Home Appliance Networking Using IPV ٦ Wireless Networks

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Abstract

This paper introduces a framework that adjusts electrical home appliances to meet the demanding needs of home networking, so that these appliances can be controlled through IP networks. Wireless IEEE ٨٠٢,١١ will be used in addition to http & TCP/IP protocols for digital audio/video appliances & electric white goods respectively. IPV ٦ will also be used as the base addressing scheme necessarily because of the impact of this framework which will lead to the need for a huge number of IP addresses. The benefits acquired are obviously opening new horizons for network technology to include home appliances and the ability to control them from any remote location in the world from any internet connection.

Keywords: Wireless, IP address, IPV ٦, HNS, HNG

الخلاصة

هذا البحث يتناول صيغة لتعديل الاجهزة الكهربائية المنزلية لتحقيق الحاجة الملحة للشبكات المنزلية لكي نتمكن من السيطرة على هذه الاجهزة باستخدام شبكات الانترنيت بروتوكول . وسيتم استخدام بروتوكول للاجهزة المرئية والصوتية http & TCP/IP بالاضافة الى Wireless IEEE ٨٠٢,١١ كصيغة IPV ٦ والاجهزة المنزلية الاخرى. وسيتم استخدام العنونة الرئيسية بسبب تاثير هذة الصيغة الذي يودي للحاجة لاعداد هائلة من عناوين الانترنيت بروتوكول .الفائدة المكتسبة هي فتح افاق جديدة لتقنية الشبكات لتتضمن الاجهزة المنزلية وامكانية التحكم بها عن بعد من اي مكان بالعالم من خلال شبكة الانترنيت.

Introduction

The emerging technologies enable general household appliances to be connected to LAN at home. Such smart home appliances are generally called networked appliances. A home network system (HNS) consists of multiple networked appliances, intended to provide more convenient and comfortable living for home users.

The HNS provides many applications and services. The applications typically take advantage of wide-range control and monitoring of appliances inside and outside the home. Moreover, integrating different appliances via network yields more value-added and powerful services, which we call HNS integrated services [١].

A computing environment where a variety of appliances are connected with one another is called a ubiquitous computing environment. The traditional idea of a ubiquitous computing environment is somewhat limited in scale when compared to the Internet, however, and so it is necessary to consider some additional issues when trying to design Internet-scale ubiquitous computing environments.

A variety of networks and protocols have been proposed for respective application domains. For example, various protocols such as Jini and UPnP (Universal Plug and Play) have been proposed for connecting various appliances without their configuration before using them. HAVi has been proposed for connecting various audio and video home appliances. On the other hand, various network systems such as ATM (Asynchronous Transfer Mode) networks, IEEE ١٣٩٤, Bluetooth, and VIA have been developed to connect a variety of appliances. Also, in the research community, PEN, networked surface, and CLAN have been proposed for connecting future advanced appliances. However, various useful characteristics of these underlying protocols and networks are hidden from applications if an IP layer is inserted on the networks. For example, the plug and play functionality provided by Bluetooth and the network bandwidth reservation functionality provided by ATM are not usually available on the top of the IP layer. Also, some appliances do not support the IP layer for connecting to other appliances and services. Moreover, each appliance may assume different control protocols and data formats to communicate each other [٢].

Components of ٨٠٢,١١ LANs [٣]

In this paper, a framework using wireless LAN (IEEE ٨٠٢,١١) will be used which was designed mainly to function according to the IP layer hierarchy. In addition, IPV٦ will be used to accommodate the enormous amount of IP addresses that will be needed to cover the huge number of connected appliances in the near future.

