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Design and Implementation of Wireless Home Network

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ABSTRACT

This study rewiews the technical development of the design and implementation of wireless home network. Emphasis is on concept of wireless communication, classification of wireless, application of wireless technology, differences between wired and wireless, basic components of wireless home network, network technology, network architecture, information signal and procedures for design and implementation of wireless home network, installation and configuration of Access Point(AP). Wireless technologies truly provide a viable way of networking information appliances within the Home. Several technologies exist to provide wireless home networking including Wireless LAN, which is to address issues and develop a standard that allows you to connect A/V digital appliances and PCs without laying any cables.

Keywords: *Wireless home network, wireless communication, network technology, network architecture and information signal*

INTRODUCTION

Wireless communication is experiencing its fastest growth period in history. This has been possible because of enabling technologies that permit widespread deployment. thus Wireless communication is the transfer of information over a distance without the use of electrical conductors or "wires". The distances involved may be short (a few meters as in television remote control) or long (thousands or millions of kilometers for radio communications).

In the same vein the introduction of Wireless and Information Technology facilities in our society and world at large has far reaching effects in its activities. These applications of Wireless Technology and

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Information Technology facilities actually create new opportunities and take away the monotonous routine work performed manually before the invention and adoption of these Technologies. This has led to increase in speed, accuracy, and efficiency in data processing, easy access, retrieval and transmission of information. Each year home networking becomes more and more important in everyday life. Until recently, the home networking only provided home computers with shared access to the Internet. But nowadays, home networks support a multitude of applications running on the different devices, including personal computers, laptops, peripherals devices (printers, scanners etc.), Internet access devices, home entertainment systems, digital video recorders and smart household appliances (Boyer, 2012).

According to Gerasimenko (2007) two major factors have presented a real opportunity for data networking within the home. The first is the explosive growth and usage of the Internet. The Internet has clearly revolutionized the delivery of information and entertainment to the home. The second is the emergence of powerful home personal computers (PCs). With these inexpensive devices, the barrier to getting on the Internet and rediscovering the utility of the PC is low enough to reach the vast majority of middle-income households. All possible applications of a home network can be divided into four groups: computing, entertainment, communications and automation.

Computing for home networks means sharing of the computing resources across multiple PCs and devices in the home. For instance, sharing of the data, files, peripherals (such as printers and scanners), mobile devices, home video recorders and digital cameras (Chiu, 2004). Usually, modern home network connects *entertainment* devices all around home. Also, home networks are used for applications that combine entertainment and computing functionality, for instance interactive TV and streaming media. Typically, home network includes digital video recorder.

Communication applications such as telephony are by definition network applications. Home users can use voice over IP (VoIP) applications to make calls from their computers within the area of a home network. Another important issue for the home users is interconnections between personal devices and the home network. Unfortunately, most of

the devices require different types of cables in order to be connected to the computer. The situation can be very problematical if each family member has several personal devices. Also, such cables have tendency to be lost, thus, wireless technologies can really become a panacea. Nowadays, it is hard to find new model of a mobile phone or PDA without Bluetooth support, even some digital cameras support Wi-Fi. Automation home networks are still only a draft of the future usability. It is supposed that automation home networks will connect security, lighting, and heating systems together for the purposes of the user's convenience and energy management (Parekh, 2000). Additionally, automation networks connect smart devices like Internet-enabled kitchen appliances together.

Nevertheless, we can state with all confidence that wireless home networking seriously improved over the past few years. Bluetooth became de-facto standard, which caused emerging of several competitive technologies (Lansford & Bahl, 2000).

In keeping in line with the information age, the main purpose of this research study is to ensure that most of homes are wirelessly connected in order to share files, stream media, share an internet connection, play network games, and share printer etc. In the most easiest and efficient way in the home. Others but not limited to the following are:

- To provide a clear understanding of the theoretical background and basis of wireless communication.
- To provide a strong practical understanding of the design and implementation of wireless home network and wireless network in general.
- To provide skills in appreciating, designing and implementing wireless home network solutions to a variety of applications and problems.

CONCEPT OF WIRELESS COMMUNICATION

Wireless communication is experiencing its fastest growth period in history. This has been possible because of enabling technologies that permit widespread deployment. It is the transfer of information over a distance without the use of electrical conductors or "wires". The distances

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involved may be short (a few meters as in television remote control) or long (thousands or millions of kilometers for radio communications) (Wikipedia, 2012). Ikuomola (2011) opined that Wireless is a term used to describe telecommunications in which electromagnetic waves (rather than some form of wire) carry the signal over part or the entire communication path.

