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Study On Low Maintenance Wireless Network Architecture In Implementing Wireless Networks In Dense Forests and Rural area

Ashwini R.Zade, Pratibha S.Bramhane, Priyanka M.Verma

Abstract-An innovative ,cost effective and ecofriendly approach for the implementation of wide area wireless network coverage for surveillance, remote wireless sensing , monitoring and other usage in dense forest and rural areas in developing countries like India .The paper gives an simplified layout for the network implementation for bridging the digital divide and the knowledge flow between the urban areas and the remote locations where telecom companies cannot reach easily or deploy network as it is a costly and difficult affair for implementation . The proposed paper shows a way to overcome challenges for implementation of the cellular and wireless network and making the technology accessible to the rural areas to enhance their growth and economic.

Index Terms—*Keyword-Wireless Networks , Passive Wireless Repeater , Wireless Sensor Networks, Cellular Networks , Bamboo , Cell Site , Wireless Tower , Solar Cell , Solar Panel, Solar Energy , Active Wireless Repeater, Cell Site, Tower*.

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1 INTRODUCTION

India has emerged as a significant economic force in the world. The economic growth has fuelled the concurrent growth in the India's Telecom sectors as well. India adds Million Telephones a month and Wireless Technology has helped the telecom sector to grow in India by making the technology affordable to the masses.. Due to the low penetration of telecom and communications in the rural areas many remote rural regions and dense forests around the world, especially in developing regions in India, do not have good connectivity solutions which are economically viable. As a result, many of these regions remain disconnected from both the rest of the world and from progress in general.

The use of wireless technology extends the scope for technological development and brings in a new hope to bridge in the gap of the digital divide and bring about a revolution by promoting information exchange amongst the masses and rural communities. Wireless communication technologies can be leveraged to develop the following in the rural areas: Education and training, Health Services, Agriculture, Rural BPOs, IT enabled outsourcing of production work, Agro-industry, Small Industry[10]. The development of these areas will have direct impacts on the community as a whole Wireless network refers to any type of computer network that is not interconnected by cables of any kind.The industry accepts a handful of different wireless technologies Which is defined by a standard that describes unique functions at both the Physical and the Data Link layers of the OSI Model."[1],[2]"

2 THE COVERAGE AND SCOPE OF VARIOUS WIRELESS TECHNOLOGIES

The coverage and scope of various wireless technologies currently which use radio communication are:"[10],[11],[12]"

1. Wireless Personal Area Network
2. Wireless Metropolitan Area Networks
3. Wireless Mesh Networks
4. Wireless Sensor Networks
5. Cellular Network

A cellular network or mobile network e.g. GSM, CDMA is a radio network distributed over land areas called cells, each served by at least one fixed-location transceiver, known as a cell site or base station.

Range of mobile phone cell site the range within which mobile can connect to it reliably which will depend on multiple factors such as:

(1) Height of antenna over surrounding terrain
(2) The frequency of signal in use
(3) The transmitters rated power
(4) Uplink and downlink of the subscribers devices connected and the capacity of the transreceiver or the mast capacity. there is a finite number of calls or data traffic that a mast can handle at once. This limitation is another factor affecting the

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spacing of cell mast sites.

The directional characteristics of the site antenna array Reflection and absorption of radio energy by surrounding buildings or vegetation local geographical or regulatory factors and weather conditions. Generally, in urban areas where there are enough cell sites to cover a wide area, the range of each one will be set to achieve the following based on the population density of that. Ensure there is enough overlap for handover to/from other Ensure that the overlap area is not too large, to minimize interference problems with other sites. Load balancing and reduced latency As a rough guide, based on a tall mast and flat terrain, it is possible to get a range between 50 to 70 km. When the terrain is hilly, the maximum range distance can vary from as little as 5 kilometers to 8 kilometers due to encroachment of intermediate objects into the wide center Fresnel zone of the signal. Depending on terrain and other circumstances, a GSM Tower can replace between 2 and 50 miles of cabling for fixed wireless networks. The country varies diversely in topography. In terms of geographical variation, the topography of the plains varies around 20-30 m in terrain with trees up to the height of 10-12 m.

