วารสารอิเล็กทรอนิกส์ ECTI
ECTI e-magazine
ISSN: 2286-7074

Message from Editor:

Dear Valued ECTI Association Members,

Happy New year to everyone!

In this issue, you may read an article titled “A comparative study of various routing protocols for smart grid communication” by Adisorn Kheaksong, Kanabadee Srisomboon and Assistant Professor Dr. Wilaiporn Lee. In addition, the activities of each Technical Area as well as the ECTI Association are listed. You will find that, recently, our ECTI Association has offered Workshops related to Journal publication and Writing techniques to domestic as well as regional universities. The publication of ECTI Journals as well as the upcoming sponsored conferences and seminars are listed. Finally, the newly elected committee members of the ECTI Association are listed. Should you have any comments or suggestions to improve the ECTI E-Magazine so that it serves our members better, please do not hesitate to contact us via E-mail or Facebook

ECTI E-Magazine Editor

Pornchai Supnithi (King Mongkut’s Institute of Technology Ladkrabang)

In this issue:

Message from Editor	Page 1
ECTI President Message	Page 2
Review Article (“A comparative study of various routing protocols for smart grid communication” by Adisorn Kheaksong, Kanabadee Srisomboon, Asst. Prof. Dr. Wilaiporn Lee)	Page 3
Paper list of ECTI Transaction (CIT, EEC)	Page 17
Reports from Conferences/Seminars/Workshops	Page 18
Announcements/Upcoming events/Call-for-Papers	Page 22
ECTI Who’s Who	Page 27

วารสารอิเล็กทรอนิกส์ ECTI
ECTI e-magazine
ISSN: 2286-7074

ECTI President Message:

As the new ECTI Association president who will take this post from 2016 to 2017, I do hope this ECTI E-magazine still serves you well. It is entering its tenth year now. From its first published issue in 2007 to the end of 2015, the magazine has completed its nine years of age. It has gone through several changes and development. While keeping the flavor of leading-edge article as well as the Association's news updates such as conferences and other related events, the magazine has transformed itself to the international version since July-September 2013 issue. This marked the international move of the association. The commitment of AEC (ASEAN Economic Community) launched lately has sent a signal to all ASEAN countries that we have to work more closely and economically with the super goal of mankind happiness and prosperity. The association, likewise, responds to this challenging issue. While carefully repositioning ourselves, we are also fostering the academic cooperation with our neighbors. The ECTI journals, ECTI-EEC and ECTI-CIT, are more recognized and to be included in the international citation index shortly. We are having more international members and we are taking care of them more closely. Not only the membership development and the internationalization that the association will focus on, but also the all-year round seminars, workshops and special lectures will be implemented by our Chapters and Sections. We have set up 6 new sections, Northern section, North-Eastern section, Southern section, Myanmar section, Laos section, and Cambodia section. Sections will have their own activities and tie up closely with the ECTI Headquarter (HQ).

Let me also take this opportunity to remind you all about the upcoming conferences. We are going to have ECTI-CON 2016 in Chiang Mai from June 28th to July 1st this year. In addition, we are preparing for ECTI-CARD 2016 at Hua-Hin during 27-29 July. And of course, the ISPACS 2016 is not so far away. It will be held in Phuket during 24-27 October 2016.

Enjoy the magazine! I look forward to seeing you in the upcoming conferences.

ECTI President

Somsak Choomchuay (King Mongkut's Institute of Technology Ladkrabang)

วารสารอิเล็กทรอนิกส์ ECTI
ECTI e-magazine
ISSN: 2286-7074

[Article]

A comparative study of various routing protocols for smart grid communication

[1]Adisorn Kheaksong, [2]Kanabadee Srisomboon, [3]Wilaiporn Lee

[1]kheaksong@gmail.com, [2]s.kanabadee@gmail.com, [3]wilaiporn.l@eng.kmutnb.ac.th.

Department of Electrical and Computer Engineering, Faculty of Engineering, King Mongkut's University of Technology North Bangkok, Bangkok, Thailand.,

Abstract

To support the emerging of smart grid technology, a reliable and real-time communication capability are required. An advance metering infrastructure (AMI) is the application of smart grid that provides the data communication between the customers' smart meter to the utility in order to support several function such as a balancing of electricity generation according to the demand of customers. Since the data in the network need to be transmitted effectively, a high performance of routing protocol needs to be implemented as a routing algorithm. The main contribution of this paper is to give a comprehensive study of RPL protocol in for smart grid network. Due to the merits of RPL protocol, it meets the overall requirement of routing protocol for smart grid network.

Keywords: *Cognitive radio, spectrum sensing, Noise uncertainty, Path loss*

1. Introduction

In the traditional power grids, power that is generated from a few central generators carry to a large number of users or customers. On the other hand, Smart grid (SG) uses bidirectional of electricity and information to create an automated and distributed advanced energy delivery network. SG is the next-generation of electric power system since 2005. Therefore, the smart grid becomes one of the fast growing research topics [1-11] because the system is a promising as a solution for energy crisis. In [1], the main advantages of smart grid — a managing of demand response and demand side through the integration of smart grid devices and providing of information related to energy use and price to customers — are presented. One of the important features of the smart grid is

วารสารอิเล็กทรอนิกส์ ECTI
ECTI e-magazine
ISSN: 2286-7074

the integration of secure, high-speed and reliable data communication networks to manage the complex power systems intelligently and effectively. Thus, smart grid has harsh and complex environmental conditions, connectivity problems, dynamic topology changes, and interference and fading issues during wireless communication. It is difficult to design the information and communication technologies (ICTs) system for the overall power grid. Thus, the choice of communication infrastructure for smart grid is highly critical to provide reliable, secure, and efficient data delivery between smart grid components.

The communication infrastructure between devices in SG system including energy generation, transmission, and distribution and consumption needs two-way communications, interoperability between advanced applications and end-to-end secure and reliable communications with sufficient bandwidths and low-latencies [2-11]. Such important communication and networking technologies may be applicable in future smart grids. Six important communication types [2] include wireless mesh network, such as WiMAX, cellular communication system, such as GSM, WCDMA, and CDMA-2000, wireless communications based on 802.15.4 (ZigBee, WirelessHART, and ISA100.11a), microwave or free-space optical communications, fiber-optic communications and power line communication (PLC). The first four communication technologies are the wireless communication and the last two technologies are the wired communication. The compare the performance between wireless technologies and wired technologies for smart grid are considered in [3]. They can conclude that the wireless communication technologies have significant benefits more than wired technologies because the wireless communication has low installation cost, rapid deployment, mobility, and more suitable for remote end applications. In [4-5], they study the performance of the current communication technologies that are applied to smart grid. They found that the current communication capabilities of the existing power systems are limited to small-scale local regions and these methods implement basic functionalities for system monitoring and control, which do not yet meet the demanding communication requirements for the automated and intelligent management in the next-generation electric power systems. Therefore, a key point in the success of smart grid technology is how to meet the complicated requirement in the communication. It demands high communication quality and energy efficiency while taking care of the system expenses and bandwidth. The bandwidth is needed to manage, store and integrate the large amounts of data that smart devices will produce.

Advance metering infrastructure (AMI) application, which provides a two-way data communication between customers' smart meters and back-haul system of utility. The information between utility and customers plays as an important role for a balancing of electricity generation according to the demand of customers. Recently, there are two technologies — ZigBee [12-13] and WiFi [14-17] — that are widely studied in order to be implemented in an AMI network. Therefore, routing protocol is considered as vital algorithm that is used to satisfy the requirement of AMI communication network including reliability, real-time delivery and flexibility. Therefore, we give a comprehensive study of routing protocols [18-34] — ad-hoc On-Demand Distance Vector routing protocol (AODV) [21-22], destination-sequenced distance vector (DSDV) [23], dynamic MANET on-demand (DYMO) [24-25], topology unaware routing (TUQR) [26] and IPv6 routing protocol for low power and lossy Networks (RPL) [27-34] — for smart grid network. From the studied, we found that RPL protocol can be satisfied the requirements of several applications of smart grid including smart home, smart monitoring and a real-life outdoor smart grid substation network due to its merits such as low delay, scalability, small database and low complexity. Moreover, the RPL protocol can be used to communicate various communication technologies directly, which is the main purpose of smart grid network.

