

# **PUBLIC WIRELESS ACCESS SOLUTION**

*Dissertation submitted in fulfilment of the requirements for the Degree of*  
**BACHELORS OF TECHNOLOGY**

By  
**AAKRITI GUPTA**  
**123003**



Department of Electronics and Communication Engineering

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

May 2016

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## DECLARATION BY THE SCHOLAR

I hereby declare that the work reported in the B-Tech thesis entitled **“PUBLIC WIRELESS ACCESS SOLUTION”** submitted at **Jaypee University of Information Technology, Waknaghat India**, is an authentic record of my work carried out under the supervision of **Mr. Arundeeep Malhotra** and **Mr. Nishchal Arora**. I have not submitted this work elsewhere for any other degree or diploma.

  
Aakriti Gupta

Department of Electronics and Communication

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24<sup>th</sup> May, 2016

## SUPERVISOR'S CERTIFICATE

This is to certify that the work reported in the B-Tech. thesis entitled "**PUBLIC WIRELESS ACCESS SOLUTION**", submitted by **Aakriti Gupta** at **Jaypee University of Information Technology, Waknaghat, India**, is a bonafide record of her original work carried out under my supervision. This work has not been submitted elsewhere for any other degree or diploma.



Arundeeep Malhotra

Project Mentor

24<sup>th</sup> May, 2016



Nishchal Arora

Director Operations

24<sup>th</sup> May, 2016

Dr. Prof. S.V. Bhooshan

H.O.D. E.C.E



## ACKNOWLEDGEMENT

I wish to express my gratitude to the people who helped me & guided me during training. It is with pleasure to say that I find myself writing down these lines to express a sincere thanks to various people to help me along the way in completing my training successfully. I would like to thank all of them for their enthusiasm and support.

I would like to thank my training mentors **Mr. Arundeeep Malhotra, Mr. Nishchal Arora** and **Dr. Prof. S. V. Bhooshan** for their constant support and guidance throughout the training. They have been a constant source of help for understanding the training.

My thanks and appreciation also goes to my colleagues, friends and classmates who have always willingly helped out with their abilities.

Aakriti Gupta

## **ABSTRACT**

The purpose of this project is to develop a high level approach to design, implement and manage the public Wireless (Wi-Fi) network in the villages of Sabhapur and Chauhan Patti.

This project involves the site survey and design of Wi-Fi Mesh in both the villages and after the necessary approvals it involves deployment of essential infrastructure at locations, hosting of infrastructure at hosting site and commissioning of Internet lease line at both villages.

My role in this project was to work with the technical team and carry out the site survey for requirement gathering and to check the technical feasibility. Thereafter, the network was accordingly designed and mesh structure was successfully implemented.

The Wi-Fi facility will further aid towards the development and progress of these villages and help in raising the standards of living in the areas by providing them with better and faster municipal services.



## **LIST OF ACRONYMS & ABBREVIATIONS**

AC	Alternate Current
AES	Advanced Encryption Standard
CCM	Controlled Carrier Modulation
CSB	Citizen Services Bureau
CSMA/CA	Carrier Sense Multiple Access/Collision Avoidance
DC	Direct Current
EDMC	East Delhi Municipal Corporation
GIS	Geographic Information System
IDS	Intrusion Detection System
ISP	Internet Service Provider
KVA	Kilovolt Ampere
LWAPP	Lightweight Access Point Protocol
MAP	Mesh Access Point
OTA	Over the Air
OTP	One Time Password
PDA	Personal Digital Assistant
QOS	Quality of Service
RAP	Root Access Point
RF	Radio Frequency
SMS	Short Message Services
UPS	Uninterruptible Power Supply

VA	Volt Ampere
VPN	Virtual Private Network
WIPS	Wireless Intrusion Prevention System
WLAN	Wireless Local Area Network

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# **CHAPTER 1**

## **COMPANY PROFILE**

PARITY offers a wealth of value-added products and services to assist the customers in managing their day-to-day IT needs. Why should an enterprise deploying the new, cloud-enabled business model select PARITY as a partner? PARITY is a marketplace leader with unique expertise in consumer, desktop, enterprise, Internet infrastructure and Internet-based solutions. PARLIAMENT OF INDIA will benefit from PARITY's breadth of solutions experience and broad range of professional services expertise.

Specifically, PARITY is committed to providing:

- The highest flexibility by accelerating standardization of leading-edge technologies;
- Faster time-to-implementation by reducing complexity and investigating closed-loop partner relationships;
- Highest added value to the existing investment in computer platforms by providing the best interoperability solutions;
- The most scalable, available, manageable, enterprise system technology;
- Outstanding customer responsiveness through a single point of accountability skilled partners;
- Total customer satisfaction throughout the lifecycle of the ownership experience from initial consulting to delivery, support and ongoing management;
- Cloud consideration as the foundation of all our products, services and solutions.