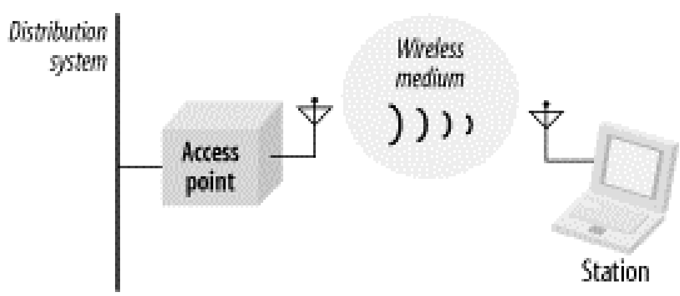

Figure١. Components of ٨٠٢,١١ LANs[٣]

Distribution System

When several access points are connected to form a large coverage area, they must communicate with each other to track the movements of mobile stations.

The distribution system is the logical component of ٨٠٢,١١ used to forward frames to their destination. ٨٠٢,١١ does not specify any particular technology for the distribution system. In most commercial products, the distribution system is implemented as a combination of a bridging engine and a distribution system medium, which is the backbone network used to relay frames between access points; it is often called simply the backbone network. In nearly all commercially successful products, Ethernet is used as the backbone network technology.

Access Points

Frames on an ٨٠٢,١١ network must be converted to another type of frame for delivery to the rest of the world. Devices called access points perform the wireless-to-wired bridging function. (Access points perform a number of other functions, but bridging is by far the most important.)

Wireless Medium

To move frames from station to station, the standard uses a wireless medium. Several different physical layers are defined; the architecture allows multiple physical layers to be developed to support the ٨٠٢,١١ MAC. Initially, two radio frequency (RF) physical layers and one infrared physical layer were standardized, though the RF layers have proven far more popular.

Stations

Networks are built to transfer data between stations. Stations are computing devices with wireless network interfaces. Typically, stations are battery-operated laptop or handheld computers. There is no reason why stations must be portable computing devices, though. In some environments, wireless networking is used to avoid pulling new cable, and desktops are connected by wireless LANs.

In this paper we propose that the stations will be the home appliances which will be connected through the wireless home network.

The Home Network Structure

A HNS consists of one or more networked appliances connected to LAN at home. Each networked appliance has a set of control APIs, so that the user or software agents can control the appliance via the network. To process the API calls, each appliance generally has embedded devices including a processor and storage [١].

A number of home networking solutions have been developed to try and get devices to seamlessly interoperate. Some approaches adopt an end-to-end solution for personalized value-added audiovisual services. Others take a broader view and try to manage the complexity associated with combining embedded systems with the Internet. As the proliferation of devices and services becomes more ubiquitous and as home networks form part of the Internet, finding and composing devices will become paramount. The trend is to use syntactic descriptions based on attribute-value pairs. However, several approaches are investigating how ontologies could be used to describe and discover devices more accurately.

Bringing this all to gather different management approaches have been adopted. Many utilize the benefits of set-top box technologies whereas ad hoc approaches are used to equip devices with plug and play capabilities [٤].

Why IPV٦

IPv٦ offers a significantly improved starting point for general purpose home-networking than IPv٤. The main benefits afforded by IPv٦ can be summarized as follows:

- Large address space: more than enough address space to allow assignment of globally unique IPv٦ addresses to every device in the home.

- Auto-configuration: hosts can automatically construct Link-local addresses on their own and acquire additional network prefixes from routers as needed.
- Automatic tunneling techniques: allowing IPv٦ to be deployed even when the local provider doesn't support it.
- Mandated security: the IP Security protocols (IPSec) are mandatory in IPv٦ stacks, so application designers can rely on their presence.
- A future path: applications using IPv٦ can avoid completely the problems associated with the use of private IPv٤ addressing and NATs [٤].

HNS Design

This paper presents a design that proposes a wireless LAN (IEEE ٨٠٢,١١) built into each home appliance with small processor and storage. IPV٦ will be used to address each appliance uniquely throughout the internet. All home appliances would be connected through a Home Network Gateway located at a central point in the building; the HNS is also connected to a router which connects the appliances to the outside world (the Internet).

