. The revenue generated from the operation of the network must exceed the network's initial capital investment recovery and the ongoing operating costs. The financial success of any communication network is based on the average revenue per user (ARPU) and the number of users. Urban areas with high density have more opportunity to generate higher revenues than low-density rural areas. It is for this reason, the commercially prudent telecom service providers focus on providing services to more highly populated areas, creating an economic "digital divide" for lower-density areas like rural. Therefore, some innovative business models based on out-of-box thinking are required to be tailor-made for rural areas.

Missing middle- and last-mile connectivity. For proliferation of broadband in rural and remote areas, adequate infrastructure, both for access as well as backhaul, is a prerequisite. Lack of backhaul infrastructure to provide middle-mile connectivity has grossly affected the deployment of broadband in rural India. The NOFN project (BharatNet) was launched to bring optic fiber as close to the end-user as possible so that high-speed broadband can be made available to the customers, laying OFC connecting all the 250,000 gram panchayats of the country and non-discriminatory access was to be provided to all service providers. The network was supposed to be commissioned in two years; however, as per the information available, as on March 2016, only a limited number of gram panchayats have been connected. Recently, TRAI invited various industry actors asking for suggestions on implementation models with an objective to improve overall BharatNet delivery and has provided landmark recommendations on best implementation model for the state-led program with an increased participation from private sector including emphasis on existing network infrastructure utilization, pushing the ball back to the government. As far as last-mile access is concerned, it is yet to get due mention in various government schemes and regulatory recommendations and that is what is leading to double-fault of both the market as well as regulatory failure.

Active infrastructure sharing through open access networks. Active infrastructure sharing can play a major role in expediting the rollout of broadband access network across the country, especially in rural India. Rural rollouts carry a higher operation expenditure. TRAI had acknowledged the need to optimize available resources while ensuring competition and availability of services at affordable prices. It is a well-known fact that infrastructure sharing can reduce costs and promote rollout of services more cheaply and quickly. Sharing also enables more rapid initial network deployment, as well as cost-effective coverage in under-served areas by making use of existing national infrastructure in an open-access manner. Only recently, the government has made the enabling provisions for the same. In addition, the government has also heralded the long-pending VNO regime to enable a low entry for the innovative niche operators in rural areas, who can bring low-cost network deployments and service offerings.

Perspective

Innovative Technology Solution for the Rural Broadband Challenge

In addition to various infrastructure-related challenges, the cost-effective and high-reliability technical solution as well as the availability of reliable power supply required for the system in rural areas are other show-stoppers. Also, there is unavailability of suitable indoor space for installing the network equipment and keeping it safe and secure.

Any technical solution to be suitable in the above environment should meet 3L criterion of low cost, low power, and low maintenance, which can also reduce the cost by making use of existing infrastructure and unlicensed spectrum, which is free.

Normally, installation of hotspots needs building space/shelter, a power supply source, and a tower on which the access network equipment is to be installed. The concept of "Everything on Tower" solution does away with all the above-mentioned cumbersome and costly requirements and physically put everything on the top of the tower in a secure and safe manner.

It enables the creation of a public hotspot for use of the telecom service providers to enable them to provide much-needed broadband access to rural masses as a business case without any perpetual subsidy. It is based on the availability of the subsidized Internet backhaul as a part of NOFN project of the government or through a PSU teleo like BSNL and making use of abandoned/discarded telecom towers of MARR legacy or some other existing structure of around 10–15 meters height in rural areas.

The business of broadband in rural and remote areas is not a normal business case but it is a complex ecosystem which needs to balance out the conflicting requirements of higher cost of deployment and the lower revenue potential.

Out-of-Box Business Models for Rural Broadband

Main reason for negligible availability of broadband in rural and remote areas is absence of a commercial business model. The traditional business case to provide broadband services does not sustain in rural areas where the population densities are lower and the cost of implementing a broadband network exceeds potential revenues. The cost of the telecommunication network infrastructure in urban areas is justified due to high density of the subscriber base in these areas. However, if the telecommunication networks, especially those supporting broadband services, are extended to the geographically large rural areas with the same deployment of architecture, per user cost of the infrastructure (CapEx) and the additionally increased operating cost (OpEx) make it economically unviable. Therefore, the penetration of the broadband networks in such remote and rural areas demands new thinking and models to make the broadband network operations economically viable.

The business of broadband in rural and remote areas is not a normal business case but it is a complex ecosystem which needs to balance out the conflicting requirements of higher cost of deployment and the lower revenue potential because of low paying capacity of the targeted customers. To make it an implementable preposition which is sustainable, all the stakeholders especially the government, regulators, service providers, local bodies, NGOs, and entrepreneurs have to play their role in this endeavor collectively.

Making It Happen – Extra mile through People-Panchayats-Public-Private-Partnership

As it is all about funding in case of any infrastructure project of national importance, a judicial mix of various funding options mentioned below for creation of Infrastructure is required:

- Full public funding like USO funding of BharatNet (middle-mile backhaul)
- Viability gap funding (VGF) for any unviable link as recommended by the regulator
- Public-panchayat funding – government funding of backhaul and community funding of access network
- Public-private partnership (PPP) – backhaul public funded and access network private funded

As in India, none of the above options in isolated mode has delivered, a mix of various options to make use of the core competency, vision, and enterprise of various actors as well as making use of existing public infrastructure and third-party managed services avenue is required. This is what leads to creation of 5Ps, i.e., People-Panchayat-Public-Private-Partnership for moving the *extra mile* to *make it happen*. ■

The author, Satya N Gupta, is Secretary General, NGN Forum

DIGIGAON
JOB FACTORY
Creating Livelihood

DIGIGAON JOB FACTORY
FOUNDATION
CIN- U74999DL2017NPL320117
Add.: Y-74, Hauz Khas, New Delhi-16
Contact- Monisha Das, Director
Cont. No.- +91 8800 7871 90
md@saamcorpadvisors.com
msmonishadas@yahoo.com

Satya N. Gupta
NGNguru
Evangelist & Founder

"*DigiGaon* Job Factory" – Converting unemployment into Intrapreneurship by creating Public Hotspots and Multi-Skilling.

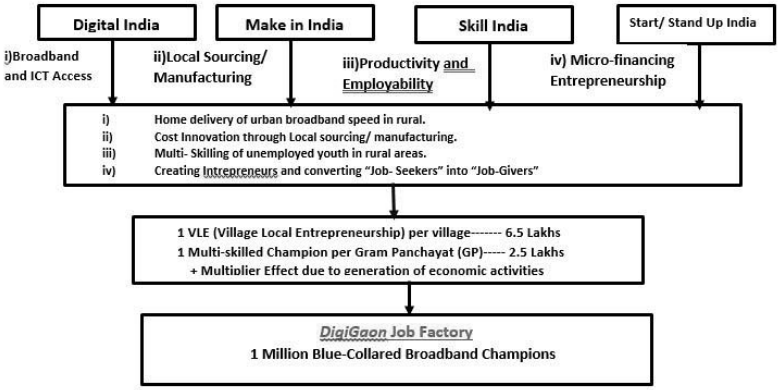
INTRODUCTION

The Central Govt. of India has a great vision and has kick-started many mission mode projects to improve the economic activities in the country specially in rural India (Bharat) to increase the productivity and standard of living of rural masses as well as to accelerate the Gross Domestic Product (GDP) growth of the country as a whole. It is well known fact that 10% increase in Broadband access can add up to 1.4% to the GDP growth of a developing nation. To this effect, the Govt. has announced many projects, few of them are interrelated and can cascade into the growth of economic activities in rural India with an overall objective of eradicating the poverty through generation of employment for the rural youth and to Provide the Urban Amenities in Rural India (PURA), under the 'RURBAN' mission of Govt.

This note brings out an implementable social enterprise project to demonstrate as to how we can use the confluence (Sangam) of four interrelated projects to convert rural unemployment into entrepreneurship.

A. CONFLUENCE AND INTER – RELATION OF MISSION – MODE PROGRAMS OF PRIME MINISTER

The confluence of the four mission mode program will not only contribute in employability through entrepreneurship but will also facilitate in the increase of manufacturing activities which in turn will accelerate the Job creation, further.



The confluence of the four mission mode program will not only contribute in employability through entrepreneurship but will also facilitate in the increase of manufacturing activities which in turn will accelerate the Job creation, further.

B. VISION FOR THE CONFLUENCE *(SANGAM)*

The Four mission mode programs which the Govt. of India has recently kick-started are:

1. **The Digital India** mission is the dream project of PM aiming at transforming India into digitally empowered knowledge economy and bringing as many as 2.5 Lakhs Gram Panchayat under broadband connectivity and delivering urban speed in the rural. To take the broadband access into the hands/homes of rural masses, public

hotspots based on Wi-Fi are being planned through managed service/system model.

2. **Make in India** mission portrays back to the history before Independence where our freedom fighters solely concentrated on the materials made in India and discarded the import of foreign goods (Swadeshi Movement). Even today, this "Make in India" mission is concentrating in making India a country where goods will be produced in India for local consumption and also export of such products. For a rural hot-spot, most of the equipments have the potential to be manufactured/sourced in India, and further exporting these as well.

3. **Skill India** is concentrating in polishing the talents of India to make it more productive. India is known for its talents, from the famous scientists to the famous doctors, from the famous engineers to the famous business personalities. Prime Minister has also emphasized this fact as how Indian talents can be used to make India a skilled nation and specially increasing their productivity through Multiskilling.

4. **Start/Stand Up India** mission aims at creating entrepreneurs and converting "Job Seekers" into "Job Givers." Whereas one village local entrepreneur (VLE) specially among the literate rural women, will be created per village i.e., around 6.5 lakhs and one multi-skilled champion per gram panchayat i.e., around 2.5 lakhs adding some more related activities jobs will ultimately contribute to one million Blue Collared Broadband Champions, in the country. Some of these can be funded by Gram Panchayat, People representatives (MP/MLAs), CSR and financial agencies like Mudra, Bandhan bank under the micro-credit schemes at easier conditions and reduced interest rate. In the end, a small part of USO fund, which was specially created for the purpose can also be tapped.

C. SCOPE & SIZE OF THE "DIGIGAON JOB FACTORY"

Out of the total equipment required for converting a village into Hotspot at least 80% can be manufactured/sourced in India today which can be increased to 100% in coming years. The potential of this to generate the employment and business is summarized below:

Projects Statistics – Next 5 Years (1 USD = 65 INR, 1Cr. = 10 Mn, 1 Lakh = 0.1 Mn)

	Nos.	UNIT Capex (INR)	Material Cost	Labor Cost	Work Man-Days @ INR 250/day
Gram Panchayat (GP)	2.5 Lakhs	3.0 Lakhs	2.5 Lakhs	0.5 Lakhs	5 Cr. Man-days
Villages	4.0 Lakhs	2.0 Lakhs	1.5 Lakhs	0.5 Lakhs	8 Cr. Man-days
Total	6.5 Lakhs	15,500 Cr.	12,250 Cr.	3,250 Cr.	13 Cr. Man-days

	Capex	Material Cost	Indian Manufactured (80%)
Total for GPs	7,500 Cr.	6,250 Cr.	5,000 Cr.
Total for Villages	8,000 Cr.	6,000 Cr.	4,800 Cr.
Total (INR)	15,500 Cr.	12,250 Cr.	9,800 Cr.

In summary, the confluence of these four mission mode programs can immensely contribute to the economy of rural India, empower the rural women, alleviate poverty and generate livelihood for rural masses, speedily.

