Review and Analysis of technologies used for Internet in Rural Area

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Abstract

In this paper I have illustrated various internet technologies which we are already using in some of the rural areas and the upcoming improved internet technologies, which we will be using in a short period of time. In the time of digital world, internet plays an important role in rural India for the overall development of our country. Most of the part of our country is rural and without the access of internet. Now, the major concern is to bring modern technologies in access to rural people. The technology is not reaching the rural areas because the sparse homes in rural areas create difficulties in providing internet facility to reach each and every home. Providing wired internet service in rural areas is much difficult and expensive, so wireless internet services are better for rural areas. Access to internet in rural areas will be beneficial for the economic as well as social development of India. The internet facility in rural India will improve literacy and employability. Also, it will be beneficial for farmers to improve agriculture, which is our basic source of income. The most important benefit of technologies in rural India is that it could improve the livelihood of the rural people especially, students. The students will be more aware of upcoming technologies and will be able to join educational activities like video conferencing for their academic improvement.

Keywords-*WI-FI, WIMAX, Satellite Technology, Project Loon, Internet.org, White Spaces*

INTRODUCTION

In this paper, I have revealed advantages and disadvantages of wireless internet services which are already in use like WI-FI, WIMAX, and satellite. Also, I have demonstrated the upcoming technologies for internet services like Google's Project loon, Facebook's Internet.org and Microsoft's White space. Wireless is the best way to provide internet facility in rural areas. After getting the internet access, the rural people will be able to get more knowledge about agriculture, academics and knowledge of each and every thing around the world. Rural productivity would be increased by the use of internet and farmers will get best prices for their products. It means after the internet access in rural areas, there will be E-commerce, E-governance, E-banking etc., which will be a big step towards the development of our country. Also, there are some challenges in rural areas like problem of energy supply, lack of infrastructure, high cost, less power etc., but these Challenges can be overcome by some efforts. The main thing is to provide internet services in rural areas.

WI-FI(Wireless Fidelity)

WI-FI was the starting effort to provide internet access in rural areas. WI-FI is the cheapest wireless option for internet rather than using expensive wired option. Each WI-FI tower installed in rural areas works effectively within the range of 100-300m. WI-FI is a LAN(Local areas networking) technology suitable for short distance communications. A 2.5GHz band is occupied by a WI-FI signal. The service set for a WI-FI network can be independent, local, extended or mesh. The WI-FI range

depends on many factors such as frequency band, antenna gain, etc.

Advantages of WI-FI

The WI-FI technology has several advantages in rural areas. The most important thing is that it is wireless. WI-FI is less expensive and can also be used without licensing. That's why this service can be easily provided for rural people

Disadvantages of WI-FI

The main disadvantage of WI-FI is its speed. The speed of WI-FI is much slower. Also, it is limited to very small range of areas. WI-FI technology consumes more power and suck electricity like water. And we all know that electricity is the basic problem in rural areas Also, there is problem of interference with WI-FI signals. The WI-FI signal cannot penetrate more dense substances. Also, the WI-FI is lack in data safety matters.

SATELLITE TECHNOLOGY

In this technology, two main types of satellite are used: - GEO and LEO. The main components' of this technology are: - a satellite, a dish antenna with a transceiver, a modem at the user and a network operations center (NOC) for monitoring the entire system. It is a broadband service, no phone line is required. It provides speed up to 50mbps using ka band.

Advantages of Satellite Technology

By using satellite internet technology, we can access internet from anywhere without the use of additional base stations. A single satellite is sufficient for many different communities. There is no requirement of additional cost for base stations for service providers. Many remote locations can be connected through a secure private link. It provides high speed and is cost efficient. Its installation is very easy and less equipment's are required. This technology provides uninterrupted internet services.

Disadvantages of Satellite Technology

There are technical difficulties to use satellites in rural areas. Reception dish antennas require obstruction free clear line-of-sight. This technology is affected by obstructions like trees and bad weather. Maintenance of satellites is also difficult and requires additional money. While reaching to each home, the speed becomes slower. There is also problem of delay and interference.

