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ECTI *e*-magazine

In this Issue…

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Message from Editor

Dear authors, reviewers and readers of ECTI E-Magazine,

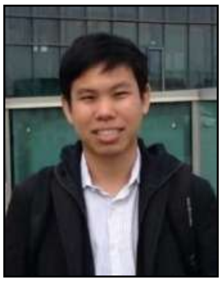
The past three months have seen some important academic activities and events. On June 26-29, 2018 the 10th ECTI-CARD conference held in Phitsanulok, Thailand was successfully complete. The conference theme is "Applications of technology to serve Thailand 4.0 policy". There are a total of 212 papers from 58 universities, government organization and private companies accepted for oral and poster presentations. This conference symbolizes a great academic collaboration of Thai academia and industries, serving as a strong and solid platform for sharing not only advanced research innovation but also creating beautiful and new friendships. The ECTI association is so proud to see the conference steadily growing and prosperous every year since its establishment in 2008. This year in particular ECTI association wishes to express our wholehearted gratitude towards the Phitsanulok university for their excellent work and congratulates them for their great success in organizing this conference. In addition, there are several workshops and mini conferences taking place locally on interesting topics, including Future of HDD Technology, Magnetic Damping Spintronics for Memory, and HAMR, Smart Wind and Solar for Power System Stabilizing Control, Hierarchically Decentralized Control Synthesis by Aggregation towards Smart Cities, 9th Instrumentation, Control, and Automation Senior Project Conference (ICA SP-CON 2018) and Thailand-Japan Microwave (TJMW 2018).

We are delighted to introduce an article entitled "A recent survey on anti-collision protocols in RFID systems" written by a group of researchers from five different countries, namely Thailand, Malaysia, Pakistan, Taiwan and Australia. This article describes the history as well as ongoing research of anti-collision protocols both aloha-based and tree-based focusing on RFID tag identification. We recommend this article for new researchers who wish to start his/her research in this field and get into the key concept quickly.

ECTI association will organize three major conferences this year, namely ITC-CSCC 2018 (Bangkok) in July 4-7, 2018, the ECTI-CON 2018 (Chiangrai) in July 18-21, 2018, ISCIT 2018 (Bangkok) in September 26-29, 2018. Members are encouraged to participate in these conferences to share experiences among regional and global leading researchers, while meeting new friends and setting up collaboration among universities and institutions. Accepted papers in conferences with exceptionally high quality can be extended for publication in two prestigious journals of ECTI, namely the ECTI Transactions on Computer and Information Technology (ECTI-CIT) and the ECTI Transactions on Electrical Engineering, Electronics, and Communications (EEC).

Finally, we are very excited and pleased to announce a new opportunity in our ECTI E-Magazine for international students, researchers and engineers to write one-page articles on interesting technology or findings in their own languages together with the corresponding English translation. The objective is to encourage international experts to express their interesting work for their own countries as well as to international community. This new section is referred to as "Unravelling Technologies in the Digital World".

Lunchakorn Wuttisittikulkij
ECTI E-Magazine Editor



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A SURVEY ON RECENT ANTI-COLLISION PROTOCOLS IN REFID SYSTEMS

Sanika Krishnamali Wijayasekara, Suvit Nakpeerayuth, Warakon Srichavengsup, Muhammad Saadi, Robitoh Annur, Pruk Sasithong, Pisit Vanichchanunt, Norrarat Wattanamongkhol, Hung Yun Hsieh, Teerapat Sanguankotchakorn, Kumbesan Sandrasegaran, and Lunchakorn Wuttisittikulkij

ABSTRACT

Radio Frequency Identification (RFID) technology is a very promising object or animal tracking technology which has already been used or proposed in various applications, such as health care, asset control, inventory management, logistics, conveyances, roll cages, retail apparel and footwear. One important and critical issue of RFID systems is the tag collision problem, which arises when multiple tags transmit reply signals to a reader at the same time, in response to the reader's probe signal. In this article, we carried out an extensive review on the existing anti-collision algorithms, including ALOHA-based, tree-based and query tree-based algorithms, that can be used to resolve the tag collision problem.

Keywords: Anti-collision, reader, tag, RFID, algorithm, tree, ALOHA

I.INTRODUCTION

RFID is a mechanism of identifying an object automatically with the aid of appropriate communicational devices and protocols. As shown in Figure 1, an RFID system consists of a reader and several tags. The reader or the transceiver is an electronic device which uses radio waves to communicate with the tags and transfer data between the software application and tags to track the asset in its interrogation zone. There are three categories of RFID tags: passive, active and semi-active. Active tags are self-powered using its internal batteries and they use the battery power to broadcast the radio waves to the reader. The semi-active tags are powered by its own battery power but rely on the power supply from the reader to broadcast the radio waves. The passive tags fully rely on the reader to be powered up by reader's radio frequency (RF) signal. The passive tags are less expensive as compared to the active and semi-active tags due to the less complexity in the hardware structure [1, 2].

In earlier days, Barcode reading was a prominent technique used for inventory management. However, it has some limitations. For example, barcode readers work for short ranges and only one object can be scanned at a time in the identification process. These limitations make the process slow. As shown in Figure 2, collision is an issue occurred during RFID tag identification process. In the RFID reader and tags communication mode, firstly, the reader broadcasts a probe to the tags in its vicinity zone and the tags which can receive the probe will transmit a reply signal to the reader. When the reader receives bulk of replies from the tags simultaneously, the reader fails to identify the tags. This failure increases the delay of tag identification in RFID systems and it wastes the system resources and energies. To mitigate such a problem, a number of Medium Access Control (MAC) layer protocols have been introduced in literature to serve as anti-collision protocols in RFID systems [2].

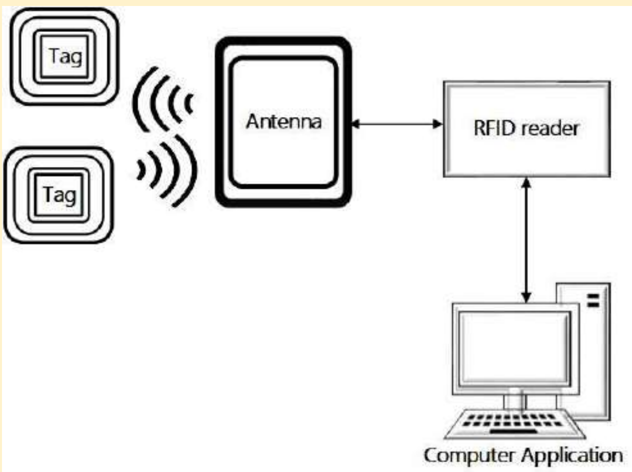

Figure 1: Components in a Basic RFID system.