The PARITY brand strongly conveys quality, reliability and technology leadership with a focus on customer satisfaction. PARITY will continue to capitalize on new technologies to improve the performance and control of the systems. It will continue to implement business-critical capabilities into the complete line of computing solutions. It will continue to strengthen the partnerships for even more integration benefits and solve user problems and meeting user requirements for today and tomorrow.

## **CHAPTER 2**

### **INTRODUCTION**

The purpose of this project is to develop a high level approach to design, implement, and manage the public Wi-Fi network in the villages of Sabhapur and Chauhan Patti.

#### **2.1 RELEVANCE OF THIS PROJECT:**

- Kick start for the economic development: By attracting new businesses, residents and tourists.
- Bridges the digital divide: By allowing rural and remote citizens to economically access online government, education, health and social services.
- Improves security and public safety: By integrating with digital surveillance cameras and thereby reducing crime.
- Helps improve Municipal operations: By reducing the time in which a municipal service is delivered.

The villages are covered using a wireless mesh set up across the strategic locations and are connected to high speed internet connection.

The primary usage of Wi-Fi connectivity is to enable residents of the area to access online services launched by East Delhi Municipal Corporation (EDMC). The Citizens would also be able to access the online applications launched through Citizen Services Bureau (CSB).

Residents of both the villages have access to internet on limited usage basis. This can further be converted into a chargeable service by EDMC in future to promote more collaborated and integrated development of the villages through effective use of Web.

The Wi-Fi access is enabled through a secure access. Also web portals for both the villages which provide the village information, citizen forum and important development programs undertaken to users.

## **CHAPTER 3**

### **REQUIREMENT GATHERING**

Requirements gathering is an essential part of any project and project management. Understanding fully what a project will deliver is critical to its success.

- A succinct requirement specification for management purposes.
- A statement of key objectives - a "cardinal points" specification.
- A description of the environment in which the system will work.
- Background information and references to other relevant material.
- Information on the primary design constraints.

#### **3.1 NEED OF REQUIREMENT GATHERING**

Requirements are an essential part of any project and the foundation on which all projects should be built. The gathering of and compiling of requirements for a project is very much a partnership between the user of the project and the developer. The stronger the foundation, and understanding of the project, the smoother it will go when working on it and deploying the project.

#### **3.2 APPROACH OF REQUIREMENT GATHERING**

##### **3.2.1 SITE SURVEY**

A site survey is an inspection of an area where work is proposed, to gather information for a design or an estimate to complete the initial tasks required for an outdoor activity. It can determine a precise location, access, best orientation for the site and the location of obstacles. The type of site survey and the best practices required depend on the nature of the project. Examples of projects requiring a preliminary site survey include urban construction, specialized construction (such as the location for a telescope) and wireless network design.

In order to have a successful and accurate requirement gathering, the site survey of the location was done. It helped us to understand the requirements of the area by understanding the geography and the constructions in the villages. This requirement gathering helped us to lay down the network design and decide the approach towards the project. Thus resulting in better deployment of the entire solution.

The steps involved during the site survey were as follows:

- Line of sight: The survey team ensured that the line of sight between the two wireless antennas was clear and unobstructed.
- Spectrum Analysis: After having established a clear line of sight, we conducted a Spectrum Analysis to determine if there was any noise in between the two sites and the installation (Fresnel) zone of the antennas.
- Noise Levels: The frequency range that the antennas were proposed to be working in were checked for noise levels and peak noise levels were identified.

Village Sabhapur and Chauhan Patti are located in East Delhi area adjacent to Yamuna River with a population of about 8000 people each. Economic activities in this community primarily include agriculture. The infrastructure and social amenities in both villages which have considered for our network design include the Community Hall, School, local market, shops and so on.