E. Next Step – "Mission" – Establishment of a Social Enterprise at national level consisting of like-minded social entrepreneurs supported by the related agencies of Central, State Govt., PSUs, Corporates, Skill Development agencies and rural development NGOs with a single point mission to enable **"Delivery of Urban Broadband speeds in Rural"** in a cost effective, timely and sustainable manner and creating at least **"One Job per Gaon."**

"*DigiGaon* Job Factory" – "Making-it-Happen" together- An NGNguru Social PPPPP Initiative inspired by Prof. Yunus's "Grameen," Dr. Kalam's "PURA" Vision, "RURBAN," "Cyber Gram Yojna" and "Digi Gaon" Mission of Govt. of India.

live mint

Print Close

Mon, Jan 11 2016. 01 43 AM IST

Li-Fi: A green avatar of Wi-Fi

Li-Fi is not expected to completely replace Wi-Fi, but the two technologies could be used complementarily to create more efficient, green and future-proof access networks

Li-Fi is not expected to completely replace Wi-Fi, but the two technologies could be used complementarily to create more efficient, green and future-proof access networks.

Li-Fi, or light fidelity, invented by German physicist and professor Harald Haas, is a wireless technology that makes use of visible light in place of radio waves to transmit data at terabits per second speeds —more than 100 times the speed of Wi-Fi.

Though it was discovered in the last decade, proofs of concept to test commercial utilization started emerging only in 2015. To start with, it is being tested for indoor usage, i.e., in offices and establishments, but it is also sure to go outdoor in a big way by making use of existing infrastructure used for street and traffic lights, which are already moving towards LED lamps.

Li-Fi offers great promise to overcome the existing limitations of Wi-Fi by providing for data-heavy communication in short ranges. Since it does not pollute, it can be called a green technology for device-to-device communication in the Internet of Things (IoT).

Move towards greener wireless communication

A technical solution for wireless pollution, power shortages and unavailability at outdoor locations should meet the 3L criteria: low interference, low power and low maintenance.

In addition, it has to support the three Hs of high data rates, high reliability and high affordability. Since Li-Fi relies on visual light and not radio waves as the carrier, it has potential for the first two Hs, but the last one—high affordability—may be achieved only when volumes increase, as it has in the case of Wi-Fi.

The above characteristics can be met by an all-IP (packetized) Li-Fi system utilizing existing LED lamps which are ruggedized, have a high MTBF (mean time between failure) and consume less power, therefore replacing conventional lamps on existing structures in both indoor as well as outdoor without need for any additional power supply.

To make LED lamps capable of working as an access point as in Wi-Fi, a kind of media converter is required to convert the electrical data signal into photons (light), and a light detector which converts light into electricity is required on the receiving device end.

Potential applications

Li-Fi is still in its infancy, but some fields where it seems eminently usable are street and traffic lights. Traffic lights can communicate to the vehicles and with each other. Vehicles having LED-based headlights and tail lamps can communicate with each other and prevent accidents by exchanging information. Also, through the use of Li-Fi, traffic control can be made intelligent and real-time adaptable. Actually, each traffic and street light post can be converted into access points to convert roadsides into wireless hot spots.

Visible light being safer, they can also be used in places where radio waves can't be used such as petrochemical and nuclear plants and hospitals. Similarly, in aircraft, where most of the control communication is performed through radio waves, there are restrictions on passenger communication using the same media, which can be easily handled through use of Li-Fi.

Li-Fi can also easily work underwater, where Wi-Fi fails completely, thereby throwing open endless opportunities for military and navigational operations. Still, the technology comes with some limitations.

As visual light can't pass through opaque objects and needs line of sight for communication, its range will remain very restricted to start with. Also, it is likely to face interference from external light sources, such as sunlight and bulbs, and obstructions in the path of transmission, and hence may cause interruptions in communication.

Also, initially, there will be high installation costs of visual light communication systems as an add-on to lighting systems. Li-Fi receiving devices will require adapters to transmit data back to the transmitter.

Challenges and opportunity in India

The lack of ubiquitous broadband access, which thereby restricts data access, and chaotic traffic management leading to traffic jams and pollution are just two of the many problems in India. Li-Fi has scope to help with both. By converting traffic lights into LED-based access points, traffic management can be made intelligent, adaptive and real-time—and so, more efficient and effective. In the same way, street lights can also be converted into Li-Fi access points, making them broadband access transmitters to mobile Li-Fi enabled smartphones, converting areas into seamless hot spots.

The main challenge is to create a Li-Fi ecosystem, which will need the conversion of existing smartphones into Li-Fi enabled ones by the use of a converter/adapter. Also, an integrated chip that has both light-to-electrical conversion and data-processing capability (Wi-Fi/Bluetooth) combined into one needs to be developed and manufactured in the millions. This is one opportunity where the country can capture the initial lead advantage, making up for earlier missed cases.

If Li-Fi can be put into practical use, every LED lamp (indoor as well as outdoor) can be converted into something like a hot spot to transmit data to every mobile device to achieve universal broadband communication between devices. Also, it presents another unique possibility: transmitting power wirelessly, wherein the smartphone will not only receive data through Li-Fi, but will also receive power to charge itself.

Sayta N. Gupta is founder and secretary general of NGN (Next Generation Networks) Forum.

VNO REGIME – CAN IT BE A GAME CHANGER (FOR RURAL BROADBAND)? FEBRUARY 2017

Satya N. Gupta,
Secretary General,
NGN Forum

Virtual Network Operators (VNOs) have evolved globally to create flexible, technology-neutral innovative services and applications providing value addition and differentiation using the basic and bearer services provided by traditional telcos.

In June, 2016, the Telecom Department released licencing guidelines for VNOs. This opened the doors for a new class of innovative telecom players in the country, which are expected to be lightly regulated and expand the market beyond the capacities of conventional telcos. In addition to other objectives, VNO regime can help spread the Internet better to areas where main operators are generally not interested, i.e., it could help extending Digital India to villages and small towns by making use of existing Infrastructure of the network operators.

A VNO works like a managed services provider and a value-adding reseller (VAR) of main telcos. VNOs do not own core network infrastructure; however, they provide services by acquiring the required capacity from licenced telecom carriers (NSOs). VNOs usually lease bandwidth/infrastructure at agreed wholesale rates from different telecom providers and offer services directly to end users, under their own brand and after some value addition.

Business Model of VNOs in India – A Great Opportunity for Rural Market

The main feature of VNO business model is making use of spare infrastructure of telcos and infrastructure sharing. When the new players are allowed to exploit the infrastructure available with

NSOs, it can address some of the major gap faced by rural market and provide opportunity for niche players:

- Un-met demand for broadband connectivity.
- VNOs are well positioned to grow within this market.
- Low Capex by utilizing the existing infrastructure of NSOs
- Focused on customer service and value addition as differentiators
- Flexibility in charging plans for customers

Why Rural India Requires VNOs or "Is It Too Late"?

- In India, most of the access service licensees are integrated TSPs providing access, long distance, and Internet/ broadband services. They provide services either by using their own infrastructure or by sharing/leasing infrastructure of other TSPs.
- Despite the presence of so many TSPs, there is still a wide digital divide between urban and rural India.
- Though urban tele-density has reached about 149 percent, the rural tele-density is lagging at around 47 percent only. Also against a target of achieving 160 million broadband connections by 2014, only 150 million have been achieved by June, 2016 and that too with the broadband speed (download) of 512 kbps. Also in rural India, broadband connectivity is not worth the mention.
- VNOs can help achieve the targets defined in NTP-2012 for 100 percent rural tele-density by the year 2020.

Regulatory Hurdles – Show Stoppers?

As a reality check, around 70 applications were received from many small start-up companies and LOIs were issued to majority

of them, but after that there has been a hold due to some regulatory hurdles, and some enabling changes are required to facilitate the same, which already seems to be active work in progress in Govt.

Issues in VNO Guidelines and Way Forward to Kick-Start Implementation

- Time taken to issue licences is too long – not a single licence issued in 6 months after the announcement of the policy.
- Eligibility for LLPs (Limited Liability Partnerships) also at par with companies.
- FDI under automatic route should be made 100 percent as is for IP-1 and OSPs.
- Annual licence fee on AGR – 8 percent for VNOs – needs to be removed or passed through to avoid double levy on the customers.
- Single NSO parenting condition, in case of Access VNOs should be removed, allowing tie up with multiple NSOs.
- Ambiguity in guidelines for VNEs (Virtual Network Enablers) needs to be removed.
- Mandating retail-minus principle for wholesale pricing for VNOs by NSOs.
- Delicense VNOs – Need for light-handed regulations to bring them under registration regime (as for OSP).

In case, the government can facilitate the entry of smaller, niche, and innovative players by removing the unintended myopic hurdles, it can be a real game changer even if late, as they say, **"It is better late than never."**

Danish firm Bluetown offers low-cost, local internet to hinterland in India

Mansi Taneja
mansi.taneja@dnaindia.net

New Delhi: Denmark-based firm Bluetown plans to offer wi-fi solutions in India, especially in rural areas, under which one can access specific internet content without an active data connection.

This will be extremely critical in areas where network connectivity is low. The company works through 5L — low cost (works on free band of 2.5 Ghz), low power (only 20 watts of power required), low maintenance, local cloud and local content.

"The local cloud will keep users connected to local content, even if the internet connection is interrupted," Satya Gupta, country managing director, Bluetown India, told **DNA Money**.

"Since we use local cloud, the content gets saved locally. It is part of BTS and put in a box in the tower. There can be pre-loaded local government content which can be accessed besides the cached content which gets saved while accessing the internet. Also, the content keeps updating automatically when the internet connection is on," he said.

Satya Gupta

However, this comes at an extra cost of Rs 50,000 or the state government/telecom firm/content owner can pay lease charges.

The company has got a contract from BSNL for installing 15,000 wi-fi hotspots in Jharkhand, Assam, Bihar with an investment of $80 million over a period of 3-5 years.

Bluetown is in discussions with many state governments and entities for installing their solutions as there is a shift towards moving to a digital society. Under the Digital India initiative, the government plans to deliver many services through an online medium.

According to him, about 70% of India's population, equivalent to 857 million people, lives in rural/remote areas. And as per estimates, about 500 million users are yet to be connected by internet.

"Our solution is designed to work in even the most rural parts of the world, powered 100% by solar energy and comes with rechargeable batteries as a backup for 24/7 performance. Also, users can charge their mobile devices at a specially designed charging station and extra features such as a streetlight and webcam can easily be added. The base station is delivered as a turnkey installation. It connects to the internet by existing infrastructure via fibre or microwave link, satellites, drones or balloons," he said. The company has already installed such solutions in Africa and Latin America.

Once the system is installed, users are up and running within minutes. Multiple base stations can be set up in a mesh of access points and the masts connect via a microwave link designed to operate at a distance of up to 20 kilometres.

This makes it easy to cover a larger area or connect several villages starting from the same internet connection, he said.

CONNECTING PEOPLE

- The local cloud will keep users connected to local content, even if the internet connection is interrupted
- **The content keeps updating automatically when the internet connection is on**
- The firm has got a contract for installing 15,000 wi-fi hotspots

Annex VII
CEO Magazine Interview of the Author – CMD Bluetown, India

1. ***Pls tell us in brief about the company, mentioning Solution/ Product Offerings/Business.***

BLUETOWN (India) Private Limited, a subsidiary of Danish technology innovation company has pioneered a low cost, low power, low maintenance Wi-Fi access solution tailor-made for Rural & Remote areas of developing nations like India & Africa.

BlueTown has developed an end-to-end communication platform, specially designed for the needs and conditions in rural area of the world. The solution provides 'out-of-the-box' access to the Internet, via a low-cost mobile phone without the need of a SIM card, or any other device. The solution is based on cost efficient standard technology with low maintenance, which is easy and fast to deploy, and includes own power supply based on solar power and rechargeable batteries.

2. ***When the company was formed?***

BLUETOWN (India) was incorporated in end-January 2016 and became operational from April, 2016.

