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Internet of Wi-Fi Enabled Things

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Abstract: ***The Internet of things (IoT) is a technological phenomenon which is evolving from the innovative developments in Information and Communication Technology. Using Internet Protocol connectivity it is now possible to connect any devices to the internet and allowing them to be controlled and managed from any place and at any time. With the increase in the use of Wi-Fi technology to access internet, IoT is further evolving into Internet of Wi-Fi enabled things. Wi-Fi provides advantages such as IP-based communications, Security and integrity, flexibility. This paper discusses the scenario of Internet of Wi-Fi enabled things and the related technologies.***

Keywords: Internet of Things, Service Discovery Protocol, Wi-Fi, Connected Product, IP

1. Introduction

The Internet of Things is a global network infrastructure that interconnects objects physically and virtually, in order to exploit the captured data and their communication skills. This infrastructure includes sensors and connection capability as the basis for the independent development of services and applications. Also it provides a unique identification to every object and it is characterized by a high degree of autonomous data capture, network connectivity and interoperability. In IoT, the 'things' could be anything from consumer electronics such as coffee maker, smart cooker, to medical instruments such as Mimo monitor. Efforts for porting the IP stack on embedded devices and the introduction of Internet Protocol version 6 (IPv6), which provides extremely large addressing capabilities, facilitated the merging of the physical and the digital world, through the Internet. Intelligent IoT appliances integrate network communication technology and control systems to automate equipment via IoT system and to control appliances remotely via broadband of telecommunications, fixed line and 3G networks [1].In 2020, it is estimated that there will be more than 50 billion machines connected to the IoT, nearly five times more devices than people on the planet .

The very essence of IoT is that any device can be connected to and controlled by other devices from anywhere. To achieve this device must have a unique identity and networking capabilities. Wireless technologies that can support some form of remote data transfer, sensing and control such as Radio-frequency identification (RFID), Bluetooth, Wireless Fidelity (Wi-Fi), and cellular networks can be utilized to embed various levels of intelligence into the IoT enabled system. Networking technologies combined with the data acquisition techniques [2] provides a greater way to build Internet of things. Embedded physical devices such as cooker, washing machines, and air conditioners are becoming smarter and smarter. They are equipped with embedded microprocessors, wireless transceivers and sensors offering limited communication capabilities and providing smart behavior. Such devices are called as connected products in the context of IoT where connected product can be defined as a combination of smart components, physical components and connectivity component [3]. A smart component in a connected product amplifies the capabilities and value of the physical components, while connectivity component amplifies the capabilities and value of the smart components. *Physical* components comprise the product's mechanical and electrical parts. In air purifier, for example, these include the filters. *Smart* components comprise of microprocessors, sensors, data storage, software, controls, and, typically, an embedded operating system and enhanced user interface. The engine control unit, rain-sensing windshields with automated wipers, antilock braking system and touch screen displays are some of the examples for smart components in a car.

This paper is structured as follows: Section 2 Background Research, Section 3 Related Technologies, section 4 Methodology and section 5 Conclusions.

2. Background Research

The IoT encompasses a wide range of technologies that drive its vision. Since 2005, the development wave of the IoT has swept across the world leading to the innovations in the field of information technology. Many countries have put forward long-term national strategies for the IoT. For example South Korea's smart home [4] enables residents to remotely control appliances and enjoy high-quality two-way interactive multimedia services. Singapore's next generation I-Hub [5] aimed to realize the next-generation "U" type network through a secure and ubiquitous network [6]. All these and similar initiatives laid the foundation of the IoT [7].

In the document, Vision and challenges for realizing the Internet of Things, by CERP-IoT [8], a comprehensive set of technologies was listed. Vast research has been conducted by many authors [9] [10] [11] [12] [13]. Smart Home System based on IoT Technologies [14] discusses the architecture for smart home using IoT technologies. Based on this architecture many applications can be integrated into the home system through uniform interface as this architecture provides the scalability. A Novel Smart Home Application Using an Internet of Things Middleware [15] describes the integration of light and temperature sensors. The residences

can interact with these sensors using the middleware. LinkSmart middleware was used in the implementation of this application. The devices equipped with sensors and actuators are interconnected via the Arduino microcontroller, which implements the IoT gateway functionality. Review of the literature survey indicated that most of the authors worked on IoT applications and showed how the devices can be accessed via internet with the help of controllers. Enabling such devices with Wi-Fi module and remote control (from any place and at any time) is not addressed.

3. Related Technologies

Wi-Fi is a wireless networking technology that uses radio waves to provide wireless high-speed Internet and network connections to the systems within the range of wireless network. In [16] the author discusses the implementation of home control system using Wi-Fi network infrastructure. Wi-Fi technology's excellent range, global standards, high data rates, and almost ubiquitous installed infrastructure have made it the access technology of choice for most IoT applications. Wi-Fi's range (up to 400m line of sight) makes it a clear winner for many wireless systems which have widely-dispersed nodes. IoT systems require reliable, low-cost Internet connectivity, which can be supplied by embedded Wi-Fi wireless technology. Using embedded Wi-Fi technology in IoT devices eliminates the use of gateways to connect these devices to Internet.

UPnP technology provides a distributed, open networking architecture to enable a connectivity of smart appliances, mobile devices, Wi-Fi access points and data sharing and control among these networked devices. UPnP includes a set of protocols such as TCP, IP, UDP, HTTP and XML. UPnP technology can be used be with a device that supports IP including Ethernet, FireWire, IR (IrDA), home wiring (G.hn) and RF (Bluetooth, Wi-Fi). Hence UPnP technology can be easily adopted in IoT system.