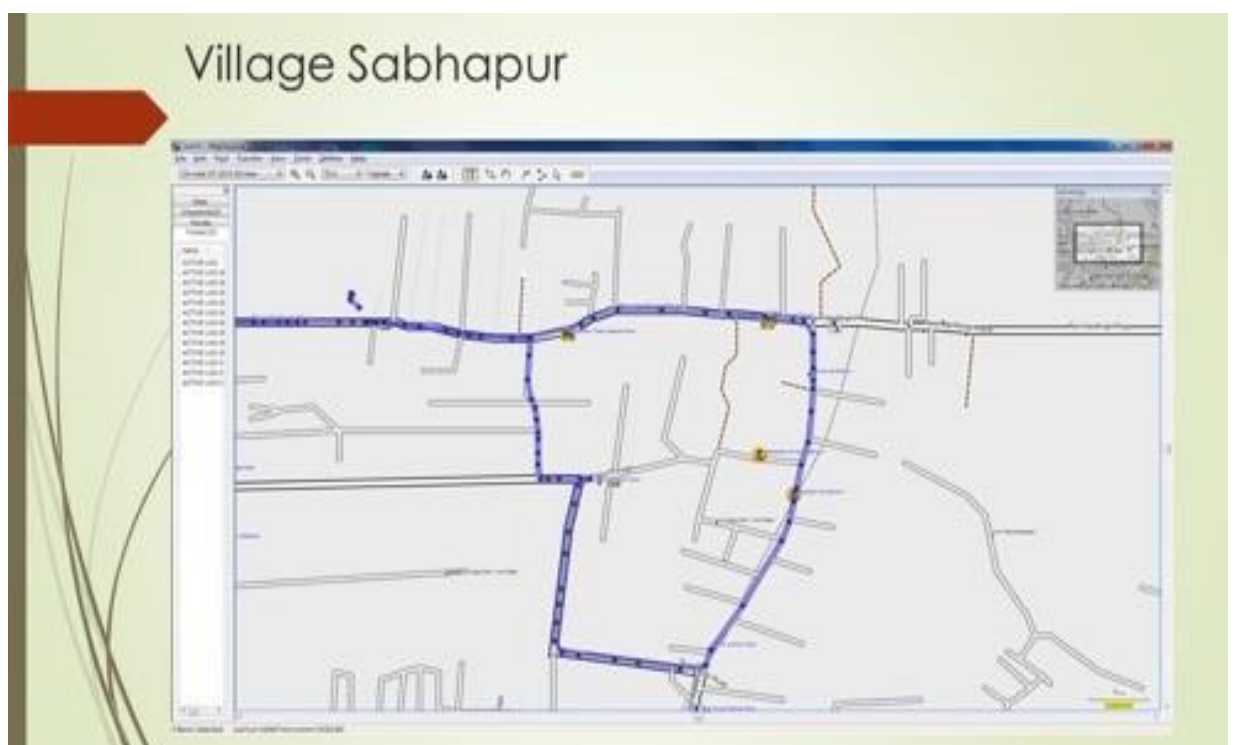
Based on the GIS survey of both the villages, the applications and usage assumptions are listed below:

- Both the villages have an approximate population of 7 – 8 thousand people.
- Sabhapur village periphery is about 2.5–3 km and that of Chauhan Patti is about 2 km.
- There is a High Tension Grid passing over the Sabhapur village.
- The community centre in the Sabhapur village and Government School in Chauhan Patti is proposed to be the location for terminating the Internet lease line.
- The access is proposed to be used primarily for using EDMC and CSB applications and limited internet access by the residents.





**Figure 3.1:** Google earth view of Chauhan Patti



**Figure 3.2:** Google earth view of Sabhapur

### **3.3.2 GAP ANALYSIS**

The gap analysis after the site survey and complete requirement gathering was as follows:

- The villages needed an end to end architecture which is controlled, managed and configured centrally.
- The services were to keep pace with customers' mobile data traffic demands.
- Provision for a secure, reliable, and scalable wireless connectivity with enhanced mobility capabilities of endpoint devices and users.
- A high-performance, flexible and easy to deploy network solution.
- To provide for policy server in order to detect any breach in the policy.
- It also needed to have a firewall software so as to protect itself against any harm by viruses or hacking.

### **3.3.3 SECURITY ISSUES**

Wi-Fi users are at risk from hackers. The same features that make free Wi-Fi hotspots desirable for consumers make them desirable for hackers; namely, that it requires no authentication to establish a network connection. This creates an amazing opportunity for the hacker to get unfettered access to unsecured devices on the same network.

Despite all the precautions taken to secure the wireless network, a serious security risk can still exist, exposing the network and users to risks and possible regulatory violations. Even a "no Wi-Fi" policy is no guarantee of security against these threats. Rogue access points can be brought in by users using Laptops with embedded Wi-Fi that can connect to neighbouring networks.

Traditional wireline security methods such as firewalls and VPNs do not detect these types of threats. And once the device is behind the firewall, it is viewed as trusted. In this new era of almost ubiquitous Wi-Fi, the air space itself must be considered an asset and protected.

There are several risks involved in not properly securing a wireless network:

- **Data interception**

Data interception is the practice of listening in on the transmissions of various wireless network users. By default, a wireless network is unsecured. This means that it is open to everyone, and anyone within the coverage area of an access point may potentially listen to communications being sent on the network. For an individual, there is little threat, as data is rarely confidential, unless the data is of a personal nature. For a business, however, this may pose a serious problem.