2.1 Mobile Phone Signal

A mobile phone signal is the signal strength received by the mobile phone from the cellular network. Depending on various factors, such as proximity to a tower, obstructions such as buildings or trees, etc., the signal strength will vary. Most mobile devices use a set of bars of increasing height to display the approximate strength of the received signal to the mobile phone user..Generally, a stronger mobile phone signal is easy to obtain in an urban area, though urban areas do have some "dead zones" where no reception can be obtained. Since cellular signals are designed to be resistant to multipath issues. On the contrary, many rural or minimally inhabited areas lack a signal or have a very weak fringe reception many mobile phone providers are attempting to set up towers in parts of these areas most likely to be occupied by users, such as along major highways. For coverage it is important to select antenna Before we begin it's important to understand that we will need three pieces of equipment to improve our mobile signal.

1. Antenna
2. Cable
3. Something to connect cable to phone/mod

3 A Low-Cost Efficient Wireless Architecture for Rural Network Connectivity

3.1 Introduction for low cost connectivity

Many rural regions around the world, especially in developing regions, do not have good connectivity solutions which are economically viable. As a result, many of these regions remain disconnected from both the rest of the world and from progress in general. In this proposal, describe the design of WiFi-based Rural Extensions (WiRE), a new wireless network architecture that can provide connectivity to rural regions at extremely low costs. The WiRE architecture is tailored for the typical rural landscape in several developing regions, in which the population is spread across small but scattered rural regions within 100-200 kms of the city. WiRE is designed to be a wireless distribution network that extends connectivity from the city to each via

3.2 Wire network architecture

In this section, describe the WiRE network architecture and discuss important real-world challenges in deploying rural wirelessnetwork (3).

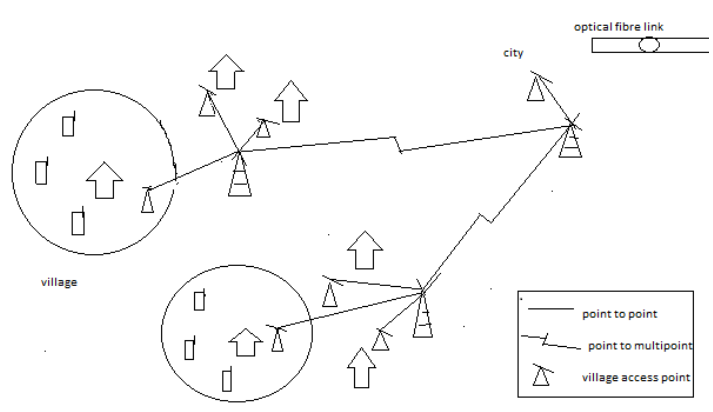

Fig 1: Wire Network Architecture

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Fig1 describes the basic WiRE network architecture. Unlike the traditional cellular model of providing broad coverage, the design philosophy of WiRE is to provide focused coverage within specific rural regions where connectivity is most required. The WiRE architecture has six important network components :[3]

1. wireless nodes which are low-power single board computers that have the capability to support multiple wireless cards for different network links.
2. point-to-point links using highly directional antennas to provide network connectivity over long distances in the range of 50 − 100 kms.
3. point-to-multipoint links using sector antennas to distribute connectivity to multiple endpoints within relatively short distance lasting a few kilometers.
4. multi-radio mesh links using omni-directional links to extend wireless coverage within small local regions.
5. cellphones or low cost computing devices with WiFi-enabled interfaces that can act as end devices.
6. large local storage of at least a few GB at each local wireless node to perform in-network optimizations for applications as well as store-and-forward intermittent operations in the event of a network outage. The basic network structure of WiRE is a natural extension of WiLD networks. The focus of the WiRE network architecture is much broader in scope than WiLD networks[3]. WiRE focuses on challenges across different protocol layers to build a complete solution for rural connectivity including support for a wide range of applications. Even from the MAC layer perspective, WiRE operates in a combinational wireless environment of point-to-point, point-to-multipoint and omnidirectional links, each of which have completely different MAC needs and interference characteristics. WiRE has the flexibility to operate in any frequency spectrum. However, for practical and cost-related constraints, we choose all network links in WiRE to operate in the WiFi frequency band space. Since WiFi is classified as unlicensed spectrum in most countries, a WiRE network provider does not need to pay spectrum costs which can be significantly high for other licensed frequency bands. The use of WiFi also makes WiRE easy to deploy and experiment with given that the entire network is composed of cheap off-the-shelf components. Manufacturers of WiFi chipsets (e.g. Atheros) often support open-source drivers, allowing us to completely subvert the stock 802.11 MAC protocol and tailor the protocol to meet our needs. All these factors promotes decentralized evolution of WiRE where a grass-roots organization can easily deploy a WiRE network without any dependence on a telecom carrier. In WiRE , every wireless router uses a low power single board computers (SBC). For radios, we use off-the-shelf high power 802.11 a/b/g Atheros cards with up to 400 mW transmit power. For long-distance point-to-point links that can traverse between 20 − 150 kms, we use high power radio cards with high-gain parabolic antennas with a gain factor of upto 30dBi. The highly directional nature of the wireless beam allows us to have several point- to-point links at a given node given multiple radios. For connecting many specific locations within a certain distances of upto 20 kms, we use a point-to-multipoint topology where a single wireless router can serve as a base station for several clients. Depending on the bandwidth requirements for each client, each node can serve upto 30 clients. The multi-radio mesh nodes within a local region are used for extending the connectivity within a specific region; these links in outdoor settings with 200mW cards can cover between 0.5 kms to 1 km. If necessary, depending on the topography of a region, we may require several multi-radio mesh nodes to completely cover a region. The end-devices in WiRE can be either static computing devices such as PCs/kiosks or mobile devices such as cellphones. It is essential for cellphones to form an integral part of the WiRE architecture.

