INTERNATIONAL RESEARCH JOURNAL IN ADVANCED ENGINEERING AND TECHNOLOGY (IRJAET) www.irjaet.com

ISSN (PRINT) : 2454-4744 | ISSN (ONLINE): 2454-4752

Vol. 1, Issue 4, pp.315 - 319, November, 2015

EMBEDDED SYSTEM BASED CONTROL AND MONITORING OF SMART GRID USING RASPBERRY-PI UNDER WSN AND INTERNET-OF-THINGS

D.Vignesh | S.Sathish, M.E, MBA,(Ph.D)

PG Student, Jayalakshmi Institute of Technology, Dharmapuri

Asst professor, Jayalakshmi Institute of Technology, Dharmapuri.

ARTICLE INFO

Article History:

Received 2nd Dec, 2015

Received in revised form 4th Dec,2015

Accepted 7th Dec, 2015

Published online 8th Dec, 2015

Keywords:

ICT, Smart grid, Internet Of Things, Zigbee.

ABSTRACT

The strong coupling of Information and Communication (ICT) technologies – especially via the usage of networked embedded devices with the energy domain, is leading to a sophisticated dynamic ecosystem referred to as the Internet of Energy. In the last mile of the Smart Grid i.e. the future smart home, heterogeneous devices will be able to measure and share their energy consumption, and actively participate in house-wide or building wide energy management systems. The customer domain of the smart grid naturally blends with smart home and smart building systems, but typical proposed approaches are “distributor-centric” rather than “customer-centric,” undermining user acceptance, and are often poorly scalable. To solve this problem, we propose a detailed architecture and an implementation of a “last-meter” smart grid the portion of the smart grid on customer premises embedded in an internet-of-things (IoT) platform. A demonstrator has been built and tested with purposely developed ZigBee smart meters and gateways, a distributed IoT server, and a flexible user interface.

1. INTRODUCTION

The smart grid is the portion of the smart grid closer to the home, and the one with which customers interact. It allows a two-way data flow between customers and electric utilities, transforming the traditionally passive end-users into active players in the energy market.

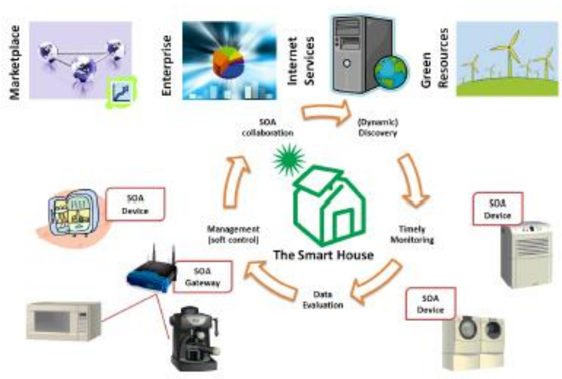

Fig.1. Collaboration within the smart house and with external entities

Considering the seven domains of the conceptual model of smart grids proposed by the National Institute of Standards and Technology the last-meter smart grid corresponds to the "customer domain." It enables residential, commercial, and industrial customers based on their different energy needs to optimize energy consumption and local generation, and to actively participate to demand-response policies, one of the most disrupting aspects of smart grids. Nontechnical customers need a simple way to control energy consumption and production, and to exchange power usage data at the proper level of granularity with energy providers or distributors. In this paper, we present an architecture for the last-meter smart grid that is embedded in a platform for the internet of things (IoT). Our architecture has four main advantages and elements of novelty with respect to the state of the art, each corresponding to the basic requirement of being "customer-centric" and scalable, in order to improve market acceptance and ease of deployment. The smart house of the future will be able to collaborate with numerous external entities, let it be alternative energy resources, marketplaces, enterprises, energy providers etc. The de facto standard for high-level communication today is via services, which allows for flexible functionality integration without revealing details for the implementation.

2. PLATFORM FOR THE INTERNET OF THINGS

We have developed a platform for the IoT as a scalable distributed system that can seamlessly support an in-home smart grid and different concurrent applications for remote monitoring and control. The platform architecture is illustrated in Fig. 1. It consists of three main parts: the sensor and actuator networks, the IoT server and the user interfaces for visualization and management. Sensor and actuator nodes communicate in a reliable bidirectional way with the IoT server.