CLASSIFICATION OF WIRELESS

Wireless can be divided into the following classes:

- **Fixed wireless**: The operation of wireless devices or systems in homes and offices, and in particular, equipment connected to the Internet via specialized modems.
- **Mobile wireless**: The use of wireless devices or systems aboard motorized, moving vehicles; examples include the automotive cell phone and PCS (personal communications services).
- **Portable wireless**: The operation of autonomous, battery powered wireless devices or systems outside the office, home, or vehicle; examples include handheld cell phones and PCS units.
- **IR wireless**: The use of devices that convey data via IR (infrared) radiation; employed in certain limited-range communications and control systems.(lior, 2008)

APPLICATIONS OF WIRELESS TECHNOLOGY

- **Security systems:** Wireless technology may supplement or replace hard wired implementations in security systems for homes or office buildings.
- **Television remote control:** Modern televisions use wireless (generally infrared) remote control units but now radio waves are also used.
- **Cellular telephony (phones and modems):** These instruments use radio waves to enable the operator to make phone calls from many locations world-wide.
- **Wi-Fi:** (for wireless fidelity) is a wireless LAN technology that enables laptops, PC's, PDA's, and other devices to connect easily to the internet.

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- **Wireless energy transfer:** Wireless energy transfer is a process whereby electrical energy is transmitted from a power source to an electrical load that does not have a built-in power source, without the use of interconnecting wires.
- **Computer interface devices:** Answering the call of customers frustrated with cord clutter, many manufactures of computer peripherals turned to wireless technology to satisfy their consumer base.

DIFFERENCES BETWEEN WIRED AND WIRELESS

- A wired network uses wires (cables) to connect devices whereas a wireless network uses radio waves.
- Wired networks are easy to set up and troubleshoot whereas wireless networks are comparatively difficult to set up, maintain and troubleshoot.
- Wired networks make you immobile while wireless ones provide you with convenience of movement.
- Wired network proves expensive when covering a large area because of the wiring and cabling while wireless network do not involve this cost.
- Wired networks have better transmission speeds than wireless ones.
- In wired networks; a user does not have to share space with other users and thus gets dedicated speed while in wireless networks the same connection may be shared by multiple users (Goldsmith, 2005).

BASIC COMPONENT OF A WIRELESS HOME NETWORK

In order to set up a home Ethernet or wireless network, you will need the basic components listed below.

Network Interface Card (NIC) - The best means of connecting a computer to a network is through a Network Interface Card (NIC). A NIC will allow a computer to send and receive electrical or radio signals in a manner that other computers can understand. Most modern computers come with Ethernet NICs installed by default.

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Hub - In order to connect more than two computers together, a device that distributes packets, or blocks of data, must be used. A hub is the most basic of these devices. When a computer connected to a network makes a request for data from another computer, that request will be sent to the hub. The hub will then send that request to every computer it is connected to, including the originating computer

Switch - A switch is a device that distributes packets, or blocks of data, between computers in a network. Switches function in a similar fashion to hubs, but are much more efficient.

Router - A router is a device that joins two different networks together. Home networks usually employ routers to connect to the Internet. The majority of routers contain a switch within them so that all of the computers on a network can communicate.

Modem - A modem is a device that allows you to connect to your Internet service provider and browse the Internet (Mitchell, 2012).

NETWORK TECHNOLOGY

The different wireless physical network technologies that can be used in the Home system are:

Wireless LAN (IEEE 802.11b)

WLAN can be used to connect various appliances like PCs, PDAs and laptops at Home. For WLAN, two possible scenarios can be implemented. The infrastructure mode provides an 802.11 networking framework in which devices communicate with each other by first going through an Access Point (AP). The ad-hoc mode provides an 802.11 networking framework in which devices or stations communicate directly with each other, without the use of an access point (AP). Ad-hoc mode is also referred to as peer-to-peer mode or an Independent Basic Service Set (IBSS).

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Bluetooth

Bluetooth as a wireless protocol can be compared to WLAN. Bluetooth has the limit of lower bandwidth and lower range but the big advantage is that Bluetooth chipsets are very small and need only a very small amount of power. Therefore Bluetooth can be used at Home to connect small appliances like PDAs, Headsets or remote control units to the in-home network.

HiperLAN/2

For the connection of multimedia equipment in the home, HiperLAN/2 can be used as a wireless solution. HiperLAN/2 operates in the 5 GHz band and offers data rates up to 54 Mb/s. The HiperLAN/2 home network is designed as an ad-hoc LAN, which can be put into operation in a plug-and-play manner (Geier, 2004).

