

出國報告（出國類別：國際會議）

參加第 16 屆 IEEE 亞太區無線通訊 研討會(APWCS 2019)會議報告

服務機關：國防大學理工學院電機電子系

姓名職稱：蔡昂勳 助理教授

派赴國家：新加坡 (Singapore)

出國期間：108/08/27-108/08/31

報告日期：108/09/09

摘 要

第 16 屆 IEEE 亞太區無線通訊研討會(16th IEEE Asia Pacific Wireless Communications Symposium, APWCS 2019)於 2019 年 8 月 28 日至 30 日在新加坡的新加坡科技設計大學(Singapore University of Technology and Design, 簡稱 SUTD)校區舉行。亞太區無線通訊研討會是由 IEEE 車輛技術協會東京分會、首爾分會、台北分會和新加坡分會所共同主辦，每年舉辦一次，其主要目的在提供一個研究的交流平台，讓亞太地區的研究學者可以在這裡分享最新的無線通訊技術研究成果，並透過互相討論之方式，與其他學者交流寶貴的意見，甚至互談合作的機會。

本人於此研討會計有投稿會議論文兩篇，論文題目分別為「空中小型基地台之親和傳播聚類干擾管理技術(Affinity Propagation Clustering for Interference Management in Aerial Small Cells)」及「運用無人機延伸限制式上行與下行鏈路災害復原通訊網路之涵蓋範圍(Coverage Extension with UAV Based on Constrained Uplink and Downlink Phases for Disaster-Resilient Communication Networks)」，因榮獲刊登，依大會議程，將於 8 月 29 日下午場次以口頭報告發表研究成果。同時，本人也應大會邀請擔任論壇主席(Session Chair)，主持 8 月 29 日下午某個場次的論壇，故前往與會。

今年研討會的主要議題還是著重在第 5 代行動通訊的關鍵發展技術。特別邀請到日本 NTT DOCOMO 公司(NTT Docomo Inc., Japan)的 Yukihiro Okumura 博士，韓國檀國大學(Dankook University, Korea)的 Hyeon-Woo Lee 教授，台灣 5G 執行辦公室(5G Program Office, Taiwan)的 Li-Fung Chang 博士，以及新加坡資訊通訊媒體發展管理局(Infocomm Media Development Authority, Singapore)的 Ong Eng Hwee 博士前來演講，相信藉由參加此次會議，可以與學界相關領域人士互動，彼此交換研究上的心得，亦能了解業界最新的發展現況，激發本人未來研究的新想法及方向。最後感謝科技部補助方得出席今年的 IEEE APWCS 2019 學術研討會。

目 次

摘要	I
目次	II
參加第 16 屆 IEEE 亞太區無線通訊研討會(APWCS 2019)會議報告內容	1
一、目的	1
二、過程	3
三、心得及建議	20
四、攜回資料名稱及內容	21
五、感謝	22
附錄	23
附錄一、發表論文中英文摘要	23

參加第 16 屆 IEEE 亞太區無線通訊 研討會(APWCS 2019)會議報告內容

一、目的：

本人這次出國的目的是為了參加第 16 屆 IEEE 亞太區無線通訊研討會(16th IEEE Asia Pacific Wireless Communications Symposium, APWCS 2019)。APWCS 研討會是由 IEEE 車輛技術協會東京分會、首爾分會、台北分會和新加坡分會所共同主辦，每年舉辦一次，其主要目的在提供一個研究的交流平台，讓亞太地區的研究學者可以在這裡分享最新的無線通訊技術研究成果，並透過互相討論之方式，與其他學者交流寶貴的意見，甚至互談合作的機會。圖一為第 16 屆 IEEE 亞太區無線通訊研討會的官方網站。

今年第 16 屆 IEEE 亞太區無線通訊研討會於 8 月 28 日至 30 日在新加坡的新加坡科技設計大學(Singapore University of Technology and Design, 簡稱 SUTD)校區舉行。本人於此研討會計有投稿會議論文兩篇，論文題目分別為「運用無人機延伸限制式上行與下行鏈路災害復原通訊網路之涵蓋範圍(Coverage Extension with UAV Based on Constrained Uplink and Downlink Phases for Disaster-Resilient Communication Networks)」及「空中小型基地台之親和傳播聚類干擾管理技術(Affinity Propagation Clustering for Interference Management in Aerial Small Cells)」，因榮獲刊登，依大會議程，將於 8 月 29 日下午場次以口頭報告發表研究成果。

另外，本人也應大會邀請擔任論壇主席(Session Chair)，主持 8 月 29 日下午的一個場次的論壇，剛好是本人口頭報告發表的場次。本人此次參加此研討會，除了藉由聽講與發表，可以讓自己的研究領域與世界接軌，同時又可以透過與各國學者的討論，了解自己研究上的優點與不足，相信這趟旅程一定能增加自己在學術方面的見聞以及拓展自己的國際視野。



Welcome to APWCS 2019

Dear APWCS 2019 Participants:

On behalf of the organizing committee, it is our pleasure to extend our warmest welcome to all of you to the 16th IEEE Asia Pacific Wireless Communications Symposium (APWCS) at Singapore University of Technology and Design in Singapore, August 28-30, 2019.

Important Dates

Paper Submission Due	April 19, 2019 May 10, 2019 May 24, 2019 (FINAL EXTENSION)
Recent Results Paper Submission Due	June 21, 2019
Acceptance Notification	June 28, 2019 July 05, 2019

圖一：APWCS 2019 官方網站，網址：

<https://apwcs2019.sutd.edu.sg/public.asp?page=welcome.html>

16th IEEE Asia Pacific Wireless Communications Symposium (IEEE APWCS 2019)
Singapore University of Technology and Design
Singapore, 28 Aug - 30 Aug 2019
<https://apwcs2019.sutd.edu.sg>

CALL FOR PAPERS

The IEEE Vehicular Technology Society (VTS) Japan Chapter, Seoul Chapter, Singapore Chapter and Taipei Chapter are cooperatively hosting this symposium every year. This symposium aims at providing the platform for researchers from the Asia Pacific area to share the fresh results, call for comments or collaborations and exchange innovative ideas of the leading-edge research in Information and Communications Technology (ICT).

You are cordially invited to submit your recent research work to the IEEE VTS APWCS 2019. Accepted papers will now be included in IEEE Explore. The interested technical fields include but are not limited to the following:

- 5G and beyond
- Antenna, propagation and channel modeling
- Big Data Analytics
- Cognitive radio & Dynamic Spectrum Access
- 5G communications
- Drone/UAV communications
- Dynamic spectrum management
- e-health
- Energy Harvesting
- Game theory applications
- Green Communication
- Information theory
- IoT, NB-IoT, and M2M
- Machine learning and AI
- Massive MIMO
- Microwave devices and systems
- Mobile radio communication systems
- Mobility management
- Modulation and coding
- Network security
- Radio resource allocation and QoS/provisioning
- Satellite communications
- Signal processing for communications
- Smart Cities
- Smart Grid
- Software defined networks
- Space time processing & MIMO systems
- Spread spectrum systems
- Systems and Applications
- TWS communications
- Ultra wideband technology
- V2V, V2I, V2X, DSRC communications
- Vehicular communications
- VLC
- Wireless ad-hoc and sensor networks
- Wireless power transfer

Keynotes:
1. Prof. Yingchang Liang, University of Electronic Science and Technology of China, China.
2. TBA

Invited Speakers:
1. Prof. Yan Zhang, University of Oslo, Norway.
2. Dr. Li-Fang Chang, Chief Architect, 5G Tech, Program Office, DoIT, MOEA, Taiwan.
3. Prof. Hyeon-Woo Lee, Dankook University, Vice Chairman of 5G Forum, Korea.
4. TBA

Special Session:
Several special sessions (e.g. NOMA, Message Passing Algorithm) are organized with participation from international experts.

Paper Submission
Paper submission is managed by TrackChair. Authors are invited to submit 5-page full paper in PDF with standard IEEE format. For detail instruction information about the submission, please visit the submission website <http://apwcs2019.trackchair.com/>.