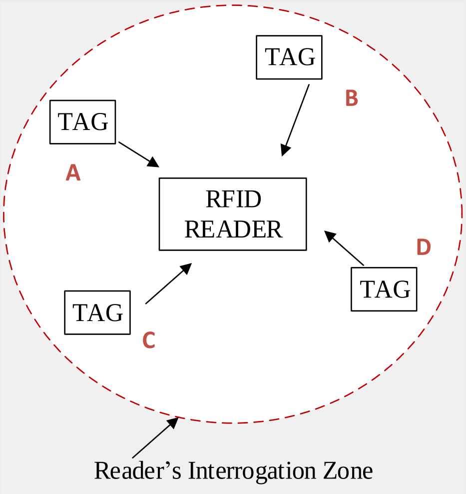

Figure 2: The tag collision problem.

II ANTI-COLLISION PROTOCOLS

As outlined earlier, the simultaneous replies from several tags to the same reader generate collisions and this leads to unwanted delay in tag identification process. In order to resolve such a collision, some anti-collision protocols are devised. These protocols can be broadly classified into ALOHA-based and tree-based protocols. The classification structure of anti-collision protocols is given in Figure 3. The ALOHA-based protocols can be further divided in to slotted ALOHA, frame slotted ALOHA (FSA) and dynamic FSA (DFSA) [3-5]. The tree-based algorithms, on the other hand, can be further divided into query tree, tree splitting, binary search and bitwise arbitration.

A. ALOHA based protocols

In 1970, N. Abramson [6] proposed a novel medium access control protocol known as ALOHA or pure ALOHA. In pure ALOHA when a user has a packet ready to transmit, it sends the packet out. If the packet is successfully transmitted, a positive acknowledgement (ACK) is received; otherwise, a negative acknowledgement (NACK) is received. Then those users who received the NACK must wait for a random backoff time before transmitting their packets. In 1975, L. G. Roberts [7] did a simple modification to pure ALOHA, where a synchronous data transmission happens in a specific time period, called a slot and the retransmission occurs after a random number of slots. This is known as slotted ALOHA.

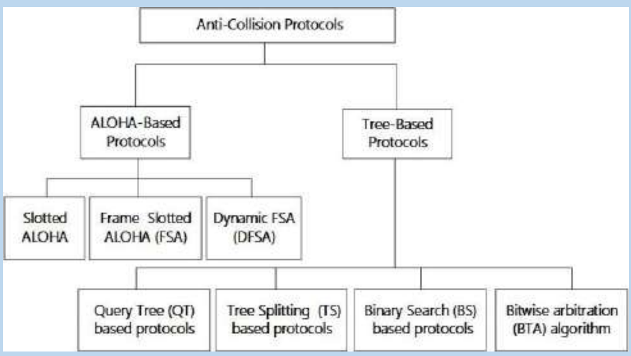

Figure 3: Anti-collision protocols [3].

With respect to RFID systems, in pure ALOHA and slotted ALOHA, a tag which has a higher response rate will collide with other tag responses frequently when accessing the shared channel (or slot). Therefore, the frame-based slotted ALOHA concept is introduced to have only one response from each tag in a reader's range in a given frame, where the frame is a collection of slots. In frame slotted ALOHA (FSA) the frame size is set to a fixed number of slots; when the frame size is not fixed and changes dynamically it is known as dynamic frame slotted ALOHA (DFSA). DFSA operates in multiple rounds and in each round the frame size is dynamically changed based on previously used frame feedback, tag number and so on. Therefore, DFSA requires some sort of tag estimation techniques to decide the next frame size. In Figures 4(a) and 4(b), an execution examples of FSA and DFSA algorithms are given to illustrate the process of FSA and DFSA algorithms respectively.

In 1983, F.C. Schoute presented the DFSA algorithm [8] by estimating previous frame tag count as $S+2.39\cdot C$, where S and C indicate the number of success and collision slots happened in the frame respectively.

Success slot means that only one tag is contained in a slot, while collision indicates that several competing tags are involved in a slot. In [9], H. Vogt introduces an estimation mechanism based on the minimum mean square error or the minimum distance between the mean of success, idle and collision in a frame and the actual read results. Being idle means that the slot doesn't contain any tags.

Recently, the Q protocol is adopted in RFID standard such as ISO/IEC 18000-6 type C and Electronic Product Code (EPC) global Class 1 Generation 2 [10] and it is a variation of DFSA. In the Q protocol, the reader initially broadcasts the slot counter Q, which indicates the frame size of 2^Q. Depending upon the ternary feedback of being idle,

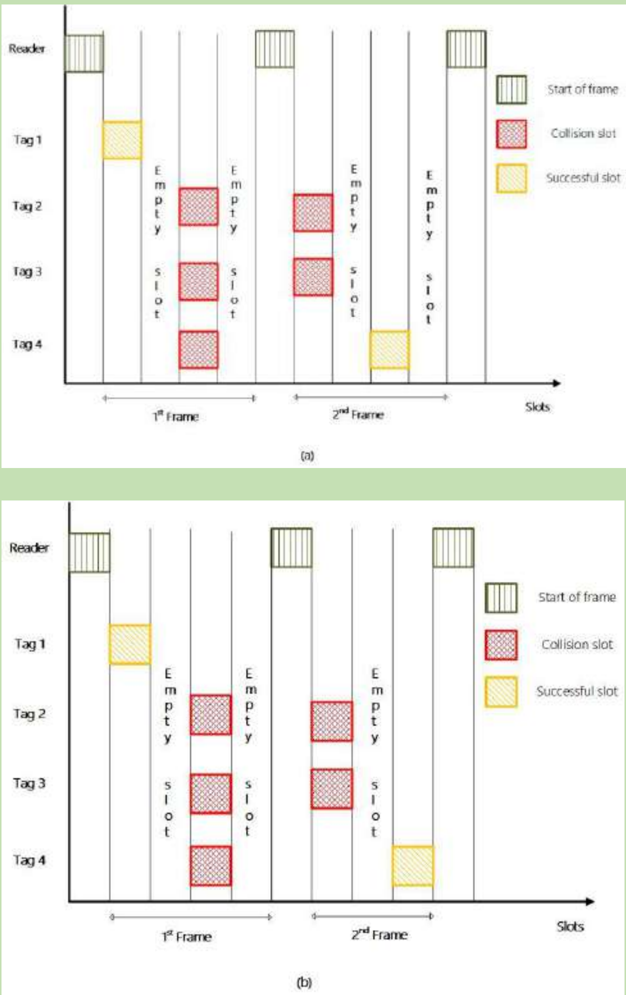

Figure 4: An execution example of FSA and DFSA protocol with respect to 4 tags.

success or collision from a slot, the *Q* value is changed by a constant value c where c is $0.1 \leq c \leq 0.5$. For an idle feedback the *Q* value decreases and for a collision the *Q* value increases by the C value. For a success, the *Q* does not change. When the frame size is larger than the number of tags, the probability of experiencing more number of idle slots increases; when the frame size is less than the number of tags, probability of occurrence of collision increases. Therefore, using this algorithm, an adjusted frame size closer to the number of tags than the original frame size can be achieved without using any estimation method. This algorithm can achieve an efficiency of 34% in tag identification and Figure 5 shows the flow of the Q algorithm.

