A Report
On
Technical & Policy Consultation

FOCUS

Empowering rural communities of India through unlicensed (free) spectrum

FORDFOUNDATION
Working with Visionaries on the Frontlines of Social Change Worldwide

10 YEARS DEF
DIGITAL EMPOWERMENT *foundation*

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Acknowledgement

Empowering rural communities is crucial for the development of rural India. Bringing rural communities into mainstream of the digital technologies is one of the major concern areas these days.

Indians constitute about 17 per cent of world population, nonetheless for about 35 per cent of the population is poor and 40 per cent of the illiterates in the world. Specifically when 70 percent of population is residing in villages, the agenda of achieving inclusive growth cannot be fulfilled unless access to information, media and communication infrastructure and resources are not channelized in properly manner.

In developing countries community networks and low-cost access technologies such as wireless networks allow for new communities based configurations to emerge, to be responsive to the broader development needs of the communities concerned and to operate sustainably.

On the other hand, there are existing provisions like free spectrum allocations as provided by the Government not being utilized to provision information and media infrastructure to reach out to unreached communities. Globally, and in India, frequency bands in 2.4 GHz, 5.8 GHz and 3.3 GHz have been kept aside as free spectrum that can be used by anyone without taking a license or paying a fee to the Government.

Using the context of unlicensed spectrum, Digital Empowerment Foundation ideated project, Wireless for Communities (W4C) utilizing low-cost wireless technology and unlicensed band to create community-wide wireless communication networks in rural India with support from its project partners, the Internet Society (ISOC) and Ford Foundation. The project overall aims to provide internet connectivity at the remotest regions of the country and enabled community members, who have been deprived of accessing information.

In an effort towards advocating how unlicensed spectrum can offer other advantages compared with licensed air waves, DEF organized technical and national-level consultations to share challenges and the best practices in a common platform

I take this opportunity to thank with all sincerity to our partners, the Internet Society and Ford Foundation for providing the timely support for this important project.

My special thanks and acknowledge to Ms. Anriette Esterhuysen, Executive Director of APC and Mr. Steve Song, Founder, Village Telco for participating at the short notice and sharing their invaluable experience with us.

The consultation would not have been achieved its objectives but for the invaluable presence of best practitioners, technologists, experts, speakers, delegates and participants who shared their inputs and thoughts with suggestions to seek for sustainable solutions for empowering rural and underserved communities of the country through unlicensed band.

The post consultation report gives you overall understanding of what the programme was about, session highlights and policy and regulatory framework in India. It comes out with key recommendation and suggestions as relevant for policy formulation and documentation towards achieving larger development and empowerment goals by providing equitable access to information to everybody.

The report has been prepared with all sincerity, care and focus. However, readers may forgive any errors and mistakes that may occurred unintentionally.

I wish thoughtful reading to all!

Warmest regards,

Osama Manzar
Founder & Director
Digital Empowerment Foundation

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Introduction

Technology can play a decisive role in determining how networks can be used, whether they will be centralized or decentralized, who can own them, who can set them up, and whether they can be adapted to the specific needs of individuals and communities. Certain technological developments can be decentralized and it can play vital role in shaping lives of local communities by providing affordable services and applications.

In developing countries, the wireless connectivity has been emerged as one of the inexpensive technologies to bridge the connectivity gap in remote areas. These wireless technologies have created much interest on the part of the international-development community. For example, in India, even with mobile penetration, the teledensity in rural areas is still less than 40 percent, and internet connectivity is a far cry. The reason has mostly been the issues around last mile connectivity. On the other hand, last mile wireless connectivity has the potential to resolve the issue of prohibitive cost of deploying conventional wired infrastructure in remotest areas of the country.

With an objective to address the issues of internet accessibility and connect remote and underserved regions of the country, in late 2010, Digital Empowerment Foundation (DEF) and Internet Society (ISOC) initiated a joint called "Wireless for Communities" (W4C) which utilizes low-cost Wi-Fi based equipment and unlicensed spectrum (free spectrum) to connect and empower rural and underserved communities. The motivation behind ideating for the project is twofold – firstly to democratize the availability of connectivity and enable internet accessibility to information in rural parts of the country, secondly to address the issue of lack of content product and services originating from rural areas which affects the economy from percolating to the bottom of the pyramid.

The project includes two factors – providing Training of Trainer (ToT) programme to community members on wireless technology and wireless mesh technology and deploying wireless mesh network in cluster-based environment to understand and observe the benefits and impact of the project over a period of time.

The first pilot project was launched in late 2011 in Chanderi cluster, highly populated with marginalized handloom weavers, located in Madhya Pradesh experimenting on the following key factors:

a) Addressing the issue of last mile connectivity;
b) Democratizing the availability of connectivity and enable internet accessibility and information decentralization;
c) Addressing the issue of content and services gap that obstructs local economy and pulls back social indicators; to address wireless technology skill gaps;
d) Initiating a dialogue and deliberation between stakeholders including public and private parties on the impact, need, scope, viability and sustainability of wireless deployment for community empowerment and meeting needs of underserved regions;
e) Initiating advocacy with the relevant public and private partners to propagate and adopt wireless technology as an unconventional solution to connect rural remote areas and communities with broadband connectivity and services on it.

The project has all key elements in such as network deployment, internet access, developing capacity of local human resource in wireless skills and empowers community with content and service.

The impact is overwhelming; stakeholders is not only connecting remotest regions such as Tura (Meghalaya), Guna & Shivpuri (Madhya Pradesh); Giridh (Bihar) and other regions of the country but also attracted the attention of stakeholders, including policy advocators, government and private players to adopt the wireless technology as an alternative solution towards connectivity and access.

Background

One of the core challenges in the country is to create equitable society where the citizens have universal access to information and knowledge to benefit. Specifically, when 70 percent of India's population is residing in villages, the inclusive growth agenda of the government can only be successfully realized after addressing the growth and developmental issues in rural India. Though it has been proven that information and communication technologies play an important role in rural development, however, provision of telecom services in rural areas is still a concern thrust area to attain the goal of accelerated electronic development and social change. Although the telecom network has grown rapidly in recent years, but a mere percentage of Indians have internet connection in their home.

With an objective to connect remotest regions of the country, the Broadband Policy was announced in Oct 2004 which in result broadband subscribers have grown from impacted 0.18 million to 10.34 million at the end of October 2010. To empower the common man in the rural/remote parts, the Department of Telecom has decided to provide broadband coverage to all 250,000 village panchayats by 2012 out of which 97426 have been stated to be provided. Despite this figures, the situation is far from encouraging given the country crossing a billion plus population across almost or more than 635,000 villages.

One of the objectives of the Dept. of Telecom (India) stated in the Results Framework Document of the Department for the year 2011-2012 is to work for rapid expansion of telecom infrastructure for voice, data & broadband with special emphasis in rural and remote areas of the country. This also includes increase in wireless broadband connection in villages of India. Thus, according to the 2010-2011 annual report of the Dept. of Telecom, broadband connectivity has been provided in 4044 cities, 5431 block headquarters, 613 district headquarters covering about 1,06,559 villages.

Citing optimism, the report projected broadband coverage will get boost with the setting up of 100,000 Common Service Centers (CSCs) covering all the villages in the country. As on October 2011, 97,121 CSCs have been rolled out in the country. These CSC are expected to provide internet access and e-governance service to the common citizen. Besides CSCs, there are over 9000 internet cyber cafes providing internet access enabling communication

and interaction with other actors in e-governance through ICTs and wireless technologies such as, e-mail, audio or video chat etc.

However, India still faces technological as well as commercial challenges in penetration of broadband. The low PC penetration and affordability issue due to high cost are the main causes. With the lack of physical connectivity or telecommunication infrastructure, unaffordable cost and lack of ready accessibility to broadband technologies only few can use the Internet. Mostly rural India is lagging in development, education, health, entertainment services and the general living standard due to lack of Government support in creating ICT and Wireless infrastructure to reach rural masses.

Wireless broadband is likely to be the preferred route that operators would like to adopt in delivering broadband services to the masses of the country. Wireless technologies have capabilities to provide widespread broadband access and could drive inclusive growth by way of mobile banking, tele-education, E-governance, tele-medicine etc. However, there are not many wireless programmes that have been designed or deployed to cater needs of rural citizens.

Very few examples can cited which are working as rural wireless-based enterprises with aim of narrowing these digital gaps. AirJaldi is a wireless based social enterprise established in Dharamsala, India with aim of narrowing these gaps in 2005, and created the Dharamsala Community Wireless-Mesh Network in cooperation with the Tibetan Technology Center. DakNet provides extraordinarily low-cost digital communication, letting remote villages leapfrog past the expense of traditional connectivity solutions and begin development of a full-coverage broadband wireless infrastructure. In one such instance, Daknet has worked in Karnataka in providing point to point services. There is micro deployment & usage of wireless connectivity by Krishi Gram Vikash Kendra (KGVK) in Ranchi District of Jharkhand in India.

Another major effort has been continuously made by Delhi based NGO, Digital Empowerment Foundation (DEF) along with its partners ISOC and Ford Foundation to create equitable society by utilizing unlicensed band and low-cost wireless technology. In a desire to make several of such community oriented wireless networks to work on a sustainable basis which could be run, managed and implemented by the communities in different parts of the country in remote areas using open spectrum and providing access to remote communities, DEF is not only providing capacity-building programme to community members but also organizing national-level policy advocacy programmes.