UPCOMING INTERNET TECHNOLOGIES TO MAKE INDIA DIGITAL

There are some upcoming technologies which will provide better internet facilities at lower costs. These are:- Project Loon by Google, Internet.org by Facebook and White Spaces by Microsoft. These technologies will help our country to become Digital India by providing internet facilities in rural and remote areas.

GOOGLE'S PROJECT LOON

Project loon is developed by Google and its mission is to provide internet access to rural and remote areas. It uses high-altitude balloons which are placed in the stratosphere at a height of about 20km above the surface of the earth to create a wireless network with 3G-like speed.

Users of this service are required to attach an antenna to their building to connect to the balloon network. The balloons are made up of polythene plastic and are filled with helium or hydrogen gas. The envelop ob balloon contains circuit board and radio antennas to communicate with other balloons and with antennas on the ground. The envelope also contains solar panels and batteries to store solar energy to use at night. The balloons have maximum life of about 100 days, but Google claims that it can be increased up-to 200 days. In each layer of stratosphere, the wind blows in different directions with different speeds. The software algorithm of Project Loon discovers where the balloon need to go and then move to the required direction where the wind is blowing. Each balloon can cover about 40km diameter area using LTE wireless technology. In the balloon network, the signal travels from balloon to balloon, then to the base station on the ground. This technology is much cheaper than the previous technologies which we are using. By using this technology every village will be digital.

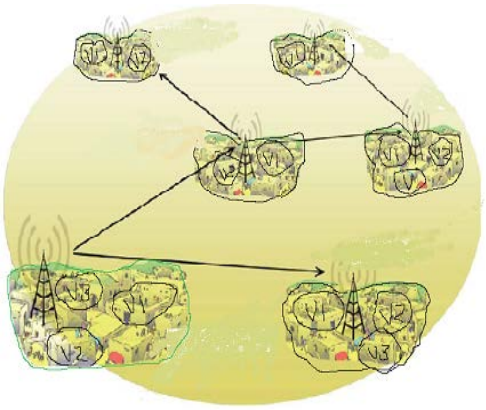
FACEBOOK'S INTERNET.ORG

Facebook has introduced Internet.org that aims to provide internet access to the two third of the world population that doesn't has access to internet. This technology is in partnership with six major companies- Samsung, Nokia, Ericssion, MediaTek, Opera Software and Qualcomm. Internet.org provides social networking services like Facebook, messaging service and other important things like search, weather, free of charge so that rural people can also connect to the world and can understand the importance of internet. Internet.org also uses solar powered drones as its medium to provide internet services to the rural areas, similar to the balloons of the Project Loon. This technology will also provide web services in different languages other than English. The range of free basic internet services provided by the Internet.org is known as Free Basics. It will provide free basic services like news, sports, health, communication, travel etc. This technology will help to improve the lives of the people of rural and remote areas. In India, Facebook has launched Internet.org jointly with Reliance. This service is available for all GSM and CDMA. Internet.org service is only for mobile device users.

MICROSOFT'S WHITE SPACES

White Spaces are the unused radio frequencies allocated to TV channels. This technology aims to provide free internet services in rural and remote areas by using the unused spectrum between two TV channels. This technology works like WI-FI but for longer ranges and with capability to penetrate obstacles. The range of WI-FI is about 100m but it ranges up-to 10km. That's why this technology is also known as 'Super WI-FI'. Like Google's Project Loon and Facebook's Internet.org, this technology also run on solar power. In India, Doordarshan is the only one terrestrial TV broadcaster, which transmits only two channels- DD1 and DD2. These channels occupy either a bandwidth in VHF or a bandwidth in UHF. There are 1415 TV transmitters for Doordarshan operating in India. Most of these TV transmitters operate in VHF band, so a large portion of UHF band is not utilized in India. In India, TV broadcasting uses band of 585-698MHz and the spectrum of 470-585MHz will be free for other applications. Practically, spectrum of about 100MHz is available in the band of 470-585MHz, which in unutilized. Minimum of 96MHz will be available at any location as unutilized frequency band. The unutilized band of 470-585MHz can be considered to provide Fixed Services. The optical fiber connectivity will reach till the Grampanchayats of India and a wireless mesh network

will be developed to provide connectivity to the villages within the radius of 1-10km.