B Tree-based protocols

Tree-based algorithms can be classified into query tree, tree splitting, binary search and bitwise arbitration. The tree splitting category is initially

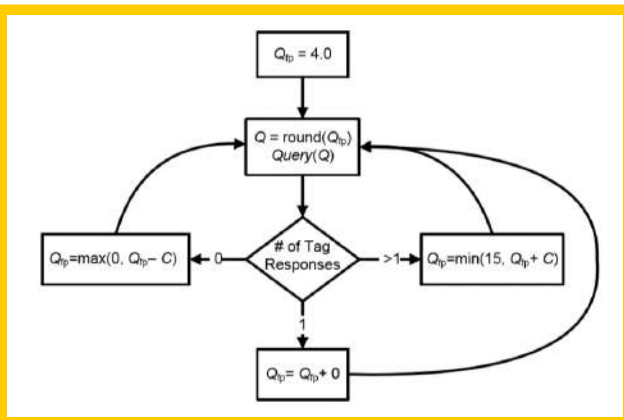

Figure 5: Execution flow of Q algorithm.

introduced in 1979 by J.I. Captanakis [11, 12] as a multiple access protocol in wireless communication systems. The introduction to binary tree has been discussed in [12], in which the collided tags are grouped into two subgroups along the tree structure, until the leaf nodes in the tree structure contains only one tag or none. Binary Tree Algorithm (BTA) also known as fair tree is used in ISO/IEC 18000-6 Type B, EPCGlobal Class 0 and EPCGlobal Class 1 as the anti-collision protocols in RFID tag identification with a system efficiency of 34.6%. In BTA, each tag maintains a counter to track the group and the counter value is set to 0 initially. When the tags receive the query command from the reader, the tags with the counter value equal to 0 send their IDs to the reader. Based on the tags response, collision happens when the reader receives more than one ID. Then the tags in this colliding group generate a binary number 0 or 1 and add it to their counter. Then, all the other unidentified tags increase the counter by one. For no tag response which indicates idleness, all the unidentified tags increase the counter by one and for one tag responses all the unidentified tags decrease the counter by one. Figure 6 shows an example of tag identification using BTA where six users (A, B, C, D, E, F) are initially collided in the initial slot and required fourteen slots to resolve this collision and identify the tags.

In [13], the authors presented a Q-ary tree algorithm with the consideration of binary and ternary feedbacks in binary and ternary tree concepts. In 1981, an algorithm called Modified tree algorithm (MTA) [14] is introduced which gives a 37.5% system efficiency by skipping the definite collision slots in basic binary tree algorithm. As aforementioned, in BTA, the collided slots are further split into two subgroups. If the first subgroup is idle, it is certain that the second subgroup is a collision. Therefore, a slot wastage can be reduced by just splitting the second subgroup into two subgroups and pretending that the collision has occurred. Based on the example given in Figure 7, slots 7 and 12 are followed by idle slots in slots 6 and 11. Therefore, all the collided users in slots 7 and 12 can be split into two subgroups without reading slots 7 and 12. Furthermore, in [14], it is given that a 38.1% system efficiency can be achieved by splitting the right subgroup of the binary tree structure with a bias probability of 0.582 in MTA. In addition, [12] initiated the optimum dynamic binary tree algorithm, where the tree structure follows binary tree concept except the top level where the frame size is set in relation to the number of tags. As shown in Figure 8, the first frame size of ODT is based on the number of tags. The collided slots in this frame are resolved using binary tree concept. In [15] it is proven that the optimal average efficiency of the ODT algorithm is around 42.9% under infinite tag population. Therefore, the ODT algorithm gives a higher efficiency compared to the basic tree algorithms such as binary tree and ternary tree algorithms. Figure 8 shows the execution processes of the ODT algorithm for six competing tags (A, B, C, D, E, F) with an initial frame size of six.

In [15], the authors introduced an improvement to the basic binary splitting tree known as adaptive binary splitting tree, which can improve the tag identification efficiency. The adaptive tree concept is given in [16] that decides the next sub group size of current collided slot upon the number of collided tags of the current collided slot. Therefore, the adaptive tree performs well with some accurate tag estimation techniques and can achieve the optimal efficiency around 43.4% with an accurate tag estimation. The process of adaptive tree is given in Figure 9 for six tags (A, B, C, D, E, F).

This adaptive tree structure has been adopted in [17] along with the Vogt's estimation to guess the number of collided tags and decide the next subgroup size of the splitting tree. This is called the Tree Slotted ALOHA (TSA) algorithm which can achieve a stable throughput around 38% due to the error in tag estimation.

In Query Tree (QT) protocols, the tags are divided into two subgroups based on their tag IDs as given in [18]. At the beginning of the tag identification process, the reader queries a prefix (which is a basically a bit string) to collect the information of the tags in its interrogation area. The tags that have the matching prefixes in their IDs reply to the reader. When the reader receives more than one reply, it queries for one more bit longer prefix than the current prefix. However, according to [19], it is difficult to implement the query tree mechanism in the EPC Global standard. In [20], an improved query tree protocol was introduced, known as bit collision detection-based QT (BQT) to detect the collision in each bit. The authors in [21] proposed a QT based protocol called Adaptive Query Tree (AQT), where the reader additionally maintains a candidate queue (CQ) other than the main queue (Q) in conventional QT protocol.

In Binary Search (BS) algorithms, initially, a reader transmits a serial number to the tags. Then those tags that have the tag IDs equal or lower than the serial number send a reply to the reader. Next, the reader applies the bit-by-bit Manchester coding for the reply and when a collision is experienced, the reader splits the tags into subgroups based on the collided bit [22].

C. Hybrid protocols

There are many hybrid algorithms introduced in the literature where the advantages of tree, and ALOHA algorithm are combined to create an efficient protocol in anti-collision paradigm. In [23], an algorithm which follows the binary tree splitting based tag estimation method with the tree slotted ALOHA (TSA) algorithm is presented which can achieve 41.5% system efficiency. Initially, the protocol splits tags into two subgroups by following BT until the leftmost leaf node of the tree contains no tags or a single tag. Then, all the right nodes are executed using TSA by applying TSA to each group separately. This method enhances the TSA performance due to the initial elegant binary tree splitting tag estimation method. The process of BSTSA is given in Figure 10.

