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To,
Shri. Arvind Kumar
Advisor, Network, Spectrum and Licensing (NSL)
Telecom Regulatory Authority of India (TRAI)
Mahanagar Doorsanchar Bhawan
Jawahar Lal Nehru Marg
New Delhi - 110 002

Subject: IIT Bombay's response to TRAI consultation paper on 'Delivering Broadband Quickly: What do we need to do?'

Dear Sir,

Please find attached IIT Bombay's response to TRAI consultation paper on 'Delivering Broadband Quickly: What do we need to do?'

I request you to please take IIT Bombay's views into positive consideration while TRAI comes out with its recommendations on the subject.

Thanking you,

With Regards,

Abhay Karandikar

Response to TRAI Consultation Paper

Delivering Broadband Quickly:

What do we need to do?

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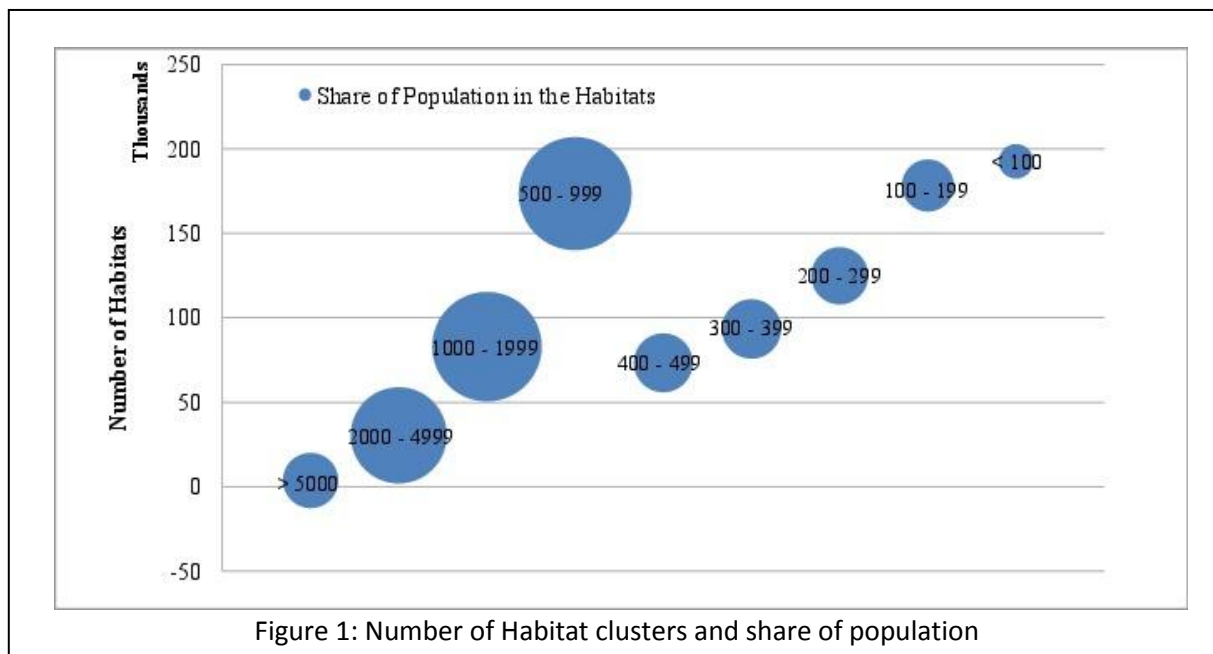
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Responses to issues raised in the consultation paper

Q2. What are the impediments to the deployment of wireless technologies in the access network? How can these deployments be made faster? Please reply separately for each technology.

In order to provide broadband in the last mile, it is essential that the backhaul is robust, affordable and agile enough to be deployed in diverse scenarios. Given the heterogeneous nature of habitation in the country both between urban and rural areas and also within rural areas, the problem of reaching the last mile is a complex problem. As an example, there are several clusters in the country that are very small in terms of population as shown in Figure 1 [1]. *There are more than 7 Lakh habitation clusters having a population of less than 500. The minimum distance separating any two clusters is more than 2kms.*

Despite the large number of habitat clusters that are spread across large distances, the Fiber connectivity in terms of backhaul being provided by the National Optical Fiber Network (NOFN) would reach only the Gram Panchayats in the country.