- **Network intrusion**

Cracking is an attempt to access a local network or the Internet. When an access point is installed on a local network, it lets any station access the wired network, as well as the Internet, if the local network is connected to it. For this reason, an unsecured wireless network gives hackers the perfect gateway to a business or organization's internal network.

Besides letting the hacker steal or destroy information on the network and giving him or her free Internet access, the wireless network might also be helping him or her to carry out cyber-attacks. Indeed, since there is no way to identify a hacker on a network, the business which installed the wireless network might be held responsible for the attack.

- **Radio Jamming**

Transmission jamming means sending out radio signals so as to interfere with traffic. Radio waves are very sensitive to interference. This is why a signal can easily be jammed by a radio transmission with a frequency close to that used by the wireless network. Even a simple microwave oven can make a wireless network completely inoperable if it is being used within an access point's range.

- **Denial of service**

Denial of service attacks make the network unusable by sending out false requests. The 802.11 standard's network access method is based on the CSMA/CA protocol, which involves waiting until the network is free before transmitting data frames. Once the connection is established, a station must be linked to an access point in order to send its packets. Because the methods for accessing a network and associating with it are known, it is easy for a hacker to send packets requesting for a station to become disassociated from the network. Sending out information intended to disrupt a wireless network is called a denial of service attack.

What's more, connecting to wireless networks uses up power. Even if the wireless peripheral devices have power-saving features, a hacker may be able to send enough encrypted data to a machine for it to overload. Many portable peripherals (like PDAs and laptop computers) have limited battery life. Therefore, a hacker may want to cause excessive power consumption that renders the device temporarily unusable, which is called a battery exhaustion attack.

The project has been designed in such a way that the network will itself be able to deal with any security issues or any unethical intrusions by means of a policy server and firewall software. These will detect and safeguard the network against any unethical or illegal usage by providing a system of user authentication.

## **CHAPTER 4**

### **FEASIBILITY STUDY**

Feasibility study is an assessment of the practicality of a proposed project. After successfully completion of requirement gathering, the next task was to define the scope of work. This phase involved the following:

- Technical Feasibility
- Legal Feasibility
- Operational Feasibility
- Economic Feasibility
- Schedule Feasibility

My task was to work with the technical team to check the technical feasibility and state end to end architecture which is able to meet the users' demands well within time and is protected against any unethical and illegal intrusion.

#### **4.1 SCOPE OF WORK**

- Provision of free Wi-Fi Services to the public for stipulated time duration capped with a limited free data usage.
- The company is required to implement an end-to-end Wi-Fi solution.
- Provision of the web based portal for user authentication for Wi-Fi Access.
- Facility to enable/disable specific user/system from Wi-Fi Access.
- Provision of restricted access to Wi-Fi network for individuals and companies from time to time based on authorized government notifications.

## 4.2 EQUIPMENT REQUIRED

The equipment required for the successful implementation of the scheme is listed below:

Product / Description	Quantity
Outdoor Access Point & Mount Systems	20
Wireless Controller & Rack Mount for 100 Users	1
6 U Rack with mounting accessories	22
1 KVA Online Rack mounted UPS with Ethernet Interface and 1 Hrs. backup	2
500 VA UPS with 30 Mins power back up	20
Servers with Xenon Processor and 8Gb Ram with 21" Monitors	2
8 Port Layer 2 Switch - Ethernet / Fiber	20
24 Port Layer 3 Switch – Fiber	3
Pole per unit	20
Base for Pole – unit	20
Authentication server	1
Security Firewall Intrusion Detection and Protection System	1
External Fiber - Hardened External (per meter)	1
SMS gateway for OTA registration and authentication for each location (Per user)	1

**Table 4.1:** List of Equipment Required

Implementation Services required at the location and host centre are as under:

Portal development for villages, integrating and launching E-panchayat, E-municipality, E-learning applications on the portal	1
Laying the cable approximately (meter)	5000
Installation and commissioning services	1
Civil – Electrical work at the POP room for both of the locations	1

**Table 4.2:** List of Implementation Services

Ongoing support and upkeep services for 1 year include the following:

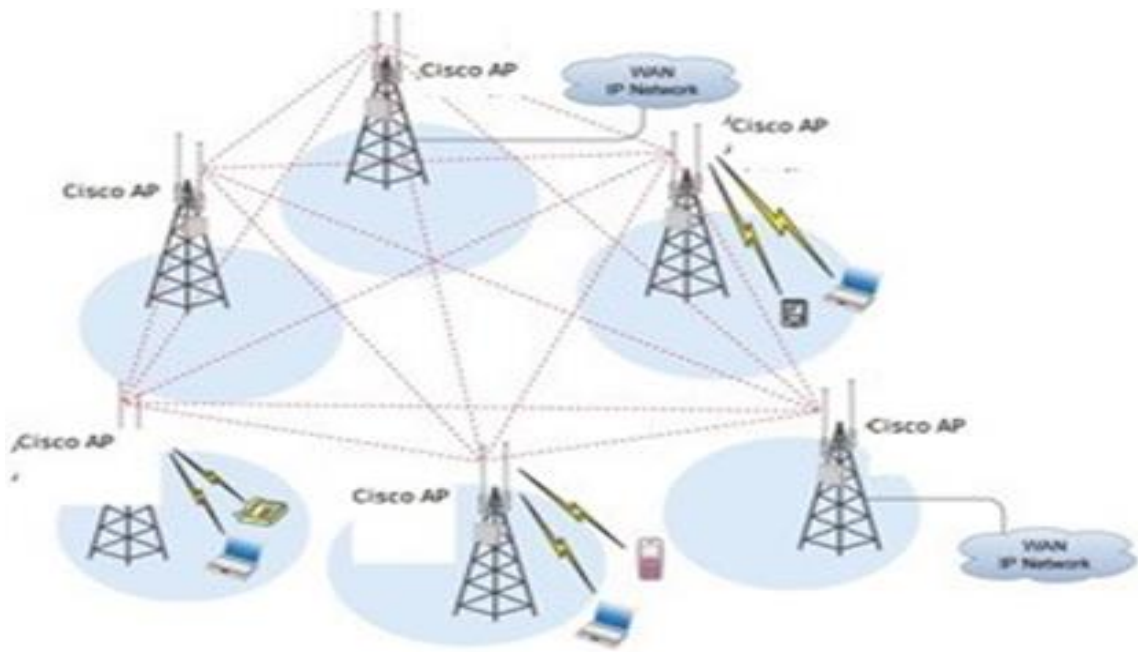
Administrator for up keep of both sites	1
Portal Maintenance	1
Hosting Charges	1
At-least 10 Mbps internet link for each site : Private ISP (per user)	1

**Table 4.3:** List of ongoing services

## CHAPTER 5

### TECHNICAL DESIGN

The technical design involves logical design of the decided approach, the sequencing of the tasks, the time restraints for each task, design of the network and complete deployment of the network and the solution.



**Figure 5.1:** Technical setup and layout of the design



## **5.1 DESIGN ASSUMPTIONS**

Design assumptions while sizing up the solution are as follows:

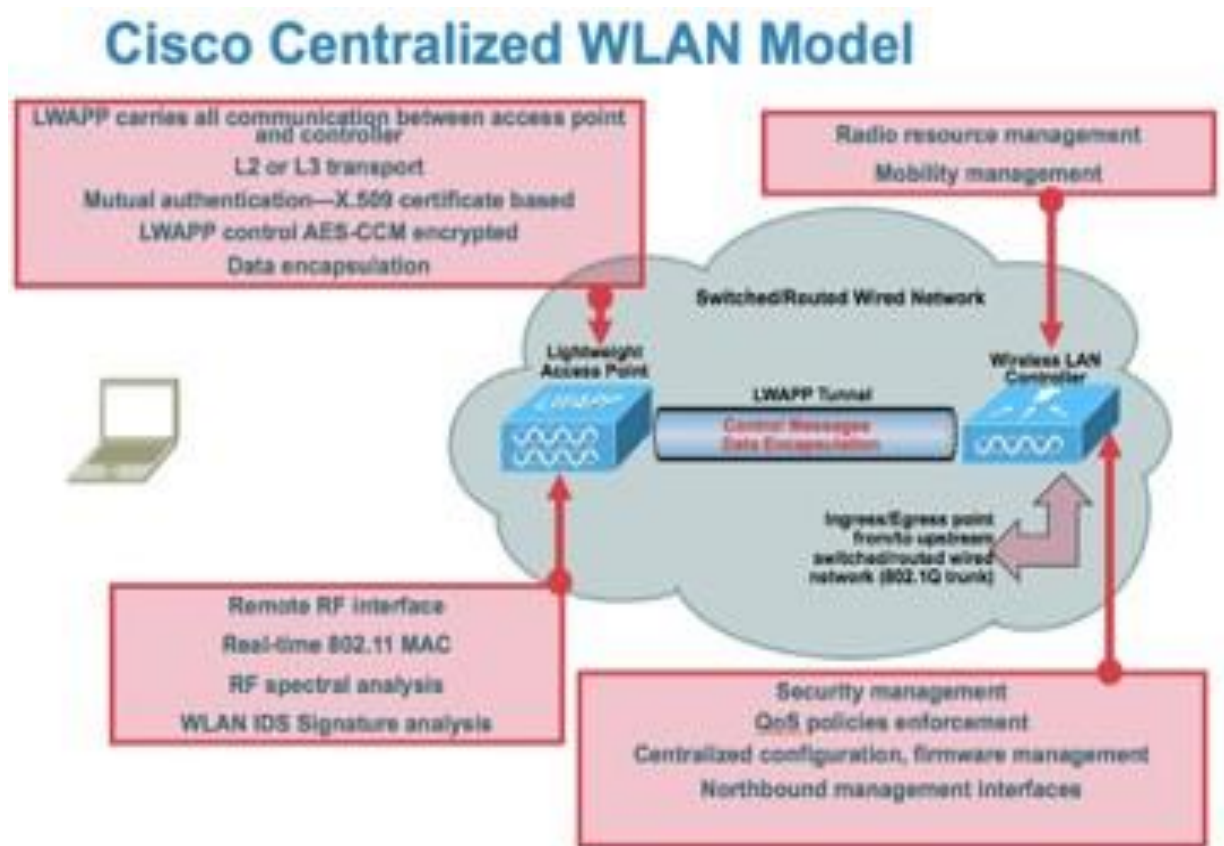
- Target throughput per connection~200 Kbps.
- To match RAP there are 10 MAPs connected in each village.
- Each RAP has direct fibre termination, enabling to reach Access Controller.
- Each MAP/RAP supports 300 Mbps at 5GHz, 40MHz BW for backhaul and Access Network.
- Each MAP/RAP supports 120-140 Mbps at 2.4 GHz, 40MHz BW for Access Network depending upon the environment conditions.
- Each MAP/RAP location right of way and AC/DC power to be provided by East Delhi Municipal Corporation.
- In order to ensure the users have consistent and reliable access to the services and internet, each of the villages is connected with 10 Mbps internet leased line.
- Each village is accessed through a village portal upon logging in by users and the portal is linked to the EDMC and CBS applications.
- In order ensure that there is no misuse of the facility, each user access is rate limited and duration barred. This policy is decided in consultation with EDMC.
- Users are authenticated using villager's authentication and each time login they are authenticated using OTP to ensure genuine usage.
- Guest users are authenticated using two factor authentication and have access to limited facilities using rate and time limit.

