# RESPONSE TO TELECOM REGULATORY AUTHORITY OF INDIA CONSULTATION PAPER

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| **Consultation topic:** | **Proliferation of Broadband through Public Wi-Fi Networks** |
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**Introduction**

Microsoft appreciates the opportunity to provide comments to the Telecom Regulatory Authority of India ('Authority') 'Consultation Paper on Proliferation of Broadband through Public Wi-Fi Networks' ('consultation paper')[1]

In 2011, the United Nations Broadband Commission for Digital Development (Broadband Commission) released five 'ambitious but achievable targets' for 2015[2].

- Target 2 was making broadband affordable in developing countries – that is, entry-level broadband services should amount to less than five percent of average monthly income.
- Target 3 was to connect homes to broadband -- 40 percent of households in developing countries should have internet access.
- Target 4 was to get people online – increase internet penetration to 50 percent of the population in developing countries.

'Measuring the Information Society Report'[3] is the International Telecommunication Union snapshot of what it calls Information and Communications Technology (ICT) readiness index as well as affordability measures. In 2014, the cost for entry-level fixed broadband service in India, which consists of 2 Mbit/sec download speed and a 1.5 GB per month data cap, represented 5.28 percent of its gross national income on fixed-broadband[4], which is above the 5 percent target. In comparison, a comparable entry-level fixed broadband plan accounts for 0.5 – 0.8 percent of per capita average monthly income in countries such as Singapore, the United States, and the United Kingdom[5].

According to Internet Live Stats[6], internet penetration in India was 18 percent of the population in 2014, an estimated 27 percent of the population in 2015, and reaching 34.8 percent of the population on July 1, 2016. Microsoft's assumption is that the majority of those connected live in urban areas, which is not where the majority of people live in the country – the more rural areas. It clear that India has made great strides in recent years in increasing the penetration of broadband throughout the country and making it more affordable. Microsoft believes that rapid expansion of public Wi-Fi networks as envisioned by the Authority can further expand broadband access and increase its affordability throughout all part of the country.

Microsoft urges the Authority to view spectrum as an enabling resource leading to economic growth, innovation, and generally improving the quality of life for all those who live in India and visit India. To these ends, we urge the Authority to recommend making available additional unlicensed

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[1] Mahanagar Door Sanchar Bhawan and Jawahar Lal Nehru Marg, "Consultation Paper on Proliferation of Broadband through Public Wi-Fi Networks", Telecom Regulatory Authority of India (TRAI), 13th July, 2016.
[2] See "Broadband Targets for 2015", United Nations Broadband Commission for Digital Development, 2011. http://www.broadbandcommission.org/Documents/Broadband_Targets.pdf
[3] See *Measuring the Information Society Report 2015*, International Telecommunications Union, Telecommunications Bureau, November 2015.
[4] Ibid.,109
[5] Ibid.
[6] Internet Live Stats. "Internet Users by Country." Accessed 18th August, 2016. http://www.internetlivestats.com/internet-users-by-country/

spectrum in several bands as well as making the rules for devices accessing existing unlicensed spectrum harmonized with the rest of the world to the greatest extent possible. Experience has shown in many countries that any loss of potential licensing revenues in the near term is more than offset by the economic activity generated by the low barrier to innovation enabled by de-licensing spectrum.[7,8,9]

**Q1. Are there any regulatory issues, licensing restrictions or other factors that are hampering the growth of public Wi-Fi services in the country?**

The growth of public Wi-Fi in the country would be aided by an increase in the availability of unlicensed spectrum in the 5 GHz, 60 GHz, 70 GHz, 80 GHz, UHF and VHF frequency bands, and technical rules for devices operating in each of these spectrum bands that are harmonized with the rest of the world to the greatest extent possible in order to create economies of scale and drive down the cost of infrastructure and user equipment. Radio waves exhibit different propagation characteristic at different frequencies. Public Wi-Fi operators should be allowed, and in fact encouraged to consider mixing and matching radio links in different frequency bands to create heterogeneous unlicensed networks (and heterogeneous networks that combine licensed and unlicensed spectrum[10]) that connect back to the internet backbone.

