出國報告（出國類別：國際會議）

赴新加坡出席
太平洋電信協會「2014 頻譜未來會議」
暨與新加坡雙邊會議

服務機關：國家通訊傳播委員會
姓名職稱：虞孝成　副主任委員
林永裕　技正
包家禎　技正
派赴國家：新加坡
出國期間：103 年 10 月 27 日至 103 年 10 月 31 日
報告日期：104 年 1 月 26 日

摘要

2014 年頻譜未來會議(the Spectrum Futures Conference)由太平洋電信協會（Pacific Telecommunications Council，簡稱 PTC）舉辦，PTC 於 1980 年在美國夏威夷成立，以促進太平洋地區電信發展及交流為宗旨，該協會目前約有 300 餘個團體、產業、個人、附屬會員及學術單位等會員，為我國(前電信總局 1983 年加入）少數具正式會員資格之國際非營利電信組織。

PTC 2014 年頻譜未來會議於 10 月 29、30 日在新加坡舉辦，本會為加強與國外通訊傳播主管機關交流、瞭解國際寬頻服務與頻譜未來發展趨勢，特由虞副主任委員孝成率綜合規劃處林技正永裕與資源技術處包技正家禎出席，希望藉由參與會議活動瞭解最新通訊傳播發展與頻譜共享應用科技，有助於未來寬頻服務及頻譜開放政策之規劃，虞副主任委員並獲邀簡介我國頻譜規劃進程，與各國代表積極互動，就通訊傳播監理機制、釋照經驗、產業發展趨勢等事項進行廣泛討論。

此行亦在我駐新加坡謝代表發達與蔡秘書芝苑全力協助安排下，與新加坡媒體發展管理局(Media Development Authority, 簡稱 MDA)的管制部門政策處處長 Lee Ee Jia 暨相關官員進行雙邊會談，互就廣播電視產業等媒體監理政策進行討論與交換心得。

本次行程虞副主任委員率團員積極參與 PTC 2014 頻譜未來會議，於會議中簡介我國頻譜規劃進程，並與新加坡媒體發展管理局進行雙邊交流，汲取未來頻譜接取技術趨勢與國外通傳媒體機構政策制定及監理之經驗，來提昇我國通訊傳播監理政策水準，並透過互動與溝通，建立及拓展亞太地區電信專業高階管理人員連結，成果相當豐碩。

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壹、目的

太平洋電信協會（Pacific Telecommunications Council, PTC）為一國際非營利、非政府組織，1980 年於夏威夷創立，原參加成員多為太平洋地區主要電話公司，後經逐年擴大成員範圍至電信設備製造商、電信顧問公司等電信相關廠商及個人，PTC 舉辦之頻譜未來會議係提供來自通訊產業及政府部門代表一個重要互動平台，邀請來自通訊產業以及電信監理機關代表，互相交流及經驗分享。

鑒於科技日益發達，各式消費性聯網終端的普及，寬頻技術、服務及應用已成為各國政府及業者發展重點，對頻譜資源的需求越來越多，然而無線電頻譜資源有限，電信、電視、廣播、衛星等新興無線服務已陸續佔用國家頻譜。此外，許多開發中國家或是農鄉村地區卻因行動寬頻建設成本高而缺乏合適的寬頻服務。因此，PTC 以頻譜未來為會議主題，自監理者及新服務提供者角度討論電視白頻利用、頻譜共享、動態接取、衛星接取及其他可能的新平台，並聚焦於亞太地區頻譜使用於接取網際網路之最新發展，探討民眾均可負擔得起的網路接取服務之新技術，如無線電視頻譜共享(TVWS)技術，以及新政策與商業模式。

我國參與除可深入瞭解頻譜接取與共享科技發展趨勢外，更可促進我國與他國電信政策監理機關之意見交流，借鏡他國因應當前科技變化所進行之相關通傳政策，提供我國寬頻服務與頻譜政策規劃上決策參考。

另為加強國家通訊傳播委員會與其他國家通訊傳播監理機關之交流互動，提升我國國際合作機會與空間，本次行程特別透過我國駐新加坡代表處安排，與新加坡媒體發展管理局進行雙邊會談，尋求雙方進一步合作之機會。