Unlike other remote user-interface technologies, HTTP does not demand that the remote clients use a particular piece of software and a proprietary protocol. Any compliant Web browser, whether it is running on a PC or another embedded system, can process and display the information delivered by HTTP. It also provides a standard mechanism by which user input can be returned to the server.

Many embedded Internet devices (EIDs) will use HTTP instead of providing a user interface through a local front panel. For example, an intelligent instrument might use an HTTP server to enable any Web browser to act as a virtual front panel, saving on the component cost of an LCD and its driver circuitry while making it easier to control or access data. This application could apply to a device as simple as a thermostat, letting itself be read and adjusted from any client that is attached to the same network. The basic responsibility of an HTTP server is to respond to requests from one or more Web browsers by sending the requested file. However, there are important differences between a common desktop HTTP server, which acts mainly as a high-performance file server, and one designed for an embedded system..[٥]

Some of the best-known commercial platforms for facilitating the development of distributed applications interacting with and exploiting the capabilities of diverse networked appliances is Jini, UPnP, Salutation and HAVi. Next, we describe related work including these commercial platforms.

Related Platforms

Jini is a Java-based infrastructure for coordinating remote services and appliances. The Jini system provides mechanisms for service construction, lookup, and communication in a distributed system. However, Jini is heavily dependent on the Java language, whose runtime system requires a large amount of computational resources, and such resources are usually very limited in a home appliance.

UPnP (Universal Plug and Play) is an architecture for providing peer-to-peer network connectivity between PCs and appliances, UPnP allows a device to dynamically join a network, allocate itself an IP address, announce its presence and its capabilities upon request. UPnP is based on TCP/IP and web technologies to enable seamless proximity networking in addition to control and data transfer among networked devices in the home and office. However, UPnP is intended to profile features and capabilities of each appliance in XML files. Although XML-based profiles allow complex, powerful description of appliance capabilityas opposed to Jini's simple service attribute, it is difficult for home appliances to interpret XML-files.

HAVi (Home Audio Video Interoperability) provides a home networking standard for connecting digital audio and video consumer devices seamlessly. HAVi also provides a Java API for controlling A/V appliances, which enables control of appliances from within their programs. HAVi assumes that each appliance has an IEEE ١٣٩٤ network interface, that has enough bandwidth to transmit multiple digital audio and video streams simultaneously. However, this requirement prevents HAVi from being widely used in various types of appliances. It is expected that in the future home appliances will support different standards depending on their manufacturers' policies. However, these standards do not support connection of multiple home networks. Our virtual overlay network allows all home appliances to be connected and to control one another.[٤]