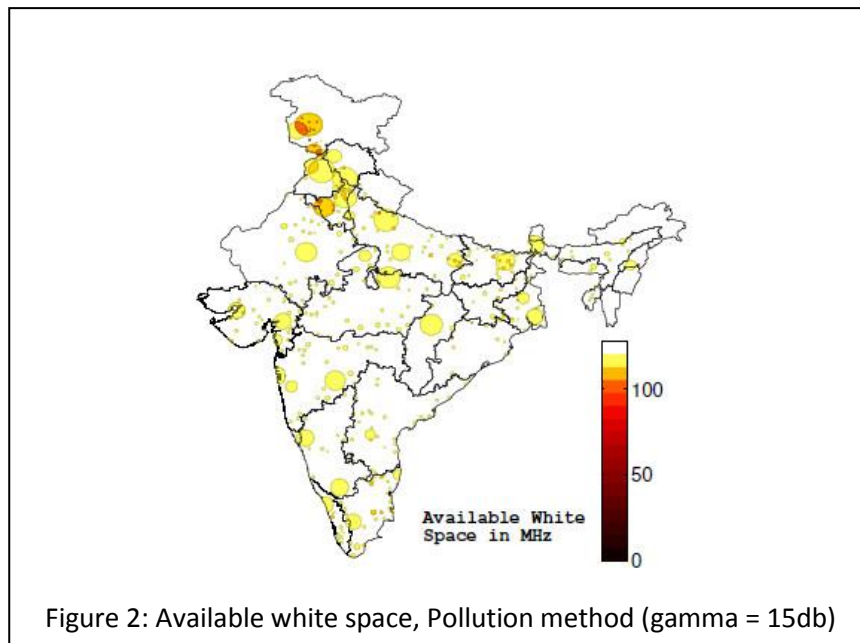


In such a scenario, the problem of connecting the backhaul link to the access network can be addressed using a mesh based **middle-mile network**.

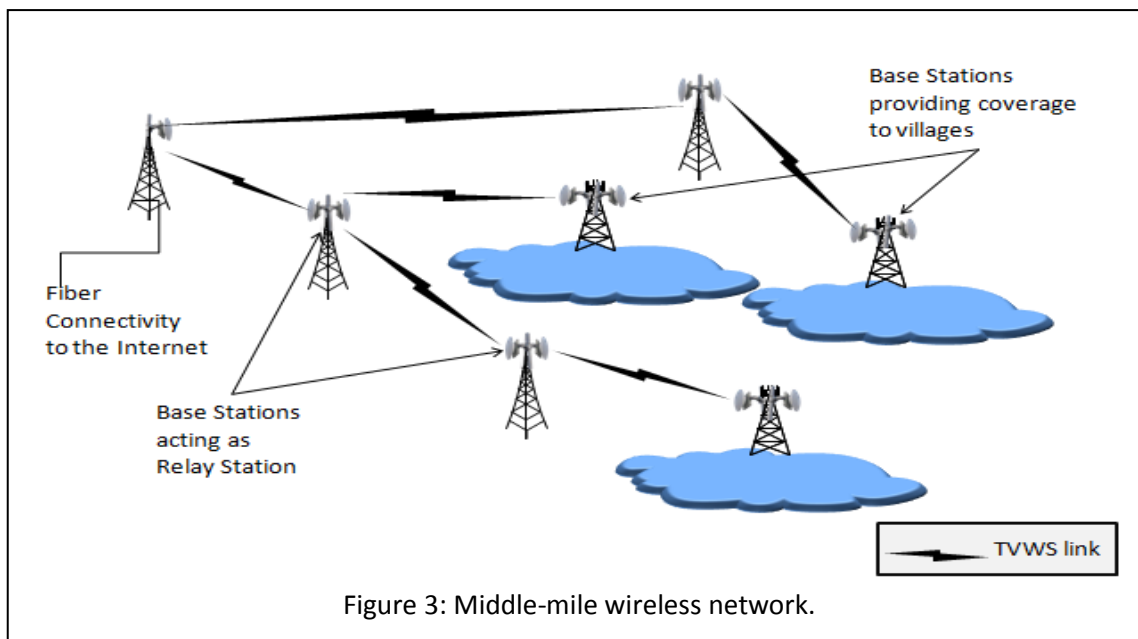
A middle-mile backhaul network is a multi-hop wireless mesh network that is capable of providing coverage within a radius of 1-5 kms to enable seamless connectivity from the access network to the backhaul point such as NOFN node. In order to reach these distances, sub-GHz spectrum provides excellent propagation characteristics and at the same time not requiring expensive infrastructure like high towers and strict line-of-sight. This is consistent with National Frequency Allocation Plan (NFAP) 2011 wherein the spectrum in the frequency band 470- 890 MHz is marked for *fixed, mobile, and broadcasting* services. The following table indicates the spectrum in the sub-GHz band that is being used by TV broadcasters [2].

