Enhancing the Coverage Area of Wi-Fi Access Point using Cantenna

Naga Haritha Devi. S[1] Reshma. K[2] Laxmi Vimala Vinodini. V[3]
[1,2,3]Department of Electronics & Communication Engineering
[1,2,3]SCSVMV University, Enathur, Kancheepuram, India

Abstract— "The next decade will be the Wireless Era." – Intel Executive Sean Maloney. Wi-Fi Internet access is fast gaining popularity as we are entering the 'unplugged' phase of communication technology. Wi-Fi has developed from synergy of wireless communication, computer networking and Internet technology. It has radically changed the way we connect and communicate. In this paper, the existing Omni directional antenna will be replaced with CANTENNA to enhance the coverage area of an access point to several hundred meters.

Key words: Wi-Fi, Routers, Access Point, Antenna, Signal Strength, Booster Antenna, Cantenna

I. Introduction

An antenna is an electrical device which converts electric power into radio waves and vice-versa. They are designed to transmit and receive radio waves in all horizontal directions equally (Omni-directional antenna),or preferentially in a particular direction (directional or high gain antennas-Cantenna). The antennas used by wireless devices have a major impact on a WLAN coverage, security and performance. The 802.11 access points use multiple antennas to greatly increase network footprint available bandwidth for a range of about one hundred meters. With careful planning and proper antennas, same equipment can be used to make point-to-multipoint links and point-to-point links of several hundred meters. In this paper, the signal strength of Wi-Fi is measured in the presence of cantenna as well as Omni-directional antenna in order to compare the results. This is done using software called Wireless-Mon which is especially used for measuring the Wi-Fi signal strength. It has other applications like locating hot-spots.

II. Methodology in Existing System

We are here to design a Wi-Fi booster with cantenna preceding Omni-directional antenna to achieve received signal strength for long distances. The drawbacks of existing technology are: Due to the high cost of booster antennas in market. Till now, high cost effective booster antennas are available in the market which includes shipping to reach the user destination. The declination in Wi-Fi signal strength for long distance. Increasing in number of access points increase signal strength, but some hot spots are available where the range is very weak. For this, the objective of our project is to use homemade Wi-Fi booster antenna. Homemade antennas are cost effective with increased signal strength. To achieve this, we need to study about the various parameters of antennas to increase the signal strength for long distances.

III. Cantenna

The main function of cantenna is to focus on the signal strength of receiving radio waves from the communication devices such as internet, ad hoc and mobile networks, and wireless cards and so on. This is so effective when compared to conventional antennas which receives signal from broader area with minimal strength. When the waves entered into the tin can, it bounces off the walls until it reaches the radiating element. The radiating element sends the information to communication with minimum amount of interference. The receiving signal of cantenna can be adjustable and so it can be used in various environments.

Fig. 1: cantenna

IV. Schematic diagram:

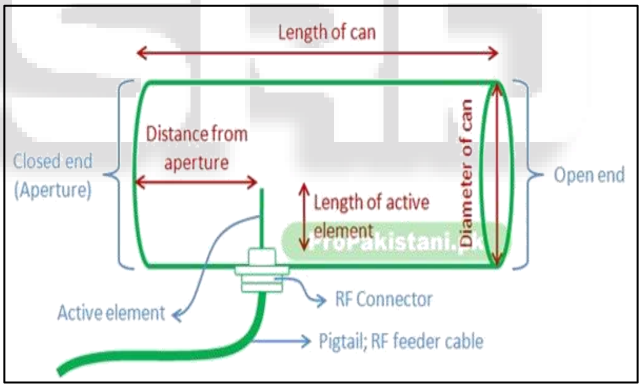

Fig. 2: Schematic Diagram

Cantennas are inherently cheap and relatively easy to build. The necessary parts and general approach to construction are described below:

- Tin can (Ideal dimensions are calculated afterwards)
- RF connector (type: N-Female)
- Active element; Short piece of high gauge (thick) copper wire.
- Pigtail to connect antenna to RF source.