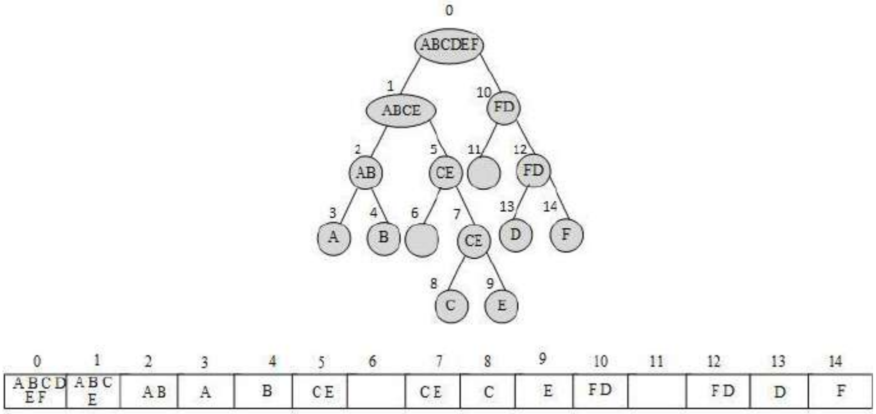

Figure 6: An execution example of BTA.

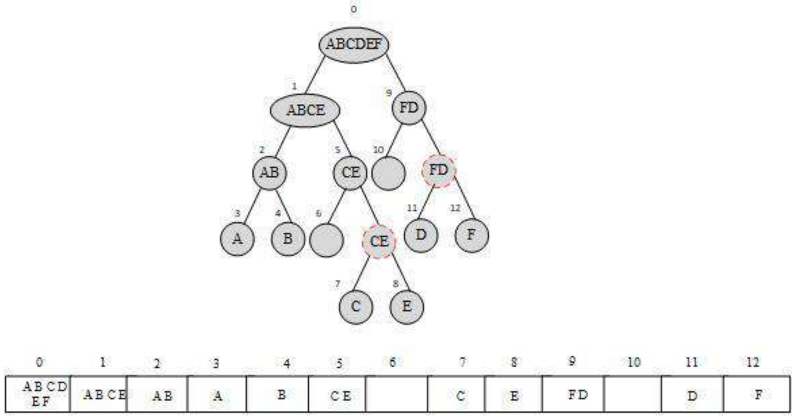

Figure 7: An execution example of MTA.

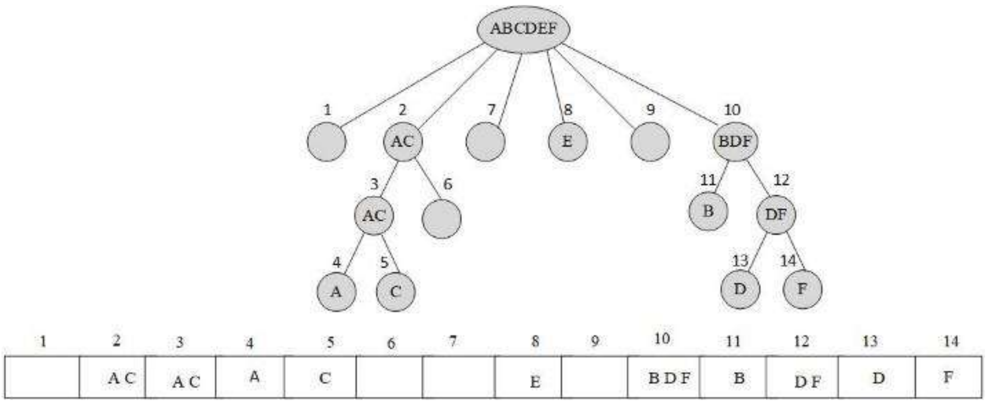

Figure 8: An execution example of ODT algorithm.

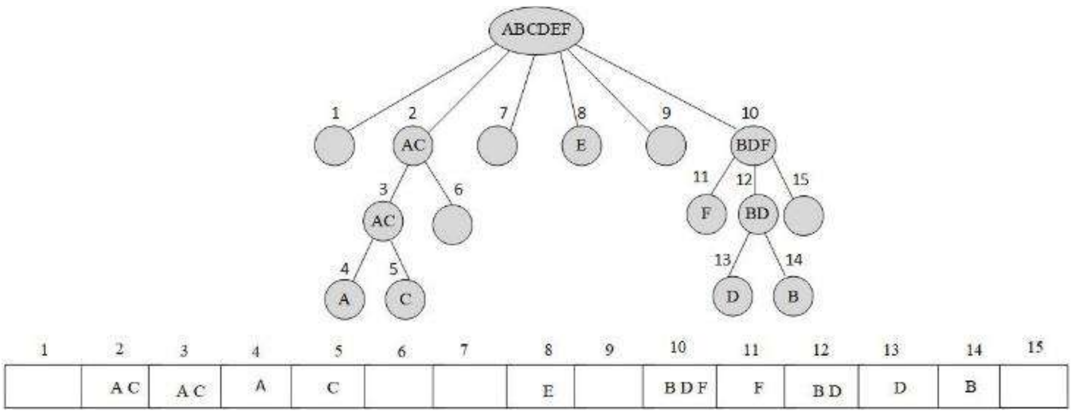

Figure 9: An execution example of adaptive tree algorithm

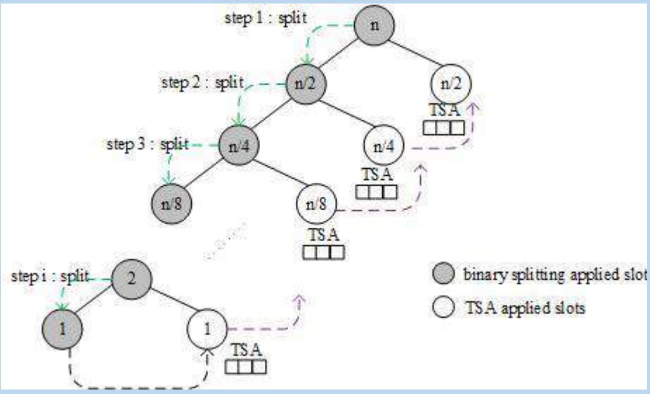

Figure 10 An execution example of BSTSA [32].

