Secure Internet of Things Environment using XMPP Protocol

Prince Shekhar Valluri
VIT University
334, Mandakini Enclve
Alaknanda, New Delhi - 110019

ABSTRACT
This paper is an effort to electronically connect everyday physical objects so that communication to all devices can be centralized and handled without any hassles. A centralized control is setup which is not connected to any outside network thus, making it completely secure from intrusion. XMPP is Extensible Messaging and Presence Protocol that will allow the devices to communicate with the user with help of a smartphone. Communication with the devices will be with the help of standard controls broadcasted by each device. A user connects to the hub (router) using a WPA2 encrypted Wi-Fi Network thereby eliminating the threat of intrusion and misuse. Each device that is logged into the network will broadcast its general set of instructions that can be used to manipulate its controls, movements etc. An app on the user's smartphone will be used to identify all the devices currently available, fetch the instruction set of each and show it to the user in an interactive user interface.

General Terms
Internet of Things, XMPP, WPA2, WEP, 802.11n

Keywords
Internet of Things; connected devices; home automation; XMPP; encrypted network

1. INTRODUCTION
Internet of Things refers to creating an ecosystem of connected hardware around us all of which can be manipulated without physically interacting with the device. This technology has come to the forefront with millions of dollars being invested into its research. However, a major drawback of the system is the lack of a standardized protocol and a secure environment to protect it from intruders. This paper researches the scope of using a general Wi-Fi network and the XMPP Messaging Protocol, which is widely used in chat applications, to be used together to form an environment that is both safe and generalized such that every device can use the same protocol for communication and carry out its tasks.[8]

Internet of Things is a fast growing technology realized today with the use of technologies like RFID, Real time localization, sensor networks etc. This marks the beginning of an era of smart and intelligent devices which are able to interact with each other and create a web of physical devices. This technology is being researched today by a wide range of professionals from both academia and industry. [1][9]

One of the available tools for prototyping, testing and deploying connected devices is the Microsoft .NET Gadgeteer that has all the key elements for rapidly constructing electronic device hardware along with the ease of coding and debugging and compatible with a raft of web services for additional processing that may be incorporated.[2]

This papers explores the possibility of using an approach that has proven to be one of the most successful communication protocols of all time, XMPP. This protocol has found a large use in messaging/chat applications but upon further research, it has been found that there can be many more applications of the protocol like the Internet of Things.

2. TECHNOLOGIES
2.1 XMPP
XMPP, which stands for Extensible Messaging and Presence Protocol, is a communications protocol for message oriented services and applications. It can used for real time communication and presence information. The most useful strength of XMPP for this application is that it is decentralized and an XMPP server can run almost anywhere for a local network too. It is flexible enough to be customized for a special purpose such as Network Management, Collaboration Tools and in this case Internet of Things. [3]

It is formalized by the Internet Engineering Task Force (IETF) as an approved messaging and communication of structured data between two entities. Every device is identifies by a unique address referred to as "bare JID" which consists of a "localpart", "domainpart", and "resourcepart" and represented as "<localpart@domainpart/resourcepart>". Structured data is transmitted asynchronously over the network to the global address of the given device concurrently. An illustration of the communication is as follows:

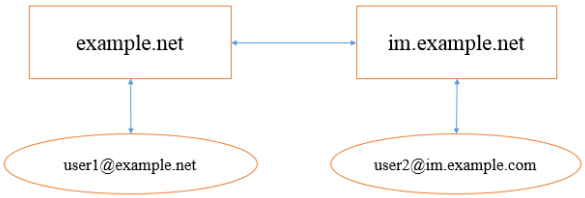

Fig 1: End-to-end communication in XMPP

It utilizes a reliable TCP service for data transmission and is fault tolerant. The data is sent as an XML stream over the network marked by an opening and closing "stream header" thereby making the transfer completely asynchronous and fast. [3][4]

2.2 IEEE 802.11n (WLAN)
IEEE 802.11n is a standard specification for the implementation of Wireless LAN networks, an amendment to IEEE 802.11 standard that is capable of high speeds up to 100 Mb/s. It consists of Media Access Control and Physical Layer specifications. Today, is it most widely used WLAN network specification around the world and an excellent contender for the purpose of a secure network for Internet of Things. [5][6]

3. SYSTEM DESIGN

3.1 Setup

Every device connected to the Wi-Fi network uses a unique IP address that can be used to reach that device. The client application on a smartphone discovers all the connected devices and enables the user to start interacting with the devices. Each device broadcasts itself over the connected network so that a smartphone that is connected to the network can discover these devices for further communication.[4]

3.2 Device

Every device is programmed to interact with a specific set of commands that can be retrieved using the "help" command. This message sent over the network reveals all the possible interactions that can be done with that device. Upon selecting each command, the device reacts accordingly.

