MANTECH Publications

Journal of Smart Grid Technology
Volume 2 Issue 3

A Lightweight and Secure Cryptography for Communication between Smart Meters and Grids using ARM cortex M0 Microcontroller

R.Stephygraph[1], K.Ganesan[2]

Professor[2]

Department of EEE

R.V.S College of Engineering Dindigul, Tamilnadu, India

Corresponding Author's Email Id: *Stephygraph25@gmail.com*

Abstract

In this paper data transmission with secure option using wireless technology the Smart Meters send the energy consumption unit and peak load usage time to the Smart Grids. Light weight and fast computing TEA algorithm is implemented for the data security. More importantly, our formal verification using the C tool and implementation on an ARM Cortex M0 Microcontroller confirms our claim using lab view at server side.

Keywords: *Component, Smart grid; Smart meter; Wireless sensor networks; Zig Bee*

I. INTRODUCTION

Computer Networks have lots of vulnerability and threats. No security for data transmitted between Smart Meters & Grids. For this reason, Cryptography (Encryption & Decryption) is used for security purpose. Encryption is the conversion of data into a form, called a cipher that cannot be understood by unauthorized people. Decryption is the process of converting encrypted data back into its original form, so it can be understand. Cipher is also known as encrypted or encoded information because it contains a form of the original plaintext that is unreadable by a human or computer without the proper cipher to decrypt it. Decryption, the inverse of encryption, is the process of turning cipher text into readable

Page 1-10 © MANTECH PUBLICATIONS 2017. All Rights Reserved

plaintext. Encryption and Decryption should not be confused with encoding and decoding. TEA operates on two 32-bit unsigned integers (could be derived from a 64-bit data block) and uses a 128-bit key. Smart Meter will send data with TEA Encryption using arm Cortex M0 Microcontroller. Smart Grid will run decryption algorithm to extract the actual data.

II. MATERIALS AND METHODS

Smart Grid with is dynamic model has an exciting potential. Fig. 1 shows evolutionary perspective of SG in past, present and future plans.SG provides two way communication and energy flow comparing to existing conventional grid. Fig. 2 shows general communication architecture for smart grid from power generation, transmission, distribution to buildings and homes. Smart grid information path starts with broadcasting from sensors or smart devices to smart meters and then passing to the control centers. In communication side the wireless networks are one of the most researched area in smart grid power systems.

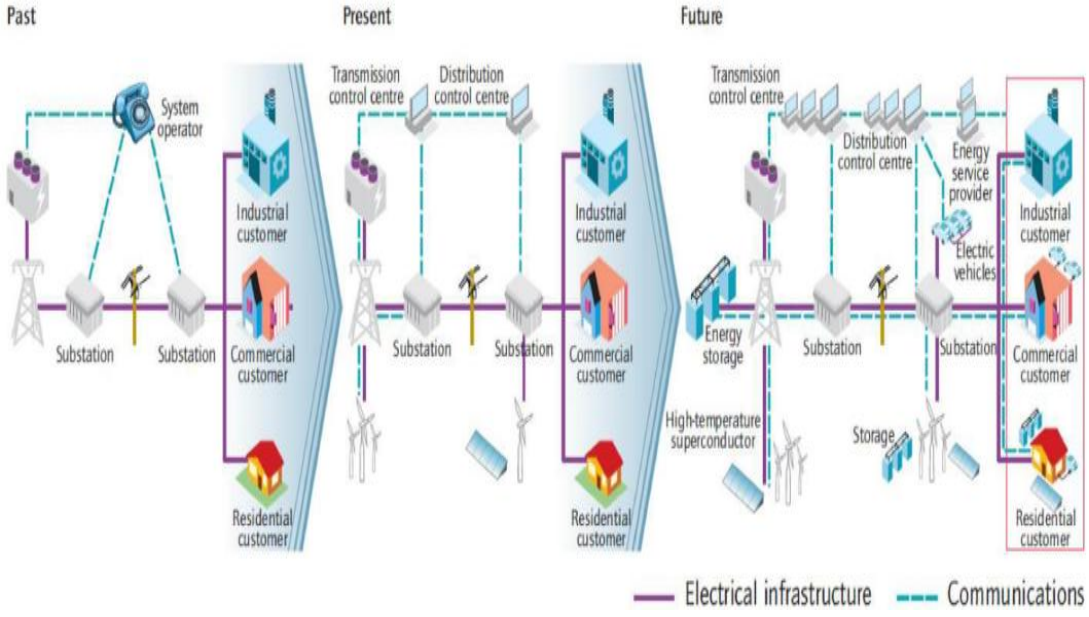


Figure 1 Evolutionary character of Smart grids

Page 1-10 © MANTECH PUBLICATIONS 2017. All Rights Reserved

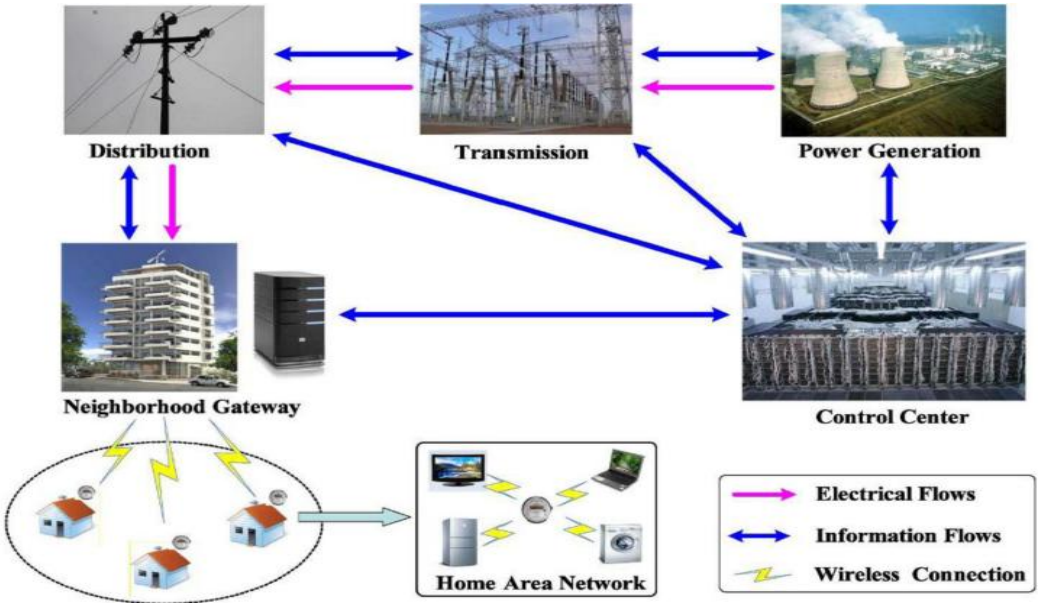


Figure 2. Communication architecture for Smart grid

III. BLOCK DIAGRAM FOR PROPOSED SYSTEM

Smart Meter (Transmitter side)

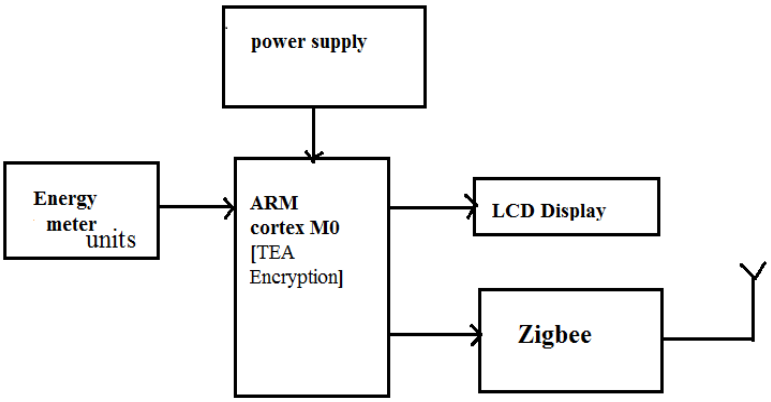


Figure: 3

TEA ALGORITHM

TEA operates on two 32-bit unsigned integers (could be derived from a 64-bit data block) uses a 128-bit key. It has a feistel structure with a suggested 64 rounds, typically implemented in pairs termed cycles. It has an extremely simple key schedule mixing all of the key material in exactly the same way for each cycle. Different multiples of a magic constant are

Page 1-10 © MANTECH PUBLICATIONS 2017. All Rights Reserved

used to prevent simple attacks on symmetry of the rounds. The magic constants, 2654435769 or 0x9E3779B9 is chosen to be [232/Ø],where Ø is the golden ratio.[4]

Smart Grid (PC side)

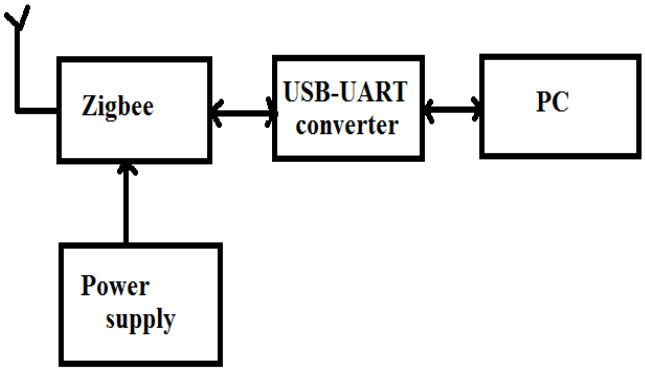


Figure: 4

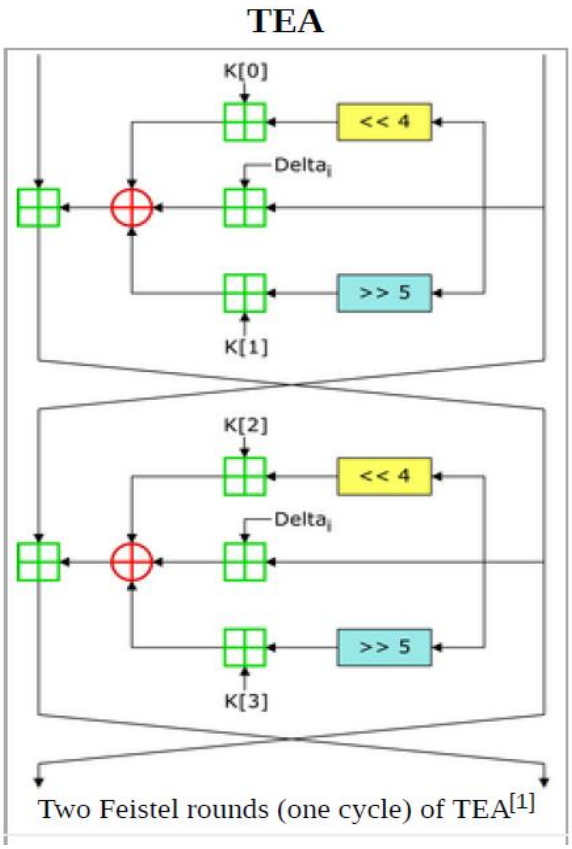


Figure: 5

Page 1-10 © MANTECH PUBLICATIONS 2017. All Rights Reserved

Power supply

A power supply is an electronic device that supplies electronic energy into electrical load. The primary function of a power supply is to convert one form of electrical energy to another. As a result, power supplies are referred to as electric power converters, some power supplies are discrete stand-alone devices. Whereas others are built into larger devices along with their loads

Every power supply obtain the energy it supplies to its load, as well as any energy it consumes while performing the task, from an energy source. Depending on its design, a power supply may obtain energy from various types of energy sources including electrical energy transmission systems, energy storage devices such as a batteries and fuel cells.

All power supplies have a power input, which receives energy from the energy source, and a power output that delivers energy to the load. In most power supplies the power input and output consists of electrical connectors or hardwired circuit connections, though some power supplies employ wireless energy transfer in lieu of galvanic connections for the power input or output.



A simple desktop power supply with power output connector seen at lower-left and power input connector (not shown) located at the rear

Figure: 6

LCD Display - A Liquid –Crystal Display (LCD) is a flat- panel display or other electronically modulated optical device that uses the light-modulating properties of liquid crystals. Liquid Crystals do not emit light directly, instead using a black light or reflector to produce image in colour or monochrome.[1]LCDs are available to display arbitrary images or fixed images with low information content, which can be displayed or hidden, such as preset words, digits, and 7-segment displays, as in a digital clock. LCDs are used in a wide range of

Page 1-10 © MANTECH PUBLICATIONS 2017. All Rights Reserved

applications including computer monitors, televisions, instrument panels, aircraft cockpit displays, indoor and outdoor signage small LCD screens are common in portable consumer devices such as digital cameras, watches, calculators and mobile telephones, including smartphones.LCD screens are also used on consumer electronics products such as DVD players, video game devices and clocks.LCD screens do not use phosphors, they do not suffer image burn-in when a static image is displayed on a screen for a long time. The LCD screen is more energy-efficient and can be disposed of more safely than a CRT can.LCD screens are available in a wider ranges of screen sizes that CRT and plasma displays.

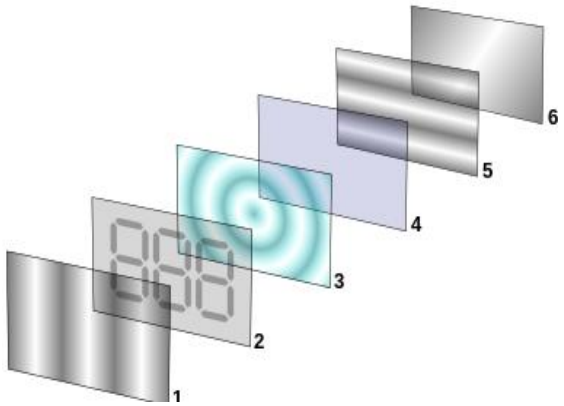


Figure:7

Zigbee :-A Zigbee is an IEE 802.15.4-based specification for a suite of high-level communication protocol used to create personal area networks with small, low-power digital radios, such as for home automation medical device data collection, and other low-power low-bandwidth needs, designed for small scale projects which need wireless connection. Hence, zigbee is a low-power, low data rate and close proximity wireless and hoc network. The technology defined by the Zigbee specification is intended to be simple and less expensive than other wireless personal area networks(WPANs)such as bluetooth or more general wireless networking such as Wi-Fi. Its low power consumption limits transmission distances to 10-100 meters line-of-sight, depending on power output and environmental characteristics. Zigbee has a defined rate of 250 k bit/s, best suited for intermittent data transmissions from a sensor or input device.



A Zigbee module

Figure:8

USB Adapter:-A USB Adapter is a type of protocol converter which is used for

Page 1-10 © MANTECH PUBLICATIONS 2017. All Rights Reserved

converting USB data signals to and from other communication standards. Commonly, USB Adapters are used to convert USB data to standard serial port data and vice versa. Most commonly the USB data signals are converted to either RS232, RS485, RS422,or TTL-level UART serial data. The older serial port RS423 protocol is rarely used anymore, so USB to RS423 adapters are less common.

UART Converter - A UART is a computer hardware device for asynchronous serial communication in which the data format and transmission speeds are configurable. The electric signaling levels and methods are handled by a driver circuit to the UART.A UART is usually an individual integrated circuit(IC) used for serial communication over a computer or pheripheral device serial port. UARTs are now commonly included in microcontrollers. A related device, the universal synchronous and asynchronous receiver-transmitter (USART) also supports synchronous operation.

IV. RESULT & DISCUSSION

Tiny Encryption Algorithm (TEA) Encryption using ARM Cortex M0 Microcontroller, smart Grid will run decryption algorithm to extract the actual data. Using encryption, datas are secured. Using decryption, the actual value will be displayed. Encryption encodes the outgoing data. Decryption decodes the incoming data. Both the Encryption and Decryption should not be confused with encoding and decoding.

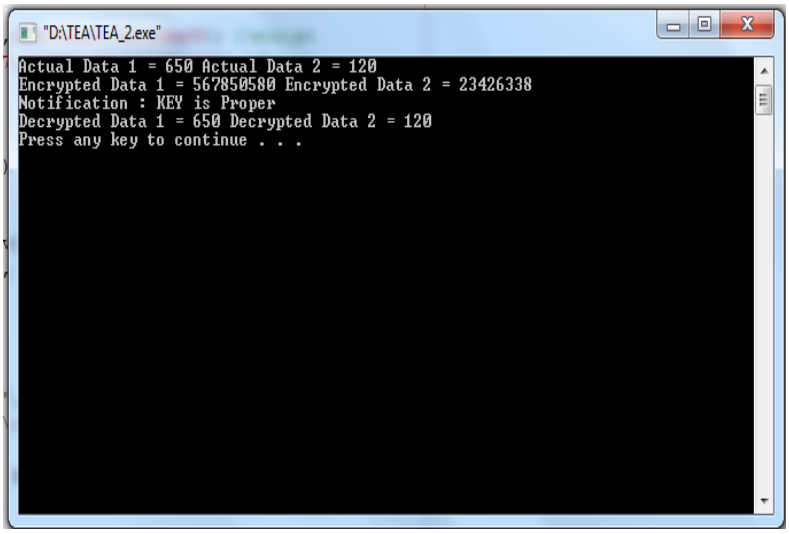


Figure: 9

Page 1-10 © MANTECH PUBLICATIONS 2017. All Rights Reserved

V. CONCLUSION

This paper describes the datas and files are secured using cryptography .i.e., Encryption and Decryption. If the decryption code is wrong, the output will be displaying wrongly. Using cryptography either be a file or message is secured.

Encryption/Decryption provides security for all datas at all time. Using password authentication to prove receivers identity, time consumed for TEA by ARM cortex ia also computed and analyzed. Formal verification using the c tool and implementation on an ARM cortex M0 Microcontroller confirm our claim using lab view at server side.

REFERENCES

[1] F. A. Al Balas, W. Mardini, Y. Khamayseh, and D. A. K. BaniSalameh,"Improved appliance coordination scheme with waiting time in smart grids," Intelllational Joulllal of Advanced Computer Science and Applications, vol. 7, no. 4, pp. 16-30, 2016,doi: 10.14569/IJACSA.2016.070403.

[2] M. L. Tuballa and M. L. Abundo, "A review of the development of Smart Grid technologies," Renew. Sustain. Energy Rev., vol. 59, pp.710-725, 2016,doi:10.1109/j.rser.2016.01.011.

[3] R. In and A. To, "Machine-to-Machine Cotmnunications for Home Energy Management System in Smart Grid," IEEE Communications Magazine, vol.49 no.4 April, pp. 53-59, 2011 doi: 10.101 6/MCOM.20 I 1.5741 146.

[4] L.I. Minchala-avila, J. Armijos, D. Pesantez, and Y. Zhang, "Design and Implementation of a Smali Meter with Demand Response Capabilities," Energy Procedia, vol.103, no. April,pp.195200,2016,doi:10.1016/j.egypro.2016.11.272.

[5] M. Erol-Kantarci and H. T. Mouftah, "Wireless Sensor Networks for Cost-Efficient Residential Energy Management in the Smart Grid,"162 IEEE Trans. Smart Grid, vol. 2, no. 2, pp. 314 - 325, 2011,doi:10.1109ITSG.201 1.21 14678.

Page 1-10 © MANTECH PUBLICATIONS 2017. All Rights Reserved

[6] E. L. Corominas and P. 1. Quintana, "Smart control for Smart Grids: from lighting systems to Grid Side Management," pp.104-109,2016, doi:10.lI09/CIEP.2016.7530739.

[7] N. Kumaraguruparan, H. Sivaramakrishnan, and S.S. Sapatnekar,"Residential task scheduling under dynamic pricing using the multiple knapsack method," 2012 IEEE PES lnnovative Smart Grid Technologies, Jan 2012,pp.16,doi:1O.1109/ISGT.2012. 6175656.

[8] A. Singaravelan and M. Kowsalya, "Design and Implementation of Standby Power Saving Smart Socket with Wireless Sensor Network," Procedia Comput. Sci., vol. 92, pp. 305- 310, 2016, doi: 10. 101 6/j.procs.201 6.07.360.

[9] Y. Jo and K. Kim, "Portable wireless smart meter controlled by a smart phone for intelligent energy management," vol. 3, pp. 1- 8,2016, doi:IO.21742/ijpdcsd.20.16.3.01.

[10] S. Courreges, S. Oudji, V. Meghdadi, C. Brauers, and R. Kays, "Performance and interoperability evaluation of radiofrequency home automation protocols and B1uetooth Low Energy for smart grid and smart home applications," 2016 IEEE Int. Conf. Consum. Electron.ICCE 2016, pp. 391 - 392, 2016 doi:IO.1109/ICCE.2016.7430660.

[11] H. Yang and S.-Y. R. Hui, "Non-intrusive Power Measurement Method with Phase Detection for Low-Cost Smart Meters," IEEE Trans. Ind. Electron. , vol. 0046, no. c, pp. I- I, 2017,doi:1 0.11 09/TIE.2017.2652344.

[12] L. C. Saikia, H. Das, N. B. D. Choudhury, and T. Malakar, "GPRS Enabled Smart Energy Meter with In -Home Display and Application of Time of Use Pricing," 2016.

[13] Y. Kabalci, "A survey on smart metering and smart grid communication," Renew. Sustain. Energy Rev., vol. 57, pp. 302- 318, 2016, doi:lO. 1016/j.rser.2015. 12.114.

Page 1-10 © MANTECH PUBLICATIONS 2017. All Rights Reserved

[14] X. Fang, S. Misra, G. Xue, and D. Yang, "Smart Grid -The New andImproved Power Grid :,"vol. 14, no. 4,pp.944980,2012, doi:IO.1109/SURV.2011.101911.00 087.

[15] H.Farhangi, "The path of the smart grid," IEEE Power Energy Mag.,vol. 8, no. I, pp. 18- 28, 2010, doi:10.1109IMPE.2009.93487.

[16] V.C. Gungor, B. Lu, and G. P. Hancke, "Opportunities and Challenges of Wireless Sensor Networks in Smart Grid," IEEE Trans.Ind. Electron. , vol. 57, no. 10, pp. 3557- 3564, 2010,doi: 10.1109/TIE.2009.203945.

Page 1-10 © MANTECH PUBLICATIONS 2017. All Rights Reserved