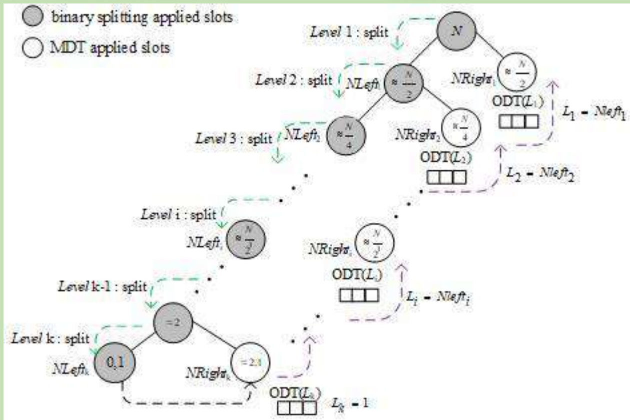

Figure 11: An execution example of splitting BTSA [32].

The performance of BSTSA [23] was significantly enhanced by using the splitting binary tree slotted ALOHA (splitting BTSA) as described in [24]. As shown in Figure 11, this follows the same binary tree splitting tag estimation method used in BSTSA with a different tag identification approach. In this protocol, the authors have noticed that each node at a given level of the tree contains approximately half of the tags at its parent node. Therefore, when the splitting step is finished, the right nodes of the tree structure execute the ODT algorithm (called as BTSA in [24]) with initial frame size equal to the number of collided tags in the left-hand side. Using this approach, a system efficiency of 42.5% can be achieved for any number of tags.

An optimal binary tracking tree (OBTT) is introduced in [25], where the bit estimation is used to estimate the number of tags in the system. Further, it introduced the optimal partitioning with frame slotted ALOHA concept and the collided tags are further identified using binary tree techniques.

Recently, [26] introduces an early frame breaking policy in DFSA to identify a suitable frame size to currently remaining tags in the system. After identifying the best frame size, the collided tags are sub-grouped and identified using DFSA. In [27], a binary splitting based idle slot skipping mechanism is introduced by initiating a binary value of *Q*. In [28], dynamic sub-frame-based maximum a posterior probability method (DS-MAP) is introduced to estimate the backlog in a sub frame to decide the next frame sizes to use in DFSA. A collision-tolerant dynamic-framed slotted ALOHA (CE-DFSA) algorithm is presented in [29], which attempts to identify multiple tags in a slot to reduce the total identification time in the process of tag identification.

III. CONCLUTION

In this paper, a number of anti-collision protocols, especially those that are recently proposed, are presented to resolve the tag collision problem in RFID. The execution procedures of each algorithm are explained in detail along with the achievable system efficiency. It is clear that the recently proposed anti-collision algorithms are tree-based and make good use of tag estimate to achieve high efficiency in tag identifications. This article will be beneficial for those who wish to conduct further research in this area to make RFID tag identification process smoother and efficient.

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Research Interests

- Multi-access communications
- Anti–Collision protocols in RFID
- MAC for industrial IoT
- Cross- layer approach in wireless network

List of Publications

[1] S. K. Wijayasekara, P. Sasithong, A. Robithoh ,P. Vanichchanunt S. Nakpeerayuth, L. Wuttisittikulkij,"A Reduced Complexity of Vahedi's Tag Estimation Method for DFSA", ENGINEERING JOURNAL, Chulalongkorn University, Volume 21, Issue 6, pp 111-125, October 2017.

[2] N. Chaosangket, P. Sasithong, S. K. Wijayasekara, W. Asdornwised, A simulation tool for vertical transportation systems using python,2018 5th International Conference on Business and Industrial Research (ICBIR), Bangkok, Thailand 2018

[3] Sanika.K.Wijayasekara, M. Saadi, W. Srichavengsup, R. Anuur, S. Nakpeerayuth and L. Wuttisittikulkij", Frame Size Analysis of Optimum Dynamic Tree in RFID", International Technical Conference on Circuits/Systems, Computers and Communications (ITC-CSCC), Bangkok, Thailand,2018.

[4] S. K.Wijayasekara, R. Annur, W. Srichavengsup, S. Nakpeerayuth, L. Wuttisittikulkij, Evaluating the influence of tree protocol as a collision resolution protocol in RFID, Regional Conference on Electrical and Electronic Engineering (RCEEE) 2017, Bumi Surabaya Hotel Jl. Jendral Basuki Rahmat No.106-128. Surabaya, Indonesia, 28-29 August 2017

[5] S. .K. Wijayasekara, P. Sasithong, W. Srichavengsup, C. Phongphanphanee, R. Annur, S. Nakpeerayuth and L. Wuttisittikulkij,"Comparison of Frame Based Tag Estimation Methods with and without Priori Knowledge", International Technical Conference on Circuits/Systems, Computers and Communications (ITC-CSCC), Busan, Korea,2017.

[6] S. K. Wijayasekara, C. Phongphanphanee, R. Annur, S. Nakpeerayuth, L. Wuttisittikulkij", An Improved Framed slotted ALOHA-Based Anti-collision Algorithm with Skipping Idle Slots for RFID System", "The 31st International Technical Conference On Circuits/Systems, Computers And Communications" (ITC-CSCC 2016), Okinawa Pref. Municipal Center, (Okinawa Jichikaikan), Japan, 10-13 July 2016.

[7] S. K. Wijayasekara, K. Mamat, R. Annur, S. Nakpeerayuth, L. Wuttisittikulkij, A Comparison of Tag Estimation Methods for the Initial Phase of Collision Resolution Interval in RFID, The 9th AUN/SEED-Net Regional Conference on Electrical and Electronics Engineering (RCEEE 2016), Ta Quang Buu Library in Hanoi University of Science and Technology (HUST), Hanoi, 17-18 November 2016.

[8] S. K. Wijayasekara, P. Sasithong, A. Robithoh ,P. Vanichchanunt, S. Nakpeerayuth, L. Wuttisittikulkij,"A Reduced Complexity of Vahedi's Tag Estimation Method for DFSA", Electrical Engineering Conference (EECON-39), Hua Hin, Thailand, 2016

[9] T. Sanguankotchakorn, S. K. Wijayasekara and N. Sugino, "A Cross-layer design approach in OLSR MANET using BER and weighted Connectivity Index," 2013 19th IEEE International Conference on Networks (ICON), Singapore, 2013, pp. 1-6.

UNRAVELLING TECHNOLOGIES IN THE DIGITAL WORLD

How mobile radio signals at 2300 MHz may interfere with WiFi 2400 MHz?

Suvit Nakpeerayuth

Last week on June 26, the Bangkok Mass Transit System (BTS) in Bangkok suffered from signaling malfunction causing passengers to stay onboard for several hours and very long queues in the train stations. The loss of communication signaling is believed to be caused by radio frequency interference between the 2300MHz spectrum band used by TOT and the 2400MHz band used by BTS. Due to several tens of MHz separation between the two frequency bands, most communication engineers would question how such interferences can take place. There is however a theoretical explanation how they may interfere.