2.1 How did you/the company generate this idea to set up this organization?

In India, we were mainly inspired with Prime Minister's Digital India mission and also the fact that more than half of the world's population lives in areas without even the most basic forms of connectivity. BLUETOWN has developed an affordable and sustainable way of connecting the unconnected and poised to solve this critical missing link.

2.2 How does the company build a successful customer base?

BLUETOWN (India) have partnered up with BSNL, a Govt. telco in India to build, operate & maintain Wi-Fi hotspots in Eastern parts of the country (specifically in the states of Bihar/Jharkhand, Assam and Andaman & Nicobar Islands). Through this partnership we will access the rural masses of the states in Eastern & North East India. We are also working towards tying up with various other Government/Private operators.

3. ***Offices (Head Office/Branches/Delivery Centres)***

Head Office: – Copenhagen, Denmark

Offices in Tanzania, Ghana, India, Silicon Valley, Peru, and Dubai

India Office – BlueTown (India) Pvt. Ltd. 217, DBS Business Centre, 1st Floor, World Trade Tower, Barakhamba Avenue, New Delhi – 11 00 01.

3.1 How did you decide on the location for your business?

Since more than 70% of Eastern India's population, live in rural areas without the availability of reliable connectivity, there was a pressing need to enable the availability of communication in these areas. Also, BSNL invited us to participate in the EOI (Tender) for Eastern India where they were not getting any partners, to work as **"Managed Hotspot Service Provider."**

4. ***Clientele (total number and a name of few if possible).***

BSNL is our main partner & client. In addition, we have tied up with TCIL also to work with them on opportunities with Wi-Fi included; also we have a tie up with ESSCI (Electronic Sector Skill Council of India) for training of our VLE's (Village Level Entrepreneurs).

Also, we have entered into MoU with CSC (Common Service Centre) Organization of Govt.

5. ***Can you pls tell us about Differentiating Factors and Revenue Model?***

BlueTown works on a Revenue Share (Opex) Model with BSNL which in turn is very innovative as we are working as "Managed Service Provider" bringing in the CAPEX to be invested for our Digital India project and the recovery of the CAPEX is through Revenue share agreement with BSNL.

We believe that there is a sustainable business case in Rural parts of the country whereas the incumbent Telco's are not there yet as they are concentrating in the urban areas. So effectively the rural areas are un-explored market and almost 70% of the population in India stays in rural parts of the country. Our differentiating factors are our innovative solution (Low cost, Low maintenance, Low power) and our "Managed Service" based revenue model.

6. ***What are the most effective marketing initiatives or programs you have used to promote your business?***

To start with, we were more of silent on the marketing initiatives as we first want to deliver and demonstrate to the world that there is a huge business potential in the rural areas as well, and there is profit to be made in addition to solve a social problem. Now we have started using various marketing initiatives as per our Business Convas and has built up a specialized commercial team to drive it.

7. ***If possible, name competitors of the company.***

No competition as nobody is working in the rural areas of Eastern part of the country. Actually, our model is based on "Blue Ocean" strategy.

8. ***How many employees are working here? What kind of culture exists in the company?***

Globally we are a team of 60 people and in India there are 10 team members. The structure is pretty much lean & flat. Most of the work is being executed through outsourcing.

We also make use of "Interns" who bring in lot of energy & new ideas at very affordable cost & liability.

9. ***Pls share us something about Investors and Investment: Where did your organization's funding/capital come from and how did you go about getting it? How did you obtain investors for your venture?***

   Mainly we started with the promoters' bootstrapping investments as seed capital, who have passion for rural market & very rich experience in running such social business. Some VC's have also started contributing at a small scale. The social angel with rural focus and employment generation potential of the project has started attracting PEs' also to have a look on the opportunity.

10. ***What are the major milestones for the company since founding? Does the company have any new projects coming up (or have you just completed a big project ~ reached a milestone, etc.)?***

    The major milestones in India are as mentioned below:

    - Three Proof of Concepts conducted at rural sites in the state of Rajasthan conducted successfully with BSNL & BBNL.
    - Participated & Awarded the big BSNL tender for Eastern India.
    - Signed an MOU with TCIL (Telecom Consultants of India Limited) for participating in various EOI's/Tenders for Wi-Fi connectivity.
    - Signed an MOU with ESSCI (Electronic Sector Skill Council of India) to train the VLE to run the Wi-Fi hotspot and thereby giving a job also to the VLE at the Wi-Fi hotspot deployed by BLUETOWN.
    - Signed an MOU with CSC e-governance services limited to engage the existing CSC (community service center) person in selling the Wi-Fi talk time and maintaining the Wi-Fi hotspot thereby increasing the monthly income of the CSC person.

11. ***What is the business problem it hopes to solve with its solutions and offerings?***

BLUETOWN vision & mission would enable the people living in rural areas with no data connectivity connect to the world of Internet at an affordable price. Also with each hotspot being created there will be one job also that will be created as a local person would be required to do the sales/ marketing & basic maintenance of the Wi-Fi hotspot.

12. ***Pls tell us about Road Map and Future Plans of your organizations.***

We intend to connect about 1,000 villages in India in the current FY (Sept. 2017) and another 5,000 villages each in the next 2 years, thereby connecting about 11,000 villages in the next three years and creating equal number of jobs.

Globally we intend to have about 100+ million subscribers over the coming 5 years in close partnership with local telecommunication service providers and governments.

13. ***Awards & Recognitions in India.***

i. Aegis Graham Bell Awards for rural broadband access innovation 2015.

ii. Recognized at 1st SCTE India 2016 award for excellence in innovation.

14. ***Key Executive (Founder/CEO etc.) and a brief background on the person.***

i. **PETER IB,** CEO

Former CEO NOKIA Denmark. 18+ years of experience in business strategy creation and execution, project – and program management, team leadership and change management programs. Significant international experience.

ii. **BRIAN BISGAARD,** Executive Group Director

Investor, IT entrepreneur, co-founder and shareholder in BLUETOWN. 25+ years of experience within IT with emphasis on solution-orientated sales, marketing and business development.

iii. **SATYA N. GUPTA,** Country Managing Director.

An International expert in NGN technologies, Regulation, Interconnection and Broadband policy with 35 years' experience in all aspects of Telecom, Satya N. Gupta is triple master in Electronics Technology, ICT Management and Telecom Regulation and Policy. After 25 years with Govt. & 10 years with telecom Industry, left his coveted position in Corporate to lead this ambitious venture in India to contribute to society by **"Making it Happen."**

15. ***How was the market last year? Where did the company stand?***

For BLUETWON the last year was more about the proving the concept and technology in the Indian environment and it worked well for us. Also as mentioned earlier we won the tender from BSNL for deploying Wi-Fi hotspots on behalf of BSNL, where we have opportunity to connect the masses in about 25,000 villagers. We are also having serious look at the new guidelines of Govt. regarding VNO (Virtual Network Operators).

16. ***Say something about the unique service/product of your company?***

THE BLUETOWN BASE STATION OFFERS MORE THAN Wi-Fi: – The base station is designed to operate under harsh environmental conditions. It delivers high quality Wi-Fi with a range of up to one kilometer and a minimum of maintenance. The entire system is 100% solar-powered and comes with rechargeable batteries for 24/7 performance.

People can also charge their mobile devices at a specially designed charging station. Extra features like streetlight and webcam can easily be added. In addition, it has the facility for the storage & caching of local content also.

Our solution works on the "5L" principle of

i. Low Cost (works on Free Band of 2.4 Ghz; no expensive spectrum required; also the cost is around 3.0 Lacs per hotspot).

ii. Low Power (requirement of only 20 Watts).

iii. Low Maintenance (can be maintained from remote and all the equipment can be placed outdoors no air-conditioning required).

iv. Local Control – AP Controller for each Hotspot.

v. Local Cloud – Content Server in the Controller box.

Our complete solution has been put in a box which can be installed on the existing tower itself without need for any shelter, air conditioning, etc.

17. *Has this organization been playing a major role for betterment of the society?*

Research shows that access to reliable communication, providing easy access to medical care, education, and commercial activities, is a self-enforcing enabler for the creation of wealth and an overall higher standard of living. Yet, more than half of the world's population lives in areas without even the most basic forms of modern connectivity.

Therefore, by providing accessibility to affordable and sustainable form of communication, BLUETOWN is making an effort to enable, the people living in rural sector to become self-reliant and creating their wealth and improving the standard of living.

Annex VIII
Interview of the Author by tele.net

Satya Narain Gupta

Chairman, India and BIMSTEC, BLUETOWN

A telecom veteran, Satya N. Gupta has spent over 38 years in the telecom industry, executing telecom projects and creating and managing telecom entities. The most notable entity created under his leadership was a JV between Indian Railways and British Telecom, called Ircon Telenet Pvt. Ltd. This was later converted into a PSU by the Ministry of Railways, which is today known as RailTel Corporation of India. During his career, he has been associated with corporations like Ircon International, BT Global Services and Sterlite Tech. He has also worked with TRAI as principal adviser. Gupta has in-depth knowledge of next-generation network (NGN) technology and is associated with the International Telecommunication Union as an NGN expert and with the Commonwealth Telecom Organisation as an NGN trainer. Despite working in key roles across leading organisations, Gupta believes that his most exciting professional phase began only three years ago when he took up an executive role in a start-up. This involved forming an Indian entity for a Danish start-up, BLUETOWN, advocating their hotspot-as-a-managed-service business model, providing broadband access in remote areas on a revenue-sharing basis, and heading its operations to make it financially sustainable. "The most attractive part of this job was having complete freedom to run the business," he says.

BLUETOWN has partnered with BSNL to build, operate and maintain Wi-Fi hotspots in the eastern parts of the country. It set up Wi-Fi-enabled hotspots in 1,000 villages during 2017 and intends to connect another 5,000 villages in each of the next two years. As chairman, India and BIMSTEC, BLUETOWN, Gupta is responsible for forging strategic partnerships in India and BIMSTEC countries, and exploring new markets to Connect the Unconnected.

In terms of management style, Gupta believes in delegating work. He considers his ability to execute projects as his biggest strength. "I don't believe in a work-life balance, but am trying to practise a work-life blend," he says. Gupta has triple master's degrees in electronics design technology, IT management, and telecom policy and regulation, the first one from the Indian Institute of Science, Bengaluru. He is a voracious reader and has a flair for writing, speaking and professional networking. His family comprises his wife, Madhu, who is a homemaker, and their two sons. "My elder son works for a US multinational corporation in China. The younger one is working in Mumbai."▲

Annex IX
360° View of Game-Changing Potential of the Suggested Solution

Connecting India via an army of entrepreneurs

An initiative by MarcaTel India and Danish tech giant Bluetown that aims to be the game-changer to bridge India's last mile digital divide.

Competitiveness in today's business environment isn't merely about cutting costs and raising revenues. Positive externalities are critical to survival and growth. The key to any successful modern-day enterprise, therefore, lies in its ability to leverage new technologies and generate a social impact.

One organisation that seems to have grasped that perspective right at the outset is MarcaTel India, which is a division of LaMarca Knowledge and Services Pvt. Ltd. – the latest initiative from the LaMarca Group of Companies.

In May this year, MarcaTel announced a major partnership with Denmark-based technology giant Bluetown for a project that seeks to revolutionise Internet connectivity in rural India. Under the project,

MarcaTel will be using technology provided by Bluetown to set up localised public WiFi hotspots in villages across India.

The core aim of the project is to bridge the digital divide in the country by ensuring that more and more people log on to the World Wide Web, without data costs burning a hole in their pockets.

Once connected, a user can enjoy a constant speed of 1MBPS. What that means is that while a consumer can select a data plan as per his or her requirement, there would be no additional charge or reduction in data transfer speed at any point of time. Once the pack is exhausted, the consumer can simply recharge and continue to access data at a constant speed.