5 GHz Band

Table 2.5 of the Consultation paper indicates that with respect to Wi-Fi type use, the 5150-5350 MHz spectrum band can be used indoors for 'low power equipment', with a maximum EIRP of 200 mW. No unlicensed use is permitted in this frequency range outdoors. Additionally, the 5725-5875 MHz band can be used indoors for wireless access systems including radio local area networks, with a maximum EIRP of 200 mW. Here also, no unlicensed use is permitted in the band outdoors.

Given the growth in the demand for mobile data services over the past dozen years, particularly the growth of mobile video, and the resulting congestion and dropped connections over licensed connections, it would be timely for the Authority to recommend that the 5150-5350 MHz, 5470-5725

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[7] Raul Katz, "Assessment of the Economic Value of Unlicensed Spectrum in the United States", Report prepared by Telecom Advisory Services, LLC. For Wi-Fi Forward, February 2014. Accessed 18th August 2016. http://www.wififorward.org/wp-content/uploads/2014/01/Value-of-Unlicensed-Spectrum-to-the-US-Economy-Full-Report.pdf
Raul Katz, "Assessment of the Future Economic Value of Unlicensed Spectrum in the United States", Report prepared by Telecom Advisory Services, LLC. For Wi-Fi Forward, August 2014. Accessed 18th August 2016. http://www.wififorward.org/wp-content/uploads/2014/01/Katz-Future-Value-Unlicensed-Spectrum-final-version-1.pdf

[8] Paul Milgrom, Jonathan Levin, and Assaf Eilat, "The case for unlicensed spectrum", Stanford Institute for Economic Policy Research. 12th October, 2011. http://web.stanford.edu/~jdlevin/Papers/UnlicensedSpectrum.pdf

[9] Richard Thanki, "The Economic Significance of Licence Exempt Spectrum to the Future of the Internet", June 2012. https://www.microsoft.com/en-us/research/wp-content/uploads/2016/02/spectrum-economic-significance-of-license-exempt-spectrum-report_thanki.pdf

[10] As a notable reference, Singaporean regulator Infocomm Development Authority (IDA) has embarked on developing a Heterogeneous Networks (HetNet) Programme as an integral part of the country's Smart National vision and 2025 ICT Master Plan. http://www.infocommguide.com/stay-connected-with-heterogeneous-network-hetnet/; https://www.ida.gov.sg/About-Us/Newsroom/Media-Releases/2014/Singapore-Unveils-Building-Blocks-of-Smart-Nation-Vision; https://www.mci.gov.sg/infocomm-media-2025.

MHz, and 5725-5875 MHz frequency ranges be de-licensed for indoor / outdoor usage on the basis of non-interference, non-protection, and non-exclusiveness. The creation of two large block of unlicensed 5 GHz spectrum (5150-5350 MHz and 5470-5875 GHz) will offer the country's public Wi-Fi providers with the ability to fully take advantage of the larger channel sizes and greater bandwidth available with Wave 2 Wi-Fi Certified ac equipment that allows for channel sizes of 20, 40, 80, and 160 MHz. The larger channel sizes will allow for rapid downloads of mobile videos and other high data-rate applications.

Additionally, the Authority should allow unlicensed devices to operate at up to 1 W conducted power in each of these spectrum bands, provided that the maximum antenna gain does not exceed 6 dBi. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power should be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. At 1 Watt conducted power, radio waves in the 5 GHz band can penetrate through one wall. The increase in power will allow Public Wi-Fi operators to provide a commercially viable (and valuable) service within an enterprise or business. Similarly, public Wi-Fi operators could in part base a business model on being able to provide both indoor and outdoor coverage from an outdoor access point.

Finally, the Authority should consider requiring Dynamic Frequency Selection or some other dynamic spectrum access technique in those 5 GHz bands or parts thereof where certain types of governmental use must be protected from harmful interference.

60 GHz Band

The frequency band 57 to 64 GHz ("60 GHz band") is unlicensed in many part of the world. Due to strong atmospheric oxygen absorption lines within this range that allow for greater spectrum re-use, these frequencies can be used to provide high speed broadband internet access in a wireless access system over a relatively short distance – typically up to 10 meters. The IEEE developed standards for Wireless Local Area Network (WLANs) and Personal Area Networks (PANs) for the 60 GHz band. The channel widths for WLANs and PANs in the 60 GHz band are 2.16 GHz. The European Technical Standards Organization (ETSI) has adopted the same channel sizes. The Wi-Fi Alliance has begun its program to certify interoperability of so-called "Wi-Gig" devices operating on the 60 GHz band.

