International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2015): 6.391

IoT Data Access via Email System using POP3 Protocol

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Abstract: ***Internet of Things (IoT) is the set of technologies enabling the interconnection of objects by uniquely identifying them in the network. These objects can be provided with sensors/actuators and can easily make information available or perform complex actions .For connecting these things, we need a common platform for communication. Email system can play a vital role when we want secure communication in the world of IoT. Communication between email servers and clients are governed by email protocols. Four important protocols used in email communication are IMAP, POP3, SMTP and HTTP. This paper will focus on POP3 which is designed to support offline/local email processing. Email is delivered to a mail server and a remote email client regularly downloads the email from the server to the user's computer. Once the messages are delivered, they are deleted from the mail server, although users can configure their email client to leave a copy of the email on the mail server.***

Keywords: IoT, Webmail, POP3, IMAP, SMTP, HTTP

1. Introduction

IoT is service oriented network with resource constraints and is compulsory subset of future Internet. IoT is convergence of sensor nodes, RFID objects and smart devices [9]. IoT connects objects around us (electronic, electrical, and non-electrical) to provide continuous communication and contextual services provided by them. IoT based email-system is an approach to give security and privacy to the all information and the communication services.

Email was designed to enhance communications by making it faster and secure. An effective business email service allows you to concentrate on your business instead of worry about managing an email system. In the world of business, managers regularly communicate with their employees, customers via email. E-mail system has become the most popular computer based service used to send and receive E-mail messages between the network clients inside or outside the local network.

Communication between email servers and clients are monitored by email protocols. The three most common email protocols are POP, IMAP, SMTP and HTTP. The original POP was developed in 1984 to offer people with a simple means of accessing their email from remote server. Let's discuss the retrieval protocol used for offline download the mails i.e. POP. The release of POP2 in 1985 provided a wide range of commands and replies. Additionally, POP2 allowed the user to select and to read only one mail instead of having to download all their email at the same time. In 1988, the release of POP3 made accommodations for the users of personal computers to retrieve their email efficiently and easily. No revisions have been made to POP since 1998. The Post Office Protocol recently in version 3, hence POP3 allows email client software to fetch email from a remote server. The Internet Message Access Protocol (IMAP4 because now it is in version 4) allows a local email client to access email messages which is present on a remote server. There's a related protocol called SMTP, which we also discuss below. POP is the older design, and hails from an era when discontinuous connection via dial-up was the normal. POP allows users to retrieve email from the mail server when connected, and then act on the retrieved messages without needing to stay on-line. This is advantageous when connection charges are too much expensive. The basic POP procedure is to fetch all inbound messages for storage on the client, delete them from server, and then disconnect. The email server works like a normal mailbox at the Post Office - a temporary holding area until mail gets to its destination, users computer. Outbound email is generated on the client, and held for transmission to the email server until the next time the user's connection get activate. After it's uploaded, the server forwards the outgoing mail to other email servers, until it reaches to its destination. Most POP clients also provide an option to leave copies of email on the server. In this case, messages are only taken off from the server when greater than a certain duration of age or when they have been explicitly deleted from web client [8].In short, you should use POP Protocol only if a) You want to access your mail from only one single device b) You need constant access to your email, regardless of internet availability c) Your server storage space is limited.

Summarizing whole scenario, IMAP and POP protocols are used to access the email and SMTP is used to send the email. Webmail is a tool which allows you to send and receive emails directly from any computer connected to the internet. Webmail is perfect when you need to check your mail inbox while traveling or using another person's computer. Person can access webmail as long as you have a browser with proper Internet connection.

2. Motivation

Now a day's industries, organization and technologists catch the IoT bug. When you look for a generic way of communication between the entities of IoT, we need a

common platform for communication. Email system can be the good option when we need secured communication between these entities. In this modern era, many are uncomfortable with keeping personal data like email on a third-party server. In such condition POP3 allows you to take out their data from email server and keep it private to their own device

3. Related Work

To understand the importance and working of this retrieval protocol, we need to study previously available webmail client. According to user's desire, webmail client allows them to retrieve emails using suitable protocol. Here is a wise selection of the best and outstanding webmail client for accessing users email account through web browser.

