ISSN:2321-1156
International Journal of Innovative Research in Technology & Science(IJIRTS)

A FOCUS ON INTERNET OF THINGS SECURITY IN MOBILE APPLICATIONS FOR SYNCHRONIZING PRE-PAID ELECTRICITY TOKENS

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Abstract

Smart home designs are becoming the new wave of technological advancements. There are many application domains in a smart home environment, and the convenience of managing and monitoring electricity consumption with the use of smart meter system is one that cannot be ignored. The need therefore to look at the security implications of such a design is what this paper focuses on as the domain of Internet of Things (IoT) is brought to life. The methodology employed for this research was predominantly qualitative. Based on literature findings, this research recommends the security component for any app designed be examined and holistically bisected.

Introduction

As informed by the researchers findings from the primary data collected, the first prepaid electrical transaction in Windhoek was in 1994 and to date there are 41 094 pre-paid meters installed in the city "unpublished" [1]. The system allows customers to buy a prepaid energy meter and have it installed at their residents. The system enables the customers to make advance payment before using the electricity by purchasing electricity vouchers. Once the purchased electricity units are used up, the electricity supply is instantly cut off. Even though different models of the prepaid energy meters have been manufactured over the years, the system still operates in the same manner since its implementation.

The growth of mobile application usage in today's technologically driven age, has witnessed many application areas being driven by mobile apps. In today's world, one can simply use their smart phone for various functions such as calculating exchange rates, get the latest weather reports, get traffic information, perform banking transactions or even book a flight. Through the use of mobile applications, it is now easier for marketers to conveniently engage with customers. The possibilities presented by mobile applications use have witnessed the growth of seamless connections on an anywhere, anytime basis [2].

It is against this background that this research focuses on the technologies involved in creating a mobile application specific to prepaid electricity. An application that will enable the customers to view their energy meter readings (units) as well as update them by entering the voucher values (token) on the mobile. The mobile application should also inform the customers once the transaction has completed successfully. Customers should be alerted by the mobile application once specified threshold values are reached, this will enable customers to proactively buy "recharging" rather than to wait until the electricity is cut off. Thus a proposal to tap into the potential of IoT in this field. The focus therefore is on how such designs can be dome in as secure manner.

The number of mobile phones users in Namibia has increased over recent years. In 2013, MTC alone recorded over 2 million active subscriber base [3]. As a result, it has become extremely important to continue innovations to offer more services in this area.

Motivation

The IT industry in Namibia has grown over the years as a result; it is significant that IT solutions are developed to enhance the living conditions. It is also important that Namibians develop solutions themselves rather than acquiring off the shelf products. A major disadvantage to acquiring off the shelf product is that they may not directly relate to the Namibian market, and appeal to the native spoken rich language.

With the advancement of technology, it is important to eliminate manual processing in many aspects of life and prepaid electricity systems are no exemptions. With the development of a prepaid electricity mobile application, prepaid electricity customers will profit greatly by being able to monitor as well as update their electricity energy meters from their mobile devices *whenever* and *wherever*.

The ability for Namibians to create mobile applications that addresses the Namibian market may lead to job creation as such skills are rare but in demand.

A. Problem Statement

Prepaid electricity customers in Namibia have been using the system for over 10 years. Even though some processes have been automated, such as being able to purchase the voucher (token) through internet banking, there are still

manual steps involved. One of the major issue is the fact that after purchasing electricity and obtaining your unique values (token), one would have to go home and physically punch in those values on the prepaid energy meter device in order for your meter units to be updated. Another issue is that, when one is not at home, it's impossible to get your energy meter units (current usage), thus you won't be able to determine whether or not you need to purchase electricity.

The MTC tango system is an exemplary solution to benchmark on how one could automate the prepaid electricity system. When one purchases a tango recharge voucher, you receive your unique values (token). You can then send an SMS to the number 139 with your unique numbers as the body of your massage. Your balance gets updated based on your recharge voucher value. To obtain your balance, you simply dial or send an SMS to the number 139 and your balance get displayed on your mobile phone screen [3].

Since both systems uses tokens, this research focus on how the pre-paid electricity systems can be improved to behave in a similar manner as the MTC tango system whereby one would use a mobile application to mainly update and read energy meter units.

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B. Overview of Prepaid meters

Prepaid energy meters have advanced in recent years and there is sufficient amount of literature available. There is enough information available in books as well as the Internet about how prepaid electricity systems work [4] and mobile application programming languages.

Frost and Sullivan released a white paper entitled "Are you ready for the prepaid meter revolution" [5] that addresses the challenges faced by utility companies and how these companies can use "Smart Meters" to create business opportunities. The paper explains how "Smart meters have the ability to send and receive data from the utility." This ability, something that is not practical with traditional meters allows for innovation in this area.

As espoused by [6], the potential benefits of using Smart Metering. Benefits such us the ability to receive real-time consumption information via display device are outlined in [6]. According to [6], utility companies can also benefit from Smart meters, as they are able to receive usage information. That information can be used to analyze and manage supply portfolios.

Smart energy meters are built with a Global System for Mobile communication (GSM) module that enables energy distribution companies to remotely control the device. Most innovation in this area is centered on the benefits the solution provides to the energy distribution companies. Very little attention is given from a customer's perspective.

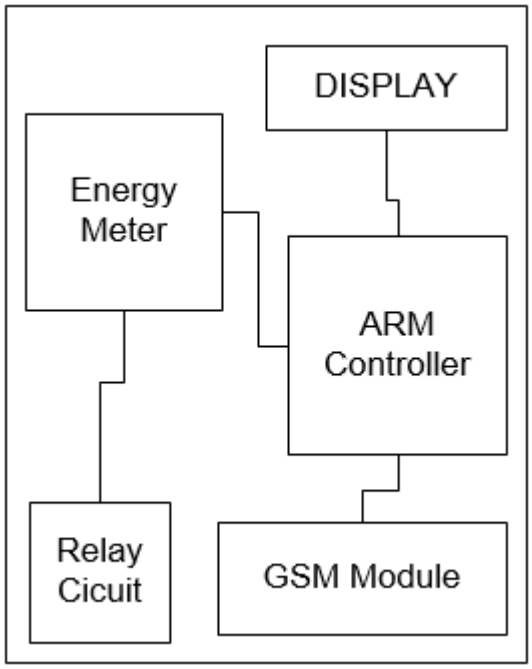

Figure 1 Components of a smart energy meter

Figure 1 is a simple overview of the components typically found in smart energy meters. The GSM module consist of a SIM card and utilizes telecommunications systems to transmit data to energy distribution companies. The number of available electricity units is digitally displayed at the top of the energy meter. The relay circuit feeds the household with electricity received by the meter from electricity distribution companies.

C. GSM Technology

GSM is broadly recognized as a digital mobile phone system that many parts of the world are using to date. The GSM technology was first launched in Finland in 1991 and it operates at either 900MHz or 1800 MHz frequency band [7]. A GSM phone makes use of the SIM card to identify the owner of the mobile phone. GSM digitizes and compress the data, then sends it down a channel with two other streams of user data, each with its own slot [7].

An alternative to GSM technology is CDMA (Code Division Multiple Access). Together with GSM, they are the mostly widely used radio systems in mobile phones. Most mobile networks including MTC and TN mobile in Namibia make

use of the GSM system. It is for this reason that research concentrated more on the GSM system.

For a GSM technology to function, The following needs to be in place, an MS (Mobile station) entailing both a SIM card and a mobile phone, a BTS (Base Transceiver Station), a BSC (Base Station Controller), SGSN, GPRS PS: Packet Switch or GGSN and then finally the core network consisting of SMS-GMSC as depicted in Figure 2.

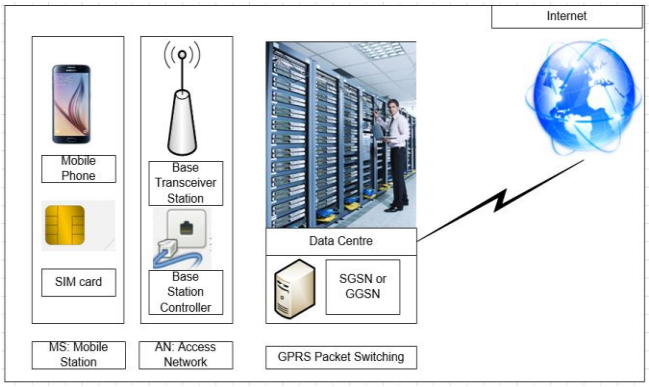

Figure 2 GSM Systems components

Orbit, a company based in Australia uses GSM technology to control different equipment's remotely. With Orbit GSM remote control, reading current dam levels and the ability to remotely operate pumps has been made possible through the use of mobile phones [8]. Figure 3 indicate the different appliance Orbit GSM remote control is able to adjust remotely.

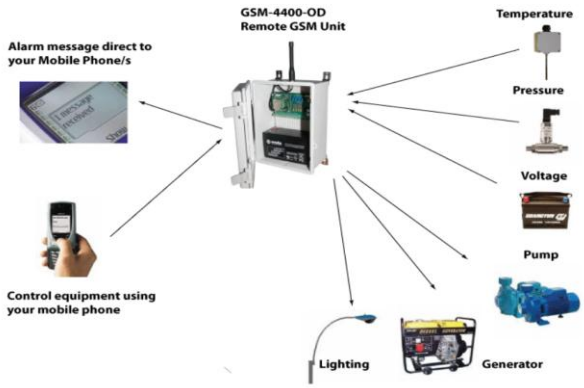

Figure 3 :GSMX Remote control and alarm system

Mobile Application

As portrayed by [9] businesses can take advantage of mobile commerce, especially as validated by [9]'s statement, "Mobile technology allows businesses to become more service-oriented in what they do and to tailor what they provide to better meet the needs of individual consumers." [9] further elaborates how our living styles have been disrupted or altered by mobile phones, therefore this research focuses on more innovation around services that can be provided using mobile devices particularly in the electricity area but with an eye towards security on the adoption of such technology.

Efforts were made in the early 2000 to develop a "smart phone" by companies such as BlackBerry. But it was only in 2007 when apple released its first iPhone that smartphones become to conquer the world. Many other mobile companies such as Samsung and Google followed soon by creating their own version of smartphones. The ability of customers being able to download mobile applications onto their smart phones was one of the key reasons for the success of this innovation.

By July 2015, android users had 1.6 million mobile applications available for download while in comparison, Apple App store had 1.5 million mobile applications available [10].

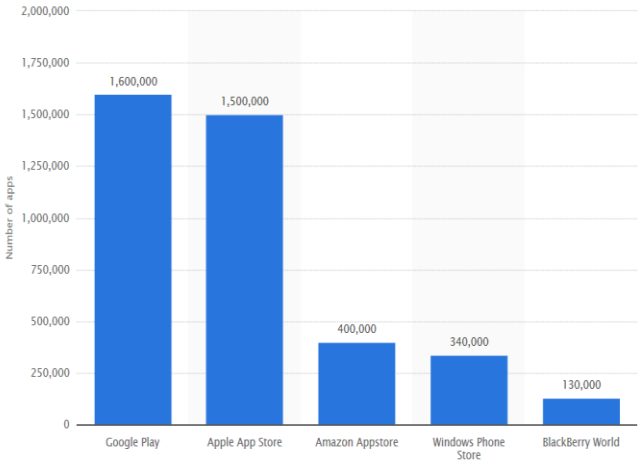

Figure 4 Number of apps available in leading app stores as of July 2015 [10]

With the integration of the GSM module with energy-prepaid meters, options are now available to continue innovation along this area. Although there are overwhelming technology innovations to date, this research finds very little literature with regard to mobile applications for pre-paid electricity in Namibia or Africa at large. This paper will perhaps supplement the research in this field of study.

Study Area

Electricity distribution companies use energy meters to determine how much units a specific residence or business consumed thus enabling them to bill them appropriately. In Namibia, there are two ways consumers pay the usage of electricity. One is by paying a monthly usage bill that electricity distribution company's issue to their customers at the end of every month and the second is by buying electricity units upfront. This research focuses on the latter whereby customers have a pre-paid energy meter installed at their premises and when they purchase electricity, they receive a token from that specific vendor. It is this token, a twenty-

digit number that customers have to go manually input on the pre-paid meter at their residents. This research's main goal is to eliminate any manual processing involved by introducing a mobile application that's lets you send this token digits to your pre-paid meter via the internet but maintaining the security and privacy of your personal data.

Of the 57 respondents, 64% had pre-paid energy meters installed at their residents while the minority 33% had conventional energy meters whereby they receive monthly usage bill from electricity distribution companies on a monthly basis.

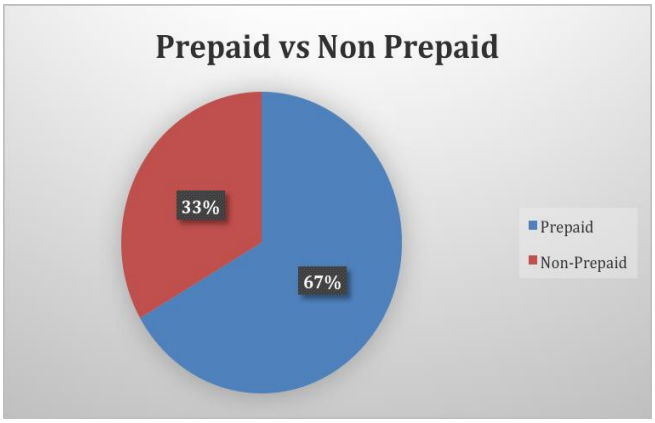

Figure 5 Prepaid vs Non-Prepaid Respondents

Sixty four percent of the respondents that have pre-paid energy meters installed at their residents indicated that they have to make a phone call at least once a month to someone at the resident to find out how much electricity units are displayed on the pre-paid energy meter.

The most popular features that respondents were keen on were the ability for the mobile application alerts them when the electricity units are low. This will enable them to proactively purchase electricity units. The ability for the mobile application to send the purchase units (token) straight to the prepaid energy meter was the second most popular feature. Third came the ability to display live units amount as displayed on the meter at their residents.

Security Concerns on Mobile App for Electricity tokens synchronization.

As a concern for the security design of the mobile app, the danger of exposing personal data is greatly of concern. Once there is a traceable link between a mobile app and a specific electricity meter that entails one can track the actual physical residence of the mobile phone owner. Usage patterns can be tracked by monitoring last bought units and next purchase.

The ability to avail a reading ability of the actual meter reading in real-time also prevents a critical risk, if an intruder gains access to such valuable piece of information, they are able to monitor when there is slow consumption which may signal absence of inhabitants in a given household.

With the interconnected nature of objects in a house setting a lot is at stake from the security side, however, our focus is on privacy issues especially safeguarding personal data. Most apps on the market do prompt and request access to many features of your mobile phone like camera, documents and profile, which is amongst the challenging issues of app design and deployment.

Proposed Security Considerations

Based on the feared security concerns, it is the recommendation of this paper that consideration be made to the salient features that compromise the privacy of personal data as such the app should be limited to only meter reading capabilities and have sharing capabilities with other objects or applications be disabled.

All information disseminated between the app and the physical electricity meter should be encrypted. Henceforth a lightweight encryption scheme should be implemented in the design of the proposed electricity synchronization app for updating tokens.

Conclusion

Statistical analysis of survey results shows that both pre-paid and non-prepaid customers are very interested in a mobile application that would allow them to remotely operate their energy meters. This will allow them to continuously and conveniently monitor their electricity usage. Further assessment of the results indicates that the most important feature the mobile application should have is the ability to alert customers when a predetermined threshold value is reached. Thus providing them with enough time to purchase electricity and prevent cut-off.

Acknowledgments

The authors are thankful to IJIRTS Journal for the support to develop this document. The Namibia University of Science and Technology's Digital Forensics and Information Security Research cluster for availing a thriving research atmosphere.

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