Unlicensed Spectrum Policy & Regulatory Framework in India

The radio frequency (RF) spectrum is vital for wireless communications infrastructure.[1] Most operations on the RF spectrum require a license provided by a national regulatory body or the government. However, many countries have allocated some spectrum for unlicensed use. Unlicensed spectrum bands can be general purpose or application specific. As Robert Horvitz, one of the founding members of the Open Spectrum Alliance explains:

> *"Essentially any equipment that does not violate the technical standards can be used for any means in general purpose unlicensed bands. There are other unlicensed bands where that is not the case. For example, there is a band for the control of modern airplanes. There is no license needed to operate in it, but you can only use it for the control of modern airplanes."*[2]

Spectrum Policy Regulatory Environment in India

Regulation of spectrum licensing, allocation and management is characterized by two key regulatory structures:

- Policies and Laws
- Governmental Bodies

Laws and rules governing spectrum regulation and management in India are elements of several legislations and policies, namely:

1. The Indian Telegraph Act, 1885[3]
2. Cable Television Networks (Regulation) Act, 1995[4]
3. The Indian Wireless Telegraphy Act, 1933[5]
4. The Telegraph Wires (Unlawful Possession) Act, 1950[6]
5. Telecom Regulatory Authority of India Act, 1997[7]
6. The Telecom Regulatory Authority of India (Amendment) Act, 2000[8]

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[1]Ponappa, S. (2010) Understanding Spectrum.Business Standard. Retrieved November 21, 2011, from http://www.business-standard.com/india/news/shyam-ponappa-understanding-spectrum/387446/

[2]Horvitz, Robert. Personal Interview. 9 Sept. 2011

[3]Read full text athttp://www.dot.gov.in/Acts/telegraphact.htm (last visited on 31 July, 2012)

[4]Read full text at http://www.trai.gov.in/Content/cable_television.aspx

[5]Read full text at http://www.dot.gov.in/Acts/wirelessact.htm

[6]Read full text at http://www.indiankanoon.org/doc/980662/

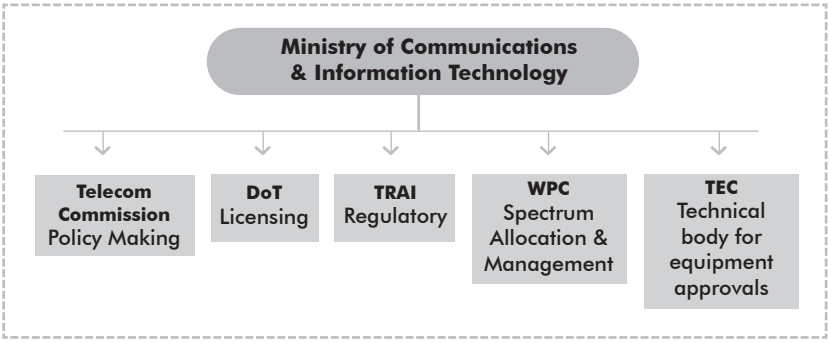
[7]Read full text at http://www.trai.gov.in/Content/act_1997.aspx

[8]Read full text at http://www.trai.gov.in/Content/Act2001.aspx

Departments Involved in Spectrum Allocation

The key decision makers on spectrum allocation and assignment include the Wireless Planning and Coordination (WPC) Wing, the Department of Telecommunications (DoT), the Ministry for Communications and Information Technology (CIT) and ad hoc groups such as the Empowered Group of Ministers (EGoM) for third generation (3G) and Broadband Wireless Access (BWA) spectrum auctions.

Spectrum management and regulation is the collective responsibility of more than one body in India. There are different bodies handling spectrum licensing, regulation, pricing, and the levy of penalties; some bodies have only an advisory role.



The International Telecommunication Union (ITU) at the World Radio Communication Conference has identified that allocation of spectrum frequencies is necessary in order to ensure interference free operation for each radio service. RF spectrum allocation is harmonized on an international level through the Radio communication Sector within the International Telecommunication Union (ITU). During the World Telecommunication Conference (WRC) held by the ITU in 2003, spectrum in the 5-6 GHz range was allocated for unlicensed use.

Each frequency band is shared amongst various radio services but the sharing is possible only with the use of similar systems. Sharing is also possible by way of geographical separation, time-sharing and through technical solutions like smart antenna and intelligent radio system. Countries such as UK, U.S. and Canada have unlicensed these frequencies consistent with the decision made at the WRC. India has also done this, although only partially.

National Frequency Allocation Plan: 2002

The National Frequency Allocation Plan (NFAP) forms the basis for development and manufacturing of wireless equipment and spectrum utilization in the country. It contains the service options in various frequency bands for India and also provides the channeling plan in different bands. Some of the typical frequency bands allocated for certain types of radio services in India are as given below:

S. No	Frequency (in MHz)	Usage
1.	0-87.5 MHz	Marine and aeronautical navigation, short and medium wave radio, amateur (ham) radio and cordless phones
2.	87.5-108	FM radio broadcasts
3.	109-173	Satellite communication, aeronautical navigation and outdoor broadcast vans
4.	174-230	Not Allocated
5.	230-450	Satellite communication, aeronautical navigation and outdoor broadcast vans
6.	450-585	Not Allocated
7.	585-698	TV Broadcast
8.	698-806	Not Allocated
9.	806-960	GSM and CDMA mobile services
10.	960-1710	Aeronautical and space communication
11.	1710-1930	GSM mobile services
12.	1930-2010	Defence forces
13.	2010-2025	Not Allocated
14.	2025-2110	Satellite and space communications
15.	2110-2170	Not Allocated
16.	2170-2300	Satellite and space communications
17.	2300-2400	Not Allocated
18.	2400- 2483.5	Wi-Fi and Bluetooth short range services
19.	2483.5-3300	Space communications
20.	3300-3600	Not Allocated
21.	3600-10000	Space research, radio navigation
22.	10000	Satellite downlink for broadcast and DTH services

Meaning of Unlicensed Spectrum in India

Unlicensed spectrum, by not requiring operators to obtain a costly license and special permission for its use is an inexpensive and barrier-free option for meeting communication requirements. Unlicensed spectrum simply means a spectrum band that has rules pre-defined for both the hardware and deployment methods of the radio in such a manner that interference is mitigated by the technical rules defined for the bands rather than it being restricted for use by only one entity through a spectrum licensing approach.

Standards Used for Unlicensed Band

The Institute of Electrical & Electronics Engineers (IEEE) has allocated IEEE 802 LAN/MAN group of standards that include the Ethernet standard "IEEE 802.3" and the Wireless Networking Standard "IEEE 802.11". 802.11b and 802.11g standards use the 2.4 GHz ISM (Industrial, Scientific, and Medical) frequency band. The 802.11a standard uses 5 GHz band UNII (Unlicensed-National Information Infrastructure).

The unlicensed 2.4 GHz band has lately become very noise in urban areas due to the high penetration of WLAN and other devices that are communicating in the same frequency range, such as microwave ovens, cordless phones and Bluetooth devices.

The 5 GHz band gives the advantage of less interference but faces other problems due to its nature. High frequency radio waves are more sensitive to absorption than low frequency waves. Waves in the range of 5 GHz are especially sensitive to water and surrounding buildings or other objects due to the higher adsorption rate in this range.

Summary of 802.11 amendments

Licensing of Unlicensed Bands: 2.4 GHz to 2.4835 GHz

According to WPC Wing of the Ministry of Communication & Information Technology:

"Notwithstanding anything contained in any law for the time being in force, no license shall be required by any person to establish, maintain, work, posses and deal in any wireless equipment, on non-interference, non-protection and shared (non-exclusive) basis, in the frequency band 2.4 GHz to 2.4835 GHz with the transmitter power, Effective Radiated Power and height of antenna as specified namely[9]:

[9]Ministry of Communications and Information Technology (Wireless Planning and Coordination Wing) NOTIFICATION on 28th January, 2005

Maximum out power of transmitter	Maximum Effective Radiated Power	Height of Antenna
(1)	(2)	(3)
1 W (30 dBm) in Spread of 10 MHz or higher	4 W (36 dBm)	Within 5 meters above the roof top of existing authorized building

Standard	Frequency	Max Data rate	Description
802.11a	5 GHz	54 Mbps	8 non-overlapping channels.
802.11b	2.4 GHz	11 Mbps	14 overlapping channels
802.11g	2.4 GHz	54 Mbps	- 14 overlapping channels. - Upward compatibility with the standard 802.11b
802.11n	2.4 GHz	360/540 Mbps	Builds upon previous 802.11 standards by adding MIMO that uses multiple transmitters and receiver antennas to allow increased data throughput through spatial multiplexing.