Microsoft agrees with the Authority's previous recommendation that "the V-band (57-64 GHz) should be delicensed for indoor and outdoor based access applications like Wi-Fi hotspots etc."[11] to facilitate broadband access. The United States regulatory authority, the Federal Communications Commission, has recently authorized unlicensed use from 64 to 71 GHz under technical and service rules harmonized with those for devices operating from 57 to 64 GHz. Microsoft suggests that the Authority consider recommending the extension of the V band to 71 GHz, under the same technical and services rules as 57 to 64 GHz, in order to help create global economies of scale for infrastructure and user equipment.

TV White Spaces

[11] Mahanagar Doosanchar Bhawan and Jawahar Lal Nehru Marg, "Recommendations on Allocation and Pricing of Microwave Access (MWA) and Microwave Backbone (MWB) RF Carriers", Telecom Regulatory Authority of India, 17th November 2015, p. 6.

The International Telecommunication Union Radiocommunication Sector (ITU-R) defines television white spaces (TVWS) as "A portion of spectrum in a band allocated to the broadcasting service and used for television broadcasting that is identified by an administration as available for wireless communication at a given time in a given geographical area on a non-interfering and non-protected basis with regard to other services with a higher priority on a national basis"[12]. In 2013, François Rancy, Director, ITU Radiocommunication Bureau, summed up where TVWS falls within the ITU regulatory framework.

> "The ITU World Radiocommunication Conference of 2012 concluded that the current international regulatory framework can accommodate software defined radio and cognitive radio systems, hence dynamic spectrum access, without being changed. The development of systems implementing this concept, such as TV white spaces, is therefore essentially in the hands of national regulators in each country… For this, regulators will depend on state of the art best practices which are currently developed by ITU-R Study Groups 1, 5 and 6."[13]

There are four countries with technical and service rules that authorize type-certified devices to share the TVWS on a secondary basis. They are the United Kingdom, Singapore, United States, and Canada. Several other countries are in the process of considering technical and service rules for the TVWS including the Philippines, South Korea, South Africa and Ghana. To date, the majority of countries are studying unlicensed use of the TVWS. For countries where all Internet Service Providers (ISP) require a general license, Microsoft would expect that ISPs using fixed TVWS links will likewise require a general license. Microsoft has participated in numerous TVWS technology demonstrations, pilot projects, and commercial trials with local partners, including in India.[14] Other companies have also participated in TVWS projects, some of which are in countries where Microsoft has not engaged.

Radio waves traveling in the TVWS experience less atmospheric attenuation and can penetrate through common building materials and foliage better than radio waves traveling at higher frequencies, and allow for non-line of sight deployments. Two types of TVWS devices are envisioned – fixed and personal / portable. Fixed TVWS links can be used in a public Wi-Fi network for point-to-multipoint communications or for backhaul. The technology is mature and there are multiple commercial providers of the access points and consumer premises equipment. Personal / portable TVWS radios, when they become commercially available, can provide a longer-range WLAN end point than unlicensed WLANs using 2.4 GHz or 5 GHz spectrum bands.

As described in Microsoft's response to Question 13, we believe that use of the TVWS as part of a communications network bears great potential for enabling internet access in rural areas, not only because it is easy to set up and maintain, but also it is cost effective. Consistent with this purpose, we urge the Authority to recommend that the unlicensed use of the TVWS for fixed and personal /portable

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[12] See ITU Report ITU-R M.2225, "Introduction to cognitive radio systems in the land mobile service", International Telecommunication Union Radiocommunication Sector, 2011.
http://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-M.2225-2011-PDF-E.pdf

[13] See comments by François Rancy, Director, ITU Radiocommunication Bureau, ITU Radiocommunication Seminar for Arab Countries, RRS13-Arab Tunis, Tunisia on December 13, 2013.