RoundCube: The RoundCube project is a free and open source webmail solution with a desktop interface which is easy to install. As a webmail solution, it has all the basic functionality you would expect, including send, receive, reply, forward, and delete...Messages can be flagged, marked as read or unread. You have the choice of All, Unread, Flagged, Unanswered and so on. This can be very useful if your Inbox is starting to get cluttered. It is totally free and open source [1].

SquirrelMail: SquirrelMail consists standards-based webmail package written in PHP. It includes built-in PHP support for the IMAP and SMTP protocols, and all pages developed in pure HTML 4.0 (with no JavaScript required) for maximum compatibility across browsers. It has very few requirements and is easy to configure and install. SquirrelMail has all the functionality you would want from a webmail client, including strong MIME support, address books, and folder manipulation. In short we can say, it provides basic and simple functionalities, so it the best option for those who want to configure webmail according to his choice [2].

Internet Messaging Program (IMP): IMP has more features compared to the earlier two webmail clients SquirrelMail & RoundCube and it has similar functions to Outlook. IMP webmail comes with features such as address book, as calendar, task list and more. The e-mail management system includes support for advanced filters, attachments, spell checking, and displays HTML e-mail well. It also comes with Task management functions, whereby you can list your task, set the task as reminders and keep track of the task progress [3].

Mailpile: Mailpile is a webmail with the focus on providing users with encryption and privacy features by default. It is free and open-source software. Mailpile has search engine and a personal webmail server However unlike other webmail solutions, Mailpile is meant to run on personal computer, so you have control over your data and privacy. Mailpile also does not force you to change e-mail addresses, it works with the e-mail addresses you already have [4].

AfterLogic WebMail Lite: It is an open source webmail front-end for your existing mail server, written in PHP [5], like other studied webmail client it is open-source webmail script for your existing IMAP server. It can run on a HTTPS server and communicate with a mail server over SSL connection. It is available in more than 20 languages. [6]AfterLogic WebMail Lite PHP is a free AJAX webmail application in which users can receive, view, compose, and send email through web interface (IMAP and SMTP supported).

4. Evaluation of Related Work

The table below shows comparison between different webmail clients available for various operating systems. Parameters selected for comparison are platform support, Protocol support, Retrieval Method which they are using for downloading the mail from server and the light weighted apps of email client

Platform support describes about the operating system platform on which email client is working. There are various webmail clients are present which have their own light weighted app version. This is the key feature will be the value added for proposed email service. Proposed webmail client is supporting to the IMAP and POP to provide flexibility of storage and privacy depending on the user's choice. Selection of proper retrieval protocol will help user to manage their personal data.

Table 1: Webmail client comparison

Client	*Operating system*	*POP3 protocol support*	*IMAP protocol support*	*Mobile OS support*	*IoT Provision*
RoundCube [1]	Cross-platform	Yes	Yes	Android	No
SquirrelMail [2]	Cross-platform	No	Yes	No	No
Internet Messaging Program [3]	Cross-platform	Yes	Yes	Android	No
Mailpile [4]	Cross-platform	Yes	Yes	No	No
AfterLogic WebMail Lite [5]	Cross-platform	No	Yes	No	No

As shown in the table we have compared five different webmail clients on five different parameters. Moto behind the study of this webmail client is that to explore what services there are providing to common person.

Being a web client these are accessible from any machine or devices which have facility to open web browser. All are open source and freeware. Advantage of using open source webmail client is that they offer significant benefits when compared with typical commercial products. Commercial products typically focus on features over harder-to measure qualities such as stability, security and similar less glamorous attributes

User can have access to his email using desired protocol POP or IMAP. AfterLogic webmail lite do not support for POP

retrieval protocol [5]. Latest version available for these protocols are POP3 and IMAP4.It's good when you have android version for your webmail application as it provides ease of access and being light weight than desktop site. This entire feature altogether will help to build powerful web application for IoT. Thus considering all these parameters of previous released webmail application, there is requirement to develop new webmail application along with feature of IoT. This will include middleware for the data communication between physical things to email server.