Licensing of Unlicensed Bands: 5.150 to 5.350 GHz and 5.725 to 5.875

The WPC Wing of the Ministry of Communications and Information Technology under its notification Jan 2005 has de-licensed 5.8 GHz Band[10]:

"Notwithstanding anything contained in any law for the time being in force, no license shall be required by any person to establish, maintain, work, possess or deal in any wireless equipment for the purpose of low power Wireless Access System, including Radio Local Area Networks, in the frequency band 5.150 to 5.350 GHz and 5.725 to 5.875 GHz with the Maximum Effective Isotropic Radiated Power, type of antenna and coverage area as specified in the Table below, namely:"

[10]Ministry of Communications and Information Technology (Wireless Planning and Coordination Wing) NOTIFICATION on 28th January, 2005

Frequency band (1)	Maximum Effective Isotropic Radiated Power (2)	Type of antenna (3)	Coverage area (4)
5.150 to 5.350 GHz and 5.725 to 5.875 GHz	Maximum mean Effective Isotropic Radiated Power of 200 mW and a maximum mean Effective Isotropic Radiated Power density of 10 mW/ MHz in any 1 MHz bandwidth	Built in or indoor antenna	Indoor usage which includes usage within the single contiguous campus of an individual, duly recognized organization or institution

Perspectives on Unlicensed Spectrums in India

India has unlicensed and license-exempt frequency bands available for use. However, there are no light-license frequency bands for use in India.

The Supreme Court of India in February 1995 declared airwaves to the public property. Justice P. B. Sawant and S. Mohan specified in their decision regarding the use of airwaves "has to be controlled and regulated by a public authority in the interests of the public and to prevent the invasion of their rights." [11]

In this context, P.K. Garg, the former wireless advisor to the Government of India, states that

"The government had de-licensed the present bands for reasons that their de-licensing would provide a benefit to society, and the regulation of the bands through license issuance for such low power usage by common public would have been impractical normally. Hence to make the decision to de-license more bands, the spectrum regulator looks at the social benefit/ impact that it would make, and whether they can shift current licensed users to other frequencies if interference concerns are present".[12]

"Spectrum could be considered for de-licensing for certain technical parameters which shall not cause interference to existing usages in the band." Stated Milind Deora, the Minister of State for Communications and Information Technology during a recent meeting held in Goa on International Mobile Communications.[13]

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[11]The Airwaves are the People's Property. (2001) India Together. Retrieved November 30, 2011, from http://www.indiatogether.org/campaigns/freeinfo/sc95.htm

[12]Garg, P. K. Personal Interview. 8 Oct. 2011.

[13]Spectrum Audit and Pooling Under Consideration-MilindDeora. (2011),Voice&Data Online - Resource Center on Indian Telecom. Retrieved November 30, 2011, from http://voicendata.ciol.com/content/news1/111101401.asp

Moreover, the National Telecom Policy 2012 made the objective to:

- De-license additional frequency bands for public use.[14]

It is further specified under section 4.6 of the policy that the government will:

- Identify additional frequency bands periodically, for exempting them from licensing requirements for operation of low power devices for public use.[15]

Presently the government controls a large part of the RF spectrum, with only a minimal amount of frequencies being allocated for unlicensed use. However policy makers are beginning to recognize the importance of allocating more unlicensed spectrum.

Existing license-exempt bands in India

Unlicensed Frequency Ranges in India	Application/Specifications
50-200 kHz	Very low power devices
13553-13567 kHz	Very low power radio frequency devices, indoor only
26.957 MHz-27.283 MHz	Low power wireless equipment (max. Effective Radiated Power of 5 watts)
335 MHz	Low power wireless equipment for the remote control of cranes
402-405 MHz	Medical RF wireless devices (max. radiated power of 25 microwatt) with channel emission band width within 300 kHz
865-867 MHz	Low power wireless device (max. transmitter power of 1 watt-4 watts Effective Radiated Power) with 200 kHz carrier bandwidth
865 MHz - 867 MHz	Radio Frequency Identification Devices (RFID) (MTP of 1 watt-4 watts ERP) with 200 kHz carrier band width

[14]Department of Telecommunications. National Telecom Policy 2012, objectives 22, 24.
[15]Department of Telecommunications, National Telecom Policy 2012, section 4.6.

Unlicensed Frequency Ranges in India	Application/Specifications
2400 MHz-2483.5 MHz	Low power wireless equipment (e.g. Wi-Fi) (max. transmitter output power of 1 watt-4 watts ERP) with spectrum spread of 10 MHz or higher
5150 MHz-5350 MHz	Low power equipment for Wireless Access Systems (max. mean Effective Isotropic Radiated Power of 200 mW and max. mean Effective Isotropic Radiated Power density of 10 mW/MHz in any 1 MHz bandwidth) indoor only
5725 MHz-5825 MHz	Low power equipment for Wireless Access Systems (MMEIRP of 200 mW and MMEIRP density of 10 mW/MHz in any 1 MHz bandwidth) indoor only
5825 MHz- 5875 MHz	Low power equipment (MTOP of 1 watt-4 watts ERPower) with spectrum spread of 10 MHz or higher

The Indian Department of Telecommunications (DoT) requires operators to obtain a license before being granted the right to use radio spectrum. There are exceptions to this rule, such as the Citizens Band in the 27 MHz range and the Wi-Fi bands in the 2.4 GHz and 5.8 GHz ranges. India's National Telecom Policy 2012 recognizes the need to reserve more frequencies for unlicensed use.

However, the country is still behind when compared to unlicensed spectrum availability in the U.S. and UK, which have already integrated innovative spectrum management techniques in their telecom policies. These policies aim to create a flexible, market-driven approach to spectrum regulation and management through integrating spectrum sharing techniques and meeting the industry demand for unlicensed spectrum. India needs to follow suit in order to provide connectivity to remote/rural regions and encourage further innovation in the telecom domain.

Therefore, additional frequencies should be freed up for unlicensed use according to demands from community groups, industry bodies, and experts in the field, in line with international best practices.

Candidate License-exempt Spectrum Bands in India

Industry bodies in India such as the Internet Service Provider's Association of India (ISPAI), the DECT Forum, the Bidirectional Access Promotion Society (BAPSI), Google and Microsoft have been advocating for more unlicensed spectrum for low power wireless equipment based on international practices. These requests vary from being general purpose to being application specific. Presently, many industry bodies and advocacy groups in India have specific requests for unlicensed spectrum. The requests cover candidate bands including, 433-434 MHz, more bands in sub-1 GHz, more slots under 2.4 GHz, 1880-1900 MHz, 5.15-5.35 GHz, and 5.725-5.825 GHz.

The DECT Forum India, an industry association which represents suppliers, operators and users of DECT equipment, is advocating for the unlicensing of additional frequency ranges for low power cordless communication to meet the Residential and Enterprise Intra-Telecommunication Requirements. A consultation between TRAI and industry bodies is presently taking place on this issue. DECT Forum points to studies conducted by the CEPT, which found that the 3G technology in the adjacent band does not incur interference from low power, indoor use of cordless telephony.[16]

Bands requiring de-licensing in India

Requested Frequency Ranges for Unlicensing	Application	Current Allocation	Countries/Regions Where Exemption is in Place
433 MHz-434 MHz	Data telemetry[17]	Low power short range devices	Australia, Singapore, Malaysia, European Union and New Zealand[18]
902-928 MHz	Low power wireless equipment[19]	• 902.5-915 MHz: Additional requirements of cellular telephone systems, train control and mobile train radio systems	U.S.[20]

[16](2011).Consultation Paper on Allocation of Spectrum Resources for Residential and Enterprise Intra-telecommunication Requirements/ cordless telecommunications system (CTS).Telecom Regulatory Authority of India.
[17]Ibid
[18]Ibid
[19]Jit Singh Chima. Raman (Google India), Personal Interview. 9 Dec. 2011.
[20](2002).Report of the Unlicensed Devices and Experimental Licenses Working Group, pg. 8.Federal Communications Commission. Retrieved November 25, 2011, from http://transition.fcc.gov/sptf/files/E&UWGFinalReport.pdf

Requested Frequency Ranges for Unlicensing	Application	Current Allocation	Countries/Regions Where Exemption is in Place
		• 900 MHz band: Micro cellular low powered telecommunication systems • 926-926.5: low power cordless telephone systems	
1880 MHz-1900 MHz	Low power cordless communication[21]	Micro cellular wireless access systems (fixed/mobile) based on TDD access techniques	Europe[22]
2483 -2500 MHz	Broadband Access[23]	----------	----------
5150- 5350 MHz	Broadband Access[24]	Low power equipments for wireless access systems indoor only	U.S.[25], UK[26]

Social & economic justification for open spectrum

Despite the number of growing technologies, many of communities, especially tribal communities and those who live in remotest region of the country suffer from non-availability of access to information and access to any kind of media. There are areas where one cannot access any media simply because it has never been facilitated or laid out.

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[21](2011).Consultation Paper on Allocation of Spectrum Resources for Residential and Enterprise Intra-telecommunication Requirements/ Cordless Telecommunications System (CTS).Telecom Regulatory Authority of India.

[22]Ibid pg. 6

[23]Jit Singh Chima. Raman (Google India), Personal Interview. 9 Dec. 2011.

[24](2011). Response to the Draft National Telecom Policy 2011.Internet Service Providers' Association of India.

[25](2002).Report of the Unlicensed Devices and Experimental Licenses Working Group, pg. 10.Federal Communications Commission. Retrieved November 25, 2011, from http://transition.fcc.gov/sptf/files/E&UWG-FinalReport.pdf

[26]Wireless Telegraphy (Exemption) Regulations 2003 SI No. 74 § 4 § (2011)

In India, there are 250,000 panchayats in 635,000 villages through 3 million elected panchayat representatives. Though the government claims that under their scheme, State Wide Area Network (SWAN), the broadband connectivity has been provided up to block level, which is the first mile of the last mile in real terms. Connecting one panchayat has potential to connect 3-5 villages. Similarly, there are 1.4 million rural schools in remote regions of the country.