[14] Microsoft has participated in TVWS technical demonstrations, pilot projects, commercial trials in countries including the United States, United Kingdom, Uruguay, Jamaica, Kenya, Tanzania, South Africa, Namibia, Ghana, Botswana, Morocco, India, Indonesia, Timor-Leste, Bhutan, Taiwan, Philippines, and Singapore.

devices be permitted for indoor / outdoor usage on the basis of non-interference, non-protection, and non-exclusiveness. Given the large amount of white spaces spectrum available, Indian consumers and business can benefit from public Wi-Fi networks that can leverage both the greater propagation range and the capacity of the broadcast television bands.

**Q2. What regulatory/licensing or policy measures are required to encourage the deployment of commercial models for ubiquitous city-wide Wi-Fi networks as well as expansion of Wi-Fi networks in remote or rural areas?**

City-Wide Wi-Fi

Microsoft believes the recent authorization of Unified License Virtual Network Operators (VNO) will support the Authority's vision to help foster city-wide public Wi-Fi networks. VNOs offer the potential of lowering barriers to entry for new companies interested in providing public Wi-Fi by lowering the cost to interconnect to the internet backbone. Start-up VNOs can connect one or more 2.4 GHz, 5 GHz, TVWS, and /or 60 GHz Wi-Fi access points to the end-point of their network operator's system. Use of a mesh architecture of Wi-Fi access points is one potential method for a small public Wi-Fi operator to extend its services footprint.

Where optical fibre is strung along utility poles in business districts or residential areas, Microsoft also sees the potential of tapping into the fiber at multiple locations and using 60 GHz spectrum to provide very high speed wireless connectivity to one or more nearby structures. Within the structure, a public Wi-Fi network can be established.

Rural / Remote Wi-Fi

Microsoft's understanding is that by the end of 2018 BharatNET will have connected all 250 lakh Gram Panchayats through optical fibre (as well as using other technologies as appropriate). Within the Gram Panchayat or in villages several kilometers from the Gram Panchayats, fixed TV White Space transmitters can be used point-to-multi-point to consumer premises equipment (CPE). The TVWS radio at each consumer premises can connect to a local public Wi-Fi access point and thus provide service within a local area. One approach might be to locate the CPE equipment at public and private anchor institutions. Public anchor institutions can be schools, libraries, government buildings, etc. Private anchor institutions can be market areas, large employers, or other areas where many people congregate. Public Wi-Fi networks could be established by having the transmission received by the TVWS CPE converted to either 2.4 GHz, 5 GHz, and 60 GHz frequencies at that location. Microsoft notes that CPE TVWS devices with integrated Wi-Fi is expected to be commercially available later this year. Again, the public Wi-Fi operator might also consider a mesh architecture to expand its services footprint.

Microsoft sees two potential ways that TVWS links can be used as part of a public Wi-Fi network. First a public Wi-Fi operator connects one of more TVWS radios to the nearest BharatNET internet Point of Presence, the TVWS radio to the CPE, and the Wi-Fi network to the CPE. As TVWS networks are relatively low cost and easy to set up, it is well within the means of a startup. In an alternate deployment, a network operator uses a TVWS link from the internet Point of Presence in the Gram Panchayat to other locations within the area or to nearby villages (depending on the distance) as part of their network infrastructure. Within a village, the Network operator could provide public Wi-Fi to anchor institutions directly or through an ULVNO agreement, allow other companies to provide public Wi-Fi.

For villages in more remote areas, a mix of wireless technologies in a multi-hop heterogeneous network may be necessary to extend the broadband connection in each Gram Panchayat to nearby villages. The Authority should consider TVWS links as a potential candidate for such networks based on its superior atmospheric propagation characteristic, ease of setting up, and relatively low cost. Within a remote area, the local public Wi-Fi provided can establish a WLAN at anchor institutions. There may need for there to be equipment to access the internet at these anchor institutions.

Alternatively, heterogeneous networks to reach rural communities might be based on microwave links connected to a satellite receiver. The TVWS operate in the UHF and VHF bands.

**Q3. What measures are required to encourage interoperability between the Wi-Fi networks of different service providers, both within the country and internationally?**

The Authority does not need to take any measures to encourage interoperability between the Wi-Fi networks of different service providers because Wi-Fi Alliance (WFA), a global non-profit industry association of which Microsoft is a member, has developed an agreed upon industry-wide solution. The Wi-Fi CERTIFIED Passpoint program (Passpoint) eliminates the need for users to find and authenticate a network each time they connect. Passpoint is an industry standard developed in Wi-Fi Alliance through the collaboration of numerous Wi-Fi operators, OEMs, chipset vendors, software vendors and Wi-Fi aggregators from across the globe. Passpoint enables a seamless connection between hotspot networks and mobile devices. Passpoint's capabilities form the basis of the Wi-Fi roaming standards currently under development between WFA and various industry groups worldwide.