貳、行程表

10 月 27(一)　出發（臺灣 08：20 出發，13：05 抵達新加坡）

10 月 28(二)　臺星雙邊交流會議-新加坡媒體發展局（Media Development Authority, MDA）

10 月 29(三)　參加頻譜未來會議（Spectrum Future）

10 月 30(四)　參加頻譜未來會議（Spectrum Future），本會虞副主任委員孝成演講「我國頻譜規劃進展」

10 月 31(五)　回程（新加坡 10：25 出發，15：00 抵達臺灣）

參、與 MDA 雙邊會議紀要

一、 MDA 簡介

新加坡媒體發展局(Media Development Authority，MDA)於 2003 年成立，是由新加坡廣播管理局(Singapore Broadcasting Authority)、電影暨出版署(the Films and Publications Department)及新加坡電影委員會(Singapore Film Commission)合併而成立的，與資訊通信發展局(Infocomm Development Authority of Singapore，IDA)及國家圖書館管理局(National Library Board，NLB)三者同屬於新加坡通訊及新聞部（Ministry of Communications and Information，MCI）的法定子機構。

MDA 致力於將新加坡打造成一個富有活力的世界級媒體城市、創意經濟體和資訊暢通的社會。為推動廣播(broadcast)、電影(film)、出版(publishing)、動畫(animation)、互動數位媒體(interactive digital media)及遊戲(games)等六大媒體產業發展，MDA 率先制定了許多計畫，希望能藉此培養本土傳媒企業、吸引國外直接投資提升經濟，並創造新的就業機會以帶動整體經濟的活絡。

MDA 為因應全球快速變化的媒體生態，於 2009 年推出了新的國家媒體發展藍圖—新加坡媒體融合計畫(Singapore Media Fusion Plan, SMFP)。此計畫主要是以媒體 21(Media 21)的藍圖為基礎，勾勒出未來十年培植本土媒體企業，並吸引外資直接投資媒體產業的計畫。這份藍圖涵蓋了所有的媒體產業，包括從印刷服務、廣播電視、電影、出版到像是數位與線上媒體這些新領域。

二、 新加坡媒體監理政策

(一) 廣播電視執照：

新加坡廣播執照類別主要可分為小眾電視執照（Niche TV Licence）與全國電視執照（Nationwide TV Licence），小眾電視執照有效期間 5 年，規定為任何單一

頻道每日觸達率(daily reach)的上限為 100,000 戶(unique viewers)，或廣播電視電台(broadcaster)每日觸達率的上限為 250,000 戶；全國電視執照可分為全國付費電視執照（Nationwide Pay TV Licence）與全國無線電視執照（Nationwide Free-to-Air TV Licence），執照有效期間均為 10 年，無訂戶上限的規定，適用於鎖定大眾媒體市場的業者（即超過 100,000 個訂戶）。

(二) 內容監理方式：

MDA 採取共管（co-regulatory）方式管理電視內容，其目的在於鼓勵產業成長並提供消費者更多選擇。MDA 不事前審查電視節目，廣播電視公司要確保其節目與 MDA 的內容指導方針相符，MDA 會依據客訴與大眾回應選擇性監測節目與廣告內容。

(三) 電視節目分級架構：

G（GENERAL）普通級：一般觀眾皆可觀賞。

PG（PARENTAL GUIDANCE）輔導級：建議家長陪同未滿 12 歲之兒童觀賞。

PG13（PARENTAL GUIDANCE 13）輔導級：適合 13 歲之少年及以上觀眾觀看，但未滿 13 歲兒童建議家長陪同。

NC16（NO CHILDREN UNDER 16）限制級：適合 16 歲之少年及以上觀眾觀看。

M18（MATURE 18）限制級：適合 18 歲之少年及以上觀眾觀看。

R21（RESTRICTED 21）限制級：適合 21 歲之成年及以上觀眾觀看。

(四) 跨臺聯播（cross-carriage）措施：

由於付費電視服務提供者（pay TV retailers）將獨家授權內容做為高度競爭策略，造成付費節目內容零碎化（content fragmentation）及消費者選臺與多重訂閱的不便，因此，MDA 實行跨臺聯播措施，要求付費電視服務提供者跨台聯播彼此的獨家授權內容及支付對方播映費，此措施將付費電視服務提供者之努力，導引至獨家內容之外的競爭層面（例如服務差異化及具競爭性之定價）。

(五) 媒體匯流（media convergence）：

面對電信與傳播之匯流現象，新加坡並未直接將法制架構重新進行調整，而係維持市場區隔之垂直劃分方式，仍將電信及廣播電視市場作完全之切割後，再就個別市場依其專屬法規進行彈性監理。MDA 界定了 4 項媒體匯流關鍵議題：

1. 更新管制內容的架構，以鼓勵產業發展、賦權予消費者、並保障社會利益。

2. 提升本土內容的活力，以營造出共享經驗和強化社群。

3. 擬定政策與管制架構，以回應著作權與數位剽竊的挑戰。

4. 更新執照核發的架構，以提供更大程度的透明與一致性。

肆、PTC 2014 頻譜未來會議

一、頻譜未來會議簡介

頻譜未來會議是 PTC 2014 年舉辦的新會議，會議主題聚焦於亞太地區頻譜使用於接取網際網路之最新發展，如新的政策、業者及商業模式等，以提高頻譜使用效率，提供民眾均可負擔得起的網路接取服務，特別是南亞及東南亞地區。此外，自監理者及新服務提供者角度，討論電視白頻利用、頻譜共享、動態接取、衛星接取及其他可能的新平台等議題(如利用無人駕駛飛機、熱氣球等)，利用免執照與執照頻譜、頻譜共享加速亞太地區網路接取服務，同時特別關注營運商收益維持模式、網路接取佈建模式及頻譜資源需求等。

二、會議議程

10月29日：下午監理機關內部專題座談會（僅限監理者參與）

Wednesday, 29 October 2014 (Regulators Only)	
Time	**Topic**
13.00 – 13.10	**Welcome & Opening Remarks** Welcome Remarks: Sharon Nakama, CEO, Pacific Telecommunications Council Convener: Stephen Ho, President & Chair, Board of Governors, Pacific Telecommunications Council
13.10 – 13.40	**Market Overview: Singapore** Presenter: Aileen Chia, Deputy Director-General, Infocomm Development Authority (IDA), *Singapore*
13.40 – 14.00	**How Much Spectrum Might Be Needed?** Presenter: John Ure, Associate Professor and Director, Technology Research Project (TRP), University of Hong Kong and Director, TRPC Pte Ltd,*Singapore*
14.00 – 14.45	**The Role of Unlicensed/Dynamic Spectrum**

	Open discussion among attendees
14.45 – 15.00	**Break**
15.00 – 16.00	**Spectrum Allocation Workshop** Presenters: Christian Koboldt, Co-Founder & Partner, DotEcon,*United Kingdom* Arisa Siong, Associate, DotEcon,*Singapore*
16.00 – 16.30	**Key Challenges for Extending Internet Access?** Open discussion among attendees
16.30 – 17.00	**Sustainable Deployment Models?** Open discussion among attendees
17.00 – 19.30	**Reception**

10月30日：全日會議（對外開放一般人報名參加）

Thursday, 30 October 2014	
Time	**Topic**
09.00 – 09.10	**Welcome & Opening Remarks** Welcome Remarks: Sharon Nakama, CEO, Pacific Telecommunications Council **Convener:** Stephen Ho, President & Chair, Board of Governors, Pacific Telecommunications Council
09.10 – 09.35	**Demand for Spectrum** Presenter: Robert Pepper, VP, Global Technology Policy, Cisco,*USA*
09.35 – 09.45	**Pakistan’ s Spectrum Auction and Future Plans** Presenter: Syed Ismail Shah, Chairman, Pakistan Telecommunication Authority,*Pakistan*
09.45 – 10.10	**Internet Connectivity in Asia** Presenter: John Ure, Associate Professor and Director, Technology Research Project (TRP), University of Hong Kong and Director, TRPC Pte Ltd, *Singapore*
10.10 – 10.30	**What Tomorrow's Networks Will Look Like** Presenter: Anup Changaroth, Director, Portfolio Marketing, Asia Pacific, Ciena, *Singapore*

10.30 – 10.45	**Break**
10.45 – 11.10	**Options for Releasing More Spectrum** Presenter: Christian Koboldt, Co-Founder & Partner, DotEcon, *United Kingdom*
11.10 – 11.35	**Tata Communications: Our View of Spectrum Requirements for the India Market** Moderator: John Ure, Associate Professor and Director, Technology Research Project (TRP), University of Hong Kong and Director, TRPC Pte Ltd,*Singapore* Panelists: Kalyan Pal, VP & Head, Wireless Engineering, Tata Communications Ltd. (TCL),*India* David Stanton, VP, Operations, Tata Communications Ltd. (TCL),*Singapore* Shachi Wadhawan, Deputy General Manager, India Access, Global Network Services, Tata Communications Ltd. (TCL),*India*
11.35 – 12.00	**TV White Spaces: How Is Spectrum Shared?** Presenter: Jeffrey Yan, Director, Technology Policy, Microsoft, *Singapore*
12.00 – 12.25	**Update on TV White Spaces in the Philippines** Presenter: Louis Casambre, Executive Director, Information and Communications Technology Office, Department of Science and Technology (ICTO-DOST),*Philippines*
12.25 – 13.50	**Lunch**
13.50 – 14.15	**A Digital Bangladesh: Robust and Affordable Access for All** Presenter: Rashed Uddin, President, BANGLALION-MAXNET,*Bangladesh*
14.15 – 14.40	**Spectrum Planning Progress in Taiwan** Presenter: Hsiao-Cheng Yu, Vice Chairperson, National Communications Commission, *Taiwan*
14.40 – 15.05	**No Backhaul, No Access** Presenter: Sean Bergin, President, APTelecom, *Thailand*
15.05 – 15.20	**Break**
15.20 – 15.40	**Spectrum Is Not the Only Issue**

	Presenter: Donnie De Freitas, Regulator, Office of the Regulator, *Samoa*
15.40 – 16.00	**Whitespace-Enabled Rural Broadband to Cognitive M2M** Presenter: Apurva N. Mody, Chairman, WhiteSpace Alliance
16.00 – 16.20	**How Dynamic Spectrum Access Works** Presenter: Parag Naik, CEO, Saankhya Labs Pvt. Ltd., *India*
16.20 – 16.40	**Development of Mobile Broadband and Spectrum Policy Vision** Presenter: Yoichi Iida, Director, International Research and Policy Coordination, Ministry of Internal Affairs and Communications (MIC),*Japan*
16.40 – 17.00	**Facilitating Mobile Broadband Development in Hong Kong** Presenter: Chaucer Leung, Assistant Director, Regulatory Affairs, OFCA, *Hong Kong SAR, China*

三、 會議重點

以下整理在本次會議中重要的內容，以及值得我國關注的議題：

(一) 如何設計頻譜拍賣作業

來自英國 DotEcon 公司的代表，介紹如何設計頻譜拍賣作業，包括：拍賣與審議制度的不同、拍賣基本要素、拍賣設計原則、利益及效率、設定底價、頻譜拍賣的主要問題、維持競爭、常用的拍賣制度和趨勢、範例。

首先，為什麼頻譜釋出要拍賣？如果頻譜釋出對市場無甚影響，技術變化也不大，通常會採取審議制釋出頻譜。而拍賣則適合使用技術彈性大的頻段，使用拍賣制度也較符合法治精神，較能反映頻譜價值。審議制通常在經濟上較無效率，頻譜需求者通常難以從監理者得到足夠的資訊，參與者通常不會透露真實的需求，拍賣制通常較能得到真實的市場價值。

拍賣是分配資源的機制，競價者在明確的規則下競爭，因此要明確定義什麼

時候競價者做什麼事、這些時點的資訊、如何產生得標者、得標者要付出什麼，好的拍賣可以得到確實的市場價值。

設計競價規則的三件工作：頻譜可用性及需求（考慮促進競爭及市場需要）、目標（頻譜得以有效率地分配、促進競爭、技術轉換及服務不中斷），以及技術限制。設計拍賣規則時，要考慮頻段區塊大小、頻譜使用的彈性、是否有圍標風險、產生拍賣結果的複雜度。尤其區塊大小及參與競價者的多寡常需要特別考量。競價者的策略競價投標，常會導致市場價值扭曲，造成政府損失。

在底價的設定部分，設底價的目的是減少未考慮周詳的參與者，也可以限制競標者過度得利，並決定國家合理的獲利。完美的底價其目的在促進競爭，底價也可以提高拍賣效率。但如果是充分競爭的市場，則底價幾乎毫無作用。

在多標的拍賣時，頻譜上限的設計可避免壟斷而降低競爭。通常頻譜上限設太低會降低競爭，而頻率使用權不易轉讓，因此頻譜上限要考量多層次上限（例如針對 1GHz 以下設定單獨的頻譜上限）。

拍賣如果想要成功，則需小心地設計，適當的設計可以減少競價過程產生問題。對於標的物要有精確的定義，並採用適當的拍賣方法，以及明確而清楚的規則，並融入欲達成的政策目標。拍賣設計不當會導致法規產生漏洞，或造成市場參進意願低，甚至導致有業者挑戰法規的正當性。拍賣的重要觀念就是要確認單一或多標的物，競價者是為了私利或公利（為了建設網路或只想轉賣），競價者的策略或其如何損益平衡。目前最常用的拍賣制度包括 SMRA 及 CCA。

拍賣制度的優點：較有效率、能反映市場價值、過程公開透明、法律效果明確、能快速產生結果、業者付出適當的建置成本；缺點則是：對小業者而言成本較大、需防止圍標的可能、業者會進行策略出價、競價可能有過熱的情形。拍賣不可能做到完美，通常還是會有不足的地方，因此拍賣制度通常附帶涵蓋率的建置義務及要求市場競爭。

(二) 新加坡市場概況

來自新加坡 IDA（Infocomm Development Authority of Singapore, 簡稱 IDA）的 Aileen Chia 分享了新加坡最新的電信市場概況，以及 IDA 最新的監理政策。

新加坡為使用戶得到無縫接軌的服務，允許電信業者使用異質網路，即混合 2G、3G、4G、WiFi、Small Cell 網路。另外新加坡於 2013 年釋出 4G 執照，釋出頻段為 1800MHz 及 2.5GHz，執照到期日為 2030 年，其中 1800MHz 頻段釋出頻寬為 150MHz，切成 15 塊，每塊 10MHz；2.5GHz 頻段釋出頻寬為 120MHz，也是切成每塊 10MHz，共 12 塊，以及時提供電信業者頻寬的需求。新加坡未來將再釋出約 450MHz 頻寬供行動寬頻使用，預估在 2020 年前將需要 1GHz 的頻寬（包括 700、800、900MHz、1.4、1.9、2.1、2.3、2.5 及 3.5GHz 等頻段均在規劃之列）。

在無線電視頻譜共享（TV White Space）部分，新加坡從 2009 年即開始 TVWS 的研究，並於 2011 年成立產官學小組試驗 TVWS 的應用及服務，2013 年將 TVWS 的法規架構對外公開徵詢意見，2014 年正式公告實施 TVWS 的法規。

(三) 日本行動寬頻發展及頻譜政策規劃

日本總務省總合通信基盤局情報通信政策總合研究官飯田陽一先生，介紹日本電信市場概況及頻譜政策規劃。

日本目前人口數約 1.28 億，其 3G 加上 LTE 用戶數約 1.45 億，行動數據流量近年來以每年 1.6 倍的速率成長，電信業者的平均用戶貢獻度（Average Revenue Per User, ARPU）則逐年下滑。目前日本指配給行動通信業者共約 521.2MHz 頻寬，使用 700、800、900MHz、1.5、1.7、2、2.5GHz 等頻段（如下圖）。

Frequency Allocation for Mobile Communication Systems

Bands	700MHz	800MHz	900MHz	1.5GHz	1.7GHz	2GHz*	2.5GHz	Total	Subscriber (June. 2014)
FDD/TDD Bandwidth	FDD 30MHz x 2	FDD 30MHz x 2	FDD 15MHz x 2	FDD 35MHz x 2	FDD 35MHz x 2	FDD 60MHz x 2 TDD 31.2MHz	TDD 100MHz**		
docomo	LTE(plan) 20MHz Limited	3G/LTE 30MHz	—	LTE 30MHz	3G/LTE 40MHz Only in some areas	3G/LTE 40MHz	—	160MHz	63.57 mill
au	LTE(plan) 20MHz Limited	3G/LTE 30MHz	—	LTE 20MHz	—	3G/LTE 40MHz	—	110MHz	41.02 mill
SoftBank	—	—	3G/LTE(plan) 30MHz Partially limited	3G 20MHz	—	3G/LTE 40MHz	—	90MHz	36.48 mill
Y!mobile ***	LTE(plan) 20MHz Limited	—	—	—	3G/LTE 30MHz	PHS 31.2MHz Frequency sharing	—	81.2MHz	(Cellular phone) 4.49 mill (PHS) 5.52 mill
UQ Communications	—	—	—	—	—	—	WiMAX R2.1 50MHz	50MHz	4.15 mill
Wireless City Planning	—	—	—	—	—	—	AXGP 30MHz	30MHz	3.96 mill

* Others, such as pending systems (2GHz-MSS:60MHz, 2GHz-TDD:15MHz)
** including Regional WiMAX (20MHz)
*** eAccess and Willcom merged on June 1st, 2014 (Change in corporate name from eAccess to Y!mobile on July 1st, 2014)

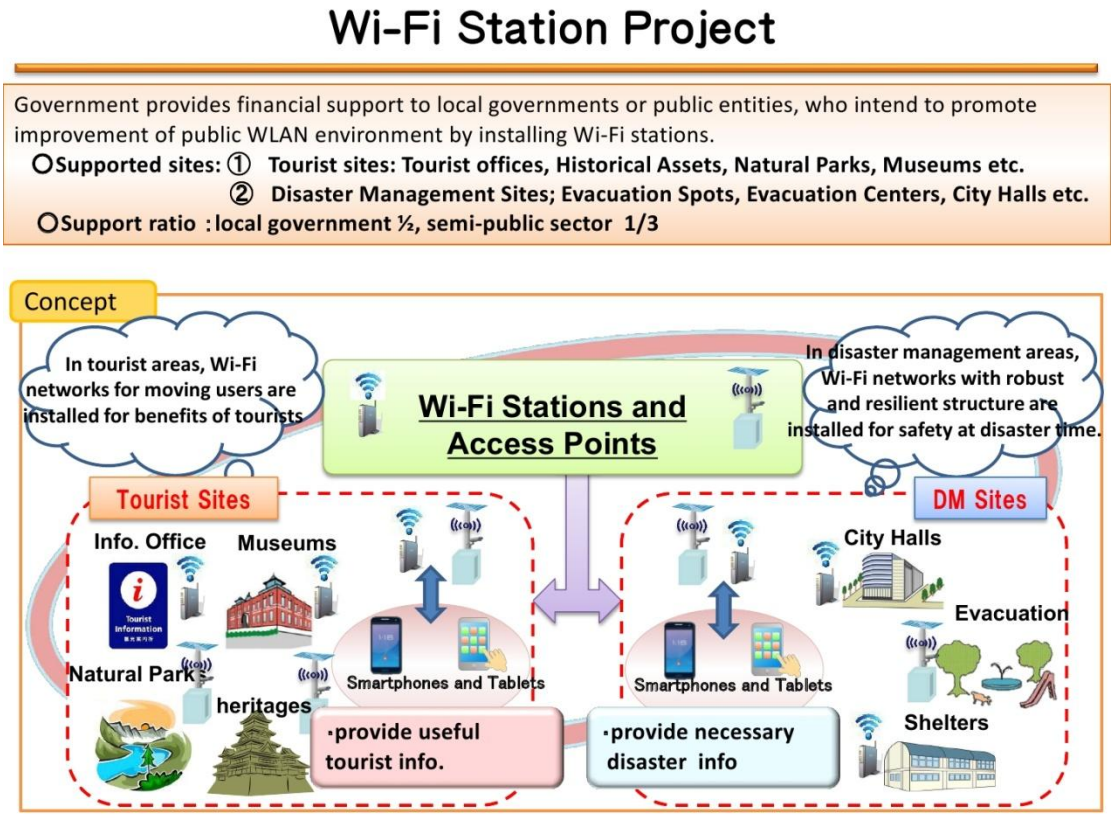
Total : 521.2MHz

資料來源：本次會議日本總務省總合通信基盤局情報通信政策總合研究官

飯田陽一先生簡報資料

為因應日本逐漸老化的人口，以及 2020 年舉辦東京奧運，日本規劃在 2020 年前釋出共 2000MHz 頻寬供行動通信使用，特別是物聯網（M2M）的應用，以創造更舒適、安全、便利及穩定發展無線通信環境。此外，日本為了在 2020 年東京奧運期間推出 5G 行動寬頻服務，政府將投入資金補助產學研發展 5G 技術。

為增加觀光發展，日本推出一系列針對外國觀光客提升資通訊服務的措施，包括擴增免費 WiFi 的熱點、改善外國人申請國內行動電話服務的使用環境、降低國際漫遊費率、推動全球溝通計畫以消除語言障礙。特別是在拓展 WiFi 服務方面，日本藉由公私合作的方式，在商業據點、觀光景點及防災避難設施等地點加強熱點的佈建，並由中央政府補助地方政府一半的建置經費，其他單位則補助三分之一（如下圖）。



資料來源：本次會議日本總務省總合通信基盤局情報通信政策總合研究官

飯田陽一先生簡報資料

另外配合東京奧運的舉辦，日本規劃提前在今(2015)年開始播出 4K 畫質的電視節目，同時在 2016 年實驗 8K 畫質節目，預計 2020 年東京奧運時能播出 8K 畫質的電視節目。

在智慧運輸系統（Intelligent Transport System, ITS）部分，日本使用 1620k、76~90M、2.5GHz 等頻段做為交通流量資訊使用，5.8GHz 頻段做為電子收費系統（ETC）及其他資訊服務使用，760MHz 頻段則做為道路安全預警系統使用，另外 24、26、60、76 及 79GHz 頻段用於車用防撞偵測系統（如下圖）。

	Spectrum	Service	Introduction time
Roadside Broadcasting (Highway Radio)	1620kHz	Provide Traffic information	Since 1980
VICS (Vehicle Information and Communications System)	76-90MHz (FM multiplex broadcasting) 2.5GHz (Radio beacon)	Provide Traffic information	Enacted in 1994
ETC (Electronic Toll Collection)	5.8GHz	Collect highway toll	Enacted in 1997
DSRC (Dedicated Short Range Communication)	5.8GHz	Provide various information	Enacted in 2001 (Revised in 2007)
Driving Safety Support System	**760MHz**	**Provide safety information**	**Enacted in 2011**
Millimeter-wave radar	24/26GHz 60/76GHz 79GHz	Detect obstacles	Enacted in 2010 Enacted in 1997 Enacted in 2012

資料來源：本次會議日本總務省總合通信基盤局情報通信政策總合研究官飯田陽一先生簡報資料

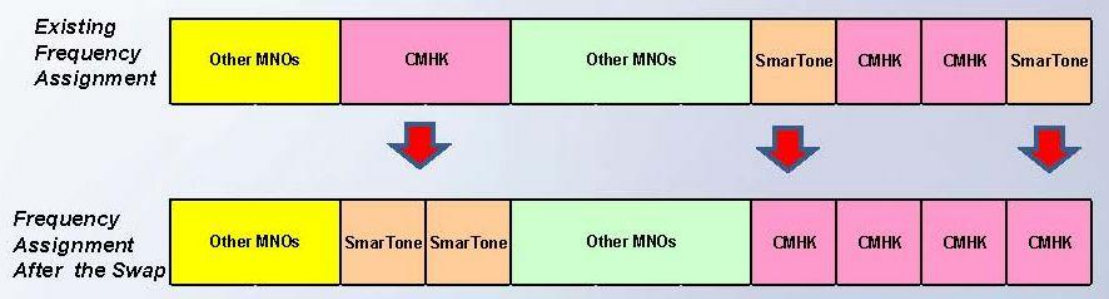
對於 TVWS 的使用，日本是由使用者組成協會的方式，由協會管理資料庫，會員使用資料庫登錄使用頻率、地點及時間等資訊，再由協會負責協調頻率使用的工作。

(四) 香港的行動寬頻發展

香港通訊事務管理局辦公室代表 Chaucer Leung 先生，介紹香港的電信市場概況、頻譜使用情形，以及無線電視頻譜共享（TVWS）、毫微微細胞接取點（Small Cell）發展情形。

香港目前 3G 加 4G 的用戶數約 1,260 萬，滲透率為 174%。指配給行動通信使用的頻寬已達 610MHz，香港計畫在今(2015)年底前完成數位電視轉換，也密切注意 ITU WRC-15 的發展。另外香港也同意業者可將其原提供 2G 服務的 900 及

1800MHz 頻段轉做 3G 或 4G 使用，並允許業者交換不連續的頻段後變成連續頻段使用，以提高頻率使用效率（如下圖）。



資料來源：本次會議香港通訊事務管理局辦公室 Chaucer Leung 先生簡報資料

有關 TVWS 部分，香港因為地理位置接近中國大陸，因此如欲發展 TVWS 需與中國大陸協調訊號干擾的問題，比較可行的方向是用來做為室內通信使用。

此外，香港為推動普及服務，指配額外的頻率供業者在偏遠地區免費使用，也允許業者使用微波電臺連接基地臺，並免費使用公有土地及建物。香港也致力於 Small Cell 的發展。

(五) 巴基斯坦、孟加拉及薩摩亞等國概況

巴基斯坦電信監理機關 Pakistan Telecommunication Authority（PTA）主席 Syed Ismail Shah 先生，介紹該國行動通信發展的歷史，特別是該國在 2005 年第 1 次舉行頻譜拍賣，以及後續 3G、4G 的頻譜拍賣，和目前該國電信市場概況。

目前巴國人口約 1.9 億，行動通信用戶數 1.45 億，滲透率為 75%。2014 年巴國舉行 3G 及 4G 的釋照作業，結果產生 1 家 4G 業者及 4 家 3G 業者。由巴國釋照經驗可看出釋照過程中，資訊愈透明愈能減少各種爭議的產生，使得釋照作業得以順利進行。

來自孟加拉 MAXNET 公司的代表 Rashed Uddin 先生介紹孟國電信市場概況，

以及孟國未來4G服務的發展計畫。孟國人口數約1.6億，行動通信滲透率為62%。

來自薩摩亞監理機關的代表 Donnie De Freitas 先生，說明薩國的國土係由眾多島嶼所組成，在特殊的地理環境下，該國主要是仰賴衛星通訊系統。因此薩國與其他國家對於頻譜的需求有很大的不同。該國特別重視衛星頻段（C-Band）的保護，而此頻段近年來常被討論用來做為其他行動通信的用途，因此薩國特別請各國能重視該國特殊需求的問題。

(六) 未來的網路樣貌、頻譜需求概況與 OTT

CIENA 公司代表 Anup Changaroth 先生分享該公司對軟體定義型網路 Software Defined Network（SDN）及網路功能虛擬化 Network Functions Virtualization（NFV）的架構。

香港大學副教授 John Ure 認為，未來頻譜政策規劃需考量各種需求，不同的業務有不同的頻寬需求，而電信的需求有時候不是列為最優先的考量。目前的頻寬雖然還夠用，但未來很快就面臨不足。各種雲端服務的發展，加速了頻譜資源的消耗。監理機關面對快速變遷的市場，技術的進步使頻譜不再區分是廣播或電信使用。監理機關需要思考什麼需要規管，什麼需要支持（例如：不需特許執照的共享頻段 unlicensed band）。而不同種類服務間，其頻率的使用通常可以共享。

來自泰國 APTelecom 公司的代表 Sean Bergin 發表目前普遍存在於電信業者的問題，即電信業者建置骨幹網路提升網路效能，而獲利較多的卻是雲端服務業者（Over The Top, OTT）；而 OTT 業者也需要將其服務建置在較佳的網路環境中，以提升其客戶之使用經驗（Quality of Experience）。

Bergin 先生認為，要尋求電信業者與 OTT 業者的雙贏策略，需考慮的因素有：頻譜成本、執照成本、網路建置成本、電信業與 OTT 業者的結盟策略等。

(七) 頻譜共享機制

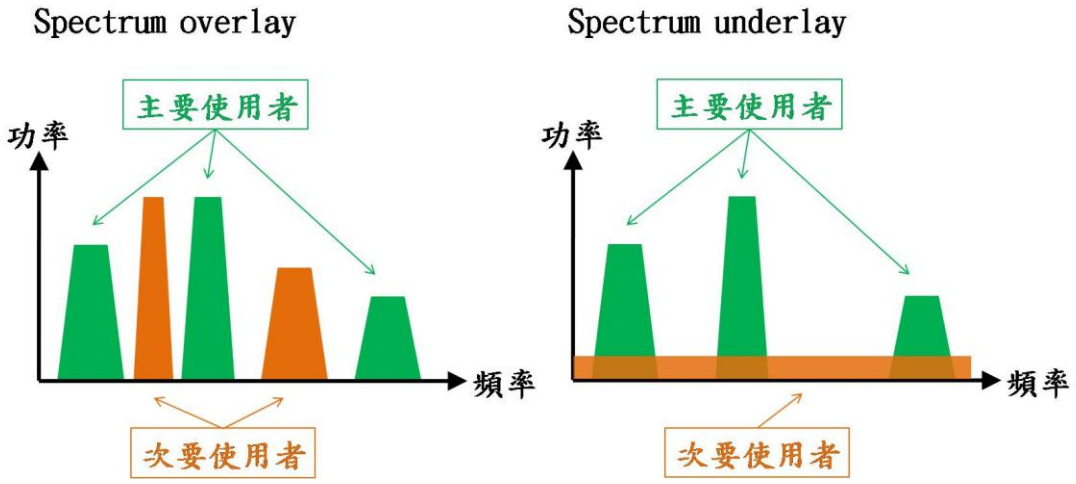
英國 DotEcon 共同創辦人 Christian Koboldt 以頻譜接取技術來做分類，頻譜共享機制可分為 spectrum overlay 與 spectrum underlay 兩種。

Spectrum overlay：

次要使用者的傳輸功率不特別限制，但必需在沒有主要使用者使用的條件下進行接取，因此何地與何時可以使用特定頻率是非常重要的議題，技術上利用數據資料庫做周期性更新、使用前向資料庫查詢、偵測主要使用者、避開主要使用者方式達到和諧共用，如頻譜空白頻段的利用。

Spectrum underlay：

次要使用者的傳輸頻率可擴張至整個頻帶，可以維持傳輸速率，但傳輸距離短，且須嚴格限制傳輸功率，使次要使用者的傳輸功率在主要使用者的雜訊臨界值以下，如此不會對主要使用者造成干擾，因此不須偵測或利用空白頻段，在主要使用者常常出現的狀況下這種方法會有較好的效用。



資料來源：本報告繪製

(八) 新加坡 TVWS 應用概況

微軟新加坡公司科技政策處長 Jeffrey Yan 演講重點為頻譜使用之未來趨勢

會朝向共享式概念（如 TV white space 技術），所謂 TV white space（TVWS）是指電視廣播頻道因時域或地域不同而產生未使用或已指配未使用之頻譜或頻道間之保護頻帶。TVWS 設備可以不需要執照的情況下，在不干擾既存的執照業務使用者（如電視廣播）之架構下運作，該技術透過地理定位功能及建立地理數據資料庫的方式，藉由資訊透明達到減少頻譜開放後的互相干擾，TVWS 設備運作之 5 個步驟為：

查詢（Query）：TVWS 設備發射頻率前須向地理位置資料庫(Geo-location database)詢問可使用之頻率

發射（Transmit）：TVWS 設備發射地理位置資料庫登載之可使用頻率

偵測（Detect）：若 TVWS 設備偵測到主要使用者（primary user）之頻率出現

移動（Move）：TVWS 設備須調整至新的使用頻率

調整（Adapt）：TVWS 設備亦須調整至適當頻寬與發射功率

由於 TVWS 技術可以不需要執照及不干擾優先用戶的情況下，使用電視頻道間未使用的電波頻率，來提供無線寬頻的服務，科技公司包括 Google、Microsoft、Mediatek 等大廠紛紛投入 TVWS 共享技術研究。目前新加坡於濱海灣花園（Gardens by the Bay）以 TVWS 技術為基礎建置 Wi-Fi 熱點，提供遊客穩定可靠的無線網