Moreover, keeping in mind the ongoing data pricing war among telecom providers in the country, MarcaTel is not only looking to offer competitive tariff plans but is also maintaining pricing constant for users across the country.

While smart pricing and constant data speed form the bedrock of MarcaTel's offering, the key differentiators of its services will likely be its alignment with Government of India's Digital India campaign and its unique distribution model. Keeping in tune with the vision of the Digital India campaign, MarcaTel says that it will be providing targeted information and knowledge pertaining to various government welfare schemes that are meant to benefit its consumers.

"MarcaTel is very much within the ambit of the Digital India initiative. It is aimed at providing last mile connectivity at the rural level. Once the network is established, one of the initiatives that we intend to undertake is to extensively promote both state and central government schemes that benefit the common man," says Narayanan Rajagopalan, President of LaMarca Group of Companies.

The company will be executing this vision through a unique distribution model that relies on a network of franchisees that it is terming as Micro Commerce Entrepreneurs (MCEs).

"A Micro Commerce Entrepreneur is the Wi-Fi tower owner who will hold the monopoly for a tower in the local area and would generate revenue by selling recharge coupons. MarcaTel will choose MCEs through local advertising and word of mouth connections," says Rajagopalan.

While MCEs will have to make an initial, one-time investment of Rs. 600,000 for the installation of the Wi-Fi tower, MarcaTel will be providing them with technical know-how and skill enhancement training from a business perspective. The company says that it is aiming to achieve complete rollout of its services by March 2018. However, getting to that stage will be step-by-step process. In the first phase, MarcaTel will focus on setting up its network and services in the southern Indian states of Karnataka, Andhra Pradesh and Tamil Nadu. That will be followed by infrastructure development in Uttar Pradesh, Madhya Pradesh and West Bengal and only then will it seek to achieve pan-India rollout.

Mr. Narayanan Rajagopalan,
President of LaMarca Group of Companies

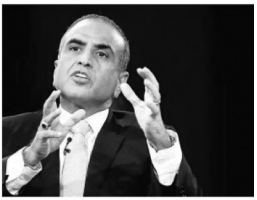
Annex X
Words of Wisdom by Father of Managed Services in India

Time has come for setting up network operating companies: Sunil Bharti Mittal, Chairman, GSMA

By *Romit Guha*, ET Bureau | Updated: Feb 28, 2017, 01.48 AM IST

Post a Comment

Sunil Bharti Mittal, chairman of global telecom body GSMA, said that his strategy for improving the financial health and credibility of the industry worldwide rests on four pillars — deepening active sharing by pooling spectrum in a separate company run by a third party; more consolidation; a change in the attitude of governments towards telecom; and abolishing roaming charges while improving transparency in billing. Mittal, chairman of India's largest telco Bharti Airtel, told ET that despite billions of dollars in annual investments, the industry was being valued at levels similar to utility companies. Mittal is in Barcelona for the Mobile World Congress, where he delivered the keynote address. Edited excerpts:



"Netco will be one big challenge because governments will have to change all their policies. Spectrum sharing is now allowed, bu even now there are many restrictions."

RELATED COMPANIES EXPAND

Videocon

Bharti Airtel

Assembly Elections 2017:
Is Modi on a road to nowhere in Uttar Pradesh?

What is your vision/strategy for the global telecom industry?
I will use four pillars to outline my strategy – credibility/reputation, time for a netco (network company), consolidation and change in the attitude of governments towards telecom.

Can you elaborate?
This industry invests a massive amount of money, roughly about $200 billion in networks a year globally. Besides, about $50-60 billion goes into spectrum annually. The density of expenses in terms of capex, spectrum is going up whereas revenue is tapering off, which is putting a massive amount of pressure on RoCE (return on capital employed) of this industry, which has lost its appeal to investors. We are down to an average multiple of about six and a half, which is usually what utility companies get, where you put up a plant, and you don't invest anything more other than that on repairs. Here, around 20% of the revenue go into capex, so this is not a utility. So, what is happening? Firstly, it is the credibility, reputation of this industry which has massively suffered.

What is going wrong?
First and foremost is roaming, which is the biggest bugbear of this industry. In our (India) case, we have domestic roaming as well but internationally, people go out with the fear of even opening their phones. We, as an industry, should work on reducing international roaming (charges). Airtel will do away with India roaming from April 1. We will also make international roaming bills shock free. The (Indian) government should get rid of the 22 circles, just make it one India, one network. The second part is that people all over the world feel that billing lacks transparency and clarity. This has to change, globally. We are moving towards bundled plans. So, simplicity of billing is needed. Third, content also has a lot of charges. They must also be part of key bundles and what is not part of the bundle must be clearly spelled out. Different charges for content could be a problem in India, which has barred discriminatory pricing of data. These are not global issues at all. Eventually, India will have to align with the world. It (bar on discriminatory pricing of data services) should go away.

How can RoCEs of telcos improve?
Time has come for setting up network operating companies (netcos). The current system of building networks for each operator needs to be completely dismantled. Some progress has been made in towers. The best progress has happened in subsea cables, almost all of which are under consortium. But fibre is still far behind on the ground. In India, Tata, Vodafone, Jio, BSNL have their own and, on top of it, BharatNet is coming.

Far too much wastage is happening and no wonder RoCEs are low. Every fibre must be built in a consortium.
Netcos and mobile companies should separate themselves. Spectrum should be pooled in a netco. You build one massive network from

which everyone is served. Benefit is that it is not just lower investment in capex but your spectrum efficiency rises significantly. The need for base stations is halved immediately. Everybody will not come together, but my views are: they should... at least two must build, ideally three. So, I say time for a netco has come.

In this netco, fibre, spectrum and towers will all get combined?
Passive side can be separate, the active side should be network. It could be like towers where everybody comes and co-builds. An independent third-party netco has to come and run it which has a clear method of charging per MB per minute or whatever. The job of that is of a utility. Then we (telcos) become digital companies, providing content. We will be true marketing companies. India doesn't allow it yet.

How will government react given a lot of revenue comes from spectrum?
That is the fourth point. What do they (governments) want? A digital nation or spectrum auction and money? Governments need to start looking at industry in a very different way. You need massive consolidation in the sector. In 2008 when we (India) took from five to 12 operators, the idea was that they will serve customers better. But investments in network slowed. Videocon, MTS are gone. Aircel and RCom will merge. Now, with Vodafone and Idea, looking at just for India, $25 billion of hard investments blown off in smoke. If we had three private sector companies with BSNL, solid, viable, strong balance sheets, India would have accelerated its rollout, invested more in capex and consumers would have enjoyed the benefits of competition. US has stopped Sprint and TMobile merger, which should have been encouraged.

5G is coming in the next two-three years. You want strong balance sheets. Governments and regulators have enough powers in their hands to intervene should they see any extra profit-making tendencies of any of the operators. On one hand they (government and regulator) want more innovation, on the other, they want the highest taxes. Governments should therefore decide — should they milk this sector or should they support the sector with various forms of incentives?

Which of your pillars do you expect will face the most challenge?
Netco will be one big challenge because governments will have to change all their policies. Spectrum sharing is now allowed, but even now there are many restrictions. Such restrictions, which are exclusive to India, must go.

Annex XI
AKGEC Journal Article
by CGM-BSNL, Jharkhand

Broadband Internet and Access Technology for Rural Connectivity

Kishore Kumar Thakur, FIETE
Bharat Sanchar Nigam Limited, ARTTC Campus, Hazaribagh Road, Ranchi 835 217 Jharkhand India
cgm_jhk@bsnl.co.in

Abstract – **Wireless backhaul is increasingly recognized as an option for combating the expenditures involved in providing fiber based backbone for rural connectivity. Wireless backhaul solutions can take the form of point-to-point or point-to-multipoint wireless Ethernet bridges or wireless mesh networks. They can use licensed or unlicensed spectrum band. With throughput from as low as 10 Mbps up to Gbps, full duplex, a licensed microwave link or wireless bridge can provide sufficient capacity for many rural applications.**
Aspects of rural connectivity are explained that provide inputs for proposed solutions and policy formulation. Limitations of cellular, the need to focus on non-mobile endpoints, the use of unlicensed spectrum, and wireless links as an alternative for fibre are pointed out.

Keywords: Rural connectivity, Wireless internet, Access technology, Broadband internet, High-speed internet, Backhaul network, Very small aperture terminals

I. INTRODUCTION

RURAL areas especially those of the developing countries provide challenging environment to implement communication infrastructure for data and Internet based services. The main challenges are the high cost of network implementation and lack of customer base, as rural areas are characterized by low income, highly scattered and low population density. This situation drives network operators to establish network infrastructures in urban/city centres leaving rural areas as underserved community.

To achieve country-wide Internet access is an important goal to sustain the progress of our societies. Nevertheless, there is important gap between the urban and rural areas in terms of Internet Connectivity that is mainly due to a lack of interest by Internet Service Providers (ISPs) in deploying a wired infrastructure in these areas; such lack of interest is expected to be maintained since the estimated Return of Investment (ROI) is not attractive.

It is widely accepted that new information and telecommunication technology are needed to alleviate a wide range of obstacles for economic and social development in rural areas. This is particularly true for Internet accessibility, since it offers a global platform for retrieving and sharing information.

During past few years, there has been a remarkable progress in the most developed countries in terms of telecommunications facilities. However, outside the main urban areas, there are significant handicaps that make Internet connectivity a complex and costly task.

New wireless technologies offer effective and inexpensive solution to bring wireless Internet to rural areas. In fact, the promise of wireless Internet technologies led to increased interest of international development community. This synergy has driven by wireless standards recently ratified by IEEE, namely IEEE 802.11 standard [Ieee99] for wireless local area networking (also known as Wi-Fi), and the IEEE 802.16 [1] standard for long distance point-to-point connectivity (also known as WiMax) targeting MANs [2].

Wireless Internet will offer significant applications such as e-education, e-health, e-business or e-agriculture to remote users. However, additional efforts are required to extend the deployment of wireless infrastructures from urban centres and laboratories to low density population areas.

II. EXISTING AND EXPECTED RURAL CONNECTIVITY TECHNOLOGIES

Currently, a number of wireless technologies are either available or will be available soon which will bring high-speed internet access to most of the villages. The wireless technologies have progressed over the last few years like WiMAX (802.16d), 802.20 or Wi-Fi Mesh etc. These should soon allow the introduction of countrywide low cost rural broadband services. A list of present and expected connectivity technologies that can be used at present or in near future is listed below:

- Fixed Lines
- Cell Phones
- Cable Modems
- VoIP / VOB
- VSAT
- Wi-Fi
- WiMAX [3]
- Wi-Fi Mesh [4].

AKGEC INTERNATIONAL JOURNAL OF TECHNOLOGY, Vol. 9, No. 2

Providing connectivity to the rural areas may be possible through VSAT link or an Optical Fibre Cable (OFC) feed leased from an Alternative Telecommunication Network (ATN), this feed can be used in combination with Wi-Fi Technology like Bharat Sanchar Nigam Limited is doing in rural and remote areas under the Bharat Net Initiative**.** It can, therefore, be assumed that, countrywide low cost rural Broadband services shall be made available.

III. TECHNOLOGY ALTERNATIVES FOR ACCESS, BACKHAUL AND DEVICES

Technology options are always a function of type of locations, geography and terrain. Though there are various geographies that may exist, the terrains in most likely scenarios are likely to be the following:

i. Flat Open Space
ii. Valley
iii. Rugged Mountain Terrain
iv. Deserts
v. Islands.

The technology choice for a broadband network in rural areas has to be made mainly keeping into account the type of terrains which generally are difficult geographically, to select the most appropriate solution while keeping the cost low.