Cans with different dimensions will yield slight difference in radiation patterns and directional gains. The optimum length and diameter for a particular frequency can be calculated using mathematical functions discussed later on.

V. Description

N-Type connectors are most popular at frequency Wi-Fi operates (2.4GHz).The N connector is a threaded, weatherproof, medium-size RF connector used to join coaxial cables. It was one of the first connectors capable of carrying microwave-frequency signals. The active element is the part of antenna that actually radiates the waves. With the dimensions, the element can be made using a piece of an ordinary copper wire which is attached to the N-type connector. Pigtail is radio frequency transmission line; the wire that connects the wireless device to the antenna.

A. Design:

The following are to be considered in order to obtain the desired model of the cantenna.

- Length of the primary antenna.
- How to calculate the diameter of the can.
- How to calculate the length of the can.
- Find the position of the primary antenna in can.

1) Length of the Element:

Length of the primary element: As antenna should be designed for centre frequency.

$$c = f\lambda$$

By substituting the values,
f =2450MHZ, C is the velocity of light.
We will get λ=122mm and

$$\frac{\lambda}{4} = 30.5mm$$

The copper wire of 30.5mm is placed as the primary element in the N-type connector
Diameter of the Can

B. Diameter:

Choosing the frequency is the main important part of the design. As the Wi-Fi networking equipment operates at a range of frequencies from 2.412 GHz to 2.462 GHz. Ideally, the TE11 cut-off frequency should be lower than 2.412 and the TM01 cut-off should be higher than 2.462.

$$\lambda = \frac{2\pi r}{k}$$

For a circular wave guide, considering the TE11 mode then λ=2.412 MHZ and k is the Eigen vector of value 1.84.
Combining both the equations we get,

$$r = \frac{ck}{2\pi f}$$

On further substituting the values we get r=36.44 mm, d=72.88mm. The λ=72.88 mm is the minimum diameter required. For the frequency of f=2.462 MHZ ,the Eigen vector value is 2.4 . On applying the same formula we get d=93.13mm. The diameter of the can should be selected, which is nearer to the maximum diameter, as the can should allow TE11 mode and block the TM01 mode.

1) Length of the Can:

From the theory of circular waveguides,

$$\left(\frac{1}{Lo}\right)^2 = \left(\frac{1}{Lc}\right)^2 + \left(\frac{1}{Lg}\right)^2$$

Where Lo = central wavelength which is 122.45 mm .
Lc = wavelength of cut-off frequency for the obtained diameter where d=90mm , r=45mm and k=1.84. On using the formula,

$$Lc = \frac{2\pi r}{k}$$

Lc=153.58 mm .Thus, the length of the can is calculated by using the Lc and Lo values.

$$\left(\frac{1}{Lg}\right)^2 = \left(\frac{1}{Lo}\right)^2 - \left(\frac{1}{Lc}\right)^2$$

We get Lg= 202.9 mm ~ 200 mm

VI. WORKING

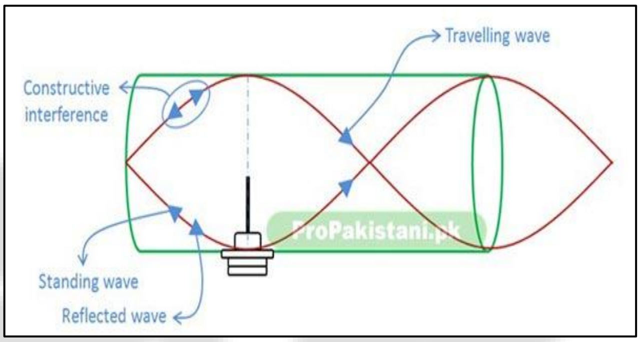

Fig. 3:

In the above figure, the probe radiates the electromagnetic waves spreading away from the source. The waves radiated towards the bottom of the can are reflected back. Because of the careful placement of the probe, the reflected wave superimposes the wave which naturally get radiated towards the open end of the can, combining the radiated power in one direction.