วารสารอิเล็กทรอนิกส์ ECTI
ECTI e-magazine
ISSN: 2286-7074

The remainder of this paper is organized as follows. Section 2 describes the basic theory of smart grid. In section 3, the details of five routing protocols are shown. The routing performance is discussed in section 4. Finally, the conclusion is presented in section 5.

2. Smart Grid

To support the noticeable increasing in an electricity demand, the electrical grid of the 21st Century, smart grid, is proposed. The smart grid [1-11] aims to address the challenges of the traditional electrical grid by improving the grid efficiency, reliability and safety through several applications such as demand side management, power outage detection, overhead transmission line monitoring, advance metering infrastructure (AMI) and etc. To achieve the objective of the proposed smart grid technology, high reliability of communication technology is required because the communication network is integrated to the smart grid infrastructure. Since the main concept of smart grid communication is two-way communication, the two most important requirements about the communication capability are reliability and real-time information transferring.

In general, two main communication infrastructures — wired and wireless — are proposed to be used for the communication between the utility and smart meters. However, based on some constraints of the implementation of wired network such as difficult of installation, then the wireless communication seems to be an appropriate infrastructure to be implemented in practical. In this paper, we focus on two wireless technologies including ZigBee and WiFi.

2.1. ZigBee

ZigBee [12-13] is a wireless communication technology which is specified for a low power communication network — wireless personal area network (WPAN). ZigBee operates on a 2.4 GHz of the industrial, scientific and medical (ISM) radio bands specified by an IEEE 802.15.4 standard. The merits of ZigBee are that it can be used easily with low complexity, operates with low-power and requires little maintenance. Generally, ZigBee can be used as an application such as home automation, wireless sensor networks (WSN), industrial control, embedded sensing, medical data collection and building automation. Moreover, ZigBee is the most interested technology that suggested to be used in some application of smart grid including smart lightning, energy monitoring, home automation, and automatic meter reading, etc.

Normally, there are three types of node in a ZigBee network — Coordinator, Router and End devices. The coordinator is determined as a root of network tree and is the component that connects its network to the other

วารสารอิเล็กทรอนิกส์ ECTI
ECTI e-magazine
ISSN: 2286-7074

networks through the coordinator of those networks. The operation and operating parameter of the network are initiated and selected by the coordinator. Moreover, the information, such as security key, can also be stored at the coordinator. The router plays as an intermediate node, which forwards the data traffic to the other nodes. The end node is a low power device that gathers the data traffic from the router. This kind of device activates only the time that it wants to receive/transmit the data traffic.

2.2. WiFi (IEEE 802.11)

WiFi, or IEEE 802.11 [14-17] is the most accepted standard for wireless local area networks (WLANs). There are several versions of IEEE 802.11 — 802.11a, 802.11b, 802.11g, 802.11n and 802.11s — are used recently. Normally, WiFi operates on two frequency bands 2.4GHz ISM and 5GHz. Three modulation techniques — direct-sequence spread spectrum (DSSS), frequency Hopping Spread Spectrum (FHSS) and orthogonal frequency-division multiplexing — work with Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) protocol on the MAC layer in order to prevent a data collision in a random access mode. Two communications infrastructure is implemented with WiFi technology including ad-hoc network and infrastructure network.

In smart grid network, 802.11s [16] for wireless mesh network is desired by IEEE 802.11s TG (Task Group) who presents an architecture, routing on MAC layer and for routing and set HWMP (Hybrid Wireless Mesh Protocol) for mesh network [17] in order to be used in smart grid network.

3. Existing routing protocol

In order to forward the data from a source to the destination on the appropriate path, a routing protocol [18-34] is a vital function which is used to determine the path for the transmission. Three main tasks of routing protocol are including learning of available routes for the transmission, generating the routing table and determining the best route for the transmission. The two main requirements for the routing protocol performance are reliability and low-latency. In this section, we give basic theoretical and individual merits/demerits of five well-known routing protocols including AODV, DSDV, DYMO, TUQR and RPL.

3.1. Ad-Hoc On-Demand Distance Vector routing protocol (AODV)

AODV [21, 22] is a reactive routing protocol, which is proposed to be used in a mobile ad-hoc network (MANET). Fig.1 shows a structure of AODV protocol. Through AODV protocol, the data packet in a network is transmitted on-demand. To route the data traffic to the destination, AODV builds the route for data

วารสารอิเล็กทรอนิกส์ ECTI
ECTI e-magazine
ISSN: 2286-7074

transmitting only when the transmission is required. Firstly, a node who wants to send the data broadcasts a request message — route request (RREQ) — across the network. Nodes who receive the message will record the nodes which also received the received RREQ message and forward the received RREQ message to other nodes. Once the RREQ message reaches to the destination node, the node will determine the most appropriate route and reply the message — route reply (RREP) — back to the source through the selected route. Then, these nodes will set up to route to reach the data from the source to the destination by using generated routing table. In addition, the route can be update if the source finds the better route.

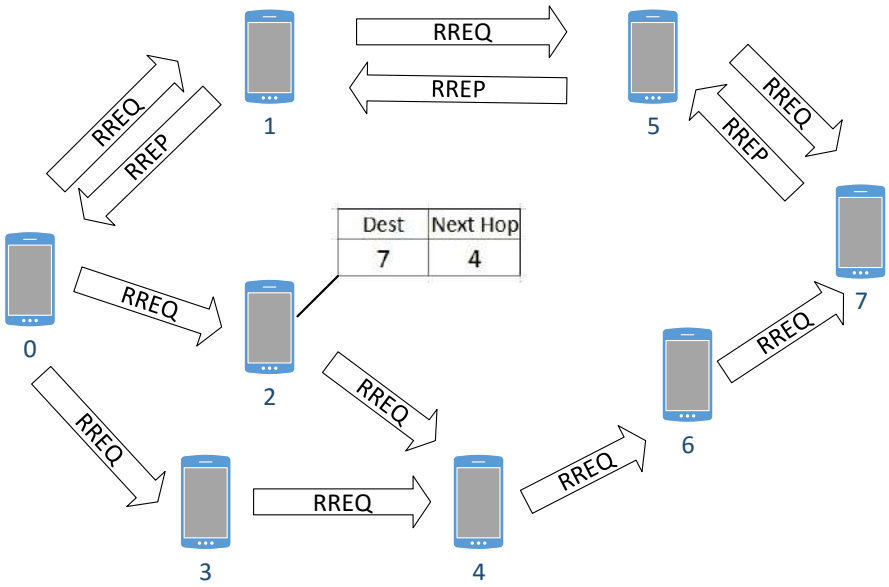

Fig.1. A structure of AODV protocol.

On the other hand, once the generated route fails which may be caused by link failure, the message — route error (RERR) — is generated and broadcasted to other nodes in order to update the routing table and re-route. By broadcasting the message over the network, the overhead of control message is dynamic and causes delay in the routing mechanism initiation.

3.2. Destination-Sequenced Distance Vector (DSDV)

DSDV [23] is a proactive routing protocol where routing information is stored in the routing table and this information is updated periodically. Each node is contained with a routing table where the information about next hop, metric, destination nodes and a sequence of node reaching to destination itself is contained in the table.