Important Dates
Full Paper Submission
~~24-May-2019 (extended)~~
Recent Results Paper Submission
~~24-June-2019~~
Notification of Acceptance
05 July 2019
Camera-Ready Submission
14 July 2019

Organizing Committee

General Chair
Chao Yuen, SUTD, Singapore

General Co-chair
San-Keel Hong, Yonsei University, Korea
Seiichi Sampei, Osaka University, Japan
Jen-Ming Wu, National Tsing Hua U, Taiwan

Technical Program Chair
Boon-Hua Soong, NTU, Singapore

Technical Program Co-chair
Christopher Lee, NTU, Singapore

Borching Co-chair
Borching So, National Taiwan U, Taiwan
Jae-Ryan Kim, Ajou University, Korea
Hiidekazu Murata, Aoyama University, Japan

Finance Chair
Sun Chih Sean, NUS, Singapore

Finance Co-chair
Po-Hsuan Tseng, National Taiwan University of Technology, Taiwan
Seung-Hoon Hwang, Dongguk University, Seoul, Korea
Satoshi Sugama, NTT DOCOMO, Japan

Publicity Chair
Ernest Kurniawan, FR, Singapore

Publicity Co-chair
Chin-Ya Huang, National Taiwan University of Science and Technology, Taiwan
Oh-Soo Shin, Seoul National U, Korea
Masakatsu Ogawa, Sophia University, Japan

Publication Chair
Ruilong Deng, NTU, Singapore

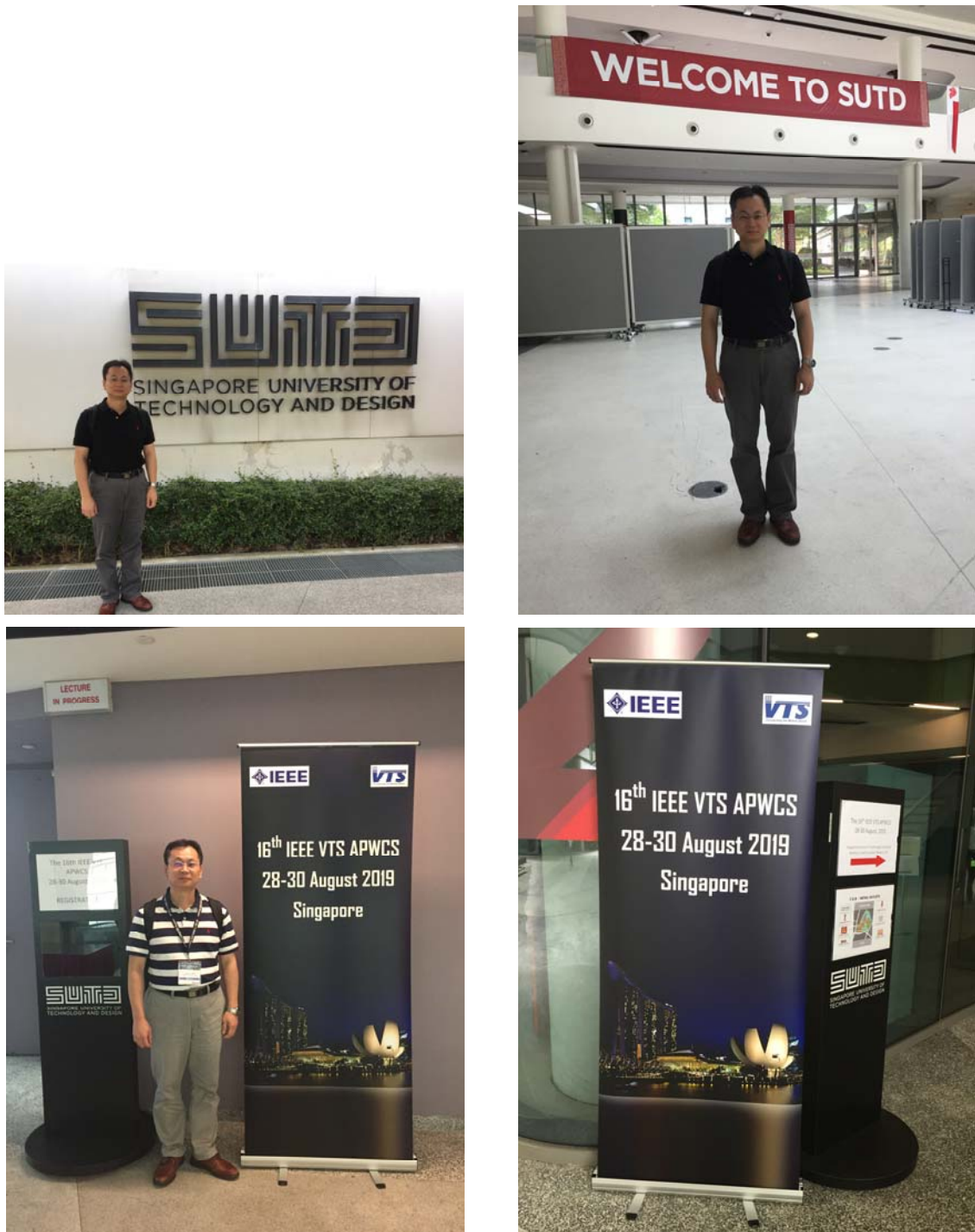
Local Arrangement Chair
Neelakantam Venkataswamy, SUTD, Singapore

Board of Governors
Fumiyuki Adachi, Tohoku U, Japan
Youngnam Han, KAIST, Korea
Takashi Harbort, Sophia U, Japan
Nah-Ryoung Kim, Seonkang University, Korea
Jae Hong Lee, Seoul National U, Korea
Ying-Chang Liang, UESTC, China
Seiichi Sampei, Osaka U, Japan
Sumel Sun, FR, Singapore
Yu-Chen Tseng, National Chiao Tung U, Taiwan
Li-Chen Wang, National Chiao Tung U, Taiwan

圖二：APWCS 2019 徵稿活動海報

二、過程：

第 16 屆 IEEE 亞太區無線通訊研討會(16th IEEE Asia Pacific Wireless Communications Symposium, APWCS 2019)於 8 月 28 日至 30 日舉行，研討會的會場就在新加坡的新加坡科技設計大學(Singapore University of Technology and Design, Singapore)校區內，如圖三。



圖三：APWCS2019 研討會在新加坡的新加坡科技設計大學(Singapore University of Technology and Design, Singapore)校區內舉辦。

研討會的議程如表一。第一天的議程有安排了相關課程，主題為非正交多工存取 (Non-Orthogonal Multiple Access, NOMA) 技術的講解，是由車輛技術協會(VTS)傑出講座教授(VTS Distinguished Lecture)的 Pingzhi Fan 教授以及英國薩里大學(University of Surrey, UK) 的 Zilong Liu 教授所主講，Pingzhi Fan 教授主講的題目為 When Multicast and Full-duplex Meet NOMA: Orthogonality versus Non-orthogonality，而 Zilong Liu 教授主講的題目為，From Sequences to Codebooks: Code-Domain NOMA for Massive Connectivity。在這項課程中，我學到了非正交多工存取(Non-Orthogonal Multiple Access, NOMA)技術的概念，也了解為什麼這項技術會被 3GPP 列為 5G 的主流技術之一。現場照片如圖四。



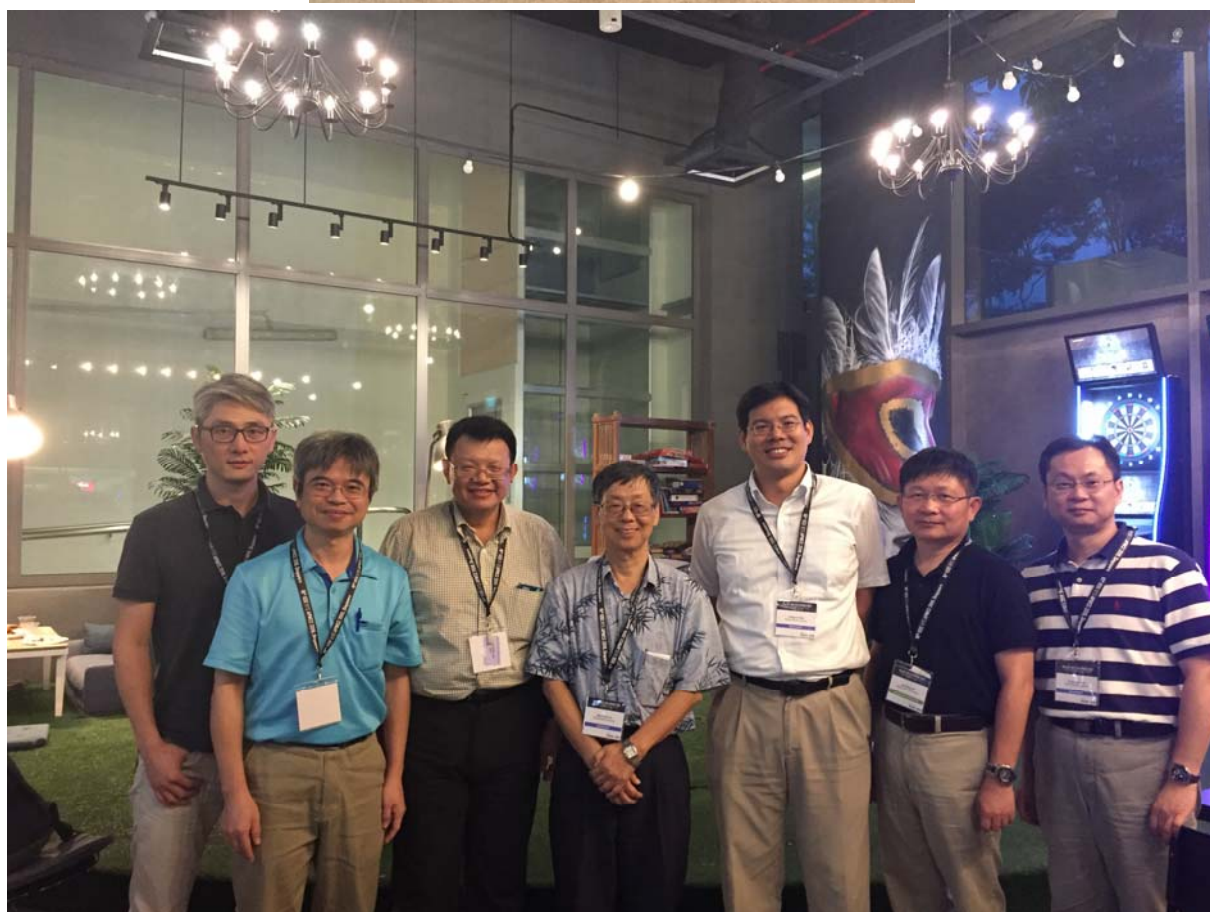
圖四：Pingzhi Fan 教授與 Zilong Liu 教授針對非正交多工存取技術的演講