On the other hand, there are existing provisions like free (unlicensed) spectrum allocations as provided by government of India which is not being utilized to provision information and media infrastructure to reach out to unreached communities.

Considering that the entire last mile is disconnected, meaning all the villages under a block and panchayat are suffering from no information and media access, it is imperative to see how alternatively they could be provided network access and that too quickly and affordably. To connect all institutional points such as panchayat offices, block offices, schools, there is need to aggressively adopt alternative solutions such as unlicensed wireless spectrum which can not only connect these institutions in remote areas where quality education is big question mark.

Globally, and in India, frequency bands in 2.4 GHz, 5.8 GHz and 3.3 GHz have been kept aside as free spectrum that can be used by anyone without taking a license or paying nominal fee to the Government.

There are very few social enterprises are working for designing or deploying wireless programmes to cater to citizen communities. Examples are very limited such as AirJaldi, which is providing community-based wireless mesh network in cooperation with the Tibetan Technology Center in Dharamshala. DakNet provides extraordinarily low-cost digital communication, letting remote villages leapfrog past the expense of traditional connectivity solutions and begin development of a full-coverage broadband wireless infrastructure. In one such instance, Daknet has worked in Karnataka in providing point to point services. There is micro deployment & usage of wireless connectivity by Krishi Gram Vikash Kendra (KGVK) in Ranchi District of Jharkhand in India. The Chanderi ICT for Weavers programme in Madhya Pradesh has deployed and using wireless to serve local user communities.

Understanding the advantages of unlicensed spectrum in the country, Digital Empowerment Foundation along with Ford Foundation decided to come forward and bring all stakeholders together to formulate and stipulate clear strategy as 'how to make community based ISPs' and to make several such community oriented wireless networks to work on a sustainable basis which could be run, managed and implemented by the communities in dif-

ferent parts of the country in remote areas using open spectrum and providing access to remote communities. The objective of this partnership is twofold – firstly to organize the technical consultation to understand how unlicensed wireless band/free spectrum can be used to connect isolated areas and communities of the country. Secondly to bring policy advocators, social ISP enterprises, experts, and government stakeholders together to have dialogue, debate and open discussion on the importance of open wireless spectrum and how it can be utilized as a means of access to information, rights and resources.

Technical Consultation On

"WiFi Mesh Networking: Technologies & Prospects"

6-8 August, 2012 | New Delhi

About the Technical Consultation

On 6-8 August 2012, Digital Empowerment Foundation and Ford Foundation organized the two-day technical consultation on the 'WiFi Mesh Networking: Technologies & Prospects' at Sanskriti Foundation, New Delhi.

The workshop aimed to understand how unlicensed wireless band/free spectrum can be used to connect isolated areas and communities of the country. The workshop was an effort to understand the scope and opportunities of unlicensed wireless band/free spectrum provided by the government.

The objective of the workshop was to understand theoretical and practical understanding of wireless environment in India especially driven through the unlicensed band facilities as provisioned by the government. The workshop is an effort to explore and understand the cost-effective technologies to propagate the wireless network networks far and wide across the country for ensuring equality of access, digital equity and media access.

Objectives

- Understand the definition of unlicensed band/free spectrum
- Understand the scope and opportunities of unlicensed band / free spectrum
- Discuss the importance of free spectrum for public good & advocacy towards it
- Sharing of existing practices/case studies in wireless network deployment and operations in India and other developing countries
- Deliberate on the need, availability & challenges of appropriate wireless technologies to bridge access and connectivity divides

Players to Collaborate

S. No	Organisation	Mode of organisation	Skills/ Capacity
1	Ford Foundation	Non-for-Profit	Access, Media, Rights, Technology
2	Airjaldi	Non-for-Profit + For Profit	Access, Technology (ISP, designing, building, & operating), Capacity Building & Training
3	Village Telco	Non-for-Profit + For Profit	Technology, Rights, Access, Communication

S. No	Organisation	Mode of organisation	Skills/ Capacity
4	Nepal Wireless	Non-for-Profit	Communication, Deployment, Access, Rights, and Content Management, Training & Capacity Building
5	Digital Empowerment Foundation	Non-for-Profit	Access, Ethics, Rights, Content Management, Deployment & Network Management

Workshop Agenda

The two-day workshop aimed to discuss and deliberate on the issues related to media, access and rights, technological aspects of unlicensed band, ownership of unlicensed spectrum, ownership of accessibility and exploring opportunities in terms of accessibility. The workshop focused on addressing issues and challenges under 6 focal points:

A. Policy & Regulations
B. Access & Rights/Ethics
C. Technology and Network Management
D. Business Model & Sustainability
E. Training & Capacity Building
F. Partnership Collaboration

a) Policy & Regulations

The discussion initiated was around managing the spectrum in India. Spectrum regulation in India is majorly managed, regulated and controlled by the WPC wing in the Dept. of Telecommunications (DOT), which not only handles licensing use of spectrum for wireless purposes for government and private users including for commercial use in India.

The wing is responsible for managing the "policy of spectrum management, wireless licensing, frequency assignments, and international coordination for spectrum management and administration of the Indian Telegraph Act. The WPC has different sections such as Licensing and Regulation (LR), New Technology Group (NTG) and the Standing Advisory Committee on Radio Frequency Allocation (SACFA).

The SACFA makes recommendations on major frequency allocation issues, formulation of the frequency allocation plan and on issues related to the International Telecom Union (ITU). The SACFA also resolves disputes be-

tween wireless users referred to the WPC, apart from site clearances for all wireless installations in India. It is also important to note that the SACFA makes actual allocation of the frequency and assignment decisions.

The Internet Service Provider (ISP) Policy was announced in November, 98. ISP Licenses, are primarily allowed to provide services such as internet access (through any method including IPTV) and internet telephony (which is a service to process and carry voice signals offered through the internet by the use of personal computers ("PC") or internet protocol based equipment). Currently the ISP license allows limited internet telephony by permitting connections between the following[27]:

Category	Service
Category "A"	Whole of India
Category "B"	20 territorial Telecom Circles, four Metro Districts- Delhi, Mumbai, Calcutta or Chennai and four major Telephone Districts- Ahmadabad, Bangalore, Hyderabad or Pune.
Category "C"	Any Secondary Switching Areas (SSA) of DOT with geographical boundaries as on 1.4.98

As in India, license under the 'category C' is not applicable, thus telecom operators need to get license either under category B or category A. And to obtain the license for A category, Bank Guarantee of INR 2,00,000,00 and INR 20,00,000 for Category B service area and INR 3,00,000 for each Category C service area.

Thus, for any non-profit-organisation, it is tough to get license under category A or category as it is quite expensive. The following questions rose during the discussion on regulating and controlling of spectrum management.

Queries

- How to bring transparency in spectrum management?
- How to bring international experts and regulators together with the Ministry to plan for the spectrum?
- What are Wi-Fi Regulations in India?

[27] http://www.dot.gov.in/isp/ispindex.htm

- How to map and monitor the services provided by telecom providers?
- Documentation required on policies and regulations on unlicensed spectrum utilization in India.
- Listing of telecom service providers in India along with their location, services provided by them and price.
- What is policy on white space?

b) Access & Rights/Ethics

Presently the government controls a large part of the RF (radio frequency) spectrum, with only a minimal amount of frequencies being allocated for unlicensed use. However policy makers are beginning to recognize the importance of allocating more unlicensed spectrum.

In India, the Institute of Electrical & Electronics Engineers (IEEE) has allocated IEEE 802 LAN/MAN group of standards that include the Ethernet standard "IEEE 802.3" and the Wireless Networking Standard "IEEE 802.11". 802.11b and 802.11g standards use the 2.4 GHz ISM (Industrial, Scientific, and Medical) frequency band. The 802.11a standard uses 5 GHz band UNII (Unlicensed-National Information Infrastructure).

One of the objectives of the Ford Foundation is to bridge the digital divide by enhancing the reach broadband and community broadcasting. With the convergence of technology, the workshop discussed the challenge of the ownership of accessibility and explored the opportunities in terms of accessibility ownership. Ford Foundation aims to remove the barrier between technology and community.

Moreover, the Article 19[28] states, *"everyone has the right to freedom of opinion and expression; this right includes freedom to hold opinions without interference and to seek, receive and impart information and ideas through any media and regardless of frontiers."*

In terms of accessibility, there are two parameters; pre-access and post-access and in a country like India, internet accessibility is in pre-access stage, there is a need to develop a strategy on spectrum planning and managing in a broader way.

The unlicensed 2.4 GHz band has lately become very noise in urban areas due to the high penetration of WLAN and other devices that are communicating in the same frequency range, such as microwave ovens, cordless phones and Bluetooth devices.

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[28] The Universal Declaration of Human Rights http://www.un.org/en/documents/udhr/index.shtml

The 5 GHz band gives the advantage of less interference but faces other problems due to its nature. High frequency radio waves are more sensitive to absorption than low frequency waves. Waves in the range of 5 GHz are especially sensitive to water and surrounding buildings or other objects due to the higher adsorption rate in this range.