The arrows shows the optical connectivity and the towers create wireless connectivity zones between the different villages- v1, v2, v3 etc.

WIMAX (World Wide Interoperability for Microwave Access)

Like WI-FI, WIMAX technology is also available openly. WIMAX provides excellent security and mobility. WIMAX has high data rates up to 70mbps and range up to 50km. WIMAX is based on IEEE 802.16 standard. It is similar to WI-FI but can be used at larger distances with greater speed. The setup and activation of WIMAX is quick and fast; one BTS can be used for a number of villages

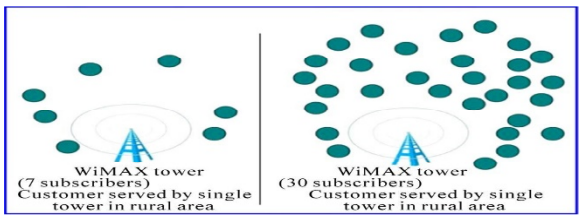


Figure 1. WiMAXscenario in urban and rural usage.

Advantages of WIMAX

WIMAX provides longer range internet connectivity with higher speed. It is more suitable than WI-FI. It can penetrate obstacles like trees, buildings etc. Also, it is economically feasible. A single station is sufficient for hundreds of users. It is not effected by weather condition easily and is best for rural and remote areas. WIMAX technology offers both fixed and mobile applications. Rural areas can be served with high speed internet facility with a lower investment in infrastructures by this technology.

Disadvantages of WIMAX

Even though WIMAX is cheaper, it is still expensive to install and maintain. The speed becomes slower while using practically. Maintaining high quality becomes harder during high traffic. A number of users may cause problem of interference. The WIMAX network needs much power due to its heavy structure. The service of WIMAX is unreliable; rainy season can have a big impact on its service.

Comparison of Four Major Rural Wireless Options

Technology	Data Rate	Coverage**
Wi-Fi	11 or 54 Mbps; <= 200 Mbps*	100-1000 ft; < 10 km
WiMAX	<= 70 Mbps	<= 50 km
Satellites	256 kbps – 1.5 Mbps	40% of earth
Balloons	(unsure)	40 cell towers

*Wi-Fi typically has a rate of 11 or 54 Mbps (802.11a,b,g), but rates can get as high as 200 Mbps for 802.11n.

**Coverage range of a single tower or device; For Wi-Fi, one source cites ranges only up to 1000ft, while another gives a range of kms.

Role of WiMAX in E-Governance in Rural India

The Empowerment of Rural communities is crucial for the development of Rural India. Bringing the rural people into the mainstream of the digital technologies is a major concern now. Rural Development implies both the economic development of the people and social transformation using e-governance. In order to provide the rural people with better prospects and opportunities for economic development, increased participation of rural people in electronic governance through

information and communication technologies are envisaged. In near future, rural population is likely to increase with further increase in poverty aggravating social, economic and environmental problems. Due to these problems, management of different services, natural resources and financial resource mobilization in rural areas, it would be necessary to study the application of e-governance using Information and Communication Technologies (ICTs)/ wireless technologies for its economic development

Table 2. Comparisons of rural wireless options.

Technology	Data Rate	Coverage**
Wi-Fi	11 or 50 MBps <= 200 Mbps*	100 - 1000 ft < 10 Km
WiMAX	<= 70 Mbps	<= 50 Km
Satellite	256 Kbps - 15 Mbps	40% of earth
Balloons	Unsure	40 cell towers

*Wi-Fi typically ha a rate of 11 or 54 Mbps (802.11a, b, g) but rates can get as high as 200 Mbps for 802.11n; **Coverage range of a single tower or device. For WiFi, one source cites ranges only to 100 ft while another gives a range of Kms.

Table 3. Comparison of WiMAX standards.