第二天與第三天的議程主要是安排專題演講、主題演講與分組論壇。專題演講和主題演講主要是邀請來自日本、韓國、台灣和新加坡在學界及業界著名的教授與專業人士針對目前學界及產業界的最新無線技術發表演說。分組論壇則是由投稿的學者依據各自的主題在不同的討論室以口頭報告方式發表研究成果。

表一：APWCS2019 研討會主要議程

Program at a glance			
August 28, 2019 (Wednesday)			
Building 2 Level 4, Singapore University of Technology and Design (SUTD)			
Time	Program		
14:00 – 17:00	Registration		
15:00 – 17:00	Half-day Program on NOMA (Cohort Classroom 11) Prof. Pingzhi Fan (VTS Distinguish Speaker) Prof. Zilong Liu, University of Surrey, UK		
17:00 – 18:30	Welcome Reception (Venue: Crooked Cooks)		
August 29, 2019 (Thursday)			
Building 2 Level 4, Singapore University of Technology and Design (SUTD)			
Time	Program		
08:30 – 14:00	Registration		
09:00 – 09:10	Opening Speech (LT4)		
09:10 – 10:00	Keynote Speech (LT4) Dr. Ong Eng Hwee, Infocomm Media Development Authority, Singapore		
10:00 – 10:30	Coffee Break		
10:30 – 11:20	Invited Talks (LT4) Prof. Yan Zhang, University of Oslo, Norway		
11:30 – 12:10	Invited Talks (LT4) 5G: Are We Ready? Dr. Li-Fung Chang, 5G Program Office, Taiwan		
12:10 – 13:30	Lunch		
	LT 4	LT 3	TT 23
13:30 – 15:30	Session A1 Wireless Sensor & IoT	Session A2 MIMO 1	Session A3 Drone and Satellite
15:30 – 16:00	Coffee break		
16:00 – 18:00	Session B1 Modulation and Channel Modelling	Session B2 MIMO 2	Session B3 Security
18:30 – 20:30	Banquet (Venue: Little Island Brewing company)		
August 30, 2019 (Friday)			
Building 2 Level 4, Singapore University of Technology and Design (SUTD)			
Time	Program		
08:30 – 14:00	Registration		
09:00 – 09:10	Welcome Speech (LT4) Prof. Kiat Seng Yeo, SUTD, Singapore		
09:10 – 10:00	Invited Talks (LT4) Prof. Hyeon-Woo Lee, DanKook University, Korea		
10:00 – 10:30	Coffee Break		
	LT 4	LT 3	TT 23
10:30 – 12:30	Session C1 5G Technologies	Session C2 Multiple Access	Session C3 Relay
12:30 – 13:50	Lunch		
13:50 – 15:50	Session D1 Wireless Network	Session D2 Message Passing Algorithm	Session D3 Wireless Device and System
15:50 – 16:20	Coffee break		
16:20 – 17:10	Invited Talks (LT4) Dr. Yukihiro Okumura, NTT Docomo Inc., Japan		
17:10 – 18:00	Keynote Speech (LT4) Prof. Yingchang Liang, University of Electronic Science and Technology of China, China		
18:00 – 18:10	Closing Remark (LT4)		

另外，本人也利用時間與其他學者互相認識、進行交流，並與他們合照留念(如圖五)。



圖五：本人在 APWCS2019 研討會的會場與其他學者進行交流並合照留念。

研討會的第 2 天早上有三場演講，分別是 1 場主題演講(Keynote Speech)及 2 場專題演講(Invited Speech)。

第 2 天早上的主題演講(Keynote Speech)的講者為新加坡資訊通訊媒體發展管理局 (Infocomm Media Development Authority, Singapore) 的 Ong Eng Hwee 博士，演講題目為 Services 4.0: Thriving in Singapore's Future Digital Economy，現場照片如圖六。



圖六：Ong Eng Hwee 博士演講

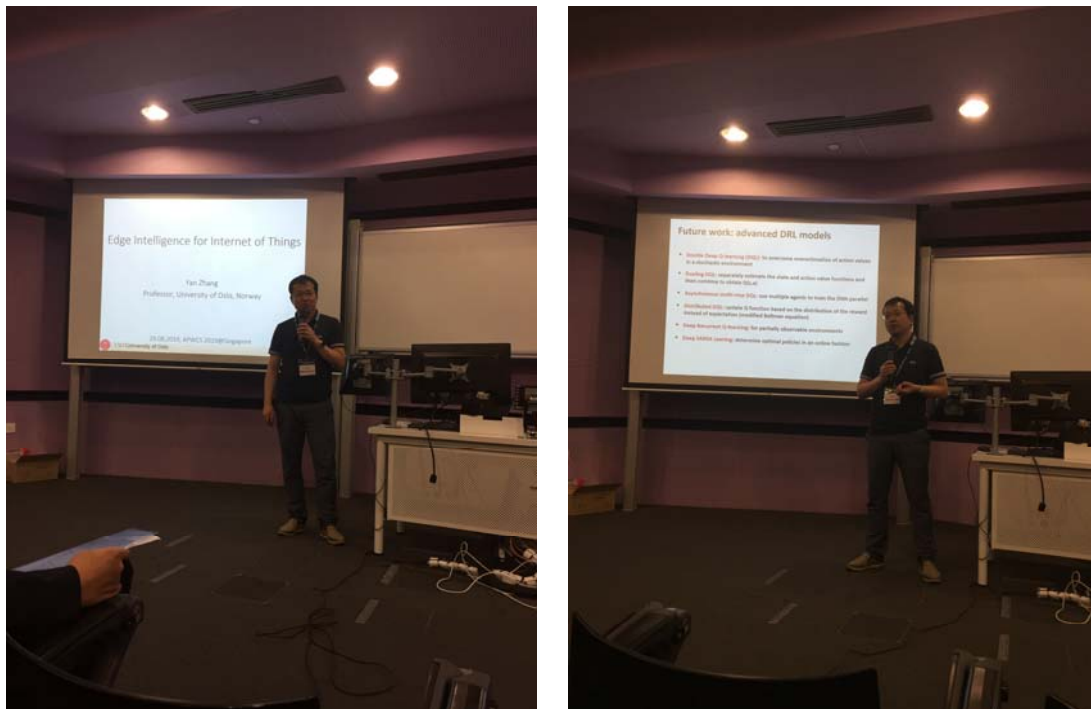
Ong Eng Hwee 博士從第 1、2、3 次工業革命開題，進展到第 4 次工業革命，談到了新加坡未來的數位經濟要成功必須注重在 1) 服務 4.0：各項服務要讓消費者有無縫的體驗；2) 本地雲：發展專屬新加坡適宜的雲伺服器，同時強調保密及安全性；以及 3) 連通性：強調高效益的服務。

Ong Eng Hwee 博士也提到了要達到上述三要件應該要怎麼努力以落實新加坡數位經濟的目的。Ong Eng Hwee 博士觀察到新加坡有 9 種轉變：第 1 種是快速技術發展(Rapid technological development)，第 2 種是高度的連接性(Hyper-connectivity)，第 3 種是成長的遷移率(Growing migration)，第 4 種是愈來愈模糊的邊界(Blurring boundaries)，第 5 種是知識工作者(Knowledge worker)，第 6 種是非物質化(Dematerialization)，第 7 種是共享經濟(Sharing economy)，第 8 種是權力化(Empowerment)，第 9 種是閒暇(Disengagement)。