It is worth noting that one of the key factors for Wi-Fi's global success is the fact that the unlicensed Wi-Fi spectrum in 2.4 GHz and 5.8 GHz bands are largely harmonized across the globe, which enables any Wi-Fi device to roam and work seamlessly in almost all countries. The same would be highly desirable for Wi-Fi radios in the TV White Space bands. As such, Microsoft would like to highly recommend that the Authority take the measures to embrace the same unlicensed and dynamic access approach (e.g., using a geo-location database) towards TVWS, consistent with the recommendation from ITU and the practices of leading countries where TVWS regulatory frameworks have been adopted, such as US, UK, Singapore, and Canada, so as to facilitate the global harmonization of utilization of TVWS bands. Such measure will benefit India and the entire industry by enabling economy of scale of TVWS radios through a globally harmonized market.

**Q4. What measures are required to encourage interoperability between cellular and Wi-Fi networks?**

Microsoft recognizes that the aggregation of licensed LTE and unlicensed spectrum – carrier aggregation – will be a feature in future mobile communications networks. To the best of our knowledge there are three separate standards and one proprietary technical specification under development that will enable carrier aggregation. None of these is yet in commercial operation anywhere in the world. It is essential that the Authority ascertain before certifying any device for the market whether devices using any of these standards or technical specifications allow for fair sharing and coexistence with the 5 GHz devices envisioned for public Wi-Fi networks -- where the criterion used to ensure coexistence is that the network using the unlicensed LTE technology does not impact existing Wi-Fi neighbors any more than another Wi-Fi network would, and where 'fairness' is not determined by the operator of either a licensed LTE or public Wi-Fi network.

Earlier this year, the 3rd Generation Partnership Project (3GPP), a collaboration between groups of telecommunications associations released three standards as part of 3GPP Release 13 for carrier aggregation between licensed LTE and unlicensed spectrum in the 5 GHz band. The three technical standards are:

- Licensed Assisted Access (LAA) allows for the aggregation of licensed and unlicensed spectrum using the LTE air interface for both the control and data channels. Currently LAA is for downlink only.

- LTE WLAN Aggregation (LWA) allows of the aggregation of licensed and unlicensed spectrum using the LTE air interface for the control channel and the 802.11 air interface for the data channel (downlink). LWA can be enabled via a software upgrade to LTE and Wi-Fi deployments and requires an upgrade of Wi-Fi infrastructure.

- LTE WLAN integration with Internet Protocol security tunnel (LWIP) allows of the aggregation of licensed and unlicensed spectrum using the LTE air interface for the control channel and the 802.11 air interface for the data channel (downlink). LWIP is designed to work over legacy Wi-Fi infrastructure without requiring any specific changes.

The data channel for both LWA and LWIP standards uses the 802.11 air interface, while the data channel for the LAA standard uses the LTE air interface. Thus devices using either the LWA or LWIP standard will fairly coexist with Wi-Fi, while devices using the LAA standard will not.

In the United States, the LTE-U Forum, a private industry consortium created in 2014 consisting of a wireless chip manufacturer, two wireless carriers, three wireless infrastructure providers, one of which is also a mobile handset manufacturer; released the propriety interoperability specification for aggregating licensed and unlicensed spectrum called LTE-Unlicensed (LTE-U). LTE-U is only for downlink. It does not use listen-before-talk with exponential back-off and cannot be used in the 5 GHz spectrum bands where DFS is required to protect governmental users from harmful interference. Devices using the LTE-U technical specification may not fairly coexist with the 802.11 based devices that public Wi-Fi will use.