	IEEE 802.16—2001	IEEE 802.16a	IEEE 802.16d—2004	IEEE 802.16e—2005
Completed	Dec 2001	Jan 2003	Sept 2004	Dec 2005
Spectrum	10 - 66 GHz	2 - 11 GHz	2 - 11 GHz	2 - 11 GHz
Propagation/Channel Condition	LOS	NLOS	NLOS	NLOS
Bit Rate	Up to 134 Mbps (28 MHz channelization)	Up to 75 Mbps (28 MHz channelization)	Up to 75 MHz (28 MHz channelization)	Up to 15 Mbps (5 MHz channelization)
Modulation	QPSK-16-QAM (Optional in UL) 64-QAM (Optional)	BPSK, QPSK 16-QAM 64-QAM 256-QAM (Optional)	256 Subscriber OFDM, BPSK QPSK, 16-QAM 64-QAM 256-QAM	Scalable OFDMA, QPSK 16-QAM 64-QAM 256-QAM (Optional)
Mobility	Fixed	Fixed	Fixed/Nomadic	Portable/Mobile

Limitations of WiMAX

WiMAX is suitable technology for next generation with potential applications such as cellular backhaul, hotspot, VoIP mobiles and broadband connection, but it has some limitations as under.

- Low bit rate over Long distance: WiMAX technology offers long distance data range of 50

km or 30 miles and high bit rate of 70 Mbps. That is fine, but both these features do not work together well. With the increase in the data distance/range, the bit rate reduces and vice versa.

General Hypothesis for use of WIMAX in India for Internet Use

H1: Rural Internet growth is not related to Urban Internet growth.

H2: As Rural Subscriber rate increases, the rural Internet growth also increases.

H3: Urban Internet users mostly use wireless mode to access Internet.

Details of experimentation, analysis, modeling, etc.

The total number of telephone subscribers in india has increased from 895.51 million in Dec-2012 to 898.02 million at the end of Mar-2015 [1].

Rural subscription has increased from 338.54 million to 349.22 million, and rural teledensity has increased from 39.85 to 41.02.

Subscriber Base (in million)		
Peroid	Rural	Urban
Mar-12	330.82	620.53
Jun-12	343.76	621.76
Sep-12	342.01	595.69
Dec-12	338.54	556.96
Mar-13	349.22	548.8

Table 2. Rural and Urban subscribers in periodical wise [1].

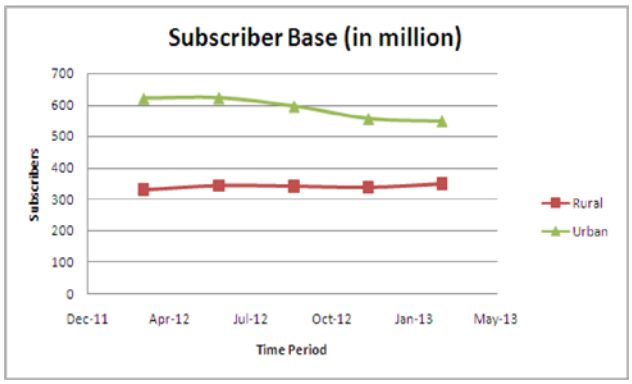


Figure 2. Graphical Representation of Rural and Urban Internet subscribers in India.

Testing this values in Statistical way

i) Correlation method, Correlation coefficient

$$r_{xy} = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \bar{x})^2 \sum_{i=1}^{n}(y_i - \bar{y})^2}}$$

Here x_i is Rural Subscribers, y_i is Urban Subscribers. If we apply our observed values in this formula we will get 0.50601.

The calculated correlation value of -0.50601 shows us low negative correlation between Rural and Urban subscribers. That means there is no correlation between them.

The overall share of subscription in rural areas out of the total subscription has increased from 37.80% in Dec2012 to 38.89% in Mar-2013 [1]. We have done correlation analysis between subscription rate and internet rate in rural and urban. Below is the correlation graph.

	Wired Internet subscribers (in million)	Wireline Subscriber base-Rural (in million)	Wireline Subscriber bade-Urban (in million)
Mar-12	19.51	11.187	20.98
Jun-12	19.66	11.19	20.24
Sep-12	21.25	11.34	19.74
Dec-12	21.57	11.64	19.14
Mar-13	21.61	11.75	18.46

Table 2. Wired Internet Subscribers in Rural and Urban areas in India with overall wired Internet subscribers [1].