Normally, a broadband network can be divided in two main components, namely Access network and Backhaul network [5] as shown in Figure 1.

Access network provides last mile connectivity between subscriber/premises and nearest node of the service provider or point of presence (POP), whereas the Backhaul network connects all POPs of the service provider for carrying aggregated traffic of subscribers [6] to other service providers, International Gateway/Content Delivery Network (CDN). Different technologies both based on wireline and wireless are available for access and backhaul networks to provide end to end broadband services. Some of the technologies can be used both for access as well as backhaul [7].

Generally, the Access network is deployed by the licensed service providers or their franchises (MHSP) using various Wireline and wireless technologies. This network extends right up to subscriber premises/handset and must be designed and dimensioned on the basis of the services and applications that each customer may require, today and in future.

While selecting a particular technology option both speed and availability are important considerations. It is important to increase throughput (data rate) by deploying efficient IP based next-generation networks so that emerging applications and services that will play important roles in improving quality of life and boosting economic growth are supported.

IV. OPTIONS FOR ACCESS NETWORK

Wireline Technologies: Wireline technologies are capable to support high speed data transfer with reliability [8]. Some of these technologies are:

- xDSL (Digital Subscriber line) over copper
- Passive Optical Network (PON) over Fibre (FTTX)
- Data Over Cable Service Interface Specification (DOCSIS)
- Ethernet-over-Coax (EoC)
- Power Line Communication (PLC).

Digital Subscriber Line (xDSL): DSL or xDSL is a family of technologies which uses the conventional telephone lines (copper cable) [9] for transmitting the digital data at higher frequency than the frequency used for voice communication. Different type of DSL technologies are:

(i) HDSL: High bit rate Digital Subscriber Line (HDSL) [10] is a bidirectional and symmetrical transmission system

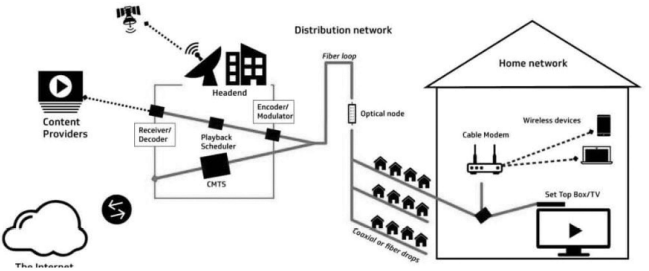


Figure 1: A typical broadband network.

that allows the transport of signals with a bit rate of 1544 Kbit/s or 2048 Kbit/s on the copper twisted pairs [11]. In this type of DSL bandwidth allocation in upstream and downstream is same. It works upto about 3 km delivering maximum speed upto 4 Mbps in each direction.

(ii) Asymmetric DSL: ADSL is a form of DSL where more bandwidth can be allocated to download than to upload. It provides maximum speed of 8-10 Mbps downstream and about 1 Mbps upstream. ADSL can provide satisfactory services upto about 3-4 km from the local exchange depending on quality of copper pair. It is suited to residential use as it shares a single twisted copper pair with voice, allowing users to use the telephone and surf the Internet simultaneously on the same physical copper pair line [12].

(iii) ADSL2, ADSL2 plus – ADSL2 is sequel to the original ADSL recommendation, enabling improved speed, longer reach and low power consumption. ADSL2 can deliver 8-12 Mbps download speed while further extending the distance coverage. Further, the voice channels are realigned and often provide the ability to combine multiple ADSL2 lines for higher bandwidth to certain customers. ADSL 2 plus (ADSL2+) builds further on ADSL2 by increasing the bandwidth throughput extending the usable frequencies on the line [13]. These increase download speed from 8 Mbps with ADSL2 to 16 Mbps with ADSL 2 plus, at the cost of coverage which is reduced to approximately 1.5 km [14].

(iv) Very-High-Data-Rate DSL (Very high speed Digital Subscriber Line) permits the transmission of asymmetric and symmetric aggregate data rates up to tens of Mbit/s on twisted pairs. VDSL2 is an enhancement that supports asymmetric and symmetric transmission at a bidirectional net data rate up to 200 Mbit/s on twisted pairs using a bandwidth up to 30 MHz. VDSL connects to neighborhood optical network units (FTTN), which then extends connectivity to the telephone company's central office (CO) main fiber network backbone.

(v) In spite of continuous technological progress, physical limitations inherent to DSL technologies make them unusable in scarcely populated areas with long distances between the end users and the nearest telephone exchanges, or in regions where most houses are not connected to the telephone infrastructure. Therefore, these are not considered for a business case for rural broadband.

Passive Optical Network (PON) over Fiber

(i) PON is an Optical Access Network (OAN) with the capability of transporting various services between the customer premises and the Service provides node over optical fibber.

(ii) The optical section of a local Access network system could be either an active point-to-point or passive point-to-multipoint architecture. Figure 2 shows the architectures which range from Fibre to the Home (FTTH) [15], Fibre to the Building/Curb (FTTB/C) and Fibre to the Cabinet (FTTCab). The Optical Access Network (OAN) is common to all architectures shown in Figure 3; hence commonality to support various options in this system has the potential to generate large world-wide volumes. The FTTB/C and FTTCab network options are predominantly different from point of view of implementation [16].

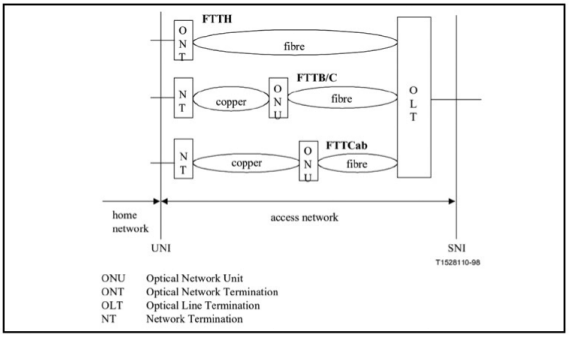


Figure 2. Network Architecture of Access Optical Network (Source: ITU-T G.983.1).

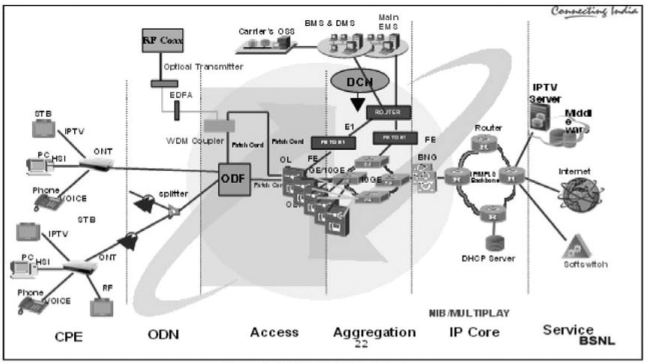


Figure 3. BSNL FTTH Architecture.

Data over Cable Service Interface Specification (DOCSIS): Data over Cable Service Interface Specification (DOCSIS) defines interface requirements for cable modems involved in high-speed data distribution over cable television system networks which enable provision for bidirectional data over coaxial and hybrid fibre-coax cables for interactive services [17].

Ethernet-over-Coax (EoC): Another technology used over cable TV networks is Ethernet-over-Coax (EoC). Standards used in this technology are Multimedia over Cable Alliance (MoCA) and Home Phone Networking Alliance (HPNA). MoCA has been designed for local in-building distribution using frequency range above 862 MHz, which limits its use mainly in HFC plants. HPNA in its latest version 3.1 uses the frequency range of 4 to 52 MHz and can therefore bridge greater distance due to low loss in coaxial cables in this frequency range.

Power Line Communication (PLC): Power line communication (PLC) is the term used to describe several systems using electric power lines to carry radio signals for communication purposes. Power line communication technology can use the household electrical power wiring as a transmission medium. Telecommunications services can be provided over power line through the modems and injectors. Access to Internet or other telecommunication services can then be provided by a leased line/wireless/satellite link attached at the Broadband over Power Line (BPL) devices [Fig. 4]. In future, it is expected that systems will be capable to offer upto 200 Mbps speed commercially [18].

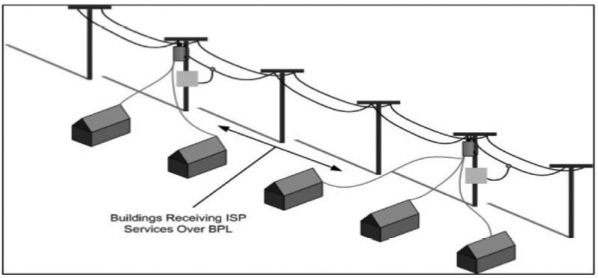


Figure 4: Broadband over power line.

Wireless Access Technologies: Wireless based technologies for Broadband access are emerging rapidly due to technological innovations. Wi-Fi as one of the wireless access technology can play very important role especially in the geographies like India. To substantiate this statement some statistics are provided below.

Various wireless technologies capable of providing Broadband are described next.

The unlicensed spectrum based Wi-Fi: The unlicensed spectrum in sub 6 GHz bands like 2.4 GHz, 5.1 GHz and 5.7 GHz can be utilized in rural areas where interferences are unlikely to occur. This technology is a low-cost option for creating the Access Points (Hotspot) in limited coverage areas. In addition; mid capacity radio links (50 Mbps) can serve as access connections to businesses, school campuses and government facilities. This option is low-cost, easy to install and can be used to provide adequate capacity for supporting Broadband services with a mix of legacy and Ethernet traffic. Due to its affordability, scalability and versatility, Wi-Fi Hotspot are spreading beyond urban to rural areas. Wi-Fi technologies can be configured into point-to-point and point-to-multipoint networks to improve range and provide last mile access for broadband.

Wi-Fi networks offer affordable, scalable and versatile technologies that can facilitate the spread of Internet access in rural and urban areas alike. Modern technology also makes it possible to integrate a server with high storage capacity with the Wi-Fi hotspot equipment. As the cost of such servers has come

TABLE 1 – INTERNET SUBSCRIBER BASE TRENDS

Segment	Mode of Access								Total Subscribers (in million)	
	Wireless Subscribers (in million)									
	Wired Subscribers (in million)		Fixed Wireless (Wi-Fi, Wi-Max, Radio & VSAT)		Mobile Wireless (Phone + Dongle)		Total Wireless			
	Dec-17	Mar-18	Dec-17	Mar-18	Dec-17	Mar-18	Dec-17	Mar-18	Dec-17	Mar-18
Broadband	17.86	17.95	0.441	0.457	344.57	394.19	345.01	394.65	362.87	412.60
Narrowband	3.43	3.28	0.013	0.014	79.65	78.06	79.66	78.07	83.09	81.35
Total	21.28	21.24	0.455	0.471	424.22	472.25	424.67	472.72	445.96	493.96

[*Source*: TRAI]

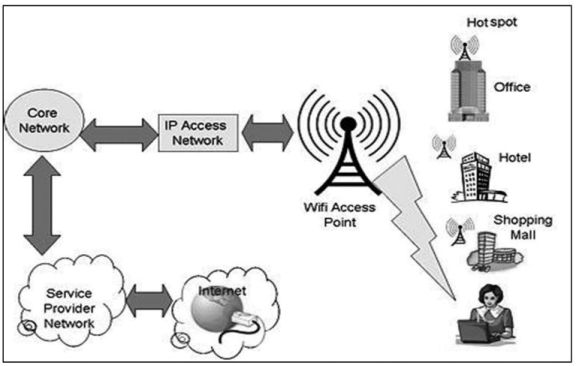


Figure 5. Wi-Fi Access through Wi-Fi Hotspot.

down significantly, along with the cost of storage, and the form factors of such devices are very small, it should be possible to cache or download content for easy browsing even when the backhaul connectivity is not available. Such an arrangement can find great application in storing children's study materials, educational data, agricultural and health related information, as well as movies and entertainment content, for the benefit of Wi-Fi users in areas with irregular connectivity, such as rural areas.