**Q5. Apart from frequency bands already recommended by TRAI to DoT, are there additional bands which need to be de-licensed in order to expedite the penetration of broadband using Wi-Fi technology? Please provide international examples, if any, in support of your answer.**

<u>70 GHz and 80 GHz Bands</u>

The Authority should allow unlicensed use of the 71-76 GHz band for Wi-Fi applications, even further extending the 60 GHz. Two additional 2.16 GHz-wide channels can be added for use by public Wi-Fi operators. Microsoft recognizes that the Authority has recommended the band be licensed to Microwave Access Carriers for point-to-point backhaul. In the United States where the band is non-exclusively licensed and all users have to register with a database provider, some have argued that cumulative licensing fees and the registration fees have led to the band being severely underutilized.

With respect to the 81-86 GHz band, based on the requirements to protect incumbent licensees from harmful interference, there may be a need apply geo-location database technology. Microsoft's assumption is that the database technology would be based on that developed for providing unlicensed

devices opportunistic access to the TVWS. In this way, unlicensed devices operating can share the 81-86 GHz band with Microwave Access Carriers.

**Q12. What measures are required to promote hosting of data of community interest at local level to reduce cost of data to the consumers?**

The use of local cache / proxy servers can both promote hosting of data of community interest as well as conserve bandwidth and decrease network-imposed latency. A cache server is a dedicated network server that saves previously requested Web pages or other internet content locally in temporary storage. Among other things, cache / proxy servers allow multiple users at some later time to access the content downloaded from the cloud without using additional data or bandwidth in order to do so. Network bandwidth is used more efficiently because rather than downloading a separate copy of the content for each user, one copy can be downloaded to the caching server and be accessed multiple times locally by each user. Thus, only one connection from the origin server is required to upload content to and receive information from remote cache / proxy servers on the network. Latency is decreased because a client can receive content from a nearby cache / proxy server more quickly than it could if it had to traverse the network or the internet to receive content from the origin server. Additionally, the load on the origin server is offset because fewer clients are connecting directly to it.

Caching / proxy servers can support public Wi-Fi located at anchor institutions such as schools, libraries, and government facilities. Content that is frequently accessed by users at each of these institutions can be stored locally, which could include content in the local language. Microsoft believes that this feature is particularly important in rural and remote areas. It can make the broadband internet access provided by to these institutions' public Wi-Fi more affordable as it can significantly reduce operating costs for bandwidth. Microsoft believes that caching / proxy servers can be made to operate on solar power, where required.

Microsoft doesn't have a specific proposal for the Authority per se regarding caching / proxy servers, but we believe that incentivizing such activities can be an important component of a public Wi-Fi effort that supports the objectives of National Telecom Policy – 2012.

**Q13. Any other issue related to the matter of Consultation**

Authorization of unlicensed TVWS throughout India can help the Authority meet its objective of proliferating broadband through public Wi-Fi networks. Microsoft sees TVWS as a tool for the communications network designer, which, depending on the specifics of the network design, can offer several advantages in terms of coverage area, affordability, low power requirements, low cost and rapid deployment, ease of use, and low maintenance. Today, commercially available fixed TVWS devices can provide point-to-point and point-to-multipoint communications for non-line of sight use with data rates at up to 15 Mbps for an 8 MHz channel at a typical cell radius of approximately 10 km, depending on the modulation scheme[15]. Broadband capacity can be increased through channel bonding and aggregation. And in rural India, there are a significant number of unassigned UHF and VHF TVWS channels.

Within India, TVWS can provide the last mile connectivity to BharatNET and help bring broadband to rural parts of the country. Depending on the distance away from the nearest BharatNET internet point-of-presence, Microsoft's expectation is that the backhaul for fixed TVWS networks last-

[15] Adaptrum Corporation

mile connections could be provided by existing telecommunications providers in the market as part of a heterogeneous network. In fact, TVWS would be creating a new potential payment stream for these providers in rural areas, as these areas have shown to be too expensive for them to service directly.

One of the benefits of TVWS is its increased affordability for consumers. The cost of establishing and operating the local infrastructure for TVWS is much lower than for LTE. Unlike in urban areas, rural India is not faced with the lack of available spectrum, it is that the upfront fixed infrastructure and variable operational costs are too expensive for the projected long-term revenues in these communities. TVWS networks can be established quickly and cheaply. The antennas are very light weight. They can be placed on iron or wooden poles, some which can be placed on top of buildings. There is no need to build a big and expensive towers, as is typically required for the LTE antenna(s). As TVWS is non-line of sight technology, the alignment of the base station and CPE antennas just needs to be in a cone of 60 degrees towards each other for the internet connection to be established. Special training is not needed to deploy TVWS networks, which would make for a more expeditious rollout in rural India. As fixed TVWS equipment is compliant with IEC 60529 IP65, which describes the ability of commercial products to keep the environment from interfering with its operation, it should require low maintenance over its expected lifetime. Again, this is important for deployment in rural India.