Queries

- Who will regulate the ownership of media?
- What are the principals of universal access?
- How to make pro-poor agenda in terms of universal access?
- How to make unlicensed spectrum more exclusive and effective?
- What are obstacles in using white space? How to use white space effectively for benefitting community?
- How to maximize the use of unlicensed spectrum?
- How to save the spectrum which is licensed to community? How to make sure that spectrum is delivered for community benefits?
- Regulatory management of community network management.

c) Technology and Network Management

Technological advancements such as Wireless Local Area Network (WLAN), Ultra Wide Band (UWB), Radio Frequency Identification (RFID), Near-Field Communication (NFC) systems, and others have demonstrated that when an opportunity for cost-efficient and flexible spectrum usage is presented in the form of unlicensed spectrum, the market is likely to respond through innovation and expansion.

Modern technologies such as OFDMA, Spread Spectrum, Frequency Hopping, BDMA, FMC, ultra wide band (UWB) and the potential for software defined radio (SDR)[29], further facilitate spectrum sharing, enabling spectrum signals to coexist with each other without interference.[30] The carrying capacity of spectrum depends entirely on the technology that we use and it is increasing day by day.

Access to the wireless network uses a variety of wireless devices to maintain connectivity between the nodes. Technology for connecting regions

[29] Unlicensed Spectrum. (2011). ICT Regulation Toolkit. Retrieved November 23, 2011, from www.ictregulationtoolkit.org/en/Section.2843

[30] Horvitz, Robert. Personal Interview. 9 Sept. 2011.

through wireless technology is based on the identification, modification and deployment of affordable equipment suitable to the needs and conditions of rural regions. Participative organizations shared their views on wireless network equipment usability, quality and its cost-effectiveness.

I. **Airjaldi's** approach is need-based. Airjaldi deploys and designs the network where network is required and asked to be deployed.

II. Airjaldi uses open-source software packages F/OSS that have ability to optimize traffic, report on their status and performance and enable remote trouble-shooting and provide hot-spot services and allow for high-level network encryption to ensure network security.

III. Integrated with various open-source software tools is a base of Airjaldi's network to extend the existing internet broadband by interconnecting wireless routers ("nodes") to form a network that provides coverage and Internet access to a given area.

IV. After intensive testing and using selected hardware platforms fitted with power supplied and charge controllers, the device is capable of handling wide power fluctuations. Each node is supported by a battery backup and in places where electricity supply is erratic or non-existent, solar power supply is provided.

V. Airjaldi uses variety of antennas to enable significant extension of the nodes' range and area of coverage. The router and other components are mounted mostly on low masts placed on rooftops or high places. The easily- installed nodes are small and unobtrusive and their low emitted radiation and power requirements make for a very low ecological footprint.

VI. In Nepal, using wireless equipments is illegal. **Nepal Wireless** uses Motorola Canopy radios at 5.7 GHz as the network backbone, whereas connections to other areas use wireless Ethernet (IEEE 802.11b standard) radios at 2.4GHz from various manufacturers.

VII. The Motorola devices were used for the backbone connection due to their reliability, robustness, and to avoid signal interference. However, 802.11b radios were used village connections due to their lower cost and the compatibility between manufacturers.

VIII. **Network Server Set-up Technology:** Linux: A well tested and proven in production environments and thus made a perfect choice for the server.

IX. **Network Management**

- **Asterisk PBX:** An open source telephone exchange based on the SIP protocol to interface network phones with the Nepal Telecom PSTN.
- **Apache and the Intranet Server:** This popular open source HTTP server provides web pages customized for internal access. This includes links to network administration resources and a directory.
- **Samba:** The Windows File Server and Master Browser: This cross-platform file server allows users to simply share files on the network. Samba allows both open and password protected shares and acts as a "workgroup master" by collecting the names and addresses of other computers on the network.
- **MySQL:** This open source database provides support for a number of other software packages, including Asterisk PBX and phpBB. It can be administered with a web browser using phpMyAdmin.
- **WebMin:** This web based administration system allows one to perform virtually every task required to keep the server in operation, including security, account management and network configuration.
- **SSH:** The Secure Shell Daemon allows administrators secure access to the server from anywhere in the world. From this interface, all aspects of the system can be analyzed, diagnosed, modified or upgraded from anywhere in the world.

Village Telco uses the latest Open Source telephony software and low cost wireless mesh networking technology to deliver affordable telephony anywhere. Village Telco uses two kinds of technologies:

Mesh Potato: A combination of a low-cost wireless Access Point (AP) running mesh networking software with an Analog Telephony Adapter (ATA). Mesh Potatoes automatically connect with each other, forming a "cloud" of Mesh Potatoes. The Mesh Potato is a simple Wi-Fi device that connects to other such devices forming a network. It lets the users make free calls to anyone else in the network using any phone, and provides both voice and data services. The Mesh Potatoes can also be connected to any internet or telecom provider. The Mesh Potato behaves like an invisible switch that operates one layer below IP address. It is used for seamless connectivity. To establish the connectivity through mesh potato, it requires three things: Web Address, Login Computer, & telephone to configure.

The Village Telco Entrepreneur (VTE) Server: Based on popular Open Source applications, VTE Server combines network management, upstream voice connectivity, and pay-as-you-go billing management to create a simple system for an entrepreneur or community organization to sustainably deliver voice and Internet services.

Queries

- What are efficient technologies? What are inefficient technologies?
- What are regulatory issues of tower?
- What is blackhaul?
- What is white space?
- What are obstacles in using white space? How can this white space effectively?
- What are open source software technologies available in the market?
- List of affordable wireless technologies available in the market

d) Business Model & Sustainability

The long-term goal of Wireless Networking is to maximize the benefits of wireless technology for the rural population in sustaining their lives. Thus, to maximize the efforts of wireless technology, it is important to use the technology in sustainable business models. These models could be public-enterprise models and community members could also be part of it.

Airjaldi approach towards sustainable business model is for-profit that means to sell unlicensed spectrum to small clients such as households, small institutes, NGOs, small organisations, etc.

Whereas Nepal Wireless approach is to use unlicensed spectrum for various community purpose which could be sustainable on its own. Nepal Wireless uses its spectrum for the following services:

- **Internet Access:** Available to students, teachers, community members, and tourists
- **Email:** Free accounts available through nepalwireless.net or other web mail services (e.g. yahoo and hotmail) to the villagers
- **Telephone Service:** Villagers can place ordinary landline phone calls through Internet telephony equipment and the PBX software on the network server.

- **Community Discussion:** Using an online discussion forum (phpBB), villagers are able to engage in community discussions in Nepali.
- **Education:** Increase opportunities in community schools by
  - Creating a live tele-teaching program
  - Providing contents in local languages to the students and villagers
- **Healthcare:**
  - Establish a tele-hospital in urban area and link it to the district level hospitals and rural health centers
  - Provide medical assistances to the villagers through telemedicine program
- **Communication**
  - Increase communication facilities in the isolated rural areas by providing
  - VoIP phone
  - video conferencing facilities
  - bulletin board
  - Internet services
- **Local e-Commerce**
  - Help villagers sell and buy their products in the local market through local intranet and internet
- **Jobs and Business Opportunities**
  - generate jobs for younger generation locally through remittance services
  - VoIP phone services for International calls
  - credit card transaction services for the tourists
  - secretarial services (photo copy, photo print, document print)
- **4 Cs Collaboration**
  - Cyber Café
  - Community Centre
  - Cinema
  - Classroom
- Partnership with other NGOs and integrate with activities through Wi-Fi

Queries

- How to create sharing business model and good community model from unlicensed spectrum?
- How to monitor clients at local level?
- Sustainability of the network? How to manage the social sustainability of the centre?

e) Training & Capacity Building

The high cost of conventional wired infrastructure is an obstacle to those who are looking to harness the potential of ICTs for development and social change. Wireless technologies offer tested, low-cost options to complement conventional infrastructure but in order for the promise of wireless to be fulfilled within inside community members, interventions are needed at a number of levels, ranging from policy to technical development and to capacity building on managing wireless equipments and networks.

AirJaldi has established AirJaldi Network Academy as part of Training & Capacity Building Division. The Academy hosts courses and workshops developed by AirJaldi and other content providers.

Oriented towards bridging the gaps in knowledge and skills - thereby enabling participation in the possibilities that Information and Communication Technology (ICT) provides - the Academy caters to network operators, organizations and interested individuals.

Airjaldi recommends that 6 months training programme is required to be trained on network designing, deployment and troubleshooting. And to train people does not require very high qualification, but it does require some knowledge and understanding of how internet operates.

Nepal Wireless suggests that management and technical training should be provided to local people, so that they can maintain technical aspect of the network. Training is also required for setting up a Wi-Fi network. Provide small training programs to implement small projects such as e-Commerce platform, website training, etc., on wireless networks.

Resources

a. WirelessU (http://wirelessu.org)
b. Village Telco (http://villagetelco.org/)
c. NetworkTheWorld (http://aj.networktheworld.org)
d. Network Startup Resource Center (NSRC) http://www.nsrc.org/
e. ITRainOnline (http://www.itrainonline.org/itrainonline/english/index.shtml)
f. Wire.less.dk (http://wire.less.dk/)

g. The African Network Operator's Group (http://www.afnog.org/)
h. The Abdus Salam International Centre for Theoretical Physics (http://wireless.ictp.it)
i. Inveneo (http://www.inveneo.org)
j. IT+46 (http://www.it46.se/)
k. APC Community Wireless Projects (http://www.apc.org/wireless/)
l. Tier Group (http://tier.cs.berkeley.edu/drupal/)

f) Partnership Collaboration

What is meant by Community Network & Community Ownership in the context of developing Wireless Community Network?