วารสารอิเล็กทรอนิกส์ ECTI
ECTI e-magazine
ISSN: 2286-7074

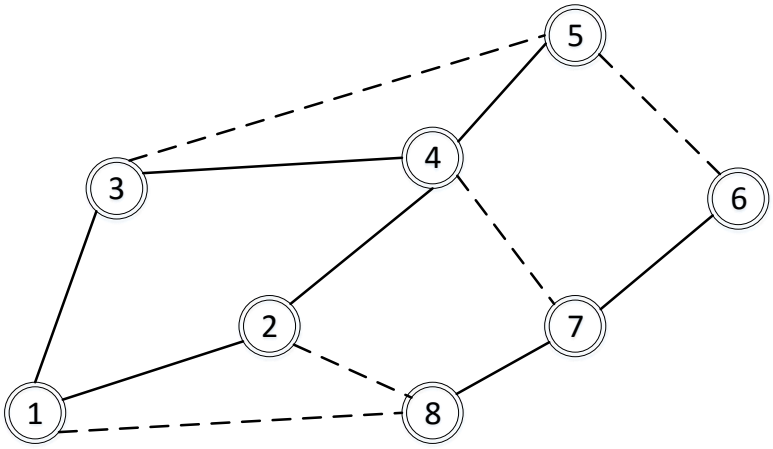

Fig.2. A structure of DSDV protocol.

As shown in Fig.2, to forward the data traffic to the destination, firstly, a source node transmits data traffic to the next node selected by using its routing table where the table is contained with all available destination nodes in the network, number and sequence of nodes to reach those destination nodes. Once the neighbor node receives the data traffic, it will check the destination node. If it is the destination, it will keep the data. Otherwise, it will check the next node in order to forward the data traffic. This data forwarding mechanism is repeated until the data traffic reaches to the destination. It should be noted that the solid line is an established route for data traffic forwarding and the dash lines are the available routes.

In DSDV, nodes in the network have to broadcast its routing table to the neighbors periodically in order to update the route of data in the network. The routing table updating mechanism can be done either time-driven or event-driven mechanism. The demerits of DSDV protocol is that once the network becomes bigger. The routing table is also bigger according to the size of network. Then, the network requires a large size of bandwidth to update the routing table according to the member in the network.

3.3. Dynamic MANET on-demand (DYMO)

DYMO [24, 25] is a routing protocol which benefits both reactive and proactive routing protocol mechanism. DYMO uses an AODV protocol as a basic theorem in order to make it easier to be implemented in practical network than AODV. To improve the routing performance, DYMO focuses on some mechanism — path accumulation of dynamic source routing (DSR) protocol — and ignores some control message — route reply (RREP) message of AODV — of conventional routing protocol.

DYMO proposes two new mechanisms, route discovery and route maintenance, to improve the routing performance. In the route discovery mechanism, a source node finds the route to the destination by broadcasting the RREQ message over the network when the source node wants to transmit the data traffic. Once a neighbor node receives the RREQ message, the address of the source node is recorded before

วารสารอิเล็กทรอนิกส์ ECTI
ECTI e-magazine
ISSN: 2286-7074

forwarding the message to other neighbor nodes. After the RREQ message reaches to the destination node, it replies the RREP message to the source node. The nodes which receive the RREP message will record the route. Once the source node receives RREP message, the route is established completely. For route maintenance mechanism, the source node will be notified by RERR message since the route is broken. After the RERR reaches to the source node, the source node will re-discover the route again. Fig.3 presents a structure of DYMO protocol. Forwarded solid lines are the RREQ message that is transmitted by N2. Since the destination node (N9) receives the message, it replies the RREP message to N2 through N6 and N1.

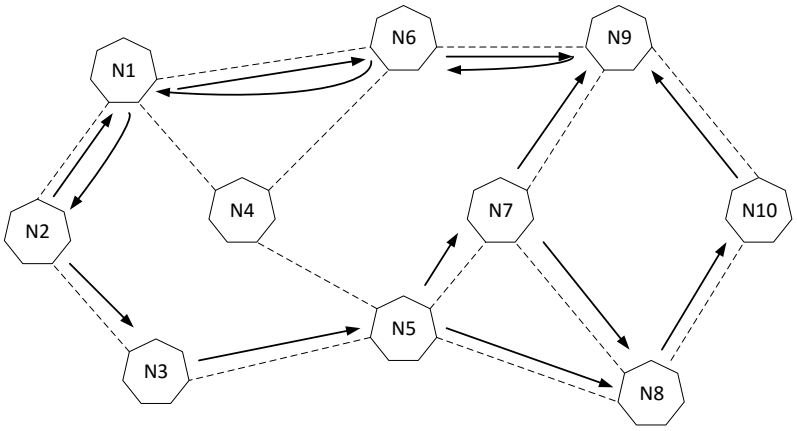

Fig.3. A structure of DYMO protocol.

3.4. Topology Unaware Routing (TUQR)

TUQR [26] is a new routing protocol whose aims to keep all available routes as much as possible in order to reduce an effect from suspicious environment. To support the mechanism of TUQR protocol, the node must capable of supplying information such as delay time and average time of packet queuing and priority of outgoing packet queuing which is contained in header. In TUQR protocol, both source node and other node do not have any knowledge about data traffic route. The route is followed by the data traffic itself. In the network, an only knowledge, which is known by the nodes, is the address of their neighbor that can forward the data to the desired destination. The main constrain of the data traffic forwarding is the transmission delay. The neighbor node is picked by the node selecting by current local connection status and given delay. This mechanism is repeated until the destination node receives the data traffic. Each node in the network of TUQR protocol, the quality of service (QoS) routing table (QRT) which is used when routes the data traffic to the destination must be stored in the node. There are three types of information that is contained in the table including destination list, delay constraints list and next-hop node list.

วารสารอิเล็กทรอนิกส์ ECTI
ECTI e-magazine
ISSN: 2286-7074

3.5. IPv6 Routing Protocol for Low Power and Lossy Networks (RPL)

RPL [27-34] is a routing protocol based on a distance vector routing protocol developed by the Internet Engineering Task Force (IETF) for low power and lossy networks (LLNs), i.e., urban area. The merits of RPL are the flexibility of designing and supporting to various applications. Constructed by a numbers of low-power devices, RPL is proposed to route the traffic of data to destination over the large-scale networks. Aims of RPL are to reduce a size of database, reduce a complexity of routing mechanism, reduce a wasted signaling overhead and increase an efficiency of link discovering.

The main concept of RPL is a using of a single or multiple directed acyclic graphs (DAG) to maintain a state of network information and to construct the routes without an existing of cycle. Generally, nodes in the RPL network can be categorized into three types including root, router and client. Normally, root node is defined as a gateway who connects RPL network to other networks. Router advertises the information of a topology to neighbors. Client is the node who has not a duty to send the DIO message; it can only join the existing topology, DODAG.

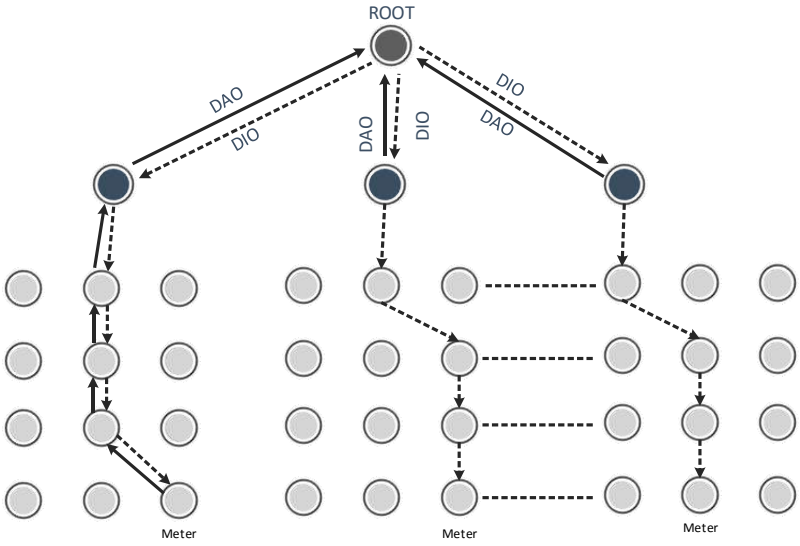

Fig.4. A structure of RPL protocol.