Suppose that BTS uses WiFi channel 11 at the RF frequency of 2462 MHz, while TOT transmits signals at the frequency of 2380 MHz, i.e., a large frequency separation of 82 MHz. If BTS receivers are heterodyne typed and select IF (intermediate frequency) at 41 MHz, the local oscillator needs to set at 2421 MHz to mix with the received RF signal, i.e., 2462-2421 = 41 MHz. As the signal frequency of 2380 MHz used by TOT is the image frequency of 2462 MHz, both signal frequencies will be translated to the same frequency of 41 MHz by

the down-conversion mixer. Typically, the receiver would include a decent pre-filter to remove the image frequency prior to the down-conversion process. What happens to the BTS case is rather unusual and unfortunate. First base stations usually transmit signals at high power for good SNR and large coverage. Second, the base station's antennas are beaming radio signals along streets which is in line with the BTS track and approximately at the same height. As a result, despite the existence of pre-filter the image frequency of TOT signals could appear significant compared to the BTS signals at the BTS receiver, hence causing serious interference.

Assistant Professor Suvit Nakpeerayuth

Digital Signal Processing Research Laboratory
Electrical Engineering, Faculty of Engineering
Chulalongkorn University

UNRAVELLING TECHNOLOGIES IN THE DIGITAL WORLD

คลื่นมือถือ 2300 MHz ไปรบกวนคลื่น WiFi 2400 MHz ได้อย่างไร?

สุวิทย์ นาคพีระยุทธ

เมื่อวันที่ 26 มิถุนายนของสัปดาห์ที่แล้ว ระบบขนส่งมวลชนกรุงเทพ (บีทีเอส) ในกรุงเทพมหานครได้รับผลกระทบจากระบบอาณัติสัญญาณขัดข้อง ทำให้ผู้โดยสารติดค้างอยู่ในขบวนรถนานหลายชั่วโมง และ มีผู้คนรอคอยอยู่ในสถานีจำนวนมาก เชื่อว่าการเสียหายของสัญญาณสื่อสารเกิดขึ้นจากการรบกวนกันระหว่างย่านความถี่ 2300 MHz ของทีโอที และย่านความถี่ 2400 MHz ของบีทีเอส วิศวกรสื่อสารส่วนใหญ่คงสงสัยว่าการรบกวนกันระหว่างสัญญาณจะเกิดขึ้นได้อย่างไรในเมื่อแถบความถี่ทั้งสองมีระยะห่างกันหลายสิบเมกะเฮิร์ตซ บทความนี้นำเสนอการอธิบายในเชิงทฤษฎีว่าด้วยปัจจัยและมูลเหตุของปัญหาการรบกวนกันที่เกิดขึ้น

สมมติให้บีทีเอสใช้ช่องสัญญาณไวไฟหมายเลข 11 ณ ความถี่ 2462 MHz ขณะที่ทีโอทีส่งสัญญาณระบบโทรศัพท์เซลลูลาร์ที่ความถี่ 2380 MHz กล่าวคือ สัญญาณทั้งสองมีระยะความถี่ห่างกัน 82 MHz ถ้าเครื่องรับสัญญาณของบีทีเอสเป็นแบบเฮ็ตเทอโรไดน์และเลือกความถี่ไอเอฟอยู่ที่ 41 MHz เครื่องกำเนิดสัญญาณความถี่โลคอลต้องสร้างคลื่นความ 2421MHz มาผสมกับความถี่คลื่นวิทยุที่รับได้จากสายอากาศ กล่าวคือ 2464-2421=41 MHz ในกรณีนี้ สัญญาณความถี่ 2380 MHz ของทีโอทีจึงปรากฏเป็นความถี่อิมเมจของคลื่นสัญญาณ 2464MHz ดังนั้น เมื่อใช้มิกเซอร์ลดความถี่ที่เครื่องรับสัญญาณทั้งคู่จะถูกแปลงไปที่คลื่นความถี่เดียวกันคือ 41 MHz

โดยทั่วไป เครื่องรับจะมีการติดตั้งวงจรกรองไว้ก่อนหน้ากระบวนการลดความถี่เพื่อกำจัดความถี่อิมเมจทิ้งไป แต่กระนั้น เหตุการณ์ที่เกิดขึ้นกับบีทีเอสเป็นเรื่องไม่ปกตินักและจัดได้ว่าโชคไม่ดี ประการแรก สถานีฐานของทีโอทีมักจะส่งสัญญาณด้วยกำลังสูงเพื่อให้ได้สัญญาณที่มีคุณภาพและครอบคลุมพื้นที่กว้าง ประการที่สองสายอากาศส่งของสถานีฐานบีมคลื่นวิทยุไปในแนวถนนซึ่งเป็นแนวเดียวกับรางของรถไฟฟ้าบีทีเอสและมีระดับความสูงใกล้เคียงกัน ผลที่เกิดขึ้นคือแม้ระบบจะมีการใช้วงจรกรองแล้วก็ตามสัญญาณความถี่อิมเมจของทีโอทีจะยังมีขนาดใหญ่เมื่อเทียบกับสัญญาณของบีทีเอส ส่งผลให้เกิดการรบกวนระหว่างกัน

ผู้ช่วยศาสตราจารย์ สุวิทย์ นาคพีระยุทธ

ห้องปฏิบัติการวิจัยการประมวลผลสัญญาณดิจิทัล
ภาควิชาวิศวกรรมไฟฟ้า คณะวิศวกรรมศาสตร์
จุฬาลงกรณ์มหาวิทยาลัย

Paper List of ECTI-EEC Transaction

ECTI-EEC Transaction (Scopus Database)
Website: http://www.ecti-eec.org/index.php/ecti-eec

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Electrical Power Systems

A dynamic model for series and parallel resistance of photovoltaic cell using material properties extraction and energy tunnel
K. Sumanonta, P. Suwanapingkarl, P. Liutanakul

Modified SCA algorithm for SSSC damping Controller design in Power System
B. Rout, B. B. Pati, S. Panda

Thyristor Controlled Series Compensator based Optimal Reallocation of Generators for Contingency Management
B. S. Kumar, M. Suryakalavathi, G. V. N. Kumar

Communication Systems

Sidelobe Reduction in a Planar Array using Genetic Algorithm under Backlobe Reduction Condition
R. Manandhar, P. Suksompong, C. Charoenlarpnopparut

Dual Band Gap Coupled Patch Antenna for Wireless Communications
A. K. Pandey, R. Singh