Fixed TVWS base stations and CPEs operate at low power. For the many villages that must endure power cuts or a large part of the day without any electricity, the significance of being able to be powered exclusively through solar panels cannot be overstated. In central Kenya, Microsoft and its local partner Mawingu Networks, developed a commercial pilot near the market town of town of Nanyuki, where there is no electricity. Here residents not only benefit from internet connectivity enabled by the solar-powered TVWS base stations, they can also plug-in and charge their electrical devices.[16] Within the community, a Solar Cyber Café was built out of a converted 20-foot shipping container. It is equipped with a WLAN that connects to the TVWS CPE. In all, the TVWS network continues to have a very positive impact on Nanyuki and the surrounding villages. Microsoft believe that TVWS base stations and CPEs in India can be powered by 20 Watt solar panels.

Microsoft experience from our commercial pilots with local partners in several countries is that, Public Call Office (PCO) model, and variant thereof, has a good probability of success. Much as the PCO model was used for local STD / ISD services a generation ago to foster rural entrepreneurship, the same potential exists with using public broadband using networks combining TVWS, Wi-Fi, and possibly other unlicensed wireless technologies.

Update of TVWS project in Harisal

Microsoft would like to update the Authority on the progress the company and its local partners have made to date on the TVWS project in Harisal, Amravati in support of the Digital India initiative as a great example of the types of immediate economic impacts and quality of life improvements public Wi-Fi can create, particularly in a rural community. As more people in Harisal, Amravati became aware of the TVWS public Wi-Fi network, they began thinking of how these capabilities could be applied to address a

[16] http://news.microsoft.com/features/benson-maina-bringing-information-to-the-masses-via-solar-powered-internet-access/#sm.00000ru5m05auseyjw2zeoeoe3x2j

myriad of local needs, many of which Microsoft had not envisioned. The proliferation of public Wi-Fi will open the doors and unleash waves of creativity and innovation in cities and villages alike.

The Digital Village project at Harisal, Amravati was borne off a meeting between Microsoft CEO Satya Nadella and Maharashtra's Chief Minister, Devendra Fadnavis last year who desired Maharashtra government to partner with Microsoft to create a digital village - powered by the best-in-class technology. Providing rural internet and digital literacy is a national priority under Prime Minister Modi's Digital India initiative and aligns with Microsoft India's National Empowerment Plan. The MOU was signed on 21st April, 2016.

*A: Connectivity: TV Whitespaces & Mobile*

TV Whitespaces technology, eminently suitable for rural internet, was rapidly launched on 18th May 2016 in Harisal, in a span of just 9 days from the time the import license was received from the government on the 9th of May 2016 to going live on 18th May 2016. The impact since the launch has been remarkable, with huge advances being made in connectivity: The TV Whitespaces tower by internet provider AirJaldi has been installed in the village

- Hotspot devices have been installed in strategic locations in the village to ensure larger coverage
- The current bandwidth provided is 20 Mbps but an agreement has been forged with BSNL to expand this to 100 Mbps by the end of August
- Despite the lack of a mobile network, residents are now able to communicate with each other on WhatsApp (messages and calling)
- People are using Skype for video conferencing
- Provision of internet has facilitated the launch of other digital provisions such as a common services centre and telemedicine

*B: Governance: Common Citizen Services Centre*

The launch of internet has enabled the creation of a Common Citizen Services Centre in the village, which can cater to 5 to 10 villages in the surrounding vicinity:

- 40+ common citizen services including health records, land permits, birth and death certificates are now enabled through the centre in the village itself, saving on a travel of 50-75 km to the government offices in Amravati district.
- The office will shortly permit the digital signature of the revenue officer from the neighboring block so as to encompass villages in the nearby tehsil. Just because Harisal has internet, it will enable people from adjoining district to also take advantage of this center.