Ong Eng Hwee 博士提到在新加坡有 9 種技術趨勢足以影響這個數位經濟：第 1 種是人工智慧運用的普及(Pervasive adoption of AI)，第 2 種是人工智慧愈來愈趨向具有移情、感知和情感的能力(More empathic, cognitive and affective AI)，第 3 種是人類與機器合作的規模愈來愈龐大(Greater human-machine collaborations)，第 4 種是自然界的技術介面愈來

愈多元(More natural technological interfaces)，第 5 種是無碼發展工具的使用愈來愈多(Greater use of codeless development tools)，第 6 種是一切皆服務(XaaS, X as a service, anything as a service, or everything as a service)技術造就了更多的無縫服務(More seamless services enabled by XaaS)，第 7 種是混合雲及多雲的技術已相當成熟(Cloud development matures with hybrid and multi-cloud)，第 8 種是區塊鏈分散管理(Blockchain decentralizes trust)，第 9 種是應用程式編程介面(API, Application Programming Interface)導向的經濟突然大受歡迎(API economy takes off)。

第 2 天的第 1 場專題演講的講者為來自挪威奧斯陸大學(University of Oslo, Norway)的 Yan Zhang 教授，演講題目為 Edge Intelligence for Internet of Things，現場照片如圖七。



圖七：Yan Zhang 教授演講

Yan Zhang 教授一開始藉由兩個問題開場，第 1 個問題是行動邊緣運算(Mobile edge computing)是一個熱門的話題，但是，行動邊緣運算(Mobile edge computing)的未來會是如何呢？第 2 個問題是為什麼深度增強式學習(Deep Reinforcement Learning)在通訊及運算領域變成一個非常普遍的方法？接著提到邊緣智慧(Edge Intelligence)與深度增強式學習(Deep Reinforcement Learning)的概念，並闡述如何將深度增強式學習(Deep Reinforcement Learning)運用在物聯網(IoT, Internet of Thing)中。

Yan Zhang 教授也提到邊緣智慧(Edge Intelligence)其實就是行動邊緣運算(Mobile edge computing)與人工智慧(AI)的整合應用結果。Yan Zhang 教授強調利用機器學習(Machine Learning)來提供智慧，特別是利用深度學習(Deep Learning)與增強式學習(Reinforcement Learning)結合應用來強化智能。接著 Yan Zhang 教授開始解釋如何運用深度增強式學習(Deep Reinforcement Learning)來解決各種物聯網(IoT, Internet of Thing)的問題。

最後 Yan Zhang 教授提到未來的研究工作可以有以下 6 項。第 1 是雙深度 Q 學習 (Double Deep Q-learning, DQL)；第 2 是決鬥式雙深度 Q 學習(Dueling DQL)；第 3 是非同步多步驟雙深度 Q 學習(Asynchronous Multi-step DQL)；第 4 是分散式雙深度 Q 學習 (Distributed DQL)；第 5 式深度週期性 Q 學習(Deep Recurrent Q-learning)；第 6 是深度 SARSA(State - action - reward - state - action)學習(Deep SARSA Learning)。

第 2 天的第 2 場專題演講的講者為來自台灣 5G 執行辦公室(5G Program Office, Taiwan) 的 Li-Fung Chang 博士，演講題目為 5G: Are We Ready?，現場照片如圖八。



圖八：Li-Fung Chang 博士演講

Li-Fung Chang 博士首先談到了行動通訊從第 1 代到第 4 代的發展，帶出了第 5 代的需求，針對 ITU 5G 願景在 IMT 2020 的目標有三個，分別是增強型移動寬帶 eMBB (Enhanced Mobile BroadBand)、大規模機器型態通信 mMTC (Massive Machine Type Communications) 及超可靠低延遲通信 URLLC (Ultra-Reliable and Low Latency Communication)。eMBB 主要是希望提升峰值數據率(peak data rate)，4G 的 peak data rate 為 1 Gbps，5G 目標為 20 Gbps，5G 在峰值數據率上預計比 4G 提高 20 倍。mMTC 則是希望提高單位連接率(Connected units/km²)，4G 每平方公里的最大連接數量約為 1000 個，而 5G 的目標約為 1000000 個，5G 在單位連接率上預計比 4G 提高 1000 倍。最後是 URLLC，URLLC 主要是希望改善延遲時間，4G 原來的延遲時間約為 10 ms 至 25 ms，而 5G 希望的延遲時間約為 1 ms，而且這個改善還必須保證傳輸資料的可靠度。

Li-Fung Chang 博士提到在台灣的 5G 計畫主要有 4 個團隊在努力，分別為 5G program under MoEA、EU-Taiwan collaboration、Taiwan 5G alliance 及 MoST/MoEA joint R&D。Li-Fung Chang 博士也稍微描述了這些團體努力的一些成果。最後 Li-Fung Chang 博士提到台灣 5G 頻譜的規劃與政策，在時間軸上區分兩個時段，一個是 2020 之前，一個是 2020 之後。在 2020 之前，頻譜運用是在 1775 MHz~1785 MHz、1870 MHz~1880 MHz、3.3 GHz~3.57 GHz 以及 27 GHz~29.5 GHz。在 2020 之後，頻譜運用會在 600 MHz、800 MHz、4.5 GHz~5.0 GHz、24.25 GHz~26 GHz 以及 37GHz~40 GHz。

研討會的第3天早上，大會安排了1場專題演講(Invited Speech)，講者為來自韓國檀國大學(DanKook University, Korea)的 Hyeon-Woo Lee 教授，演講題目為 5G Status and Future Evolution in Korea，現場照片如圖九。



圖九：Hyeon-Woo Lee 教授演講

Hyeon-Woo Lee 教授一開始先談到南韓行動通訊市場的現況，再談到 5G Forum 的目標規劃，進而提到 5G 對南韓的工業市場有何影響，最後提出 5G 如何在南韓做垂直整合以及未來願景。Hyeon-Woo Lee 教授也提到南韓在 5G 所使用的頻譜將會是在 3.5 GHz~3.7 GHz 及 26.5 GHz~28.9 GHz，以及 5G 在南韓所開發的幾項應用。

Hyeon-Woo Lee 教授又提到 5G 在 2030 年南韓垂直整合工業的市場，預計會有價值 380 億美元的社會經濟財富(38 billion worth of socio-economic wealth)，其主要應用有 9 種。分別為 1) 公共安全(Public safety)；2) 大眾交通(Public transport)；3) 衛生保健(Healthcare)；4) 媒體(Media)；5) 能源與公用事業(Energy & Utilities)；6) 金融服務(Financial services)；7) 汽車業(Automotive)；8) 製造業(Manufacturing)；9) 農業(Agriculture)。而造成南韓社會經濟財富的環境主要有 4 種，最重要的是智能辦公室(Smart office)，其次是智慧城市(Smart city)及鄉村(Rural)，最後是智慧家庭(Smart home)。

研討會的第 3 天下午有 1 場專題演講(Invited Speech)及 1 場主題演講(Keynote Speech)。研討會第 3 天下午的專題演講(Invited Speech)，講者為來自日本 NTT DOCOMO 公司(NTT Docomo Inc., Japan)的 Yukihiro Okumura 博士，演講題目為 R&D Activities on 5G Radio Access and Co-Creation of New 5G Services，現場照片如圖十。



圖十：Yukihiro Okumura 博士演講

Yukihiro Okumura 博士一開始也是先介紹 5G 的特色以及要求，包含了高速、高容量、低延遲以及大量連結等。也說明 5G 是支撐 Cloud、AR/VR、IoT 及 AI 發展的主要梁柱。接著提到日本在 5G 主要的研究計畫，主要有兩個。第 1 個計畫為 High Capacity Technologies with Ultra High-Density Multi-Band and Multi-Access Layered，分成 3 個主題，主題 1 為 Ultra high-density distributed antenna systems，主題 2 為 Optical access technologies accommodating highly densified small cells，主題 3 為 Multi-RAT system technologies for multi-band and multi-access layered cells。第 2 個計畫為 High Data Rate and Low-Power-Consumption Radio Access Technologies with Higher-Frequency-Band and Wider-Bandwidth Massive MIMO，分成 3 個主題，主題 1 為 Massive MIMO and beam control technologies for low SHF bands，主題 2 為 Wideband Massive MIMO and beam control technologies for high SHF bands，主題 3 為 Discovery technologies for terminals with low power consumption。

Yukihiro Okumura 博士針對 5G 商業化部分，談到了日本在頻譜的規劃，主要是在 3.7 GHz、4.5 GHz 以及 28 GHz 的頻帶。其應用的場景包含了超密集/超高流量 (Ultra-dense/Ultra-high Traffic)、智慧製造(Smart Manufacturing)、智慧城市(Smart City)、體育場解決方案(Stadium Solution)、智慧農業(Smart Agriculture)及遠距醫療/診療 (Telemedicine/diagnosis)等。