To route of data to the destination, RPL constructs a graph — destination oriented directed acyclic graph (DODAG). As shown in Fig.2, first, a root of RPL broadcasts control messages, DAG information option (DIO) that contained with a rank of broadcasting node, objective function (OF) and DADAG-ID. These messages are used by a node in order to discover an RPL, e.g., the node uses DIO messages to select the DODAG parents. Second, once a node who desire to join DAG receives DIO message. It has to run an algorithm in order to select an appropriate parent by adding the information —nodes travelled by DIO — to its parent list. Then,

วารสารอิเล็กทรอนิกส์ ECTI
ECTI e-magazine
ISSN: 2286-7074

the node computes its rank corresponding to the parent node. If the node is the router, it has to update the DIO message and broadcast the message to neighbors. The computed rank is corresponding to the objective code point (OCP) which identifies as OF. It should be noted that OF defines the metrics and constraints. Therefore, the parent is selected depending on rank, local link quality, cost of path and advertised OF. The node which has lower rank will be determined as parent candidate. Once DAG is constructed, each node can send the data traffic to the root by selecting the most appropriate parent as the upward hop.

On the other hand, when a node who already joined the DAG receives others DIO messages, it may discard the received DIO message, maintain its position in the DAG or improve its rank since it has a lower rank constrained by OCP and path cost. Moreover, client may broadcast a message — destination advertisement object (DAO) — who contains a rank and reverse root to the root in order to construct the path from root to the node. RPL also proposes a route repairing mechanism — global and local repairing mechanism. For global repair, the root will broadcast a new sequence number, which contains a lot of overheads to repair a broken node or find a new parent. On the other hand, for local repair, a node starts broadcasting a message to its neighbors (downward path) for link recovery. Then, the node will broadcast a control message — DODAG information solicitation (DIS) — for its neighbors to inform that they have to start broadcasting DIOs to modify their parents list. Hence, the routing graph is fixed locally.

4. Discussions

In this section, we first analyze the routing performance of a RPL protocol as compared to existing protocols including AODV, DSDY, DYMO and TUQR. Second, we discuss the RPL protocol in a ZigBee network. Finally, we discuss modified RPL protocol and the demerits of RPL protocol, which may be modified in order to its routing performance.

Generally, the routing performance is evaluated through two main factors including packet delivery ratio (PDR) and average end-to-end delay. PDR refers to the ratio of successive received data to the actual transmitted data. Normally, the PDR may decrease as a path quality. Average end-to-end delay is the time that the transmitted data is received completely. The average end-to-end delay may increase due to the network size or the distance between source node and destination node. In addition, to reduce an energy consumption, the overhead of data packet is another factor that can be used to routing performance.

From our studied, we first investigate the performance of four well-known routing protocols — AODV, DSDY, DYMO and TUQR — to determine the protocol that can be used as the benchmark. Then, the benchmark protocol is compared to the RPL protocol. As mention in [19], TUQR gives the highest rate of PDR while DYMO and DSDV is the second and third, respectively. The AODV is the routing protocol that gives the lowest rate of PDR. Moreover, in [25], the routing performance of DYMO is compared to AODV comprehensively. As mentioned earlier, DYMO is an improvement of AODV where DYMO adapts the route depending on a network changing by determining the routes between source and destination through unicast mechanism. The DYMO is shown to be the better routing protocol in perspective of PDR because it reduces the using of RREQ message when it is not necessary.

วารสารอิเล็กทรอนิกส์ ECTI
ECTI e-magazine
ISSN: 2286-7074

On the other hand, in perspective such end-to-end delay, DYMO and DSDV give the less number of delay as compared to TUQR and AODV. However, when takes the energy consumption in the account in order to determine the routing performance, they are not shown to be an interested candidate to be implemented in practical network such smart grid. Because of both DYMO and DSDV consume high energy consumption. From these evident, we found that an average performance of routing protocol that should be used as a benchmark to compare to RPL protocol is the AODV.

Then, we discuss the routing performance of RPL to AODV comprehensively. As described in [29], per-node packet delivery ratio of RPL is robust to the distance while AODV is sensitive (decreases as an increasing in distances) Per-node end-to-end delay of RPL is less sensitive to the distance than AODV. The end-to-end delay of AODB increases as an increasing in distance [30]. This is because the control message, RREQ, has to be broadcasted over the network when it want to forward data traffic. Once the network becomes larges, the distance from source node to destination also increases. Then, the end-to-end delay of a route, which establishes far-away destination node, increases significantly [31].

As implemented RPL and AODV in smart meter of smart grid network, RPL outperforms the routing performance of AODV as simulated in large-scale smart meter network especially when congestion is too probable [32]. In addition, RPL seems to be the better choice in scalability. AODV is heavily vulnerable from scalability in PDR and latency. As implemented RPL protocol in a smart monitoring application [33], RPL shown to be an interesting candidate for smart grid since it adapts efficiently to topology changing and can adapt routing knowledge rapidly. In [34], the RPL protocol is implemented as a routing protocol in a real-life outdoor smart grid substation network. RPL performs in a satisfying level of delay and control overhead providing a rapid repair of corrupted links. Trickle timer manages control overhead efficiently lower in proportion to data packet. Using local repair performs much quicker in repairing local connection disruption than global repair mechanism.

As mentioned of all above, the RPL is the best protocol to be implemented as the routing protocol for smart grid networks. This is because RPL protocol achieves the constraints of ZigBee including a performance of limited power, memory, and processing. Moreover, the RPL can be used for the large-scale network such as NAN or WAN. Therefore, we strongly believe that RPL is a good candidate routing protocol for smart grid network. Nevertheless, the RPL protocol cannot be implemented to smart grid perfectly because there are some demerits, e.g., it cannot support multiple gateway, the OF function of RPL also cannot support the peer-to-peer of large-scale network such as NAN and the DAG cannot support a real-time environment.

5. Conclusions

In this paper, we give a comprehensive study about the routing protocol for smart grid communication. We focus on five well-known routing protocols AODV, DSDV, DYMO, TUQR and RPL. Firstly, the merits/demerits of these protocols are presented. Secondly, we analyze the performance of these protocols and found that AODV should be used as the benchmark in order to evaluate the routing performance of RPL. From the studied, we found that due to the merits of RPL, it would be the best protocol to be implemented as the routing protocol for smart grid networks. Nevertheless, the RPL protocol cannot be implemented to smart grid perfectly because there are some demerits, e.g., it cannot support multiple gateway, the OF function of RPL also cannot support the peer-to-peer of large-scale network such as NAN and the DAG cannot support a real-time environment.