4 Current Overall Wireless Systems Networks Overview

The most significant cost component is the cell site or wireless access point preparation and the erection of the tower. The towers must be significantly taller for e.g. in case of a cellular network towers are about 40 m tall, and require considerable amounts of expensive steel for its construction. Infrastructure like roads and electricity has to be setup to support the equipment."[13],[14],[15]"

The second highest contributor to the cost is the powering of the infrastructure – Wireless Access-point Hardware, RF cables running to the top of the tower, the power amplifiers, RF filtering and the transceivers roughly account for more than 50% of the costs of the base tower. RF equipment is expensive affair to set up.

The maintenance of wireless repeaters or access points, cell site infrastructure requires local personnel who should be trained in wireless communications to deal with the problems that arise. Also for maintenance the exact location needs to be known. Also the weather conditions and geographic topography has to be taken into consideration before considering to develop a wireless network access point or a cell site.[13]

Too many mobile phone cellular repeaters within the crowded city can create health hazards due to increase in electromagnetic radiation due increase in power to improve the strength of the mobile signal in order to load balance the incoming mobile phone traffic which is dependant on the capacity of the repeater's hardware. One must note that with the increase in the gain the length of the pole on which the antenna is placed reduces and with the reduction in gain the length of the pole on which the antenna is placed increases vice versa. Due to lack of network coverage in the remote and dense forest regions, they can be subjected to crimes such as antisocial activities, economical hazards, illegal deforestation, wetland and water pollution, illegal encroachments and illegal killing of animals as there is no surveillance or monitoring possible for the changes in the forest ecosystem."[15],[16]" Proposed Strategies to Mitigate Challenges the mobile revolution of the last decade years has seen base stations sprouting in most towns but due to lack of infrastructure and various challenges involved telecom backbone that knits the country ends abruptly at the towns and larger villages. However there is a large scope for the telecom companies to grow their network and gain new prospective customers in the remote rural areas. Deployment of a base station or laying a link adds to the costs of the telecom companies. Cellular coverage can and will grow in rural areas, but this will depend on the rate at which infrastructure and operating costs reduce, and rural incomes increase. The proposed architecture is a means by which a telecom solution can become cost effective.[14]

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The antenna setup can be either active repeater (there is circuitry to boost the signal with additional addition of power to the signal) or passive repeater which takes in the signal through an antenna (Yagi , Dish Antenna , Omni Directional etc.) directs it through a low loss coaxial cable and directs it to the other passive repeaters or access points located in the dense forest. In case of active repeater the antenna is powered using solar panels and battery storage . This is a typical setup where the signal is then directed in the deep forest using a high gain directional antenna. The setup mentioned here can be utilized for eco monitoring and inter forest connectivity.