研討會第 3 天下午的主題演講(Keynote Speech)，講者為中國電子科技大學(University of Electronic Science and Technology of China, China)的 Yingchang Liang 教授，演講題目為 Reflective Radio, Spectrum Sharing and AI: Enabling Energy- and Spectrum-Efficient IoT and 6G Networks，是唯一一個有提到 6G 研究的講者，現場照片如圖十一。



圖十一：Yingchang Liang 教授演講

Yingchang Liang 教授一開始也是先提到 5G 未來的願景，接著提到未來到了 2020 年，將會有 500 億個物件裝置連接到物聯網(IoT)，而且 IoT 預期會與行動網路整合在一起，說明了 IoT 物聯網的重要性。Yingchang Liang 教授認為物聯網設備無處不在，大量，低速率且偶爾發生(IoT devices are everywhere, massive, low rate, and sporadic.)。目前沒有足夠的頻譜能夠滿足物聯網的應用，這是因為針對大量物聯網裝置連結 5G 專屬頻譜需要約 76 GHz 的頻譜。另外，物聯網裝置需要利用電池工作數年，因此能量效率或能量獲得會是一項挑戰。因此 Yingchang Liang 教授認為物聯網在 5G 中需要新的通訊模式及新的網路架構，才能克服物聯網 IoT 應用實現的挑戰。在此，Yingchang Liang 教授提出 Cognitive Backscatter Network (CBN)來解決這些挑戰，我認為這是個不錯的創新。

Yingchang Liang 教授認為無線網路可以利用人工智慧(AI)來實現更好的效益。也就是將無線巨量資料(Wireless Big Data)、人工智慧(AI)或機器學習(Machine Learning)及感知無線電(Cognitive Radio)三者結合在一起，形成智慧網路(Smart Networks)。這個智慧網路(Smart Networks)可以達到有效的資源利用(Efficient Resource Utilization)、動態網路最佳化(Dynamic Network Optimization)以及智能服務供應(Intelligent Service Provisioning)。

研討會的分組論壇(sessions)總共有四場，分成 A、B、C 及 D 等四個場次，安排在研討會的第 2 天下午及第 3 天的上下午舉行。相關分組論壇(sessions)的議程如表一。第 1 場分組論壇(sessions)又再分成 A1、A2、A3 等 3 場同時進行分組討論。第 2 場分組論壇(sessions)則分成 B1、B2、B3 等 3 場同時進行分組討論。第 3 場分組論壇(sessions)則分成 C1、C2、C3 等 3 場同時進行分組討論。第 4 場分組論壇(sessions)則分成 D1、D2、D3 等 3 場同時進行分組討論。各分組論壇(sessions)的主題、場次時間及文章資訊如表二、表三、表四及表五。

表二：APWCS2019 研討會分組論壇(sessions)A 場次議程(區分 A1、A2、A3 等 3 組)

Session A1 Wireless Sensor & IoT (29 Aug) 13:30 - 15:30, LT4			
Time	ID	Title	Author List
13:30	59340	Receiver-side Cooperation Schemewith Interference Reduction for Wireless Sensor Networks	Shintaro Mori, Fukuoka University
13:50	37547	Throughput-Optimized Routing for Multi-Path Multi-Channel Wireless Mesh Network with Integrated Nodes	Ming-Hung Tao, Ma Yugang, Institute for Infocomm Research, A-STAR; Ser Wah Oh, Whizpace Pte Ltd
14:10	80290	ID-Free Multigroup Cardinality Estimation for Massive RFID Tags in IoT	Tsu-Kuang Lee, Chih-Chieh Chen, National Chiao Tung University; Yi Ren, University of East Anglia; Cheng-Kuan Lin, Fuzhou University; Yu-Chee Tseng, National Chiao Tung University
14:30	47720	Outdoor Localization for LoRaWans Using Semi-Supervised Transfer Learning with Grid Segmentation	Yuh-Shyan Chen, Department of CSIE, National Taipei University; Chih-Shun Hsu, Shih Hsin University; Chan-Yin Huang, Kuang-Hung Cheng, National Taipei University
14:50	31154	Wideband Communication Channel Sounding for Wireless Industrial Internet-of-Things Applications	Syed Naveen Altaf Ahmed, Institute for Infocomm Research, A*STAR, Singapore; Peter John Green, Rohde and Schwarz Asia Pte Ltd, Singapore
15:10	35934	Identifying Indoor Points of Interest via Mobile Crowdsensing: An Experimental Study	Hasala Marakkalage, Ran Liu, Sanjana Kadaba Viswanath, Chau YUEN, Singapore University of Technology and Design

Session A2 MIMO 1 (29 Aug) 13:30 - 15:30, LT3			
Time	ID	Title	Author List
13:30	75920	Performance Analysis of Power Control Based Interference Coordination for Downlink MIMO HetNets (Invited Paper)	Ahmed Nasser, School of Information science, Kyushu University; Osamu Muta, Kyushu University
13:50	72594	Performance Study of Terminal Collaborated MIMO Reception Experimental Testbed in Actual Environment (Invited Paper)	Du Fengning, University of Kyoto; Hidekazu Murata, Kyoto University
14:10	92325	Loose Beamforming by Antenna Selection in a Multiuser Massive MIMO System (Invited Paper)	Shunta Nakamura, Toshihiko Nishimura, Hokkaido University; Takeo Ohgane, Yasutaka Ogawa, Junichiro Hagiwara, University of Hokkaido
14:30	40757	Effects of Lloyd-Max Quantization for Distributed Collaborative Interference Cancellation (Invited Paper)	Daisuke Umehara, Kyoto Institute of Technology
14:50	82595	Effect of Quantization Range Limit for Low-Resolution Analog-to-Digital Converters in Full-Digital Massive MIMO System (Invited Paper)	Peng Gao, Yukitoshi Sanada, Keio University
15:10	63356	A Study on Royalty Calculation to Correct Royalty Stacking and Holdup/Holdout of Standard Essential Patent	Byung-Nam Kim, Hyun Woo Lee, Dankook University

Session A3 Drone and Satellite (29 Aug) 13:30 - 15:30, TT23			
Time	ID	Title	Author List
13:30	83551	Radio link design for ITS integrated network using drone	Satoshi Fujii, National Institute of Technology, Okinawa College
13:50	69602	Compressive Sensing-based Intrusion Detection for Surveillance Drone	Abirami Srinivasan, Nanyang Technological University; Asha Vijayakumar, Airbus India; Anamitra Makur, Nanyang Technological University, Singapore
14:10	73304	Reliable Two-Hop Device-To-Device Communications For UAVs	Shen Wendi, Yan-Teng Kuo and Hung-Yu Wei, National Taiwan University
14:30	77086	Affinity Propagation Clustering for Interference Management in Aerial Small Cells	Shao-Hung Cheng, National Defense University; Yung-Sheng Chao, Li-Chun Wang, National Chiao Tung University; Ang-Hsun Tsai, National Defense University
14:50	89196	Coverage Extension with UAV Based on Constrained Uplink and Downlink Phases for Disaster-Resilient Communication Networks	Ming-Han Yang, Wen-Pin Chen, Chung Cheng Institute of Technology, National Defense University; Ang-Hsun Tsai, Shao-Hung Cheng, National Defense University
15:10	85415	Performance Analysis for Energy Harvesting Based Wireless Relay Systems	Thu L. N. Nguyen, Yoan Shin, Soongsil University

表三：APWCS2019 研討會分組論壇(sessions)B 場次議程(區分 B1、B2、B3 等 3 組)