Signal Processing

An approach to realisation of a Radial Phase mask using 3-D printing in transparent PLA
S. Agarwal, R. Jolivot, W. S. Mohammed

Paper List of ECTI-CIT Transaction

ECTI-CIT Transaction (In the process of Scopus Database submission)
Website: https://www.tci-thaijo.org/index.php/ecticit

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SSD Bandwidth Distributing I/O Scheduler Considering Garbage Collection
J. K. Park, J. Kim

Comparative Study of Knee-Based Algorithms for Many-Objective Optimization Problems
S. Alzahrani, N. Wattanapongsakorn

Analysis of Circularly Polarized Light Irradiation Effects on Double Ferromagnetic-Gate Silicene Junction
P. Chantngarm, K. Yamada

Cell Throughput based Sleep Control Scheme for Heterogeneous Cellular Networks
P. Phaiwitthayaphorn, K. Mori, H. Kobayashi, P. Boonsrimuang

Analyzing and Developing Competency-Based Assessment of Persons with Disabilities in Thailand
J. Watthananon, P. Chintanaporn

iRIS-RT: Eye Fatigue and Reaction Time Detector
K. Rakpongsiri

An Extra-Rate Spatial Enhancement Constructed by MSRR using Regularized Technique and SSRR using High-Frequency Pre-Forecasting
V. Patanavijit, K. Thakulsukanant

Health Risk Analysis Expert System for Family Caregiver of Person with Disabilities using Data Mining Techniques
U. Suksawatchon, J. Suksawatchon, W. Lawang

All-Optical Logic and Arithmetic Operators Designed by Modified Add-Drop Filter
P. Phongsanam, P. Yupapin

Report from Conferences/Workshops/Seminars/Events

Future of HDD Technology

Date: Apr. 5, 2018
Venue: King Mongkut's Institute of Technology Ladkrabang
Academic Group: Communications
Speaker: The specialist in HDD Academic

Magnetic Damping Spintronics for Memory, and HAMR

Date: Apr. 30, 2018
Venue: King Mongkut's Institute of Technology Ladkrabang
Academic Group: Communications
Speaker: Prof. Dr. Randall Victora, University of Minnesota, USA

Electrical Engineering Symposium and Workshop

Date: May 11-12, 2018
Venue: Mae Fah Luang University
Academic Group: Electrical
Keynote Speech: "Smart Wind and Solar for Power System Stabilizing Control"
Prof. Dr. Issarachai Ngamroo, KMITL
Workshop1: "Matlab/Simulink Modeling for a Back-to-back Converter with PMSG Drive"
Assoc. Prof. Dr. Yuttana Kumsuwan, CMU
Workshop2: "Matlab/Simulink Modeling for a Back-to-back Converter with DFIG Drive"
Assoc. Prof. Dr. Yuttana Kumsuwan, CMU
Lab Meeting: Oral Presentation meeting with "Power & Energy System Laboratory" and "Power Electronics Applications"
Master/Ph.D. students and Professors

9th Instrumentation, Control, and Automation Senior Project Conference (ICA SP-CON 2018)

Date: May 2, 2018
Venue: King Mongkut's University of Technology North Bangkok
Academic Group: Control

The aims of ICA SP-CON 2018 are to bring together 4th year students to present their senior projects or cooperative/work-integrated learning projects and to provide a chance for exchange on teaching approaches among faculty members from different universities. ICA SP-CON 2018 accepts both senior projects and COOP/WIL projects for interactive poster presentation.

Summary of Participants

Affiliation	Groups	Students	Faculty	Staff	Total from affiliation
KMUTNB	6	60	10	6	76
KMUTT	6	46	2	1	49
KMITL	13	55	10		65
CU	4	5	1		6
KU	4	11	2		13
SIIT	2	6			6
KMUTNB - Rayong	3	8	2		10
Total for all affiliations	38	191	27	7	225

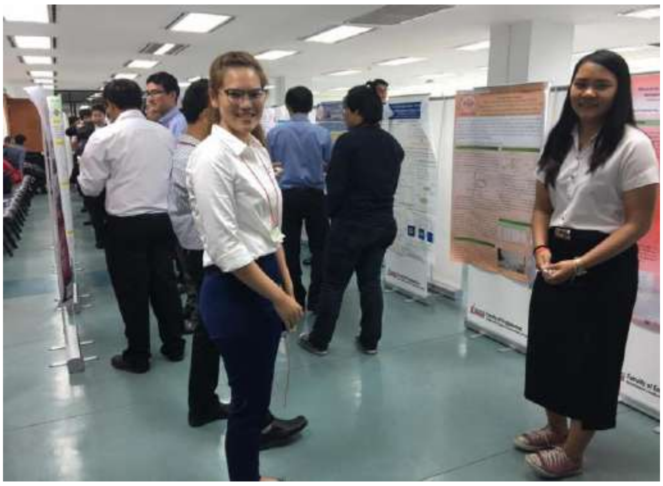
Hierarchically Decentralized Control Synthesis by Aggregation towards Smart Cities

Date: May 22, 2018
Venue: Chulalongkorn University
Academic Group: Electromagnetics
Speaker: Prof. Dr. Shinji Hara, Chuo University, Japan

Thailand-Japan Microwave (TJMW 2018)

Date: Jun. 27-29, 2018
Venue: King Mongkut's Institute of Technology Ladkrabang
Academic Group: Control





Announcements/Upcoming events/Call-for-Papers

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Prabhas Chongsatitwattana, CU

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Yoshihiro Matsui, TNCT, Japan
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The 15th International Conference on Electrical Engineering/Electronics, Computer, Telecommunications and Information Technology or ECTI-CON 2018 is the fifteenth annual international conference organized by Electrical Engineering/Electronics, Computer, Telecommunications and Information Technology (ECTI) Association, Thailand. The conference aims to provide an international platform to present technological advances, launch new ideas and showcase research work in the field of electrical engineering, electronics, computer, telecommunications and information technology. Accepted papers will be published in the Proceedings of ECTI-CON 2018 and will be submitted for inclusion in the IEEE Xplore. Acceptance will be based on quality, relevance and originality.

Technical Tracks

1. Devices, Circuits and Systems
2. Computers
3. Information Technology
4. Communication Systems
5. Controls, Instrumentation and Measurements
6. Electrical Power Systems
7. Power Electronics
8. Signal Processing
9. Other Related Areas
10. Special Sessions

Special Sessions

A proposal for a special session can be submitted to the special session chair before the deadlines. The session topic can be varied upon one's interest but still relate to the role of Electrical / Electronic Engineering, Computer, Telecommunication, Computer and IT.

Best Paper Awards

Paper with the highest score of a track that holds more than 10 papers will be nominated as a "Best Paper Award" paper.