Advancements in Wi-Fi technology: Wi-Fi uses radio waves that run at a specific frequency, generally 2.4 GHz and 5 GHz, to create wireless networks. The widespread adoption of Wi-Fi technology is attributable both to technological advancements in standards as well as the fact that most jurisdictions have fully or partially de-licensed the radio frequencies on which it operates, hence drastically bringing down the cost of delivering Wi-Fi services [19].

Wi-Fi technology has gone through significant advancements in the years since 1997, when the 802.11 standard was first adopted by the IEEE [20]. These subsequent improvements to the technology have enabled better speed, reliability and security in the usage of Wi-Fi networks. Table 2 summarises the Wi-Fi generations currently in use.

TABLE 2 – CURRENT WI-FI GENERATIONS [21]

Standard	Year of introduction	Frequency	Maximum connection speed
802.11a	1999	5 GHz	54 Mbps
802.11b	2000	2.4 GHz	11 Mbps
802.11g	2003	2.4 GHz	54 Mbps
802.11n	2007	2.4/5 GHz	450 Mbps
802.11ac	2014	5 GHz	1.3 Gbps

IMT standard based Cellular Access technologies using Licensed Spectrum: New wireless technologies are capable to provide faster data communications services along with voice. These are based on the International Telecommunication Union (ITU) family of standards under the International Mobile Telecommunications (IMT) programme and commonly known as 4G and beyond (5G) technologies [22].

However due to cost considerations for network which works in licensed spectrum band as well as high smart devices these are yet to proliferate in rural areas and are not likely support the business case for rural and remote areas yet [23].

Both wireline and wireless technologies have their advantages and disadvantages. One fact is very vital that wireline technologies are having much greater capacity as compared to wireless technologies. However, there are many developments in wireless technologies based on Wi-Fi and players have started using this technology for access in a cost-effective manner.

Satellite Based Communication for Broadband Access: VSATs offer opportunities for achieving universal broadband coverage through the large areas achievable via a single footprint, and the fact that satellite technologies can be deployed as soon as the satellite is operational, regardless of terrain, distance or any availability of 'last mile' infrastructure [24].

Use of satellite technology for broadband access offers significant advantages in terms of ubiquitous coverage, simplicity in network design, reliability and rapid deployment and is very effective to serve rural and inaccessible hilly areas where wired access as well as terrestrial wireless is cumbersome to install and maintain. Though the perception is that today's satellite solutions lag behind fiber and wireless technologies in latency, mass throughput, and cost per bit, however, in future satellites are becoming very advanced in terms of reliability, speed of deployment, and security. Indeed, the next generation of satellites have started delivering higher transmission speeds, potentially competing with other types of Broadband connectivity both in terms of speeds and costs (Broadband Commission, ITU).

Advantages of using VSAT for broadband access: VSAT based services can be deployed anywhere. It provides Broadband access independent of the local terrestrial/ wireline infrastructure, which is particularly important for backup or disaster recovery services as well as in accessible areas.

- The services can be deployed quickly - within a few hours.
- VSAT enables customers to get the same speeds and SLAs at all locations across their entire network regardless of location.
- Current VSAT systems use a broadcast download scheme which enables them to deliver the same content to tens or thousands of locations simultaneously at no additional cost [25].

Limitations of VSATs: Latency (delayed response) is generally experienced by VSAT links. As in case of GSO signals relay from a satellite 22,300 miles above the Earth, a minimum latency of approximately 500 milliseconds for a roundtrip appears. They are subject to signal disturbances due to the weather; the effect is typically far less than that experienced by one-way TV systems that use smaller dishes. VSAT services require an outdoor antenna installation with a clear view. This may make installation in skyscraper urban environments or locations where a customer does not have roof rights problematic [26].

V. SELECTION OF TECHNOLOGY FOR BROADBAND ACCESS

A host of many factors influence the optimal choice of technologies [27]. Among the most important are:

- Type of terrain
- Speed of deployment
- Data handling capability to the customer
- The existing footprint and quality of the fixed telephone network
- The availability of spectrum suitable for fixed and mobile voice and data services
- Cost of service provision
- Capacity of the masses to pay.

The technology options for delivering wired local loop broadband connectivity include the rollout of xDSL, DOCSIS cable, and fiber to the home infrastructure. All these suffer from the high cost of deployment as well as cumbersome and time-consuming process for installation. Wireless options include the rollout of mobile (2G, 3G, 4G), wireless broadband (Wi-Fi, WLAN), and VSAT infrastructure. Within cell-based (mobile) wireless standards, all users connect to a single base station, and the transmission bandwidth has to be shared among all users in the cell's coverage area. Most of these technologies suffer from the high cost of deployment except those making use of unlicensed spectrum to avoid high spectrum-oriented costs.

Wi-Fi is proving to be an ideal option for Broadband access in rural areas because of its cost advantage and ubiquity of the Wi-Fi compatible access devices. The advantages and disadvantages of Wi-Fi based wireless versus Wireline Broadband access have been analyzed and listed in Table 3.

TABLE 3 – WI-FI V/S WIRELINE

	Advantages	Disadvantages
Wi-fi based access	• Low Capex • Unlicensed Spectrum • Quick & easy deployment • Ubiquitous availability of affordable devices due to economies of scale • Low Opex	• Distance Limitation • Unable to serve very dense population areas.
Wireline broadband	• High capacity broadband • Very high data rate • Evolution to extremely high throughput	• Expensive (capex) to deploy new network • High opex

Considering the lower cost of deployment and also its usage in unlicensed band, Wi-Fi emerges as a compelling technology sweet-spot for access in rural areas, especially when the inexpensive devices which are Wi-Fi enabled are widely available.

VI. OPTIONS FOR BACKHAUL TECHNOLOGIES

Another pillar for Broadband network infrastructure is the backhaul network. Regardless of the technology selected for the Access, the main requirement of broadband services in rural areas is how to transport data capacity to and from the Access node and centralized node of core network. This backhaul connection to the access node should be able to carry at least to the order of 100 Mbps to the nearby point of presence (PoP), and sometime even more.

Terrestrial Microwave Based Backhaul: The microwave transmission in licensed spectrum band is separated into two low and high frequency groups. The low frequency group uses the spectrum between 6 and 11 GHz and is more focused on long haul, high capacity transport to rural access nodes. The high frequency group utilizes the 13-38 GHz spectrum and is more oriented towards medium and short haul applications.

Taking advantage of low frequency group radios operators can easily build long haul links that span over 30 km per hop and may reach up to 130 km with more sophisticated planning. Such high capacity links can be cascaded together to create radio trunks for networks spanning thousands of miles over virtually any terrain. Long haul radio technology is already tested and proven having been in service for years carrying real-time traffic in applications ranging from broadcast TV, to controlling and monitor of gas pipes, water systems and power grids, to military applications [28].

Today, radio solutions offer operators a reliable technology for long haul transport. Accompanied by new high capacity techniques, microwave radios can now be utilized as a cost-efficient alternative to fiber and serve the growing need for Broadband services in rural communities.

Satellite Based Backhaul: Satellites have been successfully serving the traditional markets *i.e.* telephony and broadcasting, covering large geographical areas using single beam/ transmission. For satellite operators, their footprint is virtually limitless. Demand for two-way Broadband Access over large geographical areas not served by telecommunication infrastructure is ever increasing.

Satellite telecommunications technology has the potential to accelerate the availability of high-speed Internet services in developing countries, including the least-developed countries, the land-locked and island nations, and economies in transition.

Though satellites are generally designed for a 15-year life they often provide service for periods of 18 years or longer. Satellites are inherently highly reliable and provide a very high availability (up-time) compared with terrestrial solutions like fiber/copper cable or terrestrial wireless – particularly in developing countries where long sparse distances need to be covered.

Meanwhile, there are inherent latency (the time it takes to send and receive a message, 540 ms to 800 ms for a geostationary satellite in a typical environment) issues associated with the delivery of broadband using geostationary satellites. Latency is however not a problem for many applications like basic email access and web browsing. Since latency is due to the distance between the satellites and the earth, satellites in lower earth orbits have less latency than geostationary satellite networks [29].

Besides there are frequency dependent atmospheric/rain-attenuation problems for satellite signals especially in tropical areas – which creates issues primarily for higher frequencies like Ka-band. However, with improved technology in place to mitigate latency and attenuation issues, the underlying advantage of true global Broadband Access availability of satellite Broadband (*i.e.* data and web-based applications) is unmatched. One issue is that of the data capacities of the satellite bases Backhaul, which is not up to the mark yet [30].

Optical Fiber Based Backhaul: As the optical fiber based transmission system has enormous capacity, they are ideally suited for the backhaul segment for broadband specially taking into account the futuristic high-speed broadband applications. Even though wireless is accepted as an economical option for delivering "last mile" connectivity, backhaul traffic is usually carried via fiber-optic networks because of their high capacity. That is why optical fiber systems are forming the integral part of National Broadband Backbones. Issues with optical fiber systems are high CAPEX which needs funding from public agencies and also the time it takes to create the network.

VII. SELECTION OF TECHNOLOGY FOR BACKHAUL NETWORK

Comparison of three dominant backhaul technologies is given in the Table 4.

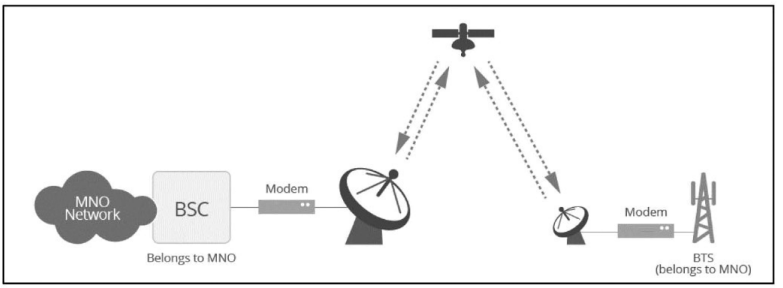


Figure 6. Satellite based backhaul services.

TABLE 4 – TECHNOLOGIES FOR BACKHAUL IN RURAL AREAS

	Terrestrial Microwave	*Fiber*	*Satellite*
Capacity	Limited	No limit	Limited
Distance	Cost per link. Some incremental cost with the distance	Directly dependent	No Dependence
Terrain	Any line of sight required	Becomes costly when trenched in mountains, desert, rocky plains or jungles	Any. Ideal for remote and difficult to Access terrain.
Climate	Sometime might need to select protected all indoor installation for the active equipment	Limits on Aerial fiber optic cable installation	Suffers from rain attenuation/ atmospheric conditions
Accessibility	Need Access only to the end points – two base stations for example	Trenching can be tricky if there is no Access for vehicles along the path	No issue
Time frame	Time taken in site acquisitions and towers erections	Right of way, and construction works may take a while and increase linearly with distance	Instant

While fiber has an obvious advantage in terms of capacity, it often does not fit the bill for rural deployment being too costly and too time consuming to deploy. Microwave on the other hand offers shorter setup cycles after obtaining the spectrum license. Satellite is suitable for providing Backhaul connectivity to remote and hilly areas which are difficult to access, otherwise.

Backhaul connectivity is often limited by the availability of the fiber-based network. The delivery of backhaul connectivity to rural areas lacking fiber-based network involves balancing of concerns about broadband access, connection quality, and the expenditures and delays entailed in rolling out supporting infrastructure. The benefits of terrestrial wireless backhaul technologies specially in unlicensed spectrum bands are worth considering in such cases.