Session B1 Modulation and Channel Modelling (29 Aug) 16:00 - 18:00, LT4			
Time	ID	Title	Author List
16:00	82279	Proposal of Frame Synchronization Method for Optical Turbo Coded System with Hybrid PPM-OOK Signaling	Tomohiro Kiguchi, Ran Sun, Hiromasa Habuchi, Yusuke Kozawa, Ibaraki University
16:20	14120	Data signal modulation scheme based on perceptually uniform color space for image sensor-based visible light communication	Taito Sasaki, Kentaro Kobayashi, Hiraku Okada, Masaaki Katayama, Nagoya University
16:40	91531	Doppler Invariant Demodulation for Shallow Water Acoustic Communications Using Deep Belief Networks	Abigail Lee-Leon, Singapore University of Technology and Design (SUTD); Chau YUEN, Singapore University of Technology and Design; Dorien Herremans, Singapore University of Technology and Design (SUTD)
17:00	74407	Dynamic Channel Modeling for Underwater Magnetic Induction Communication	Wentao Zhou, Soongsil Univ.; Yoan Shin, Soongsil University; Sai Wang, Soongsil Univ.
17:20	27031	Analysis of Path Loss Properties in Indoor Hallway with Waveguide Channel Model	Park Kyoung-Min, Lee Jung-Yong, Seong-Hwan Hyun, Seong-Cheol Kim, Seoul National University
17:40	14987	Block Error Rate Performance of OFDM with Faster-than-Nyquist Signaling Using TDM Based Reference Signal Multiplexing	Tsubasa Shobudani, Mitsutaka Anan, Mamoru Sawahashi, Tokyo City University; Yoshihisa Kishiyama, NTT DOCOMO, INC.
Session B2 MIMO 2 (29 Aug) 16:00 - 18:00, LT3			
Time	ID	Title	Author List
16:00	52872	Modified Adaptive 2-Step ICIC for Distributed MIMO System with User Clustering	Amnart Boonkajay, Institute for Infocomm Research; Tomoyuki SAITO, Fumiyuki Adachi, Tohoku University
16:20	90892	Proposal and Evaluation of ASPF-MIMO Scheduling in LTE System	Hiroki Kotake, Takeshi Hattori, Masakatsu Ogawa, Sophia University
16:40	64923	Symbol Timing Detection Based on Pilot Signal Correlation for FDE in Single-Carrier LOS-MIMO	Kana Aono, Mamoru Sawahashi, Tokyo City University; Norifumi Kamiya, NEC Corporation
17:00	50887	Complexity-Reduced Algorithm for Adaptive PAPR Reduction Method Using Null Space in MIMO Channel for MIMO-OFDM Signals	Mikihito Suzuki, Taku Suzuki, Tokyo University of Science; Yoshihisa Kishiyama, NTT DOCOMO, INC.; Kenichi Higuchi, Tokyo University of Science
17:20	75751	Construction Method of Peak Cancellation Signals in Complexity-Reduced PAPR Reduction Method Using Null Space in MIMO Channel for MIMO-OFDM Signals	Taku Suzuki, Mikihito Suzuki, Tokyo University of Science; Yoshihisa Kishiyama, NTT DOCOMO, INC.; Kenichi Higuchi, Tokyo University of Science
17:40	99114	Quantized Precoding using Gibbs Sampling in Massive MIMO Downlink	Riki Okawa, Yukitoshi Sanada, Keio University
Session B3 Security (29 Aug) 16:00 - 18:00, TT23			
Time	ID	Title	Author List
16:00	57441	Design and Development of SCADA Firewall Security Features for Protecting Industrial Operations	R Dheeraj, National University of Singapore; Huaqun Guo, Institute for Infocomm Research; Bharadwaj Veeravalli, National University of Singapore; Xingjie Yu, Institute for Infocomm Research
16:20	66095	Physical Layer Security using Artificial Noise in D2D Underlay Network	Seong-Hwan Hyun, Yeong-Jun Yoon, Seong-Cheol Kim, Seoul National University
16:40	55266	Data-Driven Attack Anomaly Detection in Public Transport Networks	Yin Rui, Nanyang Technological University; Nicholas Wong, Independent; Huaqun Guo, Institute for Infocomm Research; Wang Ling Goh, Nanyang Technological University
17:00	97429	A Survey on IIoT Security	Xingjie Yu, Huaqun Guo, Institute for Infocomm Research
17:20	56344	Machine Learning-based Jamming Detection in Wireless IoT Networks	Bikalpa Upadhyaya, National University of Singapore; Sumei Sun, Institute for Infocomm Research; Biplab Sikdar, National University of Singapore
17:40	30764	Proposal of Equal-weight (2, 2) visual secret sharing schemes on VN-CSK illumination light communication	Keisuke Manaka, Liyuan Chen, Hiromasa Habuchi, Yusuke Kozawa, Ibaraki University

表四：APWCS2019 研討會分組論壇(sessions)C 場次議程(區分 C1、C2、C3 等 3 組)

Session C1 5G Technologies (30 Aug) 10:30 - 12:30, LT4			
Time	ID	Title	Author List
10:30	87489	Design & Implement Domain Proxy based CBRS System for 5G	Szu-Yu Liu, Heng-Syuan Lin, CHIN-YA HUANG, National Taiwan University of Science and Technology
10:50	34111	Physical Cell ID Detection Probability Using Synchronization Signals of NR Radio Interface Below 6 GHz	Kyogo Ota, Mamoru Sawahashi, Tokyo City University; Satoshi Nagata, NTT DOCOMO, INC.
11:10	89726	Feasibility of URLLC in Unlicensed Spectrum	Yonghong Zeng, Yuhong Wang, Sumei Sun, Institute for Infocomm Research; Kun Yang, Huawei Technologies
11:30	78040	Design and Implementation of Image Electronic Fence with 5G technology for Smart Farms	Yen-Hao Chiu, Ching-Kuo Hsu, Kun-Ru Wu, National Chiao Tung University; Jia-Ming Liang, Chang Gung University; Jen-Jee Chen, National University of Tainan; Yu-Chee Tseng, National Chiao Tung University
11:50	93227	Survey on 3GPP Low Power Wide Area Technologies and its Application	Seung-Hoon Hwang, Shu-zhi Liu, Dongguk University
12:10	85833	Cross-layer combination of predictive control and error correction coding for wireless feedback control	Kohei Kasai, Kentaro Kobayashi, Hiraku Okada, and Masaaki Katayama, Nagoya University

Session C2 Multiple Access (30 Aug) 10:30 - 12:30, LT3			
Time	ID	Title	Author List
10:30	66405	Transmit Power Control using Fading Prediction for TDD-UL-NOMA Systems	Masafumi Moriyama, National Institute of Information and Communications Technology; Kenichi Takizawa, nict; Hayato Tezuka, National Institute of Information and Communications Technology; Fumihide Kojima, NICT
10:50	90068	A UL-NOMA system providing low E2E latency	Hayato Tezuka, National Institute of Information and Communications Technology
11:10	43201	Transmission Performance of Superposed Modulation Using QPSK and 1024-QAM in Downlink NOMA	Koki Senda, Hiroyuki Otsuka, Kogakuin University
11:30	10621	Investigation on Retransmission Scheme in IDMA-Based Random Access	Yuichiro Shake, Tokyo University of Science; Yoshihisa Kishiyama, NTT DOCOMO, INC.; Kenichi Higuchi, Tokyo University of Science
11:50	38452	CSMA-TGT: Carrier-Sense Multiple Access with Transmission Guiding Tracks	Raymond Jayaraj s/o Jayabal, Institute for Infocomm Research, A-STAR; Sumei Sun, Institute for Infocomm Research; Pang Chin Ming, Zhang Qingjun, Ma Yugang, Cheng Wang Cho, Goh Leng Meng, Institute for Infocomm Research, A-STAR
12:10	92624	Gain Division Multiple Access for Transmissions Over Independent Fading Channels	Yung-Tsao Hsu, Bei-Hao Chang, National Taiwan University; Chia-Fu Chang, MediaTek Inc.; Pin-Wen Su, School of Electrical and Computer Engineering at Purdue University; I-Hsien Yeh, MediaTek Inc.; Kai-Chuan Cheng, Ying-Chen Lin, Mao-Chao Lin, National Taiwan University

Session C3 Relay (30 Aug) 10:30 - 12:30, TT23			
Time	ID	Title	Author List
10:30	85124	Relay Selection for Bi-directional Relay Systems with XOR-Physical Layer Network Coding	Kazuma Yamamoto, Okayama University, Japan; Satoshi Denno, Yafei Hou, Okayama University
10:50	84705	Performance Evaluation of 4D-8PSK-TCM for LEO Satellite	Song Kim, Ajou University; Jun-Woo Cho, Kyeong-Rok Kim, Jae-Hyun Kim, Ajou University
11:10	51052	Wireless Information and Power Transfer in Three-Phase Two-Way DF-Relay Networks over Nakagami-m Fading	Devendra Singh Gurjar, Avinandan Das, National Institute of Technology Silchar
11:30	13594	Energy Efficiency of Cooperative Relay and Spectrum Sharing	Yee-Loo Foo, Multimedia University
11:50	18334	Non-Cooperative Interference Control for Random D2D Communications with Minority Game	Yu-Fan Wu, Jen-Ming Wu, National Tsing Hua University
12:10	85225	Second Receiver Selection Algorithm for Fairness in Full Duplex Communications	Won-Jae Lee, Jin-Ki Kim, Ajou University; Kyeong-Rok Kim, Jae-Hyun Kim, Ajou University

表五：APWCS2019 研討會分組論壇(sessions)D 場次議程(區分 D1、D2、D3 等 3 組)