Bonjour is Apple's implementation of Zero-configuration networking (Zeroconf), a group of technologies that includes service discovery, address assignment, and hostname resolution. Bonjour allows the devices and applications discover each other on the same network. Next section explains Internet of Wi-Fi enabled things using the technologies explained in this section.

4. Methodology

Wi-Fi has become a popular means of wirelessly connecting various electronic devices to the Internet. Recently, not only mobile devices such as Smartphone's and laptops but also home appliances and various kinds of sensors in local area are connected to the Internet by employing Wi-Fi. Figure 1 shows a typical scenario of Internet of Wi-Fi enabled things, where Wi-Fi enabled consumer electronics and smart phones are connected to Wi-Fi access point through they can access internet.

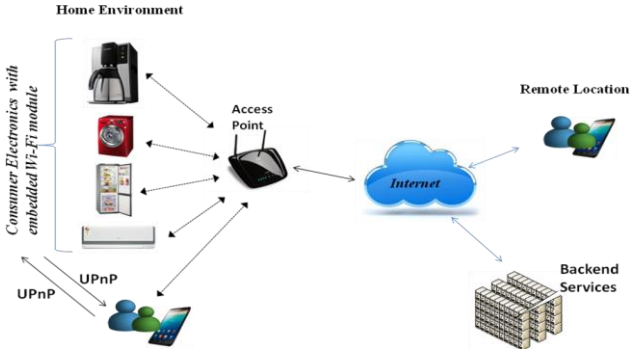

Figure1: Typical scenario of Internet of Wi-Fi enabled Things

Wi-Fi provisioning is the process of connecting a new Wi-Fi enabled system to a Wi-Fi network. The Wi-Fi provisioning process involves providing the system with the network name (referred to as Service Set Identifier (SSID)) and its security credentials. Wi-Fi allows laptops, mobile devices such as smart phones and tablets, to wirelessly connect to the Internet. These systems include a display and a keyboard for the user interface. The usual procedure for provisioning a cell phone, for instance, on a Wi-Fi network is done via the phone's Wi-Fi setting page. The smart phone scans for Wi-Fi networks and presents a list of available Wi-Fi networks to the user. After selecting the network, the user is prompted for a password. If the user provides correct password, then Wi-Fi provisioning will be successful, and it often indicated by a Wi-Fi symbol in a status bar. But the challenge in IoT systems such as air purifiers, air conditioners, is that they do not have a display and a keyboard, and sometimes they don't even have a user interface. Therefore

IoT systems are in need simple and secure alternate methods to obtain the network name and password from the user. Personal computers, phone or a tablet can be used as an extended user interface for the IoT system, allowing the user to provide the network information using the display and the keypad of the PC, the phone or the tablet. Access Point (AP) mode is the most common provisioning method. In access point mode the un-provisioned system wakes-up initially as an AP with an SSID defined by the equipment manufacturer. Before trying to connect to the home Wi-Fi network for the first time, the un-provisioned system creates a network of its own, allowing a personal computer or a smart phone to connect to it directly to facilitate its initial configuration. After the user connects Smartphone to the un-provisioned system's AP, predefined URL is used to provide home network SSID and password to this system. The system stores this network credentials in nonvolatile memory, then it switches from AP mode to the home network using the stored network credentials.

Once an IoT system is added to the home network, the next step is discovery. The simple and easier way to discover and control an IoT system is to use smart phone application which acts as a control point for IoT system. Service discovery protocols (SDP) such as Simple Service Discovery Protocol (SSDP), Service Location Protocol (SLP), and FRODO can be used to discover the services provided by the device.

When an IoT system is added to the home Wi-Fi network, SDP allows that system to advertise its services to control points on the home Wi-Fi network. This is achieved by sending alive messages. When a control point is added to the network, SDP allows that control point to actively search for system of interest on the network or listen passively to the SDP alive messages of device. The discovery message consists of few essential specifics about the system and its services, for example, system identifier, type, and network location to more detailed information about the system. After a control point has discovered a system, the control point still knows very little about that system. For the control point to learn more about the system and its capabilities, and to interact with the system, the control point must obtain the system description from the location (URL) provided by it in the discovery message. This Device Description is expressed in XML and includes vendor-specific manufacturer information like the model number and name, manufacturer name, URLs to vendor-specific web sites, serial number, etc.

In the Internet of Things every entity is accessible, addressable and communicable through the Internet. This is achieved by the ability of the system to communicate over IP address. During the discovery process the control point knows about the IP address of the IoT system. Using this IP address in the predefined URL format the control point communicates with the system. Control point sends the command to and receives the response from system in the JSON format. Further to know the status of the system and control it from the remote location backend services can be used to store the required information. With the help of this backend services users are able to get the real time information.

5. Conclusions

The Internet of Things consists of technologies that allow communication between connected devices i.e. devices with the ability to communicate over the Internet and interact with services, users and applications. Networking technologies plays an important role in this growth. This paper discusses the use of Wi-Fi as the networking and communication technology in the IoT devices. It is an added advantage to use Wi-Fi as it eliminates the requirement for an expensive internetworking gateway to handle functions like network address translation or custom provisioning. Wi-Fi provides the advantages over other networking technologies. Wi-Fi provides greater speed (11Mbps) compared to Bluetooth technology (720Kbps) also network range of Wi-Fi is more compared to Bluetooth. Wi-Fi technology comes with IP connectivity which can be used for remote control of the IoT devices.

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