Wireless backhaul is increasingly recognized as an option for combating the expenditures involved in providing fiber based backbone for rural connectivity. Wireless backhaul solutions can take the form of point-to-point or point-to-multipoint wireless Ethernet bridges or wireless mesh networks. They can use licensed or unlicensed spectrum band. With throughput from as low as 10 Mbps up to Gbps, full duplex, a licensed microwave link or wireless bridge can provide sufficient capacity for many rural applications [31].

VIII. CONCLUSION

Four aspects of rural connectivity that are inadequately understood were explained. The discussion would affect both proposed solutions and policy formulation. Limitations of cellular, the need to focus on non-mobile endpoints, the use of unlicensed spectrum, and wireless links as an alternative for fiber were pointed out.

Rural connectivity is poised to be a powerful new rural infrastructure that nurtures local economies and leads to education, social development, and other kinds of infrastructure. In the best case, rural connectivity will bring new options to these regions, produce a visible improvement in the quality of life, and reduce the pressure towards urbanization (with its associated societal costs). Besides reviewing the candidate technologies, finer points of wireless connectivity that need to be understood were covered to make this vision happen.

REFERENCES

[1] D. Johnsto and J. Walker, "Overview of IEEE 802.16 security," IEEE Security and Privacy, v 2, n 3,2004, http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=1306971.

[2] S. Nedevschi, J. Pal, R. Patra and E. Brewer, "A Multi-disciplinary Approach to Studying Village Internet Kiosk Initiatives: The case of Akshaya." *Policy Options and Models for Bridging Digital Divides,* Tampere, Finland, March 2005.

[3] J.D. Saunders, C.R. McClure and L.H. Mandel, "Broadband applications: categories, requirement and future frameworks" Peer Reviewed Journal on internet", vol.17, no. 11, 5 November 2012.

[4] S. Sen. *Topology Planning for Long Distance Wireless Mesh Networks,* Master's thesis, IIT-Kanpur, May 2006. *with Bhaskaran Raman.*

[5] World Economic Forum. *The Global Information Technology Report*. http://www.weforum.org/gitr.

[6] B. Raman and K. Chebrolu. "Design and Evaluation of a new MAC Protocol for Long-Distance 802.11 MeshNetworks." Proc. *11th Annual International Conference on Mobile Computing and Networking paper*, Aug/Sep 2005.

[7] Wireless Internet Institute, *The Wireless Internet Opportunity for Developing Countries*, ISBN-0-9747607-0-6. www.w2i.org. November 2003.

[8] T. Starr, J. M. Cioffi and P. Silverman, *Understanding Digital Subscriber Line Technology*, Prentice-Hall, 1998.

[9] M. Andrews and L. Zhang, "The access network design problem," in *FOCS,* 1998, pp. 40–59.

[10] M. J. Miller and S. V. Ahamed, *Digital Transmission Systems and Networks*, Computer Science Press. 1987 & 1988.

[11] J. Beaubein, "Rwanda Looks to a Wired Future" National Public Radio audio broadcast on August 23, 2005. http://www.npr.org/templates/story/story.php?storyId=4811417.

[12] S. Ivezic, D. Celj, V. Mandaric and Z. Unkovic, "Information Technology, Strategy Planning for Telecommunication Company- an Experience", *ConTel*, 1997, Zagreb.

[13] *Asymmetric Digital Subscriber Line (ADSL) transceivers – Extended bandwidth ADSL2 (ADSL2+)* ITU-T Recommendation G.992.5.

[14] S. Ivezic, D. Celj, V. Mandaric and Z. Unkovic, Information Technology, Strategy Planning for Telecommunication Company- an Experience, ConTel, 1997, Zagreb.

[15] S.F. Shaukat, U. Ibrahim and S. Nazir, "Monte Carlo Analysis of Broadband Passive Optical Networks," *IDOSI*, vol. 12, no. 8, pp: 1156- 1164, 2011.

[16] F.J. Effenberger, H. Ichibangase and H. Yamashita, "Advances in Broadband Passive Optical Networking Technologies", *IEEE Communications Magazine*, pp. 118-124, Dec. 2001.

[17] J. Martin and M. Westall, "Validating an 'ns' Simulation Model of the DOCSIS Protocol", under submission. Available at http://www.cs.clemson.edu/~jmarty/docsis.html.

[18] S. Galli and L. Oleg, "Recent developments in the standardization of power line communications", *IEEE Communications Magazine,* pp. 64–71, July 2008.

[19] R. Tang, "Indoor Propagation in Cellular/PCS System Design", *Proc. Wireless Communications and Systems, IEEE 1999 Emerging Technologies Symposium,* pp 8.1 – 8.4, 1999.

[20] S. Ranvier, "Path Loss Models", S-72.333 Lectures Physical Layer Methods in Wireless Communication Systems, Radio Laboratory, HUT, 2004.

[21] J. Reynolds, "Going Wi-Fi: A Practical Guide to Planning and Building an 802.11 Network", *Focal Press*, 2003.

[22] 3GPP,"Long Term Evolution of the 3GPP radio technology" www.3gpp.org/Highlights/LTE/LTE.htm.

[23] ITU-R M.1645 "Framework and overall objectives of the future development of IMT-2000 and systems beyond IMT-2000" www.itu.int/rec/R-REC-M.1645/e.

[24] H. D. Clausen, H. Linder and B. Collini-Nocker, "Internet over Direct Broadcast Satellites," *IEEE Commun. Mag.*, pp. 146–51, June 1999.

[25] *VSAT Networks*, John Wiley & Sons Ltd, 2003.

[26] Dermot Ahern, "Vsat Very Small Aperture Terminal", *Marine and Natural Resources*, September 2003.
[27] J. Scott Marcus and Rekha Jain, "Fast Broadband Deployment in India - Role for cable television".
[28] D. Bojic, E. Sasaki, N. Cvijetic, W. Ting, J. Kuno, J. Lessmann, S. Schmid, H. Ishii and S. Nakamura, "Advanced wireless and optical technologies for small-cell mobile backhaul with dynamic software-defined management," *IEEE Commun. Mag.*, vol. 51, no. 9, pp. 86–93, Sep. 2013.
[29] J. Owens, "Satellite Backhaul Viability," *Bechtel Telecommun. Technical J.*, vol. 1, no. 1, pp. 58–61, Dec. 2002.
[30] ITU Report: *Regulation of Global Broadband Satellite Communications.*
[31] World Bank: *ICT in agriculture.*

Kishore Kumar Thakur, FIETE (b.17.2.1960) is Chief General Manager Telecom, Jharkhand Circle since June2015 and Chairman, IETE Ranchi centre. Obtained B. Tech. (Electronics and Communications Engg.) from BIT Sindri in 1983 and MBA (Marketing) from BR Ambedkar Open University, Hyderabad in 2009. Currently pursuing PhD under the supervision of Ramjee Prasad, Professor, Future Technologies for Business Ecosystem Innovation, Aarhus University, Herning, Denmark. Possesses 35 years of work experience**.** Served as Assistant Computer Engineer in TISCO Jamshedpur.

Working in Bharat Sanchar Nigam Ltd, Department of Telecommunications for last 32 Years, mostly in Hyderabad Telephones. Worked with all technologies, namely manual exchanges, strowger, cross-bar, E10B (Local/ Tax), C-DOT, System-X, EWSD, OCB, 5ESS, LG (CDMA) and GSM. Associated with development works during the periods of major technological changes.

Worked for one year as DGM in Nagaland in2002-2003. Served as GMTD, at Cuddapah and Warangal, districts and as GM (Marketing), AP Circle Hyderabad in-charge of sales and distribution, franchisee management, marketing and PR activities. Also worked as GM (Mobile), J&K Circle for 2 years and as GM (Projects) Hyderabad for two years. Attended workshops, seminars and trainings on switching, transmission, mobile and management courses. Also attended comprehensive Lucent Technology training in USA on 5ESS switch. Leading balanced life with Sahaj Yoga Meditation and advise others also the same.

References

1. *Valeria Jordán, Hernán Galperin and Wilson Peres, "Fast-tracking the digital revolution: Broadband for Latin America and the Caribbean," 2011.*
2. *InfoDev/OECD workshop on "Policy Coherence in ICT for Development" Sept. 2009.*
3. *Yoel Knoll: Enabling Rural Broadband Services with Wireless Backhaul.*
4. *Broadband Commission, ITU-UN.*
5. *"Broadband policy guidelines in high-growth economies," Alcatel – Lucent, 13 March 2007.*
6. *World Bank: Broadband Strategies Handbook.*
7. *Jeffrey T. Macher, John W. Mayo: Achieving Rural Universal Service in a Broadband Era: Emergent Evidence from the Evolution of Telephone.*
8. *J. Scott Marcus, Prof. Rekha Jain: Fast Broadband Deployment in India-What role for cable television.*
9. *ITU Report: Regulation of Global Broadband Satellite Communications.*
10. *World Bank: ICT in agriculture.*
11. *http://www.Broadbandcommission.org/report2.pdf.*
12. *http://www.Broadbandcommission.org/report2.pdf.*
13. *United Nations e-Government survey 2010.*
14. *http://knowledgecommission.gov.in/downloads/documents/wg_med.pdf.*

15. *Improving Health, Connecting People: The role of ICTs in the Health Sector of Developing countries, A Framework paper, Infodev, working paper No. 7, 31 May 2006.*

16, 17. *Broadband Commission Report: State of Broadband 2012: Achieving Digital inclusion for all.*

18. *OECD (2002).*

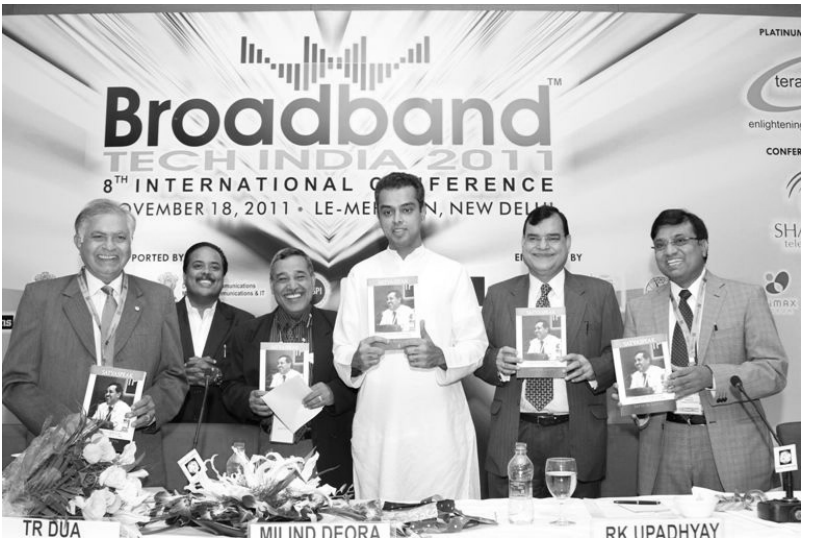
19. *https://www.trai.gov.in/sites/default/files/WiFi_Recommendation_09032017.pdf.*

20. *https://www.trai.gov.in/sites/default/files/WiFiPilotReport05042018.pdf.*

Capturing Some Momentous Glimpses

Launch of Partnership between Marcatel & BLUETOWN for spreading the use of Wi-Fi based solution to the hinterland

Minister of Communications & IT, Govt. of India, Launching 1st Wi-Fi hotspot in Rural Jharkhand, powered by BLUETOWN innovative solution



Minister of Communications and IT, Govt. of India releasing Author's first book on NGN under SatyaSpeak Series

Author with his team of ACTO (Association of Compititive Telecom Operators), which he founded (2012)

Author being faliciteted by Excecutives of ICAI at New Delhi

Author with Mr. Kapil Sibal, Cabinet Minister of Communicatios and IT, alongwith other industry stalwards at ASSOCHAM, New Delhi