วารสารอิเล็กทรอนิกส์ ECTI
ECTI e-magazine
ISSN: 2286-7074

6. References

[1] J. Ekanayake, K. Liyanage, J. Wu, A. Yokoyama, and N. Jenkins, “Smart Grid: Technology and Applications,” West Sussex, England, John Wiley & Sons, Inc., 2010.
[2] X. Fang, G. Xue, and D. Yang, “Smart Grid -- The New and Improved Power Grid: A Survey,” IEEE Communications Surveys & Tutorials, 2011.
[3] 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, October 2010.
[4] V. G. Gungor, D. Sahin, T. Kocak, S. Ergut, C. Buccella, C. Cecati, and G. P. Hancke, “Smart Grid Technologies: Communication Technologies and Standards,” IEEE Transactions on Industrial Informatics, vol. 7, no. 4, November 2011.
[5] F. Bouhafs, M. Mackay, and M. Merabti, “Links to the Future,” IEEE Power & Energy Magazine, pp. 24-32, February 2012.
[6] W. Wang, Y. Xu, and M. Khanna, “A Survey on the Communication Architectures in Smart Grid,” IEEE Computer Networks, vol. 55, pp. 3604-3629, 2011.
[7] Z. Fan, P. Kulkarni, S. Gormus, C. Efthymiou, G. Kalogridis, M. Sooriyanbandara, Z. Zhu, Z. Lambotharan, and W. H. Chin, “Smart Grid Communications: Overview of Research Challenges, Solutions, and Standardization Activities,” IEEE Communication Surveys & Tutorials, vol. 99, pp. 1-18, January 2012.
[8] http://en.wikipedia.org/wiki/Open_smart_grid_protocol.
[9] http://www.dlms.com/information/whatisdlmscosem/index.html.
[10]DLMS User Association, COSEM Architecture and Protocols, Seventh Edition.
[11]M. Ellis, “Smart Grid: The Components and Integrating Communication,” IEEE International Conference on Green Technologies Conference, pp. 1-6, April 2012, OK, USA.
[12] C. Gomez, J. Paradells, Wireless home automation networks: a survey of architectures and technologies, IEEE Communications Magazine 48 (2010) 92–101.
[13]Q. Zhang, S. Yugeng and Z. Cui, "Application and analysis of ZigBee technology for Smart Grid," in Proc. of the International Conference on Computer and Information Application (ICCIA) 2010, pp. 171-174, December 2010.
[14]B. Akyol, H. Kirkham, S. Clements, M. Hadley, A survey of wireless communications for the electric power system, Prepared for the US Department of Energy, 2010.
[15]IEEE 802.11 WG. Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications, 1999.
[16] IEEE TGs, Status of Project IEEE 802.11s: http://www.ieee802.org/11/ Reports/tgs-update.htm, 2011
[17] M. Bahr, "Update on the Hybrid Wireless Mesh Protocol of IEEE 802.11s," IEEE Conference on Mobile Adhoc and Sensor Systems, Pisa, pp. 1-6, 2007.
[18]N. Saputro, K. Akkaya and S. Uludag, “A survey of routing protocols for smart grid communications,” Computer Networks 56, pp. 2742-2771, 2012.
[19]S. Temel, V. C. Gungor and T. Kocak, “Routing protocol design guidelines for smart grid environments,” Computer Networks 60, pp. 160-170, 2014.
[20]A. Narmada and P. S. Rao, "Performance comparison of routing protocols for ZigBee WPAN," International Journal of Computer Science Issues (IJCSI), vol.8 no. 2, pp. 394-402, November 2011.

วารสารอิเล็กทรอนิกส์ ECTI
ECTI e-magazine
ISSN: 2286-7074

[21]C. Perkins, E. Royer, Rfc 3561 – ad hoc on-demand distance vector (aodv) routing, 2003.
[22] C. Perkins E. Belding-Royer, and S. Das, “Ad hoc on-demand distance vector (AODV) routing,” Experimental RFC 3561, July 2003.
[23] C.E. Perkins and P. Bhagwat, “Highly dynamic destination-sequenced distance-vector routing (DSDV) for mobile computers,” in Proceeding of the conference on communication Architectures, Protocols and Applications (SIGCOMM), pp 234-244, New York, 1994.
[24]R. E. Throup, “Implementing and Evaluating the DYMO,” February 2007.
[25]N. Sivakumar and S. K. Jaiswal, "Comparison of DYMO protocol with respect to various quantitative performance metrics," ircse 2009
[26] I. Zagli and M. Song, “Topology unaware QOS routing protocol,” in Proceeding of 5th WSEAS International Conference on Telecommunications and Informatics, pp. 207-212, May 2006
[27]A. R. Parnian, M. R. Kharazmi and R. Javidan, "RPL routing protocol in smart grid communication," ARPN Journal of Systems and Software, vol. 4, no. 5, pp. 128-132, August 2014.
[28]V. Kathuria, G. Mohanasundaram and S. R. Das, “A Simulation Study of Routing Protocols for Smart Meter Networks,” in Proceeding of the Symposium Communication Networks for Smart Grids and Smart Metering (SmartGridComm), pp. 384-389, October 2013.
[29]D. Wang, Z. Tao, J. Zhang and A. A. Abouzeid, "RPL based routing for advanced metering infrastructure in smart grid," in Proc. of the IEEE International Conference on Communications Workshops (ICC) 2010, pp. 1-6, May 2010.
[30]J. Yi, T. Clausen and Y. Igarashi, "Evaluation of routing protocol for low power and lossy networks: LOADng adn RPL," in Proc of the IEEE Conference on Wireless Sensors (ICWiSe) 2013, pp. 19-24, December 2013.
[31]J. Tripathi, J. C. de Oliveira and J. P. Vasseur, "Applicability study of RPL with local repair in smart grid substation networks," in Proc. of the 1st IEEE International Conference on Smart Grid Communications (SmartGridComm) 2010, pp. 262-267, Ocotober 2010.
[32]V. Kathuria, G. Mohanasundaram, S. R. Das, “A simulation study of routing protocols for smart meter networks,” IEEE International Conference on Smart Grid Communications (SmartGridComm), pp. 384-389, October 2013.
[33]N. Bressan, L. Bazzaco, N. Bui, P. Casar, L. Vangelista and M. Zorzi, “The Deployment of a Smart Monitoring System using Wireless Sensors and Actuators Networks,” 1st IEEE International Conference on Smart Grid Communications (SmartGridComm), pp. 49-54, 2010.
[34]J. Tripathi, J. C. de Oliveira and J. P. Vasseur, “Applicability Study of RPL with Local Repair in Smart Grid Substation Networks,” 1st IEEE International Conference on Smart Grid Communications (SmartGridComm), pp. 262-267, October 2010.

วารสารอิเล็กทรอนิกส์ ECTI
ECTI e-magazine
ISSN: 2286-7074

Adisorn Kheaksong is a lecturer at the department of Computer Engineering, Panyapiwat Institute of Management (PIM), THAILAND, where he has been a faculty member since 2009. Currently, he is a PhD student at King Mongkut's University of Technology North Bangkok (KMUTNB), THAILAND Working at the Communication and Computer Network Research Group (C2NRG) at the Electrical Engineering, Department of Electrical and Computer Engineering, Faculty of Engineering, His research interests include wireless sensor network, cognitive radio on smart grids

Kanabadee Srisomboon is a Ph.D. candidate at the Communication and Computer Network Research Group (C2NRG), Department of Electrical and Computer Engineering, Faculty of Engineering, King Mongkut's University of Technology North Bangkok, Bangkok, Thailand. He received his B.S. degree from Civil Aviation Training Center in 2011 and his M.Eng. degree from King Mongkut's University of Technology North Bangkok in 2013. His research interests include image processing, smart grid communication and cognitive radio communication.

Wilaiporn Lee is an assistant professor with the Communication and Computer Network Research Group, Department of Electrical and Computer Engineering, King Mongkut's University of Technology North Bangkok, Thailand. She received her B.Eng degree from Khonkaen University in 2002 and her M.Eng., and Ph.D. degrees from Chulalongkorn University in 2005 and 2008, respectively. Her research interests include image processing, ultra-wideband communication, cognitive radio communication and smart grid communication.

วารสารอิเล็กทรอนิกส์ ECTI
ECTI e-magazine
ISSN: 2286-7074

Paper List of ECTI Transaction

ECTI-EEC Trans., Vol.14, No. 1, Feb-2016 issue

New Website: http://www.ecti-eec.org/

Table of Contents

Special Section: ECTI-CON 2015

Performance Improvement of ACO-OFDM Indoor Optical Wireless Transmissions Using Partial Pre-Equalization

Jariya Panta,Poompat Saengudomlert, and Keattisak Sripimanwat

Electrical Power Systems

Energy Storage System Sizing for Peak Shaving in Thailand

Jackravut Dejvises

Optimal Siting of UPFC on a Transmission Line with the Aim of Better Damping of Low Frequency Oscillations

Reza Gholizadeh-Roshanagh, Behrouz Mohammadzadeh, and Sajad Najafi-Ravadanegh

Communication Systems

Policies for Channel Allocation in Cognitive Radio Networks using Game Theory

Amulya Bhattarai , Chalie Charoenlarpnopparut ,Prapun Suksompong and Patrachart Komolkiti

Adaptive Two-stage Spectrum Sensing under Noise Uncertainty in Cognitive Radio Networks

Wilaiporn Lee , Kanabadee Srisomboon, Kornkamol Thakulsukanant , Akara Prayote

Circuits and Systems

An All-Digital PLL Proposal using Gain Control Technique

Vlademir J. S. Oliveira, Wagner C. Mariani and Fábio V. Grigollo

Signal Processing

A linear least square approach for navigation using ultrasonic waves

Natee Thong-un

วารสารอิเล็กทรอนิกส์ ECTI
ECTI e-magazine
ISSN: 2286-7074

Report from Conferences/Workshops/Seminars/Events

1. ECTI Committee Meeting

The first general ECTI Committee Meeting (1/2016) was held at Asia Hotel, Bangkok, and the newly elected ECTI members were approved at the meeting. The list of all committee members, staffs and editors can be found on the Who's Who section (Pg. 27).