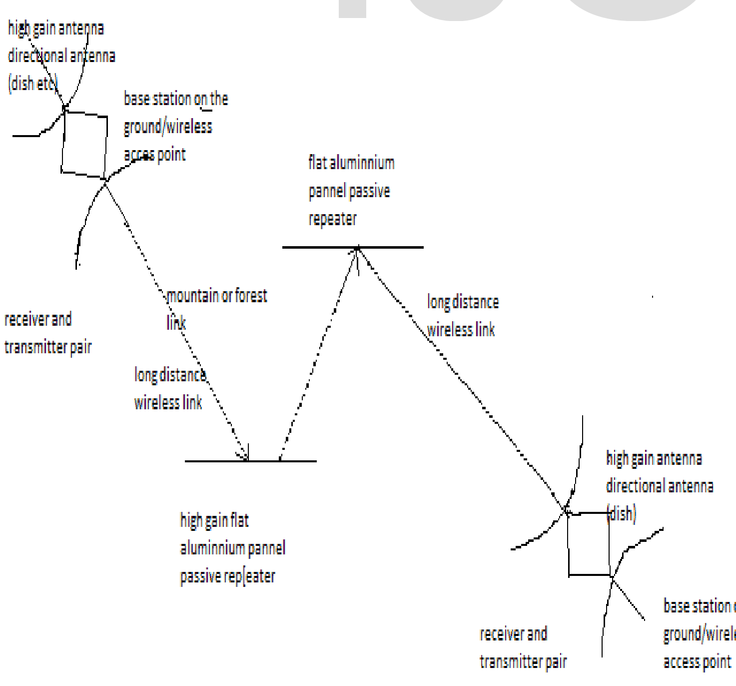

Figure 2: Shows a setup where we are using high gain flat panel

The proposed setup deploys solar powered IP surveillance cameras, wireless sensor networks that can monitor forest fires , temperature , pressure weather etc. which is the passed to base station for further analysis and government usage. Low power consumption portable wireless sensor networks which are miniature and which can run on a small cells and fit as an ideal solution for monitoring but there are still few limitations in security of these networks. The setups proposed are subject to proper calculations based on the height of towers , fresnel zones , line of sight and free space signal loss, path loss in decibels as the use of active repeaters is restricted to a few or equivalent to null as the proposed model proposes a strategy for harsh weather and difficult topographic conditions."[16],[17],[18]"

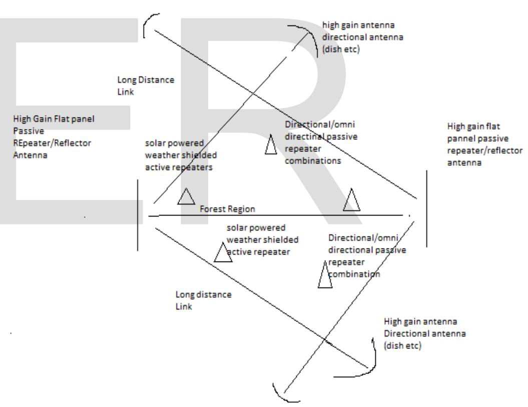

Fig 3: Flat Pannel Reflector For Connectivity within forest or remote

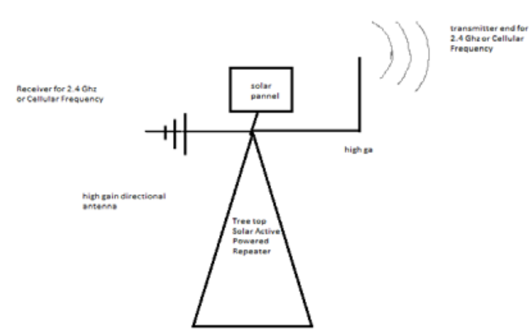

Fig 4: Solar powered active repeater model

Fig 2. Shows a setup where we are using high gain flat panel aluminum based passive repeaters to reflect the signals without addition of additional power through the dense forest or for propagating the signals over the mountain or hilly regions . This setup also used in various combinations with the setup mentioned in the Figure 2 and Figure 3. The above two setups mentioned are strategies for curing the signal strength as signal degrades at distance beyond the fresnel zones and thus extending the signal to a greater extent to various remote locations.

5 CONCLUSION

The development of the technology is limited to only the urban areas in developing countries like India and African countries due to factors such as infrastructure set up cost, maintenance, education & literacy level and economical growth of the remote rural areas. There is a need to monitor the dense forest ecology for studying its vivid ecosystem and for preventing illegal activities in forest like misuse, economical hazards, illegal encroachments and activities related to poaching which needs to be controlled to maintain healthy forest environment. There is a digital divide between the urban and the rural regions which needs to be bridged. Wireless technologies can bring a new hope for solving the communication problems among the remote rural regions and its people. Also it should be noted that with more and more cell sites coming up in various region due to increase in population density i.e. number of cellular sites is directly proportional to the population. The proposed model is one of the ways by which the remote rural areas can have the connectivity in a cost effective way without any additional maintenance cost to extend the bandwidth to rural people in a eco friendly way to the people.

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