Here again we correlated the overall wired internet subscribers with rural wired internet users. Thus we get the correlation value of 0.884.

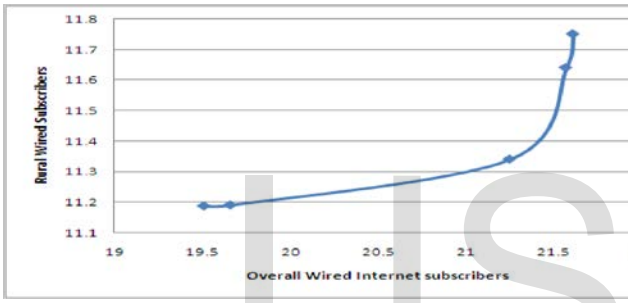


Figure 3. Correlation between overall wired internet subscribers with rural wired internet subscribers.

Similarly correlate the overall wired internet subscribers with urban wired internet users. Here we get correlation value of -0.903.

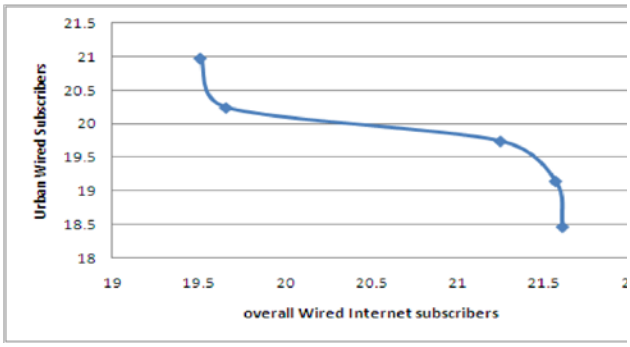


Figure 4. Correlation between overall wired internet subscribers with Urban wired internet subscribers.

Results & discussion

Testing Hypotheses

H1: Rural Internet growth is not related to Urban Internet growth.

Correlation value of -0.50601 shows a weak correlation. Hence proving the above, stating that Rural growth rate is independent of Urban.

H2: As Rural Subscriber rate increases, the rural Internet growth also increases.

Correlation value of 0.884, strongly suggests that Rural internet rate increases with more rural people subscribing to wired connections, since the wireless signal quality may be weak in rural areas.

H3: Urban Internet users mostly use wireless mode to access Internet. Correlation value of -0.903, and the negative correlation coefficient value strongly suggest that, urban people tend to access internet through wireless mode rather than wired connections.

Based on the correlation analysis done above, we have observed significance between certain variables. This analysis results shows that rural users showing more importance on Internet. As we discussed before in introduction, the internet facility can improe their wealth and health in a proper way. Anyway there is some lacking in internet development in rural areas. There are various reasons behind not using the internet services rural people. the reasons are lack of knowledge of Internet, lack of infrastructure and beliefs (personal opinions) [5]. Majority of rural people cannot access internet because they do not have an internet connection or a PC at home. Improper electricity supply is also a main reason people are unable to access internet. Also if

signal strength is improved, more rural people can access through wireless devices.

CONCLUSION

To make India completely digital, it is essential to provide internet connectivity to every rural and remote area, which has very less or no internet access. This dream cannot be completely fulfilled by the running technologies like WI-FI, WIMAX, satellite etc; but it can be fulfilled by the upcoming technologies like Google's Project Loon, Facebook's Internet.org and Microsoft's White Spaces. All these technologies have a number of advantages like less cost, high speed, high range etc. Microsoft's White Spaces is one of the best technologies among all the three technologies because it uses the spectrum which is unused or being wasted. This technology will work in India with a little effort and less cost. The other two technologies are also very effective and affordable, which can help India to become truly digital. Due to internet access in all rural and remote areas, the livelihood of the rural people will be improved and they will be able to learn a lot and will be connected to the whole world. There will be E-commerce, E-governance, and all information related to their occupation. They would be able to sell their product at best prices and their way of working will be improved.

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