2. Workshop on "iEMAT Winter EM School" at King Mongkut's Institute of Technology North Bangkok (KMUTNB), Bangkok. (Reported by Prof. Danai Torungraeng)

The Workshop on "iEMAT Winter EM School" was organized by iEMAT, under TC(Electromagnetics), on January 22nd, 2016, on the campus of KMUTNB. It was also sponsored by ECTI Association, IEEE MTT/AP/ED Thailand Chapter and ThaiCom. There were 6 speakers and 257 registrants.

วารสารอิเล็กทรอนิกส์ ECTI
ECTI e-magazine
ISSN: 2286-7074

วารสารอิเล็กทรอนิกส์ ECTI
ECTI e-magazine
ISSN: 2286-7074

3. Lecture at Yangon Technical University, Myanmar. (Reported by Prof. Kosin Chamnongthai)

A special ECTI lecture was organized at Yangon Technical University, Myanmar on Jan. 22nd, 2016. Over thirty attendants participated at this event.

วารสารอิเล็กทรอนิกส์ ECTI
ECTI e-magazine
ISSN: 2286-7074

4. Workshop on "Research paper writing" at Rajamangala University of Technology Lanna. (Reported by Prof. Kosin Chamnongthai)

A special ECTI workshop was organized at Rajamangala University of Technology Lanna on Jan. 21st, 2016. Over thirty attendants participated at this event.

วารสารอิเล็กทรอนิกส์ ECTI
ECTI e-magazine
ISSN: 2286-7074

5. Workshop on "Research paper writing" at National University of Laos. (Reported by Prof. Kosin Chamnongthai)

A special ECTI workshop was organized at National University of Laos, on Jan. 26th -27th, 2016. Over twenty attendants participated at this event.

6. Workshop on "Research paper writing for graduate students" at Mandalay Technological University (MTU), Myanmar. (Reported by Asst.Prof. Sataporn Promwong)

A special ECTI workshop was organized at Naitonal University of Laos, on February 7th, 2016. Over thirty attendants participated at this event.

วารสารอิเล็กทรอนิกส์ ECTI
ECTI e-magazine
ISSN: 2286-7074

Announcements/Upcoming events/Call-for-Papers

วารสารอิเล็กทรอนิกส์ ECTI
ECTI e-magazine
ISSN: 2286-7074

Call for Participation

International Conference on Electrical Engineering/Electronics, Computer, Telecommunications and Information Technology
ECTI-CON 2016 June 28th - July 1st, 2016 at Chiang Mai, Thailand

Advisory Committee
Monai Krairiksh (KMITL)
Prabhas Chongsatitwattana (CU)
Nipon Theeraumpon (CMU)
Steering Committee
Tomoaki Sato (Hirosaki U, Japan)
Yoshihiro Matsui (TNCT, Japan)
Kou Yamada (Gunma U, Japan)
Prayoot Akkaraekthalin (KMUTNB)
Naruemon Wattanapongsakorn (KMUTT)
Tuptim Angkaew (CU)
Kosin Chamnongthai (KMUTT)
Supattana Nirukkanaporn (RSU)
David Banjerdpongchai (CU)
Chutima Prommak (SUT)
General Chair
Prayoot Akkaraekthalin (KMUTNB)
General Co-Chairs
Udom Sutakcom (RMUTL)
Kitchar Chaitanu (RMUTL)
Sanit Pipithasombut (RMUTL)
Passawat Wacharadumrongsak (RMUTL)
Vice General Chairs
Uthen Kamnarn (RMUTL)
Krisda Yingkayun (RMUTL)
Kosol Oranpiroj (RMUTL)
Technical Program Chair
Chuwong Phongcharoenpanich (KMITL)
Technical Program Co-Chair
Sven Nordholm (Curtin U, Australia)

Special Session Chairs
Byeungwoo Jeon (Sungkyunkwan U, Korea)
Kou Yamada (Gunma U, Japan)
David Banjerdpongchai (CU)
Publication Chairs
Upady Hatthasin (RMUTL)
Pollakrit Toonkum (RMUTL)
Pratch Piyawongwisal (RMUTL)
Sponsor & Exhibition Chairs
Pracha Yeunyongkul (RMUTL)
Manus Sanun (RMUTL)
Yingrak Auttawaitkul (MJU)
Local Arrangement Chairs
Surasak Yousawat (RMUTL)
Nopadon Maneetien (RMUTL)
Information System Chairs
Anan Tubkerd (RMUTL)
Natchasit Chukiatkhajorn (RMUTL)
Public Relations
Pornhathai Tanjitanont (RMUTL)
Akksatcha Duangsuphasin (RMUTL)
Finance Chairs
Ketchat Nuandee (RMUTL)
Juthathip Suwan (RMUTL)
Sarawuth Chaimool (UDRU)
Pairin Kaewkuay (ECTI)
General Secretary
Supakit Kawdungta (RMUTL)

Honorary Chairs
Numyoot Songthanapitak (RMUTL)
Kiyoshi Yoshikawa (RMUTL)
Ryuichi Nakata (Japan)

Call for Papers
On behalf of Rajamangala University of Technology Lanna (RMUTL) and ECTI Association, we are delighted to welcome all delegates and all the distinguished guests to Chiang Mai for the 13th International Conference that will take place in the downtown of Chiang Mai, northern Thailand in June 28th - July 1st, 2016. This is Chiang Mai's largest annual event devoted to the science and practice of Electrical Engineering/Electronics, Computer, Telecommunications and Information Technology and it will give participants a platform to exchange ideas, discover novel opportunities, reacquaint with colleagues, meet new friends and broaden their knowledge. Accepted papers will be published in the proceedings of ECTI-CON 2016 and will be submitted for inclusion into IEEE Xplore. Acceptance will be based on quality, relevance and originality.

Important dates:
Submission of Full Paper: January 31st, 2016
Notification of Acceptance: May 7th, 2016
Submission of Final Manuscripts: May 22nd, 2016
Registration of Authors and Early-bird: May 22nd, 2016

Paper submission:
1) Prospective authors are invited to submit original full papers **WITHOUT author's names and affiliations, in English**, of 4-6 pages in standard IEEE two-column format only, reporting their original work and results, applications, and/or implementation in one or more of the listed areas.
2) Papers must be submitted only by internet through the submission system of the conference website.
3) At least one author of each accepted paper **MUST** register and present paper at the conference in order for the paper to be included in the program. The program will be submitted for inclusion into IEEE Xplore.