5. Proposed Architecture

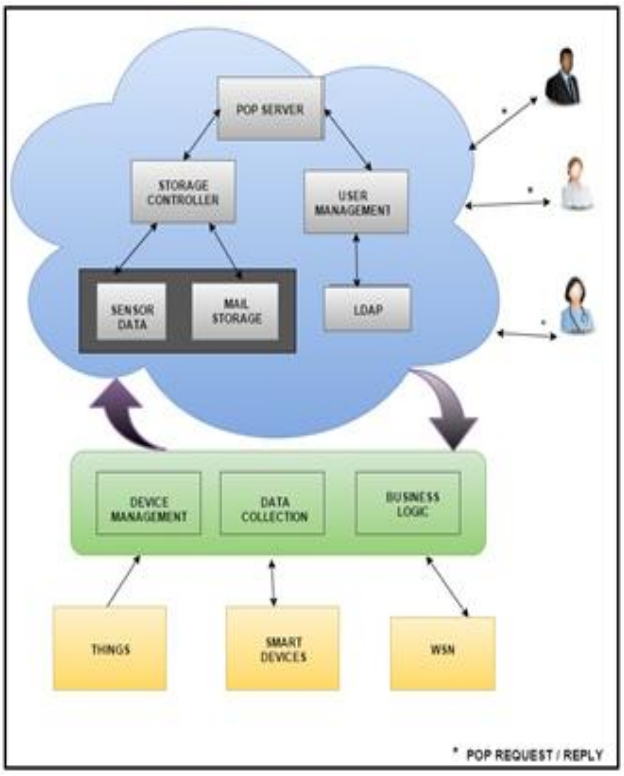

Figure 1: Proposed Architecture

Over the last few years we have seen a large number of IoT solution developed by various start-ups, small and medium enterprises, large corporations, academic research institute and private and public research organizations making their way into the market of next generation computing.

In this section we have focused on email system for the communication between the things in IoT network. Here we've proposed architecture of Email system for IoT. At the Base level; things, smart devices and WSN sends data generated by sensor to the data collection node. Data collection node has responsibility to keep track data generated by each device at the same time it needs to manage devices. The business logic at data collection node is required to adopt heterogeneous devices. These devices will communicate on common platform for better co-operation between them. Email server of IoT will be connected with two separate data base, sensor information block and mail storage block. Under the sensor information block all the information and unique identifiers of registered devices will be store this data will be in unstructured format. The second block which we have mentioned over here will be holding the information about customers such as normal email messages, user details which will be in the form of structured data. Email server will be able to manage both databases. Through webmail client, user will have facility to access their registered email account and he will have control over the data associated with them. To retrieve email linked with them they will have the facility to choose appropriate retrieval protocol IMAP or POP. Those who want to maintain a copy of their data on mail sensor will choose IMAP where as those who do not wish to keep their personal data on third party server can choose POP3. Here is the summary of operation when you choose POP3 as your default retrieval method, The POP3 service is the interface between webmail clients and the mail store. POP3 listens to TCP port 110 for connections from e-mail clients, authenticates the client, and manages the connection with the client. The authentication store is the repository of user's information needed to authenticate the user. The authentication module (LDAP) accesses the authentication store to verify the credentials submitted by the user to the POP3 service. The Mail Storage Access API is the common interface to the mail store for all processes. The mail store uses the file system for storage. The mail store is typically situated on the same server as the POP3 service, but it should be located on a different local or network volume than the operating system to avoid potential disk space problems. For large mail stores, the mail store can be placed on a Network Attached Storage (NAS) device and accessed by servers running the POP3 service... This process of email communication will generate huge data through things, devices and WSN which can be used for different purpose like online survey, social media or any business intelligence solution

6. Mathematical Modelling

Mathematical model of architecture helps to calculate the impact of given problem statement on whole system. The service time define the number of mails processed per unit time M is the number of servers, L is packet length, B is bandwidth, L_d is Login delay and P_d is processing delay.

$$\text{Service Time}(S) = M\frac{L}{B} + L_d + P_d \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

The departure rate can be determined by following equation (2).

$$\text{Departure Rate} = \frac{1}{M\frac{L}{B} + Ld + P_d} \quad \ldots\ldots\ldots (2)$$

The Utilization can be determined by following equation(3)

$$\text{Utilization (U)} = \frac{A\frac{LM}{B} + Ld + P_d}{M} \quad \ldots\ldots\ldots (3)$$