## **5.2 PROPOSED APPROACH**

Broadband wireless access networks are enterprise level networks that provide more capacity as well as coverage. In rural inaccessible areas, wired network are not at all cost effective. Wireless networking offers an alternative solution for such problem of information access in rural areas. They have definitely changed the way people communicate and share information among themselves by overcoming problems nowadays associated with distance and location.

Considering the complexity and scale of the project, it is proposed that the project be executed in phased manner. The main phases are:

- Site Survey and design of Wi-Fi Mesh in both the villages and necessary approvals.
- Deployment of essential infrastructure at locations, hosting of infrastructure at hosting site and commissioning of Internet lease line at both villages.
- Portal development, linking EDMC and CSB applications to the portal to enable archiving, and media management.
- Project Acceptance and commissioning of operations and support phase.



**Figure 5.2:** Proposed Design and Structure

## **5.3 DESIGN CONSIDERATIONS**

The facility is designed for personal and individual usage by residents and authorized guests to the villages and not for any commercial usage.

### **5.3.1 THE WIRELESS MESH**

A radio and population clustering survey was carried out in both the villages. Based on the survey, the number of External Wi-Fi access points in each village was decided. These access points offer a very efficient wireless mesh in the area.

Some of the features of such Antenna and mesh are:

- Wi-Fi cellular system provides cost-effective metro scale Wi-Fi solution for a wide range of broadband applications.
- Utilizing smart antenna technologies and advanced signal processing algorithm, wireless external antenna effectively provide much larger coverage than any other available in the market.
- Wi-Fi controller is another critical element to provide comprehensive management of user access and bandwidth control.
- HT Electric Towers with over 29dbm interference.
- Pole Specific to Wi-Fi is being erected as existing pole would need permission.
- Access point physical security is ensured in the area.

## **5.4 SECURITY CONSIDERATIONS**

The wireless intrusion prevention system (WIPS) provides a trusted security system that prevents these Wi-Fi security risks. Much like an intrusion prevention system for wireline systems, a wireless intrusion prevention system both detects threats and automatically prevents them. WIPS solutions detect all wireless transmissions over-the-air, classify them and based on rules set up by the administrator can automatically quarantine dangerous devices.

Wireless intrusion prevention systems stop attacks before they penetrate and harm the enterprise. WIPS solutions detect each category of attack using deterministic techniques involving a combination of device and event auto-classification, protocol analysis and association analysis. Signatures are only used to provide additional details and are not necessary for detection.