Areas:
1) Devices, Circuits and Systems: Semiconductor Devices, Circuits and Systems, Sensing and Sensor Networks, Filters and Data Conversion Circuits, RF and Wireless Circuits, Photonic and Optoelectronic Circuits, VLSI Physical Design, Biomedical Circuits, Assembly and Packaging Technologies, Test and Reliability, Advanced Technologies (i.e. MEMS Devices, Nano-electronic Devices and Metamaterials), Agritronics, Embedded Systems;
2) Computers: Computer Architecture, Computational Biology, Knowledge and Data Engineering, Multimedia Services and Technologies, Mobile Computing, Distributed Computing, Pattern Analysis and Machine Intelligence, Software Engineering, Visualization and Computer Graphics;
3) Information Technology: IT Bio/Medical Engineering, Bioinformatics and Applications, Ontology, Business and Information Systems, Information Security and Forensics, Information Retrieval, Data Mining, Knowledge Management, Electronic Commerce, Health and Medicals Informatics, Hybrid Information Technology;
4) Communication Systems: Communication Theory and Information Theory, Antenna and Propagation, Microwave Theory and Techniques, Modulation, Coding, and Channel Analysis, Networks Design, Network Protocols, Network Management, Optical Communications, Wireless/Mobile Communications and Technologies, Green Wireless Networks, Green Radio;
5) Controls, Instrumentation and Measurements: Adaptive and Learning Control System, Fuzzy and Neural Control, Mechatronics, Control Systems and Applications, Robotics and Automation, Data acquisition systems, Measurement of electric and mechanical quantities, Medical and biological measurement, Non-invasive measurement techniques and instrumentation, Sensors/Wireless sensors/ sensory systems, Materials in measurement, Optical measurement and instrumentation, Nano technology in instrumentation and measurement, Fiber optics instrumentation;
6) Electrical Power Systems: Power Engineering and Power Systems, Electromagnetic Compatibility, Energy Conversion, High Voltage Engineering and Insulation, Power Delivery, Illumination, Renewable/Alternative Energy, Energy Policy and Planning;
7) Power Electronics: Power Devices and Components, Power Quality Control, Harmonic Analysis and Compensations, Switching Circuits and Power Converters, Motor and Drives, Smart Grid, Distribution Generation and Electrical Vehicles, Photovoltaic Materials and Solar Cells;
8) Signal Processing: Digital Signal Processing Algorithms, Digital Filter Design and Implementation, Array Processing, Adaptive Signal Processing, Audio, Speech and Language Processing, Image and Video Processing, Signal Processing Theory and its applications;
9) Other Related Areas

Contact Address: Faculty of Engineering,
Rajamangala University of Technology Lanna (RMUTL)
128 Huay Kaew Road, Muang, Chiang Mai 50300, Thailand
e-mail: ecticon2016@gmail.com; **Tel:** +66-53921444 ext. 2641
website: www.ecticon2016.org

Organized by ECTI Association
Technical Sponsor by IEEE THAILAND SECTION

วารสารอิเล็กทรอนิกส์ ECTI
ECTI e-magazine
ISSN: 2286-7074

JCSSE 2016

The 13th International Joint Conference on Computer Science and Software Engineering (JCSSE 2016)

"Machine Learning in the Internet of Things Era"

13-15 July 2016
Pullman Khon Kaen Raja Orchid Hotel, Khon Kaen, Thailand

Call for Papers

Topics of Interest

Prospective authors are invited to submit their original and unpublished papers in the areas of computer science and software engineering and the related fields. Topics include, but are not limited to, the followings:

- Algorithmic Bioinformatics
- Cluster and Grid Computing
- Computational Science and Engineering
- Computer and Internet Security
- Computer Networks and Communications
- Computer Vision
- Embedded Systems
- Geoinformatics
- Information Technology
- Information Retrieval
- Internet of Things
- Knowledge and Data Management
- Machine Learning and Intelligent Systems
- Multimedia and Computer Graphics
- Ontology and Semantic Web
- Pervasive and Mobile Computing
- Software Engineering

Papers should not exceed six (6) pages including results, figures, and references. All manuscripts must be prepared in the standard IEEE Conference Proceedings format in PDF. Manuscript templates are made available on the website (http://jcsse2016.cs.kku.ac.th). Only electronic submissions in PDF format will be accepted via EDAS submission system. All submissions will be subjected to a double-blind review procedure. Authors are expected to present their papers at the conference upon acceptance. Presenting authors are required to register for the conference. Presented and selected papers will be submitted for inclusion in IEEEXplore® Digital Library.

Selected papers will be invited for further extension before publishing in ECTI-Transaction on Computer and Information Technology (ECTI-CIT), indexed by TCI, (http://www.ecti-thailand.org/paper/journal/ECTI-CIT).

Important Dates

Submission of Papers	1 April 2016
Notification of Acceptance	25 May 2016
Submission of Camera-ready Manuscripts	10 June 2016
Registration Deadline	10 June 2016
Conference Dates	13-15 July 2016

Keynote Speaker

Associate Professor Guang-Bin Huang, Ph.D., Senior Member of IEEE
School of Electrical and Electronic Engineering
Nanyang Technological University, Singapore

International Advisory

Hosted by

Department of Computer Science, Faculty of Science, Khon Kaen University, Thailand

JCSSE 2016 Secretariat

Further information, please refer to
Conference website: http://jcsse2016.cs.kku.ac.th
Email: jcsse2016@kku.ac.th

Technical Co-Sponsor ECTI Association IEEE THAILAND SECTION

วารสารอิเล็กทรอนิกส์ ECTI
ECTI e-magazine
ISSN: 2286-7074

การประชุมวิชาการ งานวิจัย และพัฒนาเชิงประยุกต์ ครั้งที่ 8

ECTI CARD 2016

27-29 กรกฎาคม 2559

โรงแรมหัวหินแกรนด์ โฮเทล แอนด์ พลาซ่า จังหวัดประจวบคีรีขันธ์

Conference Committee

Advisory

รศ.สุกัทรา โกไศยกานนท์(มทร.พระนคร)
ศ.ดร.ประภาส จงสถิตวัฒนา(จุฬาลงกรณ์)

General Co-Chair

ศ.ดร.ประยุทธ อัครเอกสิน(มจพ.)
ผศ.ดร.วิโรจน์ ตุหมื่องอ(มทร.พระนคร)
นายประยูร เชี่ยวรัตนา(มว.)
อ.อนันต์ เดิมเปี่ยม (มทร.พระนคร)

Technical Program Chairs

ศ.ดร.โกสินทร์ จำนงไทย(มจธ.)
รศ.ดร.พิทัตน์ พรหมมี(สจล.)
รศ.ดร.ภิพิทพงศ์ ขัยสิงห์(มเชียงใหม่)
รศ.ดร.พรชัย พฤกษ์ภัทรหานนท์(มอ.)
ดร.พลิษฐ์ สุวรรณภิงคาร(มทร.พระนคร)
ดร.สมชัย ทิรัญวโรหม(มทร.ธัญบุรี)
ดร.ชัยวัฒน์ เจษฎาจินดา (มว.)

Secretaries

ผศ.ดร.ณัฐพงศ์ พันธุนุช (มทร.พระนคร)
อ.ธนะกิจ วัฒกีกำธร (มทร.พระนคร)

2nd Call for Papers

งานประชุมวิชาการ ECTI-CARD 2016 ครั้งที่ 8 **"การประยุกต์ใช้เทคโนโลยีอย่างชาญฉลาดเพื่อตอบสนองภาคอุตสาหกรรมสมัยใหม่อย่างยั่งยืน"** จัดโดยคณะวิศวกรรมศาสตร์ มหาวิทยาลัยเทคโนโลยีราชมงคลพระนคร สถาบันมาตรวิทยา และสมาคมวิชาการไฟฟ้า อิเล็กทรอนิกส์ โทรคมนาคม และสารสนเทศประเทศไทย ที่ถูกจัดขึ้นระหว่างวันที่ 27-29 กรกฎาคม พ.ศ.2559 **ณ โรงแรมหัวหินแกรนด์แอนด์พลาซ่า จ.ประจวบคีรีขันธ์** มีจุดมุ่งหมายหลักของการจัดงานเพื่อรวบรวมผลงานวิจัยและพัฒนาเชิงประยุกต์ งานนวัตกรรม และสิ่งประดิษฐ์รวมถึงเปิดโอกาสให้นักวิจัย ผู้พัฒนาและผู้ใช้งานหรือหน่วยงานต่างๆ ได้มีโอกาสในการแลกเปลี่ยนเรียนรู้ซึ่งกันและกันและสามารถนำผลงานที่ตีพิมพ์ไปพัฒนาต่อยอดหรือพัฒนาสู่ผลิตภัณฑ์เชิงพาณิชย์ได้ ซึ่งบทความที่ส่งมานั้นจะได้รับการพิจารณาโดยผู้ทรงคุณวุฒิจากคุณภาพและความสมบูรณ์ของงาน บทความที่ได้รับการคัดเลือกและได้ถูกนำเสนอในที่ประชุม ECTI-CARD 2016 จะถูกตีพิมพ์ใน ECTI-CARD Proceedings ซึ่งสามารถสืบค้นได้ที่ฐานข้อมูลของสมาคม ECTI