Session D1 Wireless Network (30 Aug) 13:50 - 15:50, LT4			
Time	ID	Title	Author List
13:50	95020	Incentive Design for Efficient Federated Learning in Mobile Networks: A Contract Theory Approach	Jiawen Kang, Nanyang Technological University; Xiong Zehui, Nanyang Technological University, Singapore; Dusit Niyato, Han Yu, Nanyang Technological University; Ying-Chang Liang, University of Electronic Science and Technology of China; Dong In Kim, Sungkyunkwan University (SKKU), Korea
14:10	48728	Clustering Design of Vehicular as Cloud over Vehicular Networks	Chun-Wei Wu, Li-Yang Huang, Po-Hsuan Tseng, National Taipei University of Technology
14:30	50593	On the Wireless Extension of PROFINET Networks	Wu Xuepei, Xie Lihua, Nanyang Technological University
14:50	44546	Analysis on the Optimal Number of Clusters in UDN Environment	Eung-Hyo Kim, Kyung Hee University
15:10	13816	Joint Offloading and Streaming in Mobile Edges: A Deep Reinforcement Learning Approach	Soo Hyun Park, Junhui Kim, Dohyun Kwon, MyungJae Shin, Joongheon Kim, Chung-Ang University
15:30	70456	Performance Evaluation of Route Selection Schemes over a Clustered Cognitive Radio Network	Mariam Musavi, Kok Lim Alvin Yau, Sunway University, Malaysia; Hafizal Mohamad, Nordin Ramli, MIMOS Berhad

Session D2 Message Passing Algorithm (30 Aug) 13:50 - 15:30, LT3			
Time	ID	Title	Author List
13:50	58778	Approximate Message Passing Detection for Beam-Index Spatial Modulation in Massive MIMO (Invited Paper)	You-Xuan Hu, Jen-Ming Wu, National Tsing Hua University
14:10	22886	DNN-Aided Message Passing Based Block Sparse Bayesian Learning for Joint User Activity Detection and Channel Estimation (Invited Paper)	Zhaoji Zhang, Xidian University
14:30	38887	Message Passing Receiver for SEFDM Signaling Over Multipath Channels (Invited Paper)	Yunsi Ma, Weijie Yuan, Nan Wu, Beijing Institute of Technology; Yonghui Li, University of Sydney
14:50	15191	Sparse Bayesian Learning Based on Approximate Message Passing with Unitary Transformation (Invited Paper)	Qinghua Guo, University of Wollongong
15:10	17002	TurboNet: A Model-driven DNN Decoder Based on Max-Log-MAP Algorithm for Turbo Code (Invited Paper)	Yunfeng He, Jing Zhang, Southeast University; Chao-Kai Wen, National Sun Yat-Sen University, Taiwan; Shi Jin, Southeast University
15:30	50630	Multilevel Space-Time Block Codes for Two Transmit Antennas and Three Time Slots (withdrawn)	Shang-Chih Ma, National Taipei University of Technology

Session D3 Wireless Device and System (30 Aug) 13:50 - 15:50, TT23			
Time	ID	Title	Author List
13:50	18650	Experimental Validations on Low-Error Estimation Models in Determining the Maximum Specific Absorption Rate of Multi-Antenna Mobile Handsets	Dinh Thanh Le, Kun Li, Soichi Watanabe, National Institute of Information and Communications Technology (NICT)
14:10	75051	Wirelessly Accessible Batteryless Sensors Distributed on Conductive Textile	Akihito Noda, Nanzan University
14:30	23441	Modeling and Measurement of Grounded Coplanar Waveguide on Printed Circuit Board for 5G and Automotive Radar Applications	Chien-Chang Huang, Chang-Lin Peng, Chen-Yu Liao, Po-Yen Lin, Ping-Han Yang, Kuan-Chien Cheng, Yuan Ze University
14:50	90897	Advantages and Characteristics of a WPT System with a Resonant Wired-2-Coil Repeater	Motoki Ishizaki, Atsushi Kurokawa, Hiroasaki University
15:10	97948	Receiver-side Compensation Circuits Based on T and \hat{T} equivalent models for Constant Voltage IPT	Shogo Isogai, Quang-Thang Duong, Nara Institute of Science and Technology; Minoru Okada, NAIST
15:30	88862	Circuit Design and Simulation of Quantum Phase Estimation in 4x4 Matrices	Gun Sik Min, Korea University; Jun Heo, Korea university

本人在各個分組時段參與了 A3、B2、C1 及 D1 等分組論壇(sessions)，而本人的兩篇文章也在 A3 分組時段進行發表並與相關領域學者交流學術意見。此外，本人同時在 A3 分組時段擔任該分組論壇(sessions)的會議主席(session chair)。

在“Parallel Session A3: Drone and Satellite”這場論壇中，本人應大會邀約擔任該分組論壇(sessions)的會議主席(session chair)，主持這場論壇。該論壇的主題為無人機與衛星，總共計有 6 篇文章待口頭發表，每位講者計有 15 分鐘針對自己發表的文章做演說，結束之後會有約 3 分鐘的討論。現場照片如圖十二。



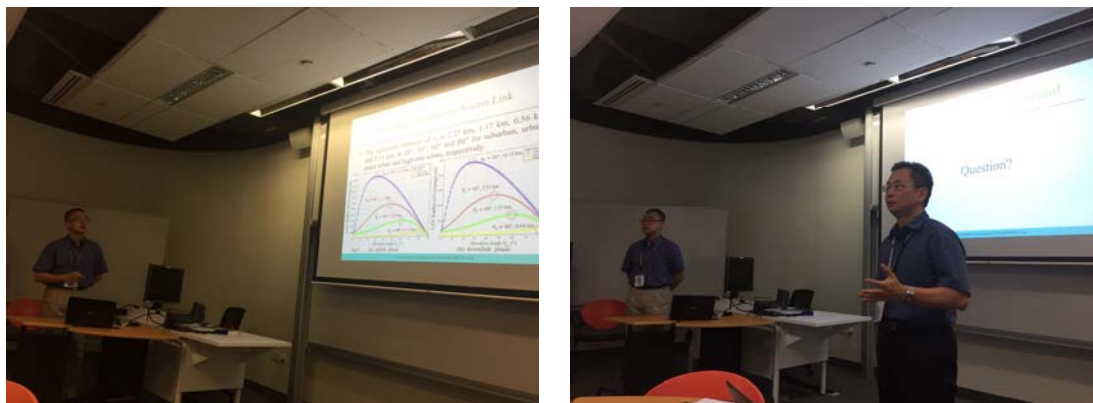
圖十二：本人擔任 Parallel Session A3: Drone and Satellite 的會議主席(session chair)

本人投稿的文章因榮獲刊登，依大會議程，以口頭方式在此“Parallel Session A3: Drone and Satellite”論壇中發表。本人所發表的第 1 篇論文英文題目為“Affinity Propagation Clustering for Interference Management in Aerial Small Cells”，論文中文題目為「空中小型基地台之親和傳播聚類干擾管理技術」，主要是利用無監督式學習方法分析所觀察的數據，使用親和傳播聚類（APC）設計了干擾感知功率控制（IPC）架構，以減少系統干擾並顯著提高無人機小型基地台（DSC）網絡的能量效率。該篇文章由共同作者鄭紹宏教授擔任講者，演說結束之後由本人及鄭紹宏教授與來賓一同討論。現場照片如圖十三。



圖十三：本人的文章在分組論壇(sessions)中口頭發表，由文章共同作者鄭紹宏教授擔任講者。

本人所發表的第 2 篇論文英文題目為 “Coverage Extension with UAV Based on Constrained Uplink and Downlink Phases for Disaster-Resilient Communication Networks”，論文中文題目為「運用無人機延伸限制式上行與下行鏈路災害復原通訊網路之涵蓋範圍」，主要在分析災害復原通訊網路的涵蓋範圍，並可以為中央災害應變中心（CEOC）提供立即部署災害復原通訊網路的準則。該篇文章由共同作者楊明翰擔任講者，演說結束之後由本人及楊明翰與來賓一同討論。現場照片如圖十四。



圖十四：本人的文章在分組論壇(sessions)中口頭發表，由文章共同作者楊明翰擔任講者。

關於 “Parallel Session B2: MIMO 2” 的討論，其發表的文章如表三。這個分組論壇 (sessions)的主題為 MIMO，也就是指多輸入多輸出系統，通常指的是天線的多輸入多輸出系統的設計。例如在這場論壇中的第 4 篇發表文章，題目為 “Complexity-Reduced Algorithm for Adaptive PAPR Reduction Method Using Null Space in MIMO Channel for MIMO-OFDM Signals”，作者在多輸入多輸出的正交分頻多工通道中，設計可降低峰均值比(peak-to-average power ratio, PAPR)信號處理方式，同時降低計算所需的複雜度，讓本人覺得很有創意。