P_0 Again found by summing state probabilities

$$1 = P_0\left(\sum_{k=0}^{m-1}\left(\frac{A\frac{LM}{B} + Ld + P_d}{M}\right)k * \frac{1}{K!} + \sum_{k=0}^{\infty}\left(\frac{A\frac{LM}{B} + Ld + P_d}{M}\right)k\right)$$

7. Result and Discussion

The performance of proposed system analysed by considering various parameters and proposed mathematical model. In this analysis, Bandwidth and packet length are kept constant and arrival rate is varying. There is no impact of packet length on the processing delay. Arrival rate of email in the system is exponentially distributed or randomly

distributed in time domain. After the arrival of email in the system it waits in the queue for processing so we need to consider the queueing delay of the email.

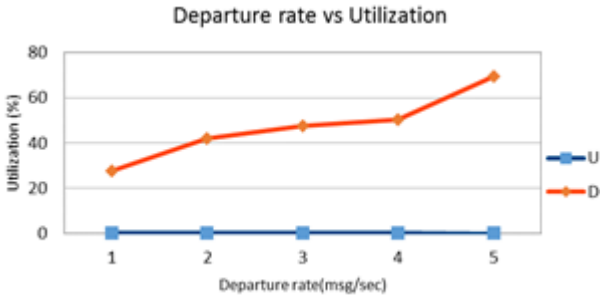

Figure 2: Departure rate vs Utilization

Fig [2] shows relationship between departure rate and utilization. As the departure rate of system increases the utilization of system decreases. After certain threshold value utilization of system remains constant.

Fig [3]shows a relationship between service time of the system to the utilization of servers in the distributed environment. Departure rate of emails is depending on the service time. As the service time increases the departure rate decreases and vice versa. The following relationship is derived from the equation 2 and 3 which are proposed in the previous section. Utilization of server depends on arrival rate, departure rate and Number of servers as well. The bent in curve shows the delay introduced which are queuing delay and login delay. The departure rate and utilization of server are inversely proportional.

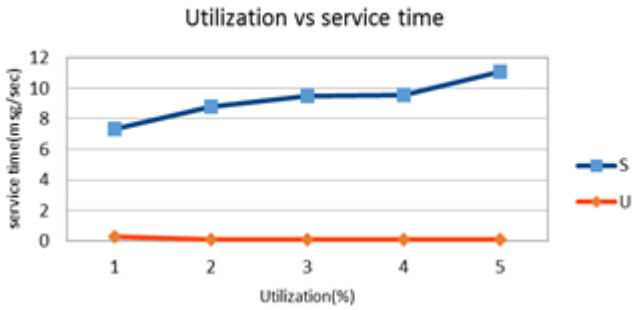

Figure 3: Utilization vs Service Time

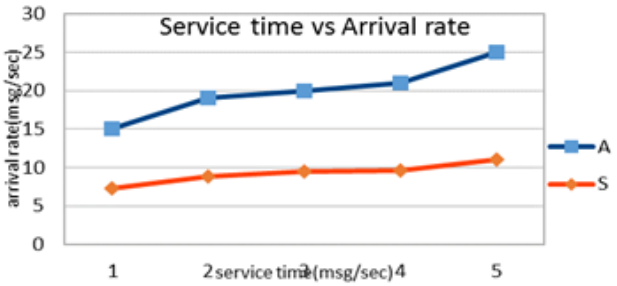

Figure 4: Service Time vs Arrival rate

The fig [4] show the relationship between arrival time and service time. As the arrival rate of mails increases the service time also increases. The arrival rate depends on inter-arrival time between two emails. Inter-arrival time of message inversely proportional to arrival time.

8. Conclusion and Future Work

In this paper, we have introduced the conceptual model of IoT based email system. To our best knowledge this is the first attempt to integrate email application on IoT system. We showed how it can be used for secure communication in modern era. We presented email retrieval method for proposed email system and their impact on whole system through representation of mathematical modeling. We also believed that Email system for communication can significantly contribute the evolution of IoT.

9. Acknowledgement

This work is sponsored by DSM Bhalerao Infotech, Mundhwa- Pune.

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