First, in the language of community development and empowerment, the concept of 'ownership' and of 'taking ownership' refers to a process of internalization of responsibility for a development process and its outcomes, and therefore a willingness to invest considerable effort and resources. In this case, the use of the term 'ownership' refers more to the fact that the action is tailored to a community's needs through a participatory process that the community has some degree of control over, rather than to holding legal title.

What is a Community Network?

- Owned by the community
- Managed by the community
- Maintained by the community
- Serving the community
- Sharing Internet connectivity (uplink)
- Sharing cost for Internet access
- Distribution network based on wireless technology
- Local value-added services

Why is community network needed?

- Serving areas where commercial ISPs do not see a business case
- Brings down the cost of connectivity by buying bulk capacity (at least in theory)
- Brings down the cost of installation
- Provides a way to share knowledge and information (local content)

In practice community network ownership can be mapped along a continuum. Formal community ownership of enterprises may include for instance:

- Local government ownership, implemented as a service for local people and organisations;
- Non-profit enterprises in which a majority of shareholders are people, or-

ganisations or firms within the community served. Such shareholders may include only a small minority of the total catchment community, and the voting power of individual shareholders may vary greatly;

- User cooperatives, in which the users are also shareholders, in general each having the same level of voting power;
- Community cooperatives, in which all members of for instance a village, irrespective of whether they are actual or potential users
- Worker cooperatives, in which the workers are also the enterprise's owners and managers;
- A community owned element in the context of a larger consortium that might include public and private interests, and non-profit and for-profit components.

Queries

- How to train community members to take the ownership on managing wireless network?
- What is community network? How to create a brigade of community networkers?
- Regulatory requirements of network management
- How to monitor clients at local level?
- Can we connect village councils through wireless connectivity? How can we train panchyat members on community network?

Practical Lessons

a) As many services as possible should be provided to the users to make it sustained and to increase the number of users such as educational, health, communication, remittance, e-commerce etc.

b) Networking projects create job opportunities.

c) Communities must be given responsibilities for managing and maintaining a network.

d) Wireless network can be useful for monitoring the climate change and for preventing disasters

e) Maintain call logs of clients for at least 5 years

POINTS TO BE LEARNT

i. According to the law, the maximum height of the antenna is 5 metre
ii. Without a license, only 5 meters above existing for tower is allowed
iii. Minimum height of antenna is 1 metre and maximum is 5 metre
iv. Antenna is a passive device which means higher the gain narrower the beam
v. Most viable technology in rural area is Wi-Fi
vi. The capability of 802.11b/g devices exceed more than manufacturer specification Wi-fi device is useful for delivering services such as video conferencing, tele-teaching, tele-training etc, other than just connecting computers to the Internet
vii. Long-range network must have to have strong backbone
viii. WiMax is the best technology but less products are available in the market for this technology
ix. There are 250,000 towers in the country, which can be utilized for networking
x. Solar power supply can be used for power supply
xi. Use natural resources such as tall trees as relay towers
xii. Use solar power at the relay stations
xiii. Wind and bicycle generator at relay stations for back up in monsoon season
xiv. Deep Cycle Batteries for storage
xv. Used PC and laptops collected from different sources
xvi. VoIP equipment such as Sipura SPA –3000, GrandStream IP phones and Cisco ATA adaptors
xvii. Network camera such as Axis 214 PTZ camera for tele-teaching. Linksys, Panasonic, Polycom network and video conferencing cameras for telemedicine program
xviii. VLC, Open source software for video conferencing – Argusoft software
xix. 2.4 GHz Wi-fi radios (802.11b/g) produced by different manufacturers
xx. 5.8 GHz Motorola Canopies for backhaul
xxi. 19 dBi homemade grid antennas
xxii. 24 dBi grid antennas
xxiii. Linksys and Soekris Routers
xxiv. Switches of different brands
xxv. To monitor call logs of clients, use open source software – NAGIOS (http://www.nagios.org/)
xxvi. Presently, Airjaldi uses devices from three companies –

- Ubiquity
- TP-Link
- MikroTik Routerboards

National Consultation On

"Empowering Communities Through Open Media Access"

1 December, 2012 | New Delhi

About the National Consultation Workshop

The national consultative workshop was a first kind effort to bring all stakeholders to deliberate, discuss, share, experience and emerge with a concrete set of recommendations as how unlicensed spectrum in India can be used to serving the last mile connectivity. The consultation saw stakeholders from the government departments, agencies, industry, civil society, academia, network implementers, policy advocators, wireless practitioners, and others to air views, opinions, inputs, concerns and suggestions on a wide area of topics. One unique approach was to present and share good practices and challenges in wireless network deployment and operations in India and other developing countries.

Workshop Objectives

Key objectives of the national consultation workshop identified were:

- Arrive at better understanding of unlicensed band, free spectrum and its importance to serve last mile connectivity
- To share good practices and challenges faced during the wireless network deployment and operations in India and other developing countries
- Deliberate on the need availability & challenges of appropriate wireless technologies to bridge access and connectivity divides
- To bring implications related to wireless, mobile & broadband technologies which help transcend traditional infrastructural bottlenecks in rural areas of India
- To emerge with working framework with necessary inputs, suggestions, comments, recommendations on ways to connect the government and business services that can reach the masses through the wireless and mobile networks in local languages and in oral medium

Workshop Broad Areas

In light of the above, the consultation discussed the following broad areas:

1. Discuss the importance of free spectrum for public good and advocacy towards utilizing it for social development
2. To understand the scope and opportunities of unlicensed spectrum in India and other developing countries
3. To understand the magnitude and extent of unlicensed wireless band/free spectrum that can be used to connect isolated areas and communities of the country.
4. Explore and understand the rights and ethics challenges and issues around unlicensed spectrum

Workshop Themes

The consultative workshop deliberated on the following themes:

1. Access, rights & ethics
2. Economic and social advancement of using wireless network
3. Developing uniform policy framework for unlicensed spectrum

Outcome

The national consultation workshop looked at the following key outcomes

1. Consolidate factors and inputs to uniform policy framework for unlicensed wireless spectrum;
2. Consolidate solutions towards issues related to media, access and rights, ownership of unlicensed spectrum, ownership of accessibility and exploring opportunities in terms of accessibility;
3. Building a roadmap towards a working framework on adopting cost-effective technologies to propagate the wireless network networks far and wide across the country for ensuring equality of access, digital equity and media access.
4. Consolidating scope of policy areas and suggest workable action steps;

Consultation Proceedings

The consultation was formed in discussion-oriented format sharing good practices, case studies and challenges in wireless network deployment and operations in India and other developing countries. The focus of the consultation is to empower communities through open media access. The consultation was chaired by Executive Director of the Association for Progressive Communications (APC), Ms. Anriette Esterhuysen and moderated by Subho Ray, President of Internet and Mobile Association of India (IAMAI). The consultation also focused on understanding the importance of unlicensed band (free spectrum) to serve the last mile connectivity.

Speakers

Guest of Honor & Chairperson

Ms. Anriette Esterhuysen, Executive Director, Association for Progressive Communications (APC), South Africa

Moderator

Mr. Subho Ray, President, Internet and Mobile Association of India (IAMAI)

Power Panel Speakers

1. Mr. Anoop Singh, Special Secretary, IT & Communication, Govt. of Andhra Pradesh

2. Dr. Ravina Aggarwal, Program Officer for Media Rights and Access, Ford Foundation
3. Mr. Rajnesh Singh, Regional Bureau Director for Asia, ISOC
4. Mr. Amitabh Singhal, Former CEO, NIXI
5. Mr. Mahabir Pun, Founder, Nepal Wireless
6. Mr. Michael Ginguld, Chief Executive Officer, AirJaldi
7. Mr. Mahesh Venkateswaran, CEO, KGVK Social Enterprises Limited

The Proceedings

The Consultation delegates and guests were welcomed by Mr. Subho Ray, President of Internet and Mobile Association of India (IAMAI). He outlined the reason and background to initiate the session dialogue through the consultation – scope and opportunities of unutilized spectrum to provide internet connectivity in rural areas. Sharing his ground experience, he quested to demonstrate the need for and importance of unlicensed spectrum as a medium for inexpensive connectivity in rural/remote areas and source of innovation by serving as a barrier-free and cost-effective platform for testing and implementing of new technologies.

Keynote address by Ms. Anriette Esterhuysen, Executive Director of APC

Executive Director of APC, Anriette Esterhuysen initiated the national consultation asking key panelists to share their views on how the free spectrum (unlicensed spectrum) can be understood and utilized for benefitting the society. Raising the issue of approaching spectrum in two perspectives – policy and regulatory, she requested panelists to shed some light on how to approach spectrum, not only in terms of policy and regulatory issues, but also in terms of implementation and application.