หัวข้อบทความที่เกี่ยวข้อง

กลุ่มที่ 1 : เกษตรกรรม อุตสาหกรรมเกษตร
กลุ่มที่ 2 : เทคโนโลยีชีวภาพ การแพทย์ วิทยาศาสตร์การภาพ วิทยาศาสตร์การกีฬา
กลุ่มที่ 3 : การประหยัดพลังงาน การจัดการพลังงานบ้านอัจฉริยะ
กลุ่มที่ 4 : การเรียนการสอนทางไกล การศึกษาบนสิ่งแวดล้อมเสมือนจริง
กลุ่มที่ 5 : การรู้ถึง ระบบเตือนภัย และพยากรณ์
กลุ่มที่ 6 : การสื่อสาร การสนับสนุนผู้ใช้งานบ้าน เครือข่ายสังคม เครือข่ายไร้สาย
กลุ่มที่ 7 : การขนส่ง การควบคุมจราจร การจัดการอุตสาหกรรม
กลุ่มที่ 8 : ธุรกิจการอนามัย การท่องเที่ยว และการโรงแรม
กลุ่มที่ 9 : ระบบความปลอดภัย การควบคุมการเข้าถึงการยืนยันตัวตน ระบบตรวจจับ
กลุ่มที่ 10 : มาตรวิทยา การวัดและควบคุม
กลุ่มที่ 11 : หัวข้ออื่นๆ ที่เกี่ยวข้อง

การส่งบทความแบ่งเป็น 2 รูปแบบ ดังนี้

1. รูปแบบบทความวิจัย เป็นบทความเต็มรูปแบบภาษาไทยหรือภาษาอังกฤษไม่เกิน 4 หน้ากระดาษ A4 ในรูปแบบมาตรฐาน 2 คอลัมน์ของ IEEE โดยต้องกล่าวถึงที่มาและผลที่ได้รับ รายละเอียดและ/หรือการนำไปใช้งาน ซึ่งเกี่ยวข้องกับหัวข้อใดหัวข้อหนึ่งหรือมากกว่า จากกลุ่มต่างๆ ที่ได้กำหนดไว้
2. รูปแบบสิ่งประดิษฐ์และนวัตกรรมเป็นบทความเต็มรูปแบบภาษาไทยหรือภาษาอังกฤษไม่เกิน 2 หน้ากระดาษ A4 ในรูปแบบมาตรฐาน 2 คอลัมน์ของ IEEE โดยผู้เขียนบทความอาจจะนำผลงานหรือสิ่งประดิษฐ์มาร่วมจัดแสดงในงานประชุมด้วยก็ได้

http://ecticard2016.ecticard.org/

WORKSHOP

Session A
การสาธิตอุปกรณ์การวัดแบบต่างๆ

Session B
การสอบเทียบเครื่องมือ ข้อมูลจำเพาะของเครื่องมือ กระบวนการสอบเทียบ สาธิตการสอบเทียบ DMM

Session C,D
ให้บริการสอบเทียบ DMM ให้แก่ผู้ร่วมงานสัมมนา

กำหนดการสำคัญ

วันสุดท้ายของการส่งบทความฉบับสมบูรณ์
วันที่ 28 กุมภาพันธ์ 2559

ประกาศผลการพิจารณาบทความ
วันที่ 11 พฤษภาคม 2559

ส่งบทความต้นฉบับเพื่อตีพิมพ์และลงทะเบียน
วันที่ 24 มิถุนายน 2559

วันจัดประชุมวิชาการ ECTI-CARD 2016
วันที่ 27 - 29 กรกฎาคม 2559

ประสานงานโดย :
ผศ.ดร.ณัฐพงศ์ พันธุนุช 081-838-6780
ผศ.กมลทิพย์ วัฒกีกำธร 090-925-5856
ดร.พลิษฐ์ สุวรรณภิงคาร 080-044-1915

คณะวิศวกรรมศาสตร์ มหาวิทยาลัยเทคโนโลยีราชมงคลพระนคร
1381 ถนนประชาราษฎร์ 1 แขวงวงศ์สว่าง เขตบางซื่อ กรุงเทพมหานคร 10800
โทรศัพท์ 02-913-2424 ต่อ 150 โทรสาร 02-913-2424 ต่อ 151
EMAIL : ecticard2016@gmail.com

ร่วมจัดประชุมโดย : ECTI Association, RMUTP, NIMT

วารสารอิเล็กทรอนิกส์ ECTI
ECTI e-magazine
ISSN: 2286-7074

ISPACS 2016
Phuket, Thailand
24-27 October 2016

2016 International Symposium on Intelligent Signal Processing and Communication Systems

Call for Papers

The 2016 International Symposium on Intelligent Signal Processing and Communication Systems (ISPACS 2016) will be held during 24-27 October 2016 at Phuket Graceland Resort & Spa, Patong, Phuket, Thailand. The symposium presents every possibility on new technologies based on signal processing and communications. ISPACS 2016 (IEEE Conference Record Number #37442) will include regular sessions on the topics listed below and some special sessions on emerging topics concerning intelligent signal processing and communication systems.

1. Communication Systems
- Radio Propagation and Channel Modeling
- Communication Theory
- Antenna and Propagation
- Wideband Communications
- Wireless Systems
- Intelligent Communication Systems and Network Protocols

2. Multimedia and Systems
- Speech Processing and Coding
- Image Processing
- Video Processing and Coding
- Video and Multimedia Technology and Communications
- Audio/Acoustic Signal Processing
- Multimedia Processing for e-Learning

3. Signal Processing
- Digital Filters and Filter Banks
- Wavelets and Multi-rate Signal Processing
- Adaptive, Non-linear and Multidimensional Signal Processing
- Fast Computations for Signal Processing, and Communication Systems
- Radar, Antennas and Mobile Signal Processing
- Intelligent Signal Processing for Communications and Systems
- Security Signal Processing
- Optical Signal Processing
- Medical Signal Processing
- Noise Control

4. VLSI
- Analog and Digital ICs for Communications
- Low Power Design and VLSI Physical Synthesis
- Modeling, Simulation and CAD Tools
- VLSI Architecture for Signal Processing

5. Circuits and Systems
- Analog Circuits, Filters and Data Conversion
- Analog and Mixed Signal Processing
- Numerical Methods and Circuit Simulation
- Circuits and Systems for Communications
- Neural Networks and Fuzzy Logic Processing
- Sensors and Devices
- Intelligent Instrumentations
- Wireless Sensor Networks

6. Emerging Technologies in Signal Processing and Communications

Important Dates
Submission of Special Session Proposals:
30 April 2016
Submission of Full Papers:
15 June 2016
Acceptance Notification:
15 August 2016
Submission of Camera-ready Manuscripts:
10 September 2016

Travelling grants, around 5% of the number of actual participants, will be given to participants who truly need support, especially the ASEAN Economic Community (AEC) members. The applications are required and will be considered by the TPC committee.

For more information about the conference, please visit our official web site: http://ispacs2016.psu.ac.th or contact ispacs2016@coe.psu.ac.th.

Phuket is one of the most internationally well-known and popular islands. Phuket, known as "Pearl of the Andaman Sea" and its unique combination of the sea and mountains, has many fine white sandy beaches and deep blue sea as well as fascinating history and mixed cultures such as Sino-Portuguese architecture, local traditions, living styles and food.

See more information about Phuket at http://www.phukettourist.com/index.php.

Organized by

Technically co-sponsored by

(Applying)

วารสารอิเล็กทรอนิกส์ ECTI
ECTI e-magazine
ISSN: 2286-7074

ECTI Who's Who

Headquarter:
ECTI Association
Sirindhon International Institute of Technology
131 Moo 5 Tiwanon Rd.,Bangkadi
Pathumthani 12000,Thailand
Tel: 02-5012578
E-mail: ecti.secretary@gmail.com