VII. RESULTS AND CONCLUSIONS:

Wireless - Mon monitors the status of Wi-Fi adapters and gather information about nearby access points and hotspots in real-time with Wireless-Mon. Wireless-Mon offers comprehensive graphing of signal level and real time IP and 802.11 Wi-Fi statistics. It can log all wireless information it has collected into a file, for archival purposes and future reference.

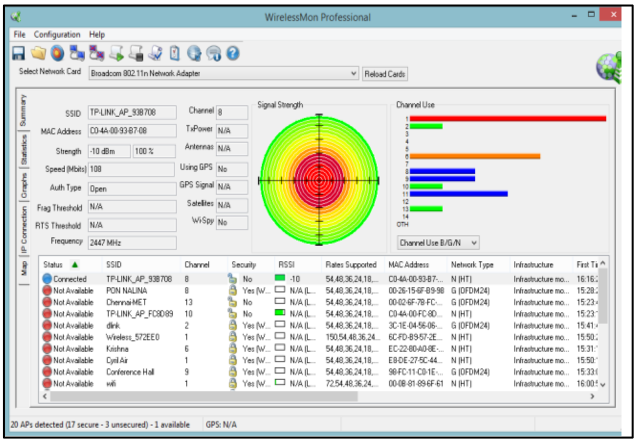

Fig. 4:

Distance (in meters)	Omni-directional Antenna	CANTENNA
25	-67db	-47db
50	-73db	-52db
75	-72db	-54db
100	-74db	-55db
125	NA	-59db
150	NA	-59db
200	NA	-65db
250	NA	-65db
300	NA	-67db

Table 1:

According to the table , it shows that the signal strength for an Omni-directional antenna increases from 25meters but after 100meters, it is completely unavailable. Comparing this to the newly designed antenna that is Cantenna , the signal strength increases from 25meters and ranges up-to -67db and increase in signal strength up-to three hundred which proves the main aim of this paper.

VIII. Future Scope

It includes designing of manually build booster antenna by following the above mentioned steps and testing the performance in the real environment where the signal strength is low .Testing of the antenna on the desktop as well as laptop. Future work also includes the manual construction of other booster antennas such as parabolic antenna booster and cantenna and testing their performance in real environment like hotspot location. Testing comparison with antenna and manual construction of booster antenna includes the performance of the antenna could be better tested on laptop , where the signal strength could be easily observed going high or less as the distance increases . The testing of antenna outside the campus area also adds to the obstruction of the signal by walls or trees.

IX. Advantages

– It is simple and easy to construct.
– Inexpensive with fewer repeater units.
– Extending the range of wireless local area network (WLAN).
– High gain.
– The increase of Wi-Fi range through the Cantennas may benefit not just the close by locations but even take public network sharing within the neighbourhood.

X. Applications

– Cantennas are mainly used for extending Wi-Fi coverage area over a LOS.
– The most important application is in Wi-Fi coverage area extension.
– Rocketeer’s use them for high altitude telemetry feedback.
– Boaters use these antennas for internet access at their ports and/or while on water.
– Military field soldiers sometimes use Cantennas for carrying wireless backhaul to their bases.

XI. Acknowledgement

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XII. Conclusion

A cantenna for Wi-Fi is proposed prototype of the proposed antenna has been designed, fabricated and tested. The cantenna is probably the best overall because of its low cost, simplicity, ease of use and 14dbm gain properties. This antenna would be easily mounted on the dash board or in the windows of a vehicle. Radar can be used here to protect the antenna from Environmental Hazards, but it should be made from certain materials that do not affect antenna performance. Also it may be possible to use the same antenna for any 2.4GHz Link Application like ISM BAND, WLAN and Bluetooth interception.

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