關於 “Parallel Session C1: 5G Technologies” 的討論，其發表的文章如表四。這個論壇的主題主要是在討論目前 5G 相關的技術，特別是實體層的技術規格所衍伸的研究。例如，在這個論壇中，第 5 篇文章題目為 Survey on 3GPP Low Power Wide Area Technologies and its Application，就針對 3GPP 所定的規格，探討如何實踐低功率廣域的技術以及應用，尤其是應用在物聯網(Internet of Things)中。其他相關的應用有 LoRa、Sigfox、RPMA、NB-IoT、EC-GSM,及 LTE-M 等。另外，該作者也提到定位技術對這些應用裝置的重要性。讓我覺得學習到很多。

關於 “Parallel Session D1: Wireless Network” 的討論，其發表的文章如表五。這個論壇的主題主要是在討論無線網路相關的設計與技術，解決無線網路的問題，讓網路有更好的效能。例如在第 5 篇文章，題目為 Joint Offloading and Streaming in Mobile Edges: A Deep Reinforcement Learning Approach，就是想解決網路壅塞的問題，該文章提出利用深度增強式學習(Deep Reinforcement Learning, DRL)演算法，在行動邊緣運算(Mobile Edge Computing)

系統的架構下，改善無線網路的系統效能。這種研究問題及其想法，讓我覺得很有興趣。

三、心得及建議：

第 16 屆 IEEE 亞太區無線通訊研討會(16th IEEE Asia Pacific Wireless Communications Symposium, APWCS 2019)是由電子電機工程協會(IEEE)所主辦的會議之一，該會議每年由東京分會、首爾分會、台北分會和新加坡分會共同主辦，舉辦地點則是在日本、韓國、台灣及新加坡等地輪流。該研討會主要的目的在提供亞太區一個研究交流平台，讓研究學者可以在這裡分享最新的無線技術研究成果，並透過討論之方式，獲得其他學者寶貴的意見，甚至是合作的機會。

本人認為，第 16 屆 IEEE 亞太區無線通訊研討會(16th IEEE Asia Pacific Wireless Communications Symposium, APWCS 2019)是一個品質非常良好的一個研討會，因為這個研討會除了邀請亞太區的學者來分享他們在無線通訊上最新的研究，也會邀請亞太區的電信業者來分享業界在無線通訊上最新的發展現況，讓我們可以將學理與實際兩者作結合，了解理論與實現之間的差距，進而反思自己的研究，讓自己的研究可以更加縮短理論與實現之間的差距。

ITU 5G 願景在 IMT 2020 的目標分別為增強型移動寬帶 eMBB (Enhanced Mobile BroadBand)、大規模機器型態通信 mMTC (Massive Machine Type Communications)及超可靠低延遲通信 URLLC (Ultra-Reliable and Low Latency Communication)。而這次研討會的議題主要還是著重在第 5 代行動通訊的關鍵發展技術。例如日本 NTT DOCOMO 公司(NTT Docomo Inc., Japan)的 Yukihiko Okumura 博士，韓國檀國大學(Dankook University, Korea)的 Hyeon-Woo Lee 教授，台灣 5G 執行辦公室(5G Program Office, Taiwan)的 Li-Fung Chang 博士，以及新加坡資訊通訊媒體發展管理局(Infocomm Media Development Authority, Singapore)的 Ong Eng Hwee 博士，他們的演講重點都是放在他們國家政策如何落實 5G 的應用，從頻譜管理的分配，到各項應用場景，都是為了滿足 5G 標準的要求。

本人此次出國參加國際研討會，不但可以增加與相關領域人士的互動，彼此交換研究上的心得，也激發了未來研究的新想法及方向。也讓本人不論在學術上或文化上，都有更寬廣的視野，實在獲益良多。本人認為，國際研討會是國際學術交流一個很好的平台，應該多多鼓勵台灣的學者與學生參加，以提升台灣學者及學生個人的專業素養以及國際視野。例如，本人這次就鼓勵本人的研究生楊明輸出國發表，相信他這次參與第 16 屆 IEEE 亞太區無線通訊研討會(16th IEEE Asia Pacific Wireless Communications Symposium, APWCS 2019)，對他本人的專業素養及國際視野都有很大的提升。

四、攜回資料名稱及內容：

- 大會議程手冊
- 大會論文資料隨身碟

五、感謝：

承蒙「科技部」的國外差旅費補助得以順利參加本次第 16 屆 IEEE 亞太區無線通訊研討會(16th IEEE Asia Pacific Wireless Communications Symposium, APWCS 2019)，讓我有機會參與國際性的研討會，增進國際視野及專業領域的成長，內心深表感謝之意。

附 錄

附錄一、發表論文中英文摘要

Affinity Propagation Clustering for Interference Management in Aerial Small Cells

空中小型基地台之親和傳播聚類干擾管理技術

Shao-Hung Cheng, *Member, IEEE*, Yung-Sheng Chao, *Student Member, IEEE*,

Li-Chun Wang, *Fellow, IEEE*, and Ang-Hsun Tsai, *Member, IEEE*

鄭紹宏、趙永勝、王蒞君、蔡昂勳

Abstract

The drone small cell (DSC) network has become a key technology for air-to-ground wireless communications in a variety of temporary or emergency situations. Based on mobile users, frequently changing DSC topologies have important challenges such as severe co-channel interference and limited battery capacity. However, temporarily dispatched drones cannot obtain labeled and historical data in advance, while they only obtain real-time operational data. The observed data can be analyzed by unsupervised learning methods to find useful information for resource management. In this paper, an interference-aware power control (IPC) framework is designed using affinity propagation clustering (APC). The APC method is one of the unsupervised learning methods. The numerical results show that our proposed IPC framework using the APC method can reduce system interference and significantly improve the energy efficiency of DSC networks.

Index Terms—Drone small cell, Unsupervised learning, Interference mitigation, Energy saving.

中文摘要

無人機小型基地台 (DSC) 網路已成為各種臨時或緊急情況下空對地無線通訊的關鍵技術。基於移動用戶，頻繁變化的無人機小型基地台拓撲結構具有重要的挑戰，例如嚴重的同頻干擾和有限的電池容量。然而，臨時派遣的無人機無法提前獲得標記和歷史數據，而他們只能獲得當前的操作數據。因此可利用無監督式學習方法分析所觀察的數據，以找到用於資源管理的有用訊息。在本研究中，使用親和傳播聚類 (APC) 設計了干擾感知功率控制 (IPC) 架構。APC 方法是無監督式學習方法之一。模擬數值結果表示，我們提出的使用 APC 方法的 IPC 架構可以減少系統干擾並顯著提高 DSC 網絡的能量效率。

關鍵詞：無人機小型基地台；無監督式學習；干擾減輕；節能。

Coverage Extension with UAV Based on Constrained Uplink and Downlink Phases for Disaster-Resilient Communication Networks

運用無人機延伸限制式上行與下行鏈路災害復原通訊網路之涵蓋範圍

Ming-Han Yang, Wen-Pin Chen, Ang-Hsun Tsai, *Member, IEEE*, and
Shao-Hung Cheng, *Member, IEEE*
楊明翰、陳文彬、蔡昂勳、鄭紹宏

Abstract

Unmanned aerial vehicles (UAVs) have been considered as a solution to extend coverage for disaster-resilient communication networks in a disaster area when the communication infrastructure which is known as the base station (BS) cannot afford the service as usual. However, when the link between the UAV and the serving BS is constrained, the UAV must keep the appropriate distance for reliable transmission. In addition, the altitude of the UAV may significantly affect the link quality between the UAV and the BS, as well as the link between the UAV and the users/rescuers. In this paper, we analyze the coverage of the disaster-resilient communication network with a UAV for guaranteeing the reliability of all links. We show that the position of UAV can be a function of the BS's and user's elevation angle. The simulation results show that the maximum radius of coverage in the high-rise urban environment can be 5.25 km and 2.46 km for downlink and uplink, respectively. Moreover, this paper can provide a principle for the central emergency operation center (CEOC) to immediately deploy the disaster-resilient communication network.

Index Terms—UAV; disaster-resilient communication network; coverage; link quality.

中文摘要

當地面基地站台無法繼續為用戶提供通訊服務時，利用無人飛行機作為基地站台的替代方案已經成為了災害復原通訊網路中的一個有效地解決方案。然而無人機並非無所不能的，無人機所構成的通訊網路可能會受限於距離、高度及障礙物等等因素而影響鏈結可靠度。本研究分析了在確保通訊鏈路的可靠度情況下之災害復原通訊網路的涵蓋範圍。我們發現在不同的發射功率情況下，都導出無人機的最佳位置是地面基地站台對無人機的一組固定仰角。模擬結果表示，在未考慮回程鏈路與考慮回程鏈路的情況下，high-rise urban 的最大涵蓋半徑分別為 5.25 km 和 2.46 km。另外，本文可以為中央災害應變中心（CEOC）提供立即部署災害復原通訊網路的準則。

關鍵詞：無人機；災害復原通訊網路；涵蓋範圍；鏈結可靠度。