Author with Assocham President, Mrs. Piramal, SG Mr. Rawat and Committee Chair Ms. Juhi Chawala

Author being facilitated by His Excellency Dr. Hamadon Toure, Secretary General, International Telecom Union (ITU), Geneva

BLUETOWN MANAGEMENT TEAM – DARING TO WALK THE TALK BY INNOVATING BUSINESS MODEL

Brian Bissgard
Executive Group Director

Peter IB
CEO

Carsten Brond
COO

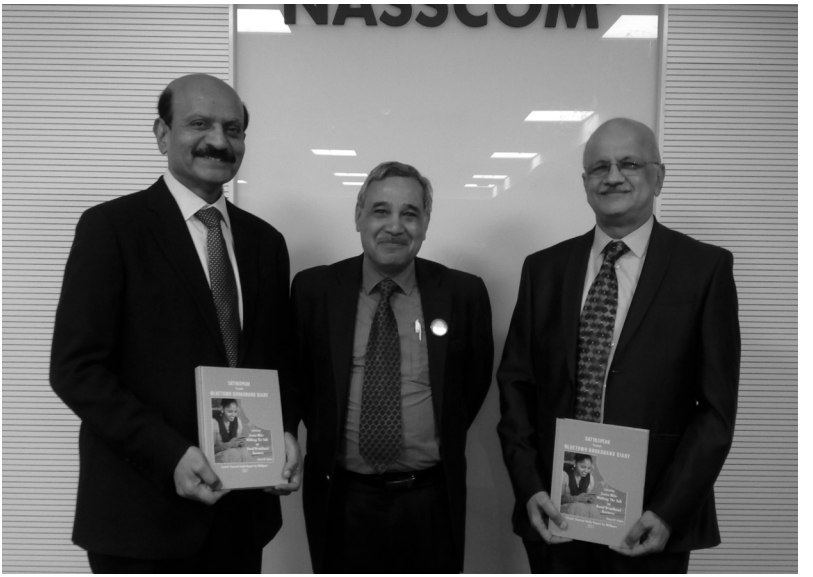
Troels Gert Nielsen
CFO

Nick Pallesen
Chief Commercial Officer

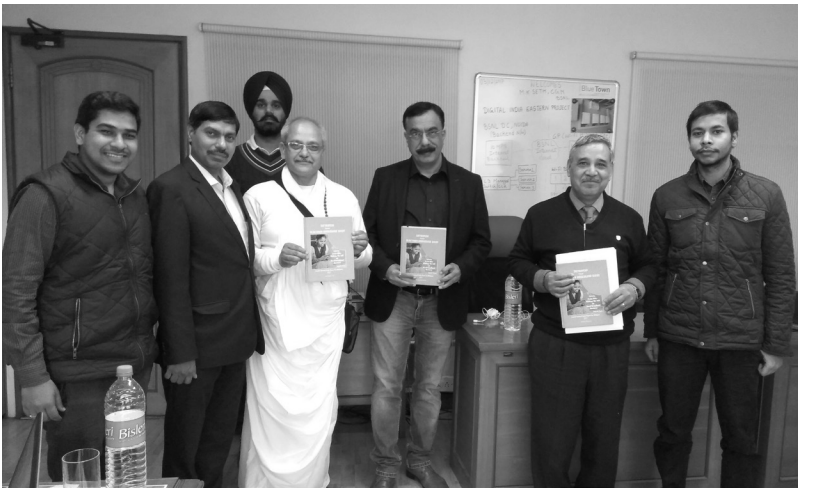
Mogens Birk-Elkjaer
VP, Partnerships & Alliances

Jens Raarup
CTO

Satya N. Gupta
Chairman – India & BIMSTEC, S. Asia



Author presenting the work to Padma Shri Dr. BVR Mohan Reddy, Chairman NASSCOM & Mr. R. Chandershekhar, President NASSCOM



Sanchar Ratan Shri M. K. Seth, CGM BSNL Assam accompanied by Mr. R. R. Yadava, ITS with Author and Team BLUETOWN

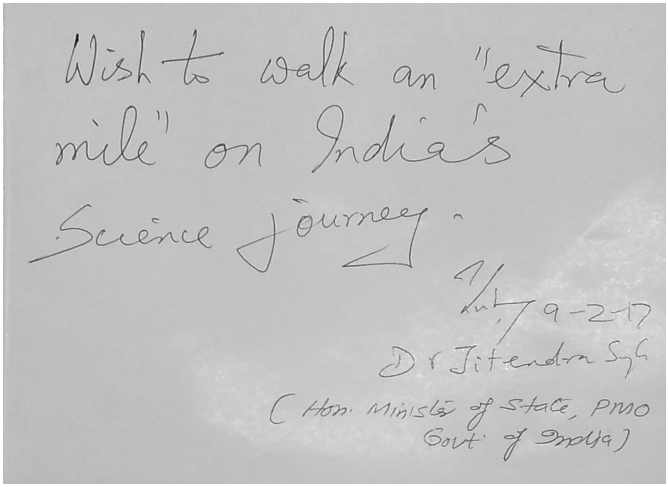
Prof. Sures, KL University & IPV6 Forum Malaysia and Mr. Rahul, Mentor GOIP with Author and BLUETOWN Team – Making it Happen in India

Author Presenting SatyaSpeak to Her Excellency Neelie Kross, Vice Chairman European Union

Author with Danish PM H.E. Lars Løkke Rasmussen, witnessing signing of MoU between BLUETOWN DK and TCIL at Vibrant Gujarat – 2019.

Author welcoming Mr. Puneet Chawla, IRSSE, CMD-RailTel in ITU-APT reception in New Delhi.

Minister of State, PMO Govt. of India Dr. Jitender Singh releasing BLUETOWN Broadband Diary containing "Extra Mile – Walking the Talk on Rural Broadband Business" – New Delhi, 9th Feb, 2017.



About the Author

SATYA N. GUPTA, CEng, DIISc, DRP, IRSSE (VR)
Author

An International expert in NGN technologies, Regulation, Interconnection and Broadband policy with 35 years experience in all aspects of Telecom, including 25 years with Govt. and Regulator, Satya N. Gupta is publicly recognized as an Analyst, Author, Advocate and Advisor on ICT related Policies, Projects and Business.

Globally known as "NGNguru" he is a trainer and coach for telecommunication technologies, policy and regulation and a Govt. Affairs and Regulatory advocate. Author of "Everything over IP-All you want to know about NGN" and "Bandwidth Factory – Last mile as a Managed Service." He also authored a concept called "Job Factory – Converting Unemployment into Intraprenuership" which is being used to create jobs in rural India. A public, key note speaker on most of the ICT events in India and Founder of NGN Forum in India to spread awareness about NGN all-over.

He is triple master in Electronic Technology, ICT Management and Telecom Regulation and Policy. Joined Ministry of Communications in 1981 and Ministry of Railways in 1983, through Indian Engg, Services after Post Graduation in Electronics and Communication from IISc, Bangalore, the premium technical institute of India. During 25 years with Government he worked in various capacities in different departments of Govt. Some of these beings Senior Project Manager (passenger reservations computerization) in Mumbai area, Prof. of Telecom Training at IRISET Secundrabad, Project Director (GM) of IRCON International's

OFC Project, Principal Advisor TRAI (In – charge of Converged Network, Broadband, NLD, ILD and Interconnection Division).

He was awarded the Railways Minister award during 1995–96 for outstanding performance for Delhi area Digitalisation project of Indian Railways. He also pioneered the concepts of NIXI, NIR, IPV6, Unlicensed Spectrum, VOIP, Broadband Policy, NGN and Railtel in the Country all these are up and running. As a freelancer he established a mentoring and advisory company "SAAM CorpAdvisors," engaged in "Managing Govt. Affairs as a Service."

He has also been associated with International Telecommunication Union (An UN Body) as an NGN Expert and also Commonwealth Telecom Organisation (CTO) as an NGN Trainer. Vice-President and Trustee of PTC India Foundation, he is also elected as the Jt. Secretary General of APT-ITU Foundation of India. He is member of India IPV6 Task Force oversight committee an Apex body of the Govt. for IPV6 implementation and a Nominee Director of IT-ITES SSC of National Skill Development Corporation and Executive Secy. General of Amity International Telecom Forum. He is also appointed as Vice -Rapporteur of SG1 of ITU-D dealing with NGN, Broadband and IPV6 migration.

Presently he is Chairman – BLUETOWN India & BIMSTEC, South Asia with overall responsibility for "Making It Happen" its Vision of "Connecting the Unconnected People Living in Rural Areas of the World."

Buzz About the Author

"Satya is a walking Encyclopaedia of Telecom Industry in India"
– Anshul G., *Executive Director, RailTel Corporation of India*

"Thanks for the term 'Copyleft,' it should be used to make the internet content freely available without any cost"
– Mr. Milind Deora, *Minister of State for Telecom & IT, Govt. of India*

"SN is Sachin of Indian Telecom. He keeps it Simple and Straight"
– Mr. R.R.N. Prasad, *Ex-Member, TRAI*

"No global forum of ITU on NGN can be completed without contribution by Satyen"
– Mr. Riccardo, *Counsellor ITU, Geneva*

"Don't claim to be Google of Indian Telecom, unless your name is Satyen"
– Anonymous, *Someone-Somewhere*

"In my organisation Technology discussion ends at SNG level"
– Mr. Aruna Prasada, *Ex-MD, IRCON International*

LONG TAIL - WALKING THE EXTRA MILE ON RURAL BROADBAND BUSINESS

Talk on broadband services in rural and remote areas has been the pastime of all the stakeholders in developing countries but walking on this talk has been unremarkable. The ubiquitous reason given for this state-of-affairs has been the so called "lack of business case". The main objective of this crowd-sourced study was to explore the implementable models to make the business of rural broadband happen. The imminent needs which came out are Technological Architecture, Affordable Tariff, Facilitating Regulation, Alternate Funding options to enable a "Sustainable Business Model". This book brings out an innovative business model like "HotSpot-as-Managed Service " & Architecture named Everything on Tower (EOT), tailor-made for rural, based on 5L principles (Low cost, Low Power, Low Maintenance, Local Control, Local Content).

An International expert in NGN technologies, Regulation, Interconnection and Broadband with 38 years' experience in all aspects of Telecom, including 25 years with Govt. and Regulator, Satya N. Gupta is publicly recognized as an Analyst, Author, Advocate and Advisor on ICT related Policies, Projects and Business. He joined ministry of Communication in 1981 and Ministry of railways in 1983 and is recipient of Minister of Railways award.

A triple master in Electronics Design Technology, IT Management and Telecom Policy & Regulation, globally known as "NGNguru". Author of "Everything over IP – All you want to know about NGN". He also authored a concept called "Job Factory- Converting Unemployment into Intraprenuership". This recent research-based work, **"Long Tail – Walking the Talk on Rural Broadband Business"**, brings out implemental business models.

Elected as the Secretary General of ITU-APT Foundation of India, he is Vice-President and Trustee of PTCIF and Co-chairs BIF committees on Rural Digital Infrastructure and IOT. He founded NGN Forum in India to spread awareness and capacity building in the field of emerging technologies. As an Expert at Commonwealth Telecom Organisation, imparts training NGN Technologies, Broadband Policy and Regulation, Interconnection Costing, Spectrum Management, IPV6, Blockchain and Blue-Ocean Strategy.

As Chairman, BLUETOWN, India & BIMSTEC, forging newer partnerships and "Making It Happen" the vision of "Connecting the Unconnected people living in Rural areas of World".

Price ₹375
ISBN 978-1-68466-584-6
90000
9 781684 665846

notionpress.com