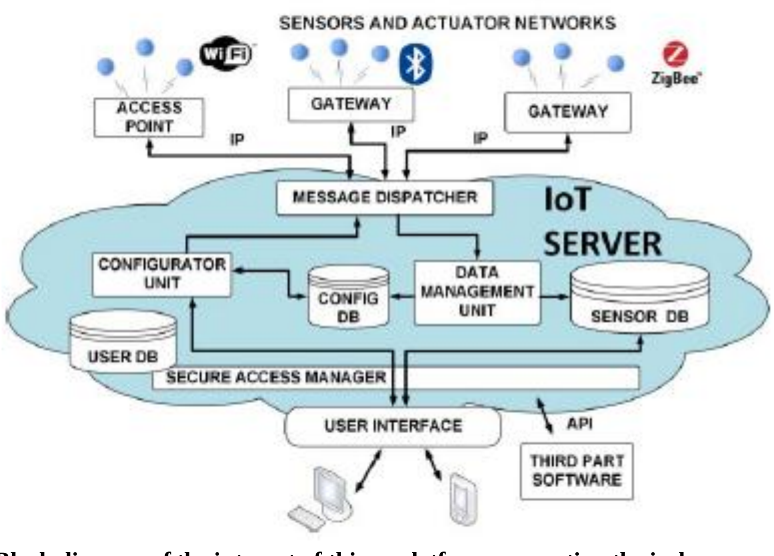

Fig.2. Block diagram of the internet of things platform supporting the in-home smart grid

The communication between the nodes and the IoT server follows the TCP/IP client-server model. Sensors send messages in their native format to the IoT server, over an encrypted link. The IoT server converts the raw payload, containing information from heterogeneous nodes, into a standard format, containing object identifier, object type, measurement unit, data field, geographical position, and timestamp. In this way, data can be easily represented, manipulated and aggregated without considering the communication protocol of the originating source. It allows to univocally map each sensor and actuator to a common abstraction layer. To simplify interaction with nontechnical users, sensors and actuators are also described at a higher abstraction level, independent of the physical details and of the communication protocols.

3. IOT SERVER

The message dispatcher manages the bidirectional communication between each gateway and the rest of the system. It only deals with low level communications from nodes to the data management unit and from the configurator unit to the nodes. It has the main task of listening to new connections from IP nodes that want to join the system. For every connection, it decrypts incoming packets and forwards them to the data management unit, for interpretation and storage. In the other direction, it encrypts and encapsulates messages from the configurator unit into a TCP message, and forwards them to the destination gateway. The opcode defines the function of each packet.

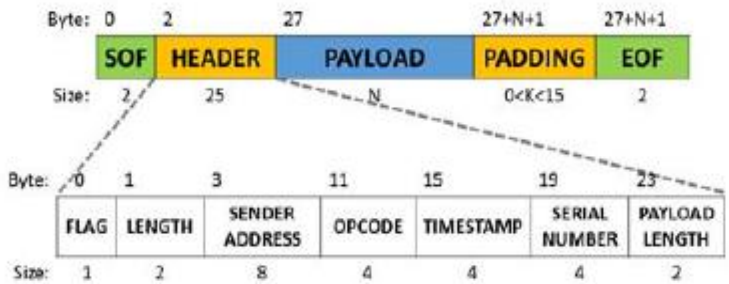

Fig.3. Structure of the TCP/IP packet of the communication protocol between gateway and message dispatcher

Packets can be divided in two main classes: administration packets and data relay packets. For every type of local sensor network protocol included in the platform two opcodes are defined: one used for the upstream and one for the downstream data transmission. The presence of the sensor database decouples data collection from data processing and visualization, so that users do not need to interrogate nodes directly. This approach is useful especially when sensor networks are heterogeneous. It is also very useful when nodes are battery-operated devices. Decoupling allows nodes to stay most of the time in sleep mode and periodically wakeup to receive commands and configurations and to send measurement and status data. protocol, and are univocally associated to the physical nodes through the unique node ID. In this way, data can then be easily accessed by performing a simple query to the database, and can be processed and visualized independently of the characteristics of the physical source.

Even if specific node characteristics depend on the network implementation, the proposed architecture supports the possibility to add or remove any network component in real time. Indeed, any node can join the system without requiring any change to the network implementation. For this reason, any new node that joins a network connected to the platform is automatically identified and immediately accessible from the network administration interface for registration and configuration. Similarly, updating or un-joining nodes are automatically referred to the IoT server.

The interface between sensor networks and the platform is based on a communication protocol between the gateway and the IoT server defined by API specifications. To avoid this user configuration, our gateway implements the client side of a TCP connection to the IoT server and always initiates the communication with the message dispatcher. It only deals with low-level communications from nodes (through the gateways) to the data management unit and from the configurator unit to the nodes. It has the main task of listening to new connections from IP nodes that want to join the system.