Amitabh Singhal, Former CEO, NIXI

Mr. Amitabh Singhal initiated the discussion by sharing his industry experience, being a President at Internet Service Providers Association of India (ISPAI) enforced the government to follow global standards and exempt few frequencies from licensing process. In 2006, the Government of India exempted frequency 2.4 GHz band license-free. Referring to the draft of the National Telecom Policy-2011, he highlighted the government is trying to connect all the villages and households in the country through its various projects such as the National Optic Fibre Network (NOFN), which aims to provide broadband connectivity to Panchayats (village councils) and State Wide Area Network (SWAN), that is envisaged to create such a connectivity in each State / UT. He

pointed out however; the last mile connectivity is the real challenge in India because of its geographical challenges, tropical challenges and accessibility issues in terms of physical infrastructure. In this context, free spectrum here plays important role to resolve these challenges. According to ISPAI, most of internet service providers (ISPs) are using 2.4 GHz these days to provide last mile connectivity. Mr. Singhal emphasized that the government is also gearing up to launch range of new technologies such as WiMAX. While private companies are also coming up with new solutions and technologies to reach remotest regions of the country. Giving wider perspective, Mr. Singhal pointed that India is currently at various stages of using licensed & unlicensed band to create last mile connectivity and to reach end user.

Mr. Anoop Singh, Special Secretary - IT & Communication, Govt. of Andhra Pradesh

Mr. Anoop Singh initiated the discussion stating that revolution in the telecom industry is happening since 2001 with small revolutions happening in the country. Referring to Mr. Singhal's point, he stated that NOFN is one of the dreams that has come true in terms of connecting the remotest regions of the country, however, the project has two challenges – firstly is the last mile connectivity, secondly is rendering of content on the free spectrum. Though, number of enormous and brilliant efforts is being undertaken by enterprises throughout the country, even in the remotest regions of the country, however, overall impact is yet not visible. At last, he concluded his points in a hope that soon the country will be able to witness the impact and revolutions that will boost the economic and social growth by leaps and bounds.

Dr. Ravina Aggarwal, Program Officer - Media Rights and Access, Ford Foundation

Dr. Ravina initiated her views by cautioning on using the word, 'revolution' itself has innumerable optimism associated to it, however; there are two major issues related to the word in the context of mobile services. In accordance with the fact that the mobile services have enormous potential in India, she mentioned however, these services also face challenge of enormous inequity. According to Ms. Ravina though availability of content is important to deliver services, however, she recommended not to take service delivery provision models for granted. She also urged that there is need to invest in equitable solutions. According to Ms. Ravina more than 80 per cent population does not have access to internet or means to access information. In the nutshell, she mentioned that though there is constant movement towards better technologies but

the promise of scaling of the services has not been delivered yet in rural regions.

Raising the issue of accessing information, she also recommended that there is need of committed players such as non-profit organizations, small enterprises and individual players in the market to provide equitable solutions to rural citizens and those who are yet deprived of accessing information as big telcos might not be interested to cover in their business models. In her conclusion, she recommended to have good partnerships between government and private stakeholders, small enterprises and big telcos and NGOs (non-profit organizations) and independent businesses, which will help in serving end users. Thus, at last she welcomed opportunities for new ideas, policy advocators who would encourage small and medium enterprises to work altogether for the benefit society.

Mr. Michael Ginguld, Chief Executive Officer - AirJaldi

Mr. Michael initiated the discussion on explaining 2.4 GHz and 5.8 GHz bandwidth are available as free (unlicensed) spectrum. Explaining about the science behind unlicensed spectrum, Mr. Ginguld further stated that radio waves or the spectrum is limited resource according to physics. Further explaining about spectrum utilization, he stated if all available bandwidth will be utilized, it will not solve the problem of delivering content. Thus, the problem could only be solved by using available spectrum efficiently and effectively.

Bestowing on the success of the Wi-Fi technology in the 5.8GHz, Mr. Ginguld added that success was partly due to cheap cost of equipment and partly due absence of license fee. Even if, lowering down the license fee for 700 or 900 MHz, there is no equipment which is even close to the price range of 2.4GHz or 5.8GHz range. At last, he concluded his points urging to use available spectrum effectively and efficiently.

Mr. Mahesh Venkateswaran, CEO - KGVK Social Enterprises Limited

Giving the background of the organization, Mr. Mahesh initiated the discussion that he has been working in Jharkhand from the last four years along with AirJaldi and struggling to expand the network in rural regions of the state. Being from the demand side, he further urged that there is need to use available spectrum wisely and effectively. Questioning on government's agenda thought-process for making digital-inclusive society through mobile phones or internet, he explained that stakeholders should not start their services from ultra-rural areas but they should start their services from semi-urban region because these regions are connected, however, the quality of connectivity is not up to the mark. These are the places with fluctuating connectivity and where existing op-

erators could do a good job. In order to strengthen connectivity in these areas, there is a need to adopt cluster-based approach and the benefits could then be spread out to the grass root level.

Giving example of his organization, Mr. Mahesh stated that cost-factor that plays crucial role in spectrum India. He concluded his points that there is need to generate strong demand in terms of employability, educational and healthcare services within communities and later on there is possibility of creating rural broadband subsidies specifically designed for villagers. In result, it will help in spectrum utilization in a structured manner as well as further allocation of spectrum.

Mr. Mahabir Pun, Founder, Nepal Wireless

In the context of unlicensed spectrum utilization in Nepal, Mr. Mahabir stated that his organization, Nepal Wireless is working in the remote villages of Himalayas and trying them to connect with internet. Referring to the fact that over 80% population in Nepal is living in villages and they cannot afford internet, he commented no matter if telecom operators are introducing 3G or 4G technology in the country, if it will be highly priced, most of people cannot afford such technologies. Thus, open (free) spectrum is utmost important to provide connectivity in Nepal. He agreed that telecom companies are certainly unable to provide their services for free as they have to pay huge licensing fees, thus, there is requisite to understand the importance of open (free) spectrum. Like India, the Government of Nepal is also making its efforts to connect 75 district headquarters of the country with optic fibre network; he questioned what about the last mile connectivity in the country.

According to Mr. Pun, connecting district headquarters or centres is not enough for last mile connectivity, there is not only need to connect to each and every villages but also make connectivity affordable to them. Giving an example of Nepal, he stated the government of Nepal has encouraged rural ISP to pay licensing fee of INR 100 in year. Further discussing about regulations, Mr. Pun recommended that in countries like India or Nepal, there is not only need to develop regulations related to open spectrum but it is also important to motivate and encourage rural small enterprises to become ISP provider within their region through which rural ISPs can also earn some additional income. Thus it is not only about opening up of spectrum but also creating resolutions for the better utilization of the spectrum.

Mr. Rajnesh Singh, Regional Bureau Director for Asia – ISOC

In the context of open spectrum, Mr. Rajnesh initiated the discussion with the utilization of white space in other countries. Giving examples of developed

countries such as USA and Singapore where government has started approaching to use analog TV spectrum for their purpose, he proposed that there is need of utilization such spectrums in India as well. In a question of what kind of spectrums can be utilized, Mr. Singh stated there are number of organizations who have not really utilized the bandwidth allotted to them and in fact that can be used. The underlying point, however is that how many of these frequencies are feasible and can be used at an affordable price. He further added though telcos buys spectrum in exorbitant rate, however, end of the day, cost needs to be paid by end users.

In a context to affordable resources available in the market, Mr. Rajnesh stated in the market affordable chipsets are available which can be used effectively in the bandwidth of 700 or 900 MHz, while the 2.4 GHz chips can now fitted to almost any device. Thus, research and development (R&D) in this field has an important role to play so that mass production of chipsets for other frequencies can be done and at a cost-effective price. He also prophesized the need of a balance in the government polices.

In the backdrop of cost-effective spectrum utilization, Mr. Rajnesh recommended to provide some kind of network access to the ones who certainly cannot afford the service of paid spectrum.

Recommendations

1. As the demand for bandwidth and connectivity is bound to grow in future. In a question of optimal utilization of available open spectrum, there is need of continuous experiment with the existing spectrum and looking for robust bandwidth solutions to provide the last mile connectivity.
2. In terms of the using new technologies, Wi-Fi is one of the most usable technologies as it doesn't have issue of the connectivity and stability.
3. In an effort to provide equitable access and increase internet penetration, there is need to explore all kind of spectrums, including open, white space and the existing spectrum.
4. One recommendation is to provide the quality content in a channelized manner and develop sustainable business models to sustain small ISPs in India.
5. Regulations like using premium bandwidths on shared basis for both paid as well as non-paid spectrum can be initiated in India to solve the issues related to substandard quality of ISP service. Though there are issues like security, interference and even non-working of the business model, however, there is still need to rework on sharing model of spectrum.
6. In an effort to provide the last mile connectivity and come up with sharing spectrum model, there is need to open up free spectrum, so that end users living villages of the country can also be connected.

7. Another major recommendation is to develop sustainable social enterprises and to generate strong demand at the lowest price that could work for the poor. There is also need to understand the price-factor which has to be reduces before it reaches at grassroots level.
8. It must be mandatory to understand whether rural communities are able to harness the benefits of the existing bandwidth.
9. The necessity of more spectrums is required these days because if many people are using the same bandwidth which causes a problem, congestion. In result, it would lead to more severe problem of the congestion such as loss of speed, security, breaches, etc.
10. In terms of bringing digital literacy in practical terms and to improve lives of the marginalized communities, it is important to use open spectrum and also provide devices which can harness the open spectrum. The rural population needs to be taught how to use computer, but not through text books but using computers in real life.
11. The word 'empowerment' should be clearly defined. It clearly describes how citizens can receive all kind of services using technology. Wireless communications and computers are means of empowerment and there is need to devise policy and methodology that will lead to actual empowerment. For the same, there is need to take immediate steps in redeveloping and redefining processes government policies and services.
12. The word, 'communities' also needs to be clearly identified and defined. For communities like NGOs, Panchayats and clusters; there is need to develop specific models which should be simple and realistic solution for such communities. Like DEF & PIR (Public Interest Registry) has addressed the needs of NGO communities and enabled them to use web and internet for community development. In a similar way, DEF & AirJaldi are working together to provide access to the internet to these NGOs. These kind of solutions need to be developed after identifying specific communities.
13. In terms of accessibility to the last mile users, there is a need to develop proper business opportunities. On the supply side of the spectrum, call needs to be taken for lowering down the spectrum. Presently in India, the cost of internet access is still highly-priced, thus there is need to work on ways which is logic.
14. Referring to the issue of physical infrastructure, government and BSNL have immense physical infrastructure in place which needs to be utilized in channelized manner.
15. In terms of new policies, policy makers and government needs to come forward and provide any kind of subsidy to internet users rather than internet service provider.