3.3 Smartphone Application

A smartphone application made for the purpose discovers all the devices currently on the network and ready to start communicating. This is done using the "Presence" functionality of XMPP. Upon retrieving the device specific instruction set with the "help" command, the app is used to analyze the commands of each device individually and make requests over the network in the form of text messages that are sent directly to that device through the hub. All the functions of the device are visible to the user through a friendly interface. Since XMPP supports delivery reports, the user can be aware of the status of the request. [4]

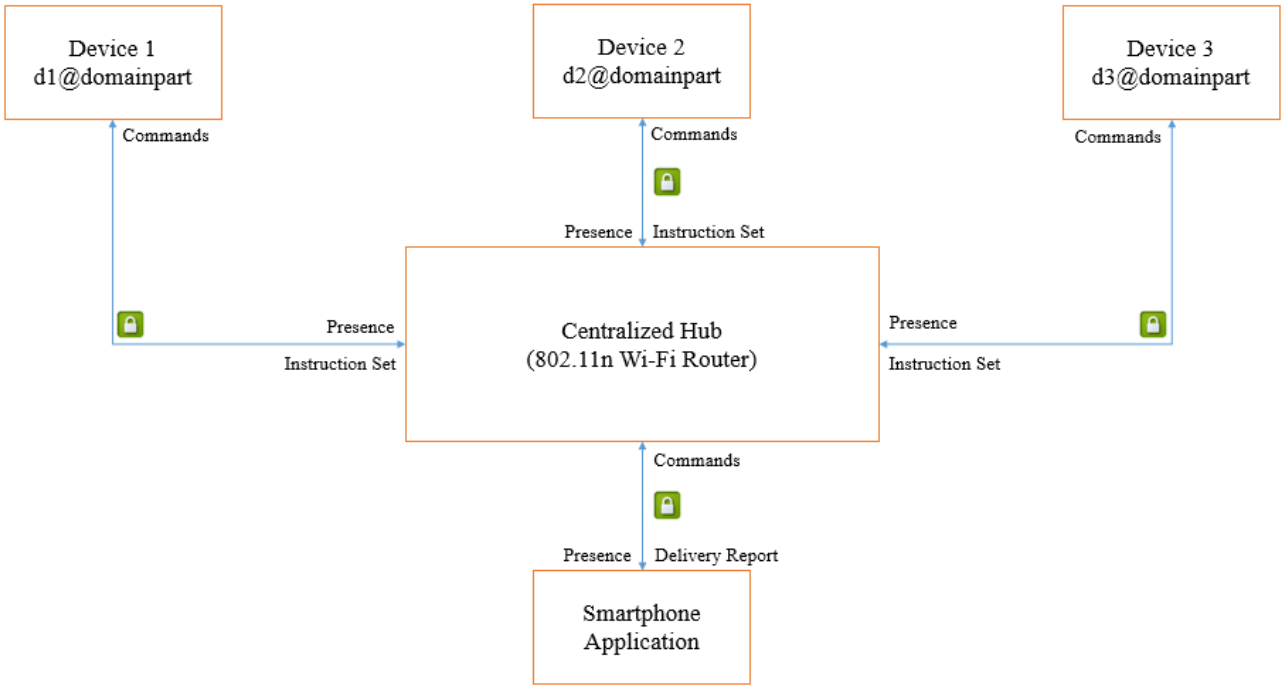

Fig 2: Schematic diagram of the network that shows XMPP ID's of the devices and the communication with the smartphone app over the 802.11 Wi-Fi network through a router.

4. INSTRUCTION SET

Once connected to the smartphone each device broadcasts its own instruction set over the network which can be used to control the device. The instruction set is the format of commands that can be communicated to the device to perform a specific task. It consists of two main parts, the "opcode" and an optional "operands". The "opcode" refers to the code name of the function that will be performed and typically represented as an abbreviation of the name of the task. The "operands" are the arguments passed in the instruction that specify the task further. [7]

Following is a table that shows an example instruction set of a microwave

Table 1. Example Instruction set of Microwave

Task	Opcode	Operand 1	Operand 2
Preheat	PREHEAT	TEMP. (Celsius)	TIME (Minutes)
	Example: PREHEAT 350 20		
Grill	GRILL	TIME (Minutes)	NONE
	Example: GRILL 15		

5. CONCLUSION

In this world of technology where Internet of Things is rapidly growing into a huge industry, a standardized communication protocol among the devices will help the development and generalization of these technologies. With an expected 10-15 billion things interconnected to each other by 2020, there is a huge potential in this field. Initial prototype suggests that the idea of using XMPP for communication between devices can be achieved with a fairly decent understanding of the protocol itself and some networking fundamentals. It seems to be a very reliable and secure method of communication between devices. [9]

This paper aims to provide a general protocol for communication for interconnected devices that can be further developed and deployed in the millions of things that will be available in the market in the near future. Thus, the proposed system will improve the existing quality and reliability of the Internet of Things.

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7. REFERENCES
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