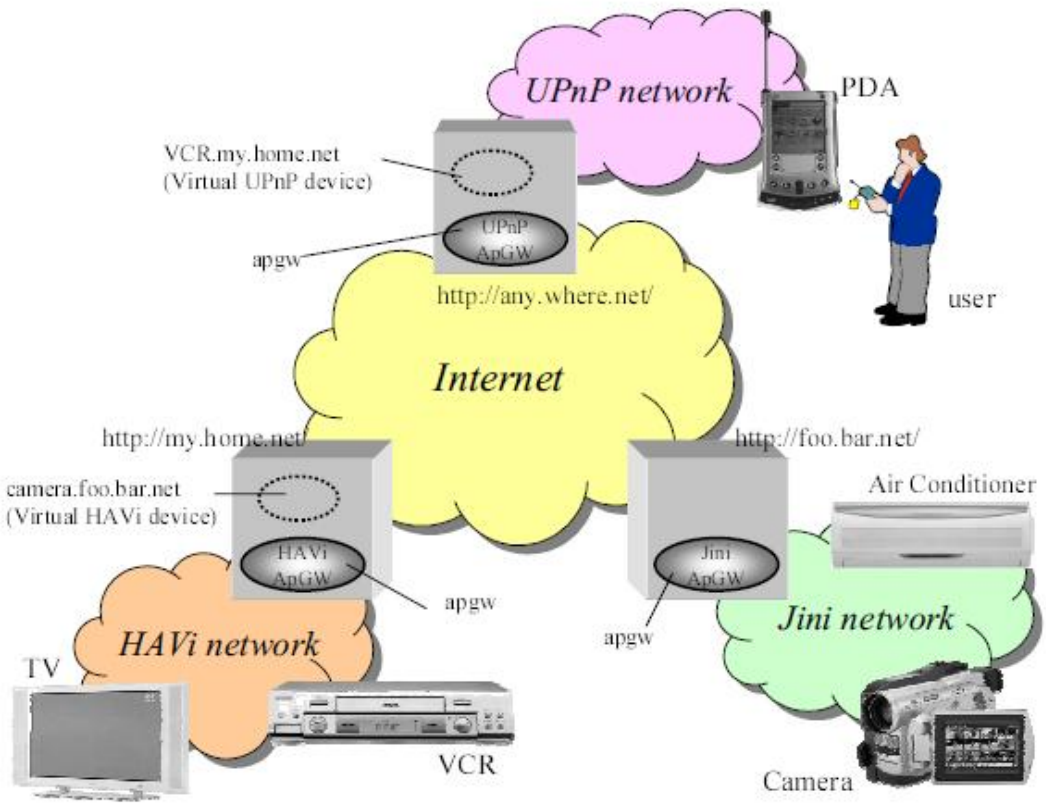

Figure ٢ Connecting Home Networks[٤]

In this paper we have used web servers embedding HTML pages at the appliances that communicate with the internet using http and TCP/IP protocols. This approach is much easier to implement than the platforms mentioned earlier since we are using global and platform independent protocols and web services that are recognized through any IP network.

Implementation

The home network system (HNS) connects to the internet through the home Network Getaway (HNG),on the other hand the internet connection can be done using any known internet providing technology like on internet provider through an access point and grid or through a GSM or CDMA modem over GPRS etc.

The home appliances will be connected to the network by wireless IEEE ٨٠٢,١١.

The home network Gateway has a unique IP address over the internet which distinguishes it from any other HNG and HNS.

In this proposal the IP address will be IPV٦ to accommodate the huge number of addresses required to cover all home network systems that will be connected to the internet .Managing all (HNG) and their addressing will required a dedicated address server .The address server will keep the IP address associated with a HNG for a certain period and the release it unless being renewed this will ensure that the address server will not contain HNG that are no longer.

Appliances connecting to the network can obtain their IP address through different scenarios. As an example they may obtain the IP from a DHCP. If no DHCP exists in the network they may randomly choose an IP address from a predefined range of IP addresses and then send broadcast massages through the network to find out if the IP address is used by another device.

Home appliances within the HNS include a web server that contains web pages to control and configure the device functions. Services of an appliance can be executed using the hyperlinks to CGI functions on this web server. A service request to a device within a HNS coming via the internet is routed to the target device by the HNG.

Conclusion

In this paper we have used http, TCP/IP protocol stack and HTML pages that are global and platform independent. This makes implementing a Home Network System much more flexible and easier in implementation.

The system proposed allows users to control their home applications remotely through the internet by using any internet connection like a cellphone in a car or computer at work or an access point in the airport.

Adopting such kind of technology will open horizons beyond our maintain capabilities in examples companies will be able to update their manufactured house hold goods online and remotely. Also companies may be informed an appliances malfunctioning and fix them online without the user interaction.

Web user interfaces can be easier to understand than hardware buttons, especially when a single hardware button may play multiple roles in the device functions which make it more complicated for the user.

Future work

- Security issues.

  One of the most important aspects that must be taken into account is the security issue it has to be made strict that only the authorized user can access the HNS and modify the home appliances.
- Friendly graphic user interfaces.

  Efforts should be put into obtaining the most friendly graphic user interfaces to make user interaction very friendly especially for users not familiar with computer technology.
- Hardware and software costs.

  The hardware and software costs associated with appliance networking are still relatively big. Efforts must be put into reducing these costs to minimum.

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