#### **5.4.1 POLICY SERVER**

The policy server is developed in such a way so as to protect the system against any breach of policy. The policy statement includes the following:

- No unethical and illegal use of the internet connection being provided. This means no commercial usage of the internet i.e. using the given connection to establish a cyber café would be a breach of policy.
- Limited time and data usage for particular media and social networking sites. The main purpose of this project is to help the people to access the EDMC services in a better and faster manner. Any other usage will be bound to a specific time and data limits. Example: there are time constraints for social networking sites like YouTube and Facebook.
- User authentication is an important feature of policy making. The villagers will be given unique user-id through a proper n secure SMS authentication System.
- The guests might have a limited internet service provided.

#### **5.4.2 FIREWALL**

- The firewall is designed in such a way so as to protect the system against any virus attack.
- It will also be able to detect the unethical practices and intrusions by the hackers or any other foreign people and protect the system from them.

## **CHAPTER 6**

### **THE SOLUTION**

This section discusses the elements required to fully bring a public Wi-Fi service to fruition. Understanding all elements required to establish a public Wi-Fi service is important in forming an agreement with a service provider and acknowledging the scope of responsibility each party has.

In addition to describing the architecture of the elements of public Wi-Fi, this section also includes guidance on the design of these elements.

The community network, envisages a two tier architecture, consisting of:

- Tier 1 – This provides the link between tier 1 and 3 and consists of a 5GHz and 2.5GHz flat panel antenna, the latter providing either a directional Wi-Fi cloud or wired (fibre + Copper) and for connecting to Tier 3 routers. In case of our solution, it is proposed that the Tier 1 would be connected to Tier 3 using a mix of fibre and copper connectivity in a Hub and Spoke model.
- Tier 3 – End user router that generally has line of site with a Tier 2 transceiver. This is the responsibility of the end user to provision and maintain.

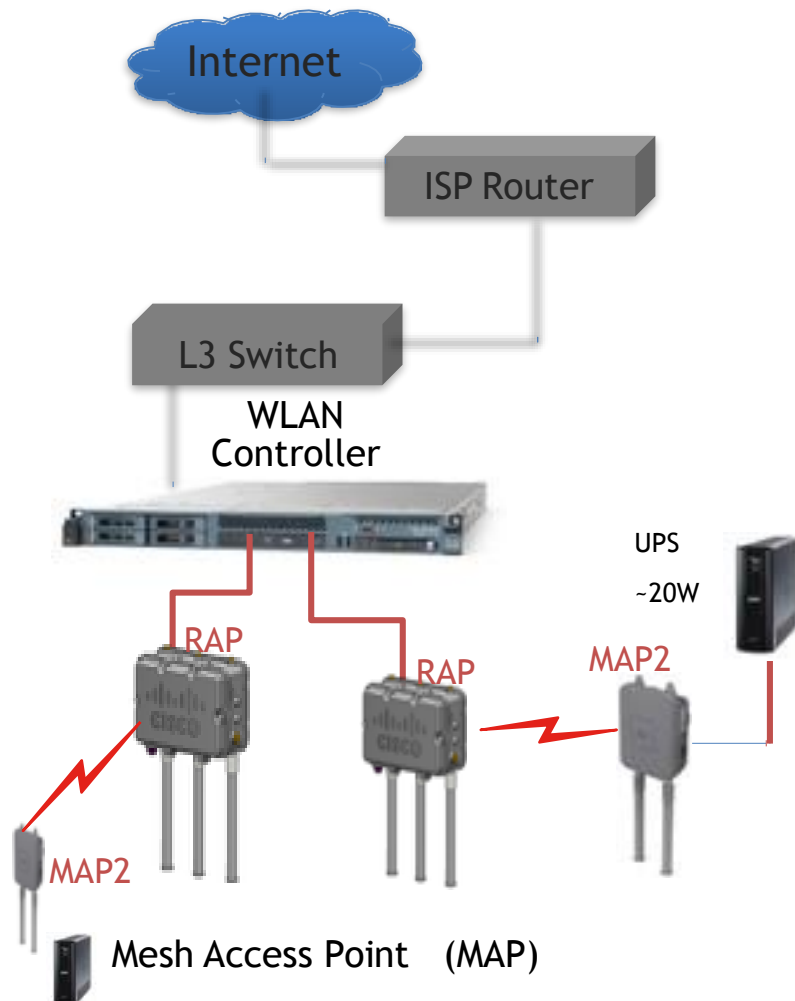
The high-level overview of the solution is such that all the access points eventually connect to the WLAN controller.

The two categories of the Access points are as follows:

- RAP – Root Access Point, which is connected to WLAN controller through a wired connection.
- MAP – Mesh Access Point, which is connected to the network via RAP over a wireless or wired (Fibre + Copper) link and carries the same network configuration from the controller itself.

The overview of the solution would be deploying RAP & MAP at the locations identified in survey so as to cover most of the village.

The controller is connected to the core network and talks to a 24 online bandwidth management & a billing box and shown in the diagram below:



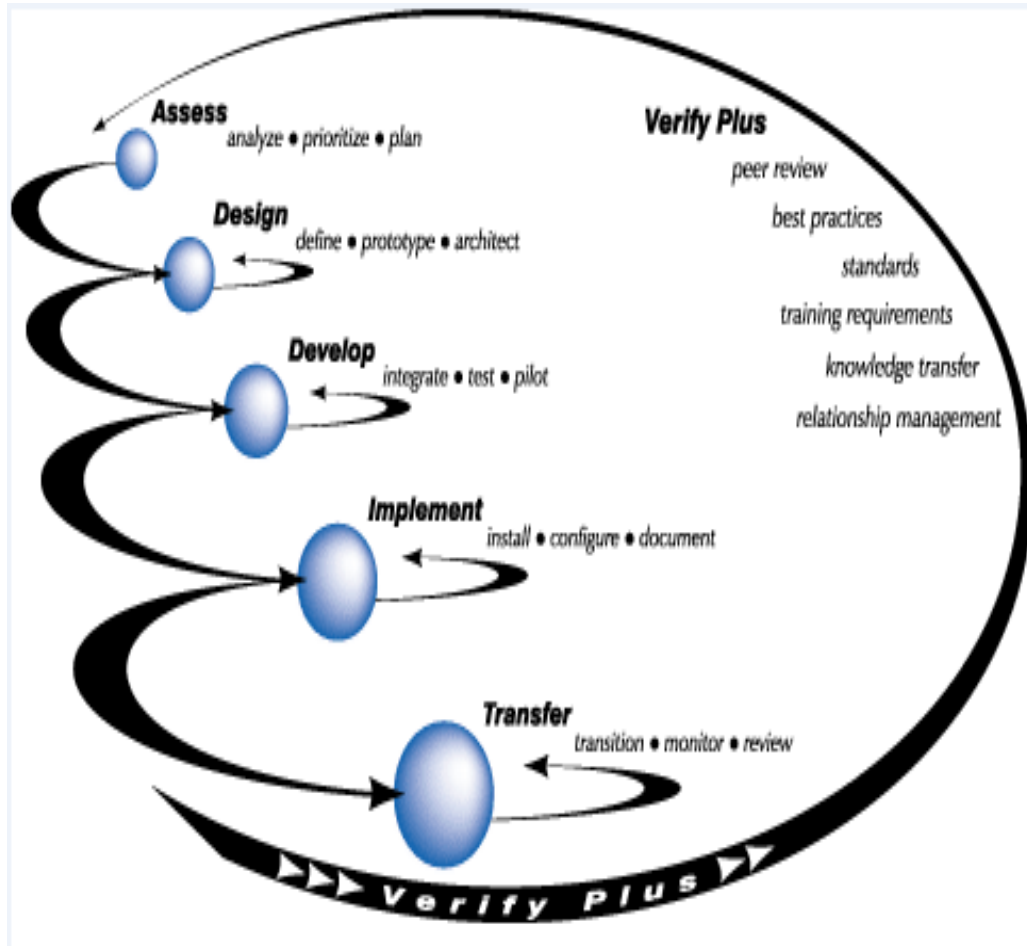
**Figure 6.1:** Design Solution depicting the flow network

This Wi-Fi solution is an end-to-end 802.11n architecture that helps us offer carrier-grade Wi-Fi services and keeps pace with customers' mobile data traffic demands. By providing secure, reliable, and scalable wireless connectivity, this Wi-Fi is designed as a natural extension to internet services. In addition, the Wi-Fi delivers the same level of management that is expected from a traditional network, while enhancing the mobility capabilities of endpoint devices and users.

It offers a high-performance, end-to-end network solution that is flexible, secure, and easy to deploy. The Cisco Wi-Fi solution leverages our broad product range and expertise in Wi-Fi and the network core to integrate, deploy, and scale your Wi-Fi network within your existing broadband infrastructure.

## CHAPTER 7

### PROJECT IMPLEMENTATION



**Figure 7.1:** Implementation Phases

Overall Project Duration: 6 months

Initial Phase Duration: 3 months (handled by the technical team)

Implementation Phase Duration: 3 months (To be carried out by the Project Management team)

## **CONCLUSION**

The project has been successfully proposed. The preparation and requirement gathering phase has been successfully completed. We have achieved significant results in terms of network design and wireless mesh layout.

After the ongoing formal proceedings, the implementation phase will shortly begin and would take probably a time span of another three months to be successfully implemented.



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