Important Dates

Deadline for Special Session Proposal	15 December 2017
Deadline for Submission	15 January 2018
Notification of Acceptance	27 April 2018
Deadline for Final Manuscript Submission	25 May 2018
Deadline for Early Registration	25 May 2018
Conference Dates	18 – 21 July 2018

Paper Submissions

1) Prospective authors are invited to submit original full papers WITHOUT authors' names and affiliations, in English, of 2-4 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 online only through the submission system of the conference website.
3) At least one author of each accepted paper MUST register and present the paper at the conference in order that the paper is to be included in the program. The program will also be submitted for inclusion in the IEEE Xplore.

Further Publication

Potential papers are encouraged for their extension and submit to ECTI Journals (ECTI-EEC or ECTI-CIT) for further publication.

Supports and Scholarship

Post graduate student whose paper is outstanding and has applied for the scholarship will be nominated for a partially supported scholarship. The grant is neither transferrable nor claimed in other forms.

More information is available at http://www.ecti-con.org/con-2018/

EiC ICROS Institute of Control, Robotics and Systems SICE

2nd Call for Papers

www.isap2018.org

ISAP 2018

2018 International Symposium on Antennas and Propagation

October 23(Tue.) ~ 26(Fri.), 2018 / Paradise Hotel Busan, Busan, Korea

The 2018 International Symposium on Antennas and Propagation (ISAP 2018) will be held during October 23~26, 2018 at Paradise Hotel Busan, Busan, Korea. ISAP 2018 offers excellent opportunities for exchanging technical information and developing friendships with worldwide participants involved in research, development and manufacturing in the field of electromagnetics, antennas and propagation. We hope you will come and enjoy the Symposium in Busan, the top convention hosting city in Asia and also the international prestige tourism city.

ISAP 2018 will be held at the Paradise Hotel Busan which is located in Busan's Haeundae Beach, where the sky and ocean meet. As the first grade hotel with luxurious facilities, Paradise Hotel Busan offers balconies in the sea view rooms with a clear view of the Haeundae beach.

IMPORTANT DATES

- Paper Submission Deadline: ~~May 18, 2018~~ June 3, 2018
- Notification of Acceptance: June 30, 2018
- Pre-registration Deadline: September 23, 2018

CONFERENCE TOPICS

A. Antennas

A1. Small Antennas and RF Sensors
A2. Antennas for Mobile and Wireless Applications
A3. Broadband and Multi-band Antennas
A4. Active and On-Chip Antennas
A5. Tunable and Reconfigurable Antennas
A6. 2D and 3D Printed Antennas and Arrays
A7. Adaptive and Smart Antennas
A8. Antenna Theory and Design
A9. Antenna Measurements
A10. Millimeter-wave, THz and Optical Antennas
A11. HF/VHF Antennas
A12. Reflector, Lens and Radomes
A13. Other Antenna Topics

B. Propagation

B1. Indoor and Mobile Propagation
B2. Millimeter-wave, THz and Optical propagation
B3. Machine-to-Machine/Infrastructure Propagation
B4. Channel Sounding and Channel Estimation
B5. DOA Estimation
B6. Remote Sensing and Radar
B7. Terrestrial, Earth-Space and Ionospheric Propagation
B8. Propagation Fundamentals
B9. Propagation Measurement Techniques
B10. Other Propagation Topics

C. Electromagnetic-wave Theory

C1. Computational Electromagnetics
C2. Time-Domain Techniques
C3. Scattering, Diffraction and RCS
C4. Inverse and Imaging Techniques
C5. Optimization Methods in EM Problems
C6. Passive and Active Components
C7. Frequency Selective Surfaces and Filters
C8. EBG, Metamaterials and Applications
C9. Nano-Electromagnetics
C10. Other EM Theory Topics

D. AP-related Topics

D1. Antenna Systems for Mobile Communications
D2. MIMO and Its Applications
D3. Broadcasting and Receiving Technologies
D4. Wireless Power Transfer Technologies
D5. Wearable Device Networks and Medical Applications
D6. Sensor Networks and Adhoc Systems
D7. RFID and Applications
D8. EMC/EMI Technologies

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ISCIT 2018

First CALL FOR PAPERS

The 18th ISCIT 2018, Bangkok, Thailand
"Communication and IT for Smart City"
26 - 29 September 2018

The 18th International Symposium on Communications and Information Technologies (ISCIT 2018) will be held in Bangkok, city of angles. ISCIT 2018, under the technical sponsorship of IEEE, will provide a forum for researchers, engineers and industry experts to exchange and discuss new ideas, recent development, and breakthroughs in IoT, communications and information technologies. ISCIT2018 will also offer an exciting social program. Accepted and presented papers will be published in the conference proceedings and submitted to IEEE Xplore as well as other Abstracting and Indexing databases.

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Important Dates

29 April 2018	Proposals for workshops, Tutorials and Special Sessions
27 May 2018	Paper submission deadline
1 July 2018	Paper acceptance notification
29 July 2018	Author registration Camera-ready paper submission

Topics

Circuit and Systems
Circuits and Systems for Communications
Embedded Communications Systems
IoT, wearable Devices
Analogue and Mixed Signal Processing
Numerical Methods and Circuit Simulation
Low Power Design & VLSI Physical Synthesis
Modelling, Simulation and CAD Tools
VLSI Architecture for Signal Processing

Wireless Communications
OFDM and multi-carrier systems
MIMO, multi-user MIMO, and massive MIMO
Interference alignment and cancellation
Heterogeneous and small-cell networks
Channel modeling and propagation
Distributed and cooperative communications
Smart antennas and space-time processing
Communication security

Wireless Networking and Internet of Things
Cellular systems, 4G/5G and beyond
WLAN, mesh, and vehicular networks
Spectrum sharing and management
IoT computing and networking
Energy efficient designs for the IoT
IoT Security, Trust, Privacy,
IoT Data management, Mining, and Fusion
New IoT services and applications

Computational Intelligence & Data Science
Fuzzy Logic
Neural Networks
Evolutionary Computation
Learning Theory
Machine Learning
Statistic & Probabilistic Methods
Data Mining
Classification
Clustering
Association Analysis
Regression Analysis
Knowledge-based Engineering
Time Series Analysis
Big Data Analysis
Deep Learning
Image Processing

Next-Generation Networking
Software Defined Networking (SDN)
Network Function Virtualization (NFV)
Data center and cloud-based networking
Self-organising networks
Network provisioning, monitoring, and management
Emerging internet applications
Energy-efficient protocol design and green communication
Network security, privacy, intrusion detection and prevention

IEEE THAILAND SECTION

ECTI Association

ECTI Who's Who

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