*C: Education: Computer-aided instruction*

Technology is changing the face of education in Harisal. Anganwadis and schools alike are enabled with computers that allow for computer-aided classes with content provided by partner, Chaitanya Technologies:

- In the Anganwadis, pre-primary educational material such as nursery rhymes and times tables are delivered to children through video content by Chaitanya in both English and Marathi

- Anganwadi workers say that the video content is so attractive to the children that it has improved attendance and increased student retention
- In primary schools, teaching is aided through video content that has both instruction and practice exercises, also developed by Chaitanya
- Children are reading sentences aloud and solving math problems through computer aided learning systems
- The infrastructure runs on battery power also which ensures that instruction will not suffer in case of power shutdowns
- Arrangements have been made to use the provisions after school hours for other kinds of digital education, therefore maximizing computer and infrastructure resource utilization

*D: Health: Telemedicine and Eye care*

Healthcare has also been transformed with the aid of Wi-Fi connectivity. Working together Microsoft and HP have enabled a state-of-the art telemedicine center in this traditionally healthcare underserved area battling manner of health challenges.

- The telemedicine equipment has already arrived in the village and will be operational in a week or so creating a state of art medical facility in this village.
- The backend operation for telemedicine has been ensured by connecting with doctors across three district hospitals in Amravati to ensure that the telemedicine facility will have a consultant doctor available for at least 8 hours of the day

To address the issue of endemic eye problems in the region, Microsoft worked with L.V. Prasad Eye Hospital to set up a centre in the village which will cater to all the surrounding villages.

- Technicians have been trained on conducting all basic eye tests and procedures by ophthalmologists from L.V. Prasad Hospital
- A schedule is being drawn up to get students in all public and private schools nearby covered by eye tests at the hospital

The regular turnout of patients at the Vision Center shows the effectiveness of the Eye Center in addressing the health need of villagers.

*E: Skilling*

Various initiatives have been undertaken in skilling

- A cutting and sewing program for 18 women is underway in a skills centre.
- Microsoft has also worked with HP to arrange a Digital Class room sponsored through HP CSR group. About 20 new computers are under installation in the Digital Classroom.
- Dayalbagh Educational Institute, a vocational training partner also participated in the visit. Out of 6 different programs that they determined were suitable for implementation in Harisal, they have decided to begin with an IT education course that they will operate from their centre in Agra through the digital classroom. They have identified a local mentor who has M.A. and B.Ed. degrees and will be facilitating the course on-ground.

*F: Agriculture*

Microsoft helped engage two partners to assist with technical interventions in agriculture. Both the partners, m-Krishi by Tata Consultancy Services, and Virtual Agri services are actively working with villagers to identify ways and means to improve the agricultural yield:

- The disitrict administration will be distributing 100 smart phones to 100 farmers in the village through which m-Krishi and Virtual Agri services can be accessed
- 10 farms will be enabled with IoT devices which will detect basic soil conditions and ensure that appropriate feedback and action points are provided to farmers

The back end of Virtual agri services runs on Microsoft Azure, so data will finally come to Azure Platform.

*G: Banking*

The Bank of Maharashtra has set up an ATM facility in the village. A discussion was conducted with the bank manager during the visit to discuss the feasibility of mobile banking in the village. Providing POS devices in the village at major sales points to enable the village to go cashless is also an option that is being considered. All these are becoming possible as a result of internet connectivity.

*H: Solar Electricity*

Solar power has been partially provided in some areas of the village. A plan is being developed to leverage various government subsidies to offset capital expenditures and ensure that most of the village is powered by solar. This will address the challenge villagers face with 16-hour electrical power cuts.

*I: Forest Conservation and Wildlife Tourism*

Since Harisal falls within the Melghat Tiger Reserve, an interesting area to explore is the use of technology for forest conservation, wildlife protection and wildlife tourism. One possibility that Microsoft and the District Administration is contemplating is the possibility of leveraging TV Whitespace for tiger tracking. Cameras mounted at strategic locations that tigers frequent can be used to track tiger movement in addition to which collars can be used to track individual animals. The video created will be stored on Microsoft Azure and could be streamed real time for tourism or forest protection programs.

This has multiple benefits: tracking will ensure protection for wildlife against poaching and other threats; alerts for villagers against animals that wander into habitations; guaranteed sightings for tourists will promote wildlife tourism and the local economy.