Frequency Band	Services	NFAP Remarks
470-585	Fixed, Mobile, Broadcasting	Requirements of fixed and mobile services will be considered in the frequency band 470-520 MHz and 520-585 MHz on case-by-case basis
585-610	Fixed, Mobile, Broadcasting, Radio Navigation, Radio Astronomy	1. The requirement of Digital Broadcasting Services including Mobile TV may be considered in the frequency band 585-698 MHz subject to coordination on case by case basis. 2. The requirement for IMT and Broadband Wireless Access may be considered in the frequency band 698-806 MHz subject to coordination on a case-by-case basis.
610-890	Fixed, Mobile, Broadcasting, Radio Astronomy	610-646 MHz has been earmarked for Broadcasting services on case-to-case basis. Beyond that primarily for MOBILE services

Our quantitative assessment [3] [Report available on request] shows that in the band 470-590MHz UHF TV band in India, a major portion is unutilized in India. The results also show that even while using conservative parameters for assessment, in at least 56.27% areas in the country, all the 15 channels (100% of the TV band spectrum) are free. The white space estimate using a pollution method is shown in Figure 2.



In order to reach the last mile access network, re-using the free spectrum available in the UHF TV band to provide middle-mile connectivity using a multi-hop wireless mesh network as shown in Figure 3 is recommended. In the figure, the blue-clouds represent a habitat cluster being provided connectivity using a local access network.



Q15. Are there any regulatory issues in providing internet facility through Wi-Fi Hotspots? What are the reasons that installation of Wi-Fi hotspots has not picked up in the country? What type of business model needs to be adopted to create more Wi-Fi hotspots?

One of the impediments to installation of Wi-Fi hotspots is lack of adequate backhaul for connecting Wi-Fi access points to the network.

We believe that sub-GHz spectrum band can be used for backhauling Wi-Fi small cells/hotspots to the network.

Q16. What are other spectrum bands which can be unlicensed for usage of Wi-Fi technology or any other technology for provision of broadband?

In order to facilitate a middle-mile wireless network that can solve the problem of connectivity to the local access network, additional spectrum from the UHF TV band may be made available.

From a Regulatory perspective, we can consider developing an approach that is fundamentally a reallocation of spectrum. However, it is different from the traditional reallocation in that it provides access to spectrum for fixed services based on broadcaster (Doordarshan) voluntarily relinquishing spectrum by geographic areas through an incentive method of dynamic allocation. Thus, parts of the spectrum and geographic areas would be used for broadcasting services and parts of the spectrum and geographic areas would be used for fixed services

This could be done in manner similar to that of **Licensed Shared Access (LSA) mechanism** [4]. LSA could be used for other spectrum bands as well.

Q18. Are there any other spectrum bands apart from the ones mentioned in Chapter-2 to be identified for provision of wireless broadband services?

The wireless spectrum in the UHF TV band, 470-590MHz being used by the TV broadcasters can be made available in a Licensed Shared Access (LSA) mechanism for enabling the middle-mile backhaul network. The LSA method allows the incumbent TV broadcasters to continue operating the TV transmitters without having to vacate the spectrum at the same time allowing the re-use in geographical locations that are not interfering with the broadcast transmission.

References:

1. Habitation in Rural and Urban Areas, All India School Education Survey, MHRD, India." Available: http://aises.nic.in/documents/pdf/reports/3RD_AISES/305.pdf
2. National Frequency Allocation Plan 2011, Department of Telecommunications, India. <http://www.wpc.dot.gov.in/Docfiles/National%20Frequency%20Allocation%20Plan-2011.pdf>
3. Gaurang Naik, Sudesh Singhal, Animesh Kumar, and Abhay Karandikar, "Quantitative Assessment of TV White Space in India", Technical Report, IIT Bombay, May 2014.
4. Licensed Shared Access (LSA), Electronic Communications Committee (ECC) Report 205, February 2014. <http://www.erodocdb.dk/Docs/doc98/official/pdf/ECCREP205.PDF>