16. Being most of rural broadband is state controlled mostly (through BSNL) and this needs to change by opening up infrastructure for shared usage and subsidy depending on location of installation. On understanding the requirements of rural broadband networks, there is need to analyze ways and models which can fill in gap with provision some level of subsidy or tax exemption for ISPs.
17. Assessing the potential of open spectrum or rural broadband networks, first steps of bringing out sustainable models in semi-urban cities and towns, so that rural communities can also get inspired and look upon these models. In result, it will create an ecosystem and help rural regions to be connected with the mainstream.

Annex-Glossary on Technologies

BDMA (Beam Division Multiple Access): The BDMA method separates the antenna beam as per the locations of the mobile stations. An orthogonal beam is allotted to each mobile station during the communication between base stations and mobile stations. This increases the capacity of the system by allowing the mobile stations to give numerous accesses. Mobile stations and the base station know each other's positions precisely, being in a Line of Sight (LOS). Hence they can transmit beams that point to each other's position to communicate with no interference with the mobile stations at the cell edge.[31]

Bluetooth: Bluetooth is an unlicensed consumer device that is used for very short-range wireless personal area networks (WPANs). Bluetooth uses 2.4 GHz spread spectrum frequency hopping technology, and is included in devices such as mobile, radio, telephones, laptops, personal computers, printers, and personal digital assistants (PDAs). Some experts are predicting that it will become a regular feature in many consumer electronic devices.[32]

DECT: DECT technology is created for short-range use as an access mechanism to the main networks. The applications provided by DECT are cordless voice, fax, data and multimedia communications, wireless local area networks, and wireless PBX.[33] The advantage of this technology is that it provides good voice quality and very high radio link reliability.[34]

DECT is generally operated in the 1880-1900 MHz frequency range in Europe. This frequency is unlicensed and exclusive to DECT devices, which secures operation with almost no interference. Outside of Europe, frequencies ranging from 1900 MHz to 1920 MHz and 1910 MHz to 1930 MHz are also widespread. These ranges are also unlicensed but not solely for DECT use. Nevertheless interference is not a big concern in these frequencies either, as they

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[31]Ali, I. (2011). Beam Division Multiple Access (BDMA) for 5G. Telecom India Online. Retrieved January 27, 2012, from http://www.telecomindiaonline.com/beam-division-multiple-access-for-5g.html

[32]Marcus, M., Burtle, J., Franca, B., Lahjouji, A., & McNeil, N. (2002). Report of the Unlicensed Devices and Experimental Licenses Working Group. Federal Communications Commission. Retrieved November 29, 2011, from http://transition.fcc.gov/sptf/files/E&UWGFinalReport.pdf

[33]DECT Technology Tutorial. Radio-Electronics.com: resources and analysis for electronics engineers. Retrieved November 29, 2011, from http://www.radio-electronics.com/info/wireless/dect/dect_basics.php

[34]Consultation Paper on Allocation of Spectrum Resources for Residential and Enterprise Intra-telecommunication Requirements/ Cordless Telecommunications System (CTS), pg. 21. (2011). TRAI. Retrieved January 4, 2012, from www.trai.gov.in/WriteReadData/trai/upload/ConsultationPapers/267/Consultation_Paper_on__CTS_%2026.12.2011.pdf

are generally adequately free of other users.[35] About 60% of the cordless communication world market is controlled by this technology.[36] In India, the 1880 - 1900 MHz or the 1910 -1920 MHz ranges need to be de-licensed to operate DECT devices.[37]

Fixed Mobile Convergence: Fixed Mobile Convergence (FMC) is one of the latest technological developments utilizing Wi-Fi technology. FMC uses the public IP network to spread all or part of the services offered by the wireless telecom service provider's core network (CN) to domestic, small and medium enterprise subscribers. Some of the benefits of FMC are:

- There is greater technological practicality, because users only have one contact number, as well as use the same device for fixed and mobile services
- Indoor coverage is enhanced, because the wireless signal is disseminated from within the indoor environment
- There is a reduction in the bandwidth load, because voice and data traffic are offloaded from the wireless to the fixed portion of the network
- The expenses incurred by the service providers as well as subscribers are reduced

A viable option for delivering FMC is through Unlicensed Mobile Access (UMA). The UMA standard combines wireless cellular telephony and Wi-Fi networking for voice, data, and multimedia services available on one dual-mode handset (DMH). This method of communication allows the use of a single device indoors and outdoors without a loss in quality, and even a potential improvement. The DMH device can automatically alternate between an IP-based network and a cellular network; the network choice being dependant on where the strongest signal is coming from. UMA promises a solution for converging fixed wire services, mobile wire services, and VoIP services.[38]

Frequency Hopping: This is a modulation technique that is employed in the spread spectrum signal transmission. It involves the continuous switching of frequencies in the process of radio transmission. This reduces the chances of interception or jamming of signals.[39]

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[35] Ibid pg. ii
[36] Air Cmde (Retd) Motial, Shubhangi (DECT Forum India). Personal Interview. 8 Nov. 2011
[37] Ibid
[38] Yarali, A., & Saleeba, K. (2010). Unlicensed Mobile Access: Leading Technological Alternative in the Fixed Mobile Convergence Stable, pg. 1. IEEE Xplore Digital Library. Retrieved November 29, 2011, from http://ieeexplore.ieee.org/xpl/freeabs_all.jsp?arnumber=5532795
[39] Frequency-hopping Spread Spectrum. (2001). TechTarget. Retrieved January 27, 2012, from http://searchnetworking.techtarget.com/definition/frequency-hopping-spread-spectrum

Near Field Communication (NFC): NFC is a radio technology that operates at a short range using the 13.56 MHz frequency. Communication between two NFC-compatible devices is activated when they are put within the proximity of about 4 cm. NFC can be applied to mobile handsets, enabling them to interact with posters, magazines, and various products. NFC applications also include electronic wallets which would act like credit cards through the handset.[40]

OFDMA (Orthogonal Frequency Division Multiple Access): Orthogonal Frequency Division Multiplexing (OFDM) is a method for transmitting a bulk quantity of digital data over spectrum. The advantage of this technique is that it reduces the amount of crosstalk within signal transmission. This is done by dividing the radio signal into several sub-signals and transmitting them to the receiver at the same time using different frequencies.[41] OFDMA provides for a multiple access on the same channel. It distributes subcarriers between all users so that everyone can transmit and receive simultaneously.[42]

RFID: Radio Frequency Identification (RFID) is used as a reference to a system that uses radio waves to wirelessly transmit the identity of an object or person in the form of a unique serial number. RFID applications include ID tags, EZPasses, SpeedPasses, and many others. RFID technology operates without needing a contact or a line of sight for communication. RFID data can be traced through the human body, clothing, and non-metallic objects.[43]

The specific frequency allocation for RFID technology is decided by national radio regulatory bodies. The frequencies for RFID use are unlicensed and generally range from 125-134 KHz, 13.56 MHz, UHF (400-960 MHz), 2.45 GHz, and 5.8 GHz.[44]

The number of RFID tags sold in 2011 is expected to be 2.88 billion, which demonstrates considerable growth from 2.31 billion in 2010.[45] Large retailers such as Wal-Mart have contributed to the increasing usage of this technology.

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Software Defined Radio (SDR): This is a compilation of hardware and software technologies where some or all of the radio's operating functions use modifiable software or firmware that operates on programmable processing technologies. SDR enables new wireless features and applications to be included in existing radio systems without the need for new hardware.[46] The potential for implementing SDR devices for spectrum sharing is through programming the technology to sense available spectrum in the vicinity of the device and coordinate with other communication endpoints to avoid interference.[47]

Spread Spectrum: This transmission method modulates a signal over multiple carrier frequencies at the same time.[48] As a consequence, the energy for transmitting the signal is spread over a wider bandwidth, appearing as noise.[49] Transmissions using spread spectrum are more secure, interference is reduced, and the bandwidth-sharing is enhanced.

Ultra Wide Band (UWB): UWB is a wireless technology that transmits large quantities of digital data over wide frequency channels at a short distance using very low power. It is mainly used for voice and data transmission utilizing digital pulses and radar applications.[50]

ZigBee: ZigBee is an open global standard of wireless technology which is used for low-cost, low-power machine to machine (M2M) networks. This standard uses unlicensed bands in the ranges of 2.4 GHz, 900 MHz and 868 MHz. ZigBee has the advantage of enabling the operation for years on inexpensive batteries for a variety of monitoring and control.

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