NETWORK ARCHITECTURE

The architecture of a network defines the protocols and components necessary to satisfy application requirements. One popular standard for illustrating the architecture is the seven-layer Open System Interconnect (OSI) Reference Model, developed by the International Standards Organization (ISO). OSI specifies a complete set of network functions, grouped into layers which reside within each network component. The OSI Reference Model is also a handy model for representing the various standards and interoperability of a wireless network.

The OSI layers provide the following network functionality:

- **Layer 7—Application layer:** Establishes communications among users and provides basic communications services such as file transfer and e-mail. Examples of software that runs at this layer include Simple Mail Transfer Protocol (SMTP), HyperText Transfer Protocol (HTTP) and File Transfer Protocol (FTP).
- **Layer 6—Presentation layer:** Negotiates data transfer syntax for the application layer and performs translations between different data formats, if necessary.
- **Layer 5—Session layer:** Establishes, manages, and terminates sessions between applications. Wireless middleware and access

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controllers provide this form of connectivity over wireless networks. If the wireless network encounters interference, the session layer functions will suspend communications until the interference goes away.

- **Layer 4—Transport layer:** Provides mechanisms for the establishment, maintenance, and orderly termination of virtual circuits, while shielding the higher layers from the network implementation details.
- **Layer 3—Network layer:** Provides the routing of packets though a network from source to destination. This routing ensures that data packets are sent in a direction that leads to a particular destination. Protocols such as Internet Protocol (IP) operate at this layer.
- **Layer 2—Data link layer:** Ensures medium access, as well as synchronization and error control between two entities. With wireless networks, this often involves coordination of access to the common air medium and recovery from errors that might occur in the data as it propagates from source to destination.
- **Layer 1—Physical layer:** Provides the actual transmission of information through the medium. Physical layers include radio waves and infrared light.

The combined layers of network architecture define the functionality of a wireless network, but wireless networks directly implement only the lower layers of the model.

The actual transmission of data, however, occurs at the physical layer. As a result, the architecture allows for a layering process where a particular layer embeds its protocol information into frames that are placed within frames at lower layers. The frame that is sent by the physical layer actually contains frames from all higher layers. At the destination, each layer passes applicable frames to higher layers to facilitate the protocol between peer layers (Peterson and Poudel, 2000).

INFORMATION SIGNAL

Data are type of information that the network stores in a computer or retrieves from it. As a result, wireless networks transfer data from one

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computer to another. This data can include e-mail messages, files, web pages, video, music, and voice conversations. Communications systems—such as a wireless network— symbolize data using codes that electrical, radio, and light signals efficiently represent. The signals carry the information through the system from one point to another. The signals are either digital or analog, depending on their location within the system (Dhir, 2001).

PROCEDURE FOR DESIGN AND IMPLEMENTATION

The procedures on how to design and implement a wireless home network are as follows:

a) DECIDING WHAT IS CONNECTED

You are wirelessly networking your home for a reason, no matter whether it's to share that cool, new color ink jet printer (or scanner or digital video recorder), or to play your computer-based MP3s on your new wide-screen TV, or to give every computer in the house always-on access to the Internet. Whatever the reason, the first thing to do is to determine what you want connected to the network.

b) CHOOSING A WIRELESS TECHNOLOGY

After you decide that you want to connect a PC to the network wirelessly, choose a wireless technology to use. The three leading wireless technologies used to connect a computer to a home network are most often referred to by their technical names: Institute of Electrical and Electronics Engineers (IEEE) 802.11a, IEEE 802.11b, and IEEE 802.11g. The marketing name for the first two technologies is *Wi-Fi,* which is a brand name coined by a wireless trade group. Wi-Fi is supposed to denote *wi*reless *fi*delity. The three most important practical differences between IEEE 802.11a, IEEE 802.11b, and IEEE 802.11g networks are speed, price, and compatibility:

c) CHOOSING AN ACCESS POINT

The most important and typically most expensive device in a wireless network is the Access Point (AP; also sometimes called a base station). An AP acts like a wireless switchboard that connects

wireless devices on the network to each other and to the rest of the wired network; it's required to create a wireless home network.

d) DECIDING WHERE TO INSTALL THE ACCESS POINT (AP)

You should strive to install your wireless network in a way that eliminates dead wireless network zones in your house. Ideally, you determine the best placement of your AP so that no spot in your house is left uncovered. To achieve optimum signal coverage, the best place to install an AP is near the center of your home.

e) ADDING ENTERTAINMENT AND MORE

When designing your wireless network, don't forget to plan to add a few gadgets for fun and relaxation. The wildly popular video-game consoles from Sony, Microsoft, and Nintendo all offer network connectivity and Internet connectively as well.

f) CONNECTING TO THE INTERNET

When you get right down to it, the reason why most people build a wireless network in their home is to share their Internet connection with multiple computers or devices that they've got around the house.

Software-based Internet connection sharing: Windows XP (and later versions of Windows) enable sharing of an Internet connection. Each computer in the network must be set up to connect to the Internet through the computer that's connected to the broadband modem. The disadvantage with this system is that you can't turn off or remove the computer that's connected to the modem without disconnecting all computers from the Internet. In other words, the computer that's connected to the modem must be on for other networked computers to access the Internet through it.

Cable/DSL router: By connecting a cable/DSL router between the broadband modem and your home network, all computers on the network can access the Internet without going through another computer. The Internet connection no longer depends on any computer on the network. Cable/DSL routers are also DHCP servers and typically include switches.

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In fact, the AP and/or the modem can also include a built-in router that provides instant Internet sharing all in one device (Briere, Bruce, & Hurley, 2003).

Installing the AP

Before you install your wireless gear, buy a 100-foot Ethernet cable. If you are installing your AP at a distance farther than that away from your router or Internet-sharing PC, you might get a longer cable.

1. Gathering the necessary information for installing the AP
   The information that you need to know includes the physical address, IP address, default gateway, subnet mask, DNS server(s), and whether DHCP is enabled**.** If you are using Windows NT/2000/ XP, and above do the following:

a. **Choose Start→Programs→Accessories→Command Prompt.**
   This will bring up the command prompt window that's similar to a DOS screen.

b. **Type** IPCONFIG /ALL **and then press Enter.**
   The information that you receive will scroll down the screen. Use the scroll bar to slide up to the top and write down the networking information (physical address, IP address, default gateway, subnet mask, DNS server(s), and whether DHCP is enabled).

2. Run the setup software that accompanies the AP or device containing your AP like a wireless or Internet gateway.

3. When prompted by the setup software to connect the AP, unplug the network cable that connects the broadband modem to your computer from the computer's Ethernet port and plug this cable into the Ethernet port that's marked *WAN* or *Modem* on your network's cable/DSL router or Internet gateway.

4. Complete the installation of the setup software and when prompted, enter the information that you collected in Step 1.

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5. Record the access point parameters.

6. Complete the installation software and you are finished.

Configuring AP parameters

Here's a little more meat on each of the access point parameters that you captured in Step 5 of the preceding section.

Service set identifier (SSID): The SSID (sometimes called the *network name*, *network ID*, or *service area)* can be any alphanumeric string, including upper- and lowercase letters, up to 30 characters in length. The AP manufacturer might set a default SSID at the factory, but you should change this setting.

Channel: This is the radio channel over which the AP will communicate. If you plan to use more than one AP in your home, you should assign a different channel (over which the AP will communicate) for each AP to avoid signal interference. If you operate only one AP, what really matters is that all wireless devices on your network must be set to the same channel.

WEP keys: You should always use Wired Equivalent Privacy (WEP) encryption. Only a determined hacker with the proper equipment and software will be able to crack the key.

Password: Configuration software might require that you enter a password to make changes to the AP setup. The manufacturer might provide a default password. Use the default password when you first open the configuration pages, and then immediately change the password to avoid a security breach.

MAC address: The *Media Access Control (MAC) address* is the physical address of the radio in the AP.

Dynamic or static wide area network (WAN) IP address: If your network is connected to the Internet, it must have an IP address assigned

by your ISP. Your router or Internet gateway should be configured to accept an IP address dynamically assigned by a DHCP server.

Local IP address: In addition to a physical address (the MAC address), the AP will also have its own network (IP) address. You need to know this IP address to access the configuration pages using a Web browser.

Subnet mask: In most cases, this value will be set at the factory to 255. 255.255.0. This number, together with the IP address, establishes the subnet on which this AP will reside. Network devices with addresses on the same subnet can communicate directly without the aid of a router.

CONCLUSION

Wireless technologies truly provide a viable way of networking information appliances within the Home. Several technologies exist to provide wireless home networking. Wireless LAN (IEEE 802.11b) is to address these issues and develop a standard that allows you to connect A/V digital appliances and PCs without laying any cables. With network equipment and architecture, one can conveniently network homes wirelessly following the laid down procedures.

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