4. COMPARISON OF RESULTS

Comparison with related works must consider recent literature in the neighboring fields of distributed sensor networks, home automation, and smart grids. We can loosely classify the large number of related papers in two groups. A set of papers focuses on the automation of the complete power distribution grid, of which the "last-meter" smart grid is only a subsystem. In this case, the complete grid includes power generation plants, transmission and distribution networks, and "smart" consumers, with local generation capabilities, flexible usage, and sometimes energy storage capacity. This large infrastructure is usually managed by a central server/data storage or Supervisory Control and Data Acquisition (SCADA) system transmission from the customer site to the last node of power distribution (last meter). Many transport options are typically proposed, such as the use of dedicated lines, to POTS/modem, PLC, wireless links. With respect to this set of papers, the advantage and the uniqueness of our approach are apparent. Our proposal is "customer centric," as opposed to "distribution centric," in the sense that favors ease of deployment and user acceptance, leveraging the smart home trend to enable the merging of smart grid and smart home applications in customers' homes. Indeed, our proposal focuses on the customer domain of the smart grid, possibly leaving the domains more evidently controlled by the utilities, such as transmission and distribution, to a "distribution-centered" treatment. With respect to this other group of papers, the advantages of our proposed architecture and implementation consist in their intrinsic scalability to large-scale deployment. This is enabled by the choice of low-cost gateway and power meter and by the accent on deployment by nontechnical users.

CONCLUSION

We have presented an architecture, an implementation, and a demonstration of the Customer Domain of the smart grid, based on a platform for the IoT that can host a broad range of smart home applications. Novelty in this field must be found in the architectural concept, in the system integration, and in the prioritization of requirements. In this sense, our proposal has unique advantages and elements of novelty with respect to the state of the art: it is customer centric, it minimizes the deployment of specific smart grid infrastructure, and it leverages possibly available smart home applications, sensors, and networks. We believe this is key for a widespread acceptance of smart grid applications and equipment to be deployed at home.

REFERENCES

[1] V. Giordano, F. Gangale, and G. Fulli, "Smart grid projects in Europe: Lessons learned and current developments, 2012 update" Eur. Commission, Joint Res. Centre, Inst. Energy Transp., Sci. Policy Rep., 2013.
[2] National Institute of Standards and Technology, NIST Framework and Roadmap for Smart Grid Interoperability Standards, Release 1.0, Office of the National Coordinator for Smart Grid Interoperability-U.S. Department of Commerce, NIST Special Publication 1108, Jan. 2010
[3] R. Ma, H. H. Chen, Y. Huang, and W. Meng, "Smart grid communication: Its challenges and opportunities," IEEE Trans. Smart Grid, vol. 4, no. 1, pp. 36–46, Mar. 2013.
[4] P. Palensky and D. Dietrich, "Demand side management: Demand response, intelligent energy systems, and smart loads," IEEE Trans. Ind. Informat., vol. 7, no. 3, pp. 381–388, Aug. 2011.
[5] K. Samarakoon, J. Ekanayake, and N. Jenkins, "Reporting available demand response," IEEE Trans. Smart Grid, vol. 4, no. 4, pp. 1842–1851, Dec. 2013.
[6] Energy Community. (2010). Energy Community Regulatory Board, A Review of Smart Meters Rollout for Electricity in the Energy Community [Online]. Available: http://www.energycommunity. org/pls/portal/docs/744178.PDF

[7] A. A. Khan and H. T. Mouftah, "Web services for indoor energy management in a smart grid environment," in Proc. 2011 IEEE 22nd Int. Symp. Pers. Indoor Mobile Radio Commun. (PIMRC), pp. 1036–1040.
[8] J. Byun, I. Hong, B. Kang, and S. Park, "A smart energy distribution and management system for renewable energy distribution and contextaware services based on user patterns and load forecasting," IEEE Trans. Consum. Electron., vol. 57, no. 2, pp. 436–444, May 2011.
[9] A. Zaballos, A. Vallejo, and J. Selga, "Heterogeneous communication architecture for the smart grid," IEEE Netw., vol. 25, no. 5, pp. 30–37, Sep. 2011.
[10] T. Sauter and M. Lobashov, "End-to-end communication architecture for smart grids," IEEE Trans. Ind. Electron., vol. 58, no. 4, pp. 1218–1228,
Apr. 2011.
[11] F. Benzi, N. Anglani, E. Bassi, and L. Frosini, "Electricity smart meters interfacing the households," IEEE Trans. Ind. Electron., vol. 58, no. 10, pp. 4487–4494, Oct. 2011.
[12] Enel Press Release. (2011, Nov. 4). Italy's First Smart Grid in Isernia [Online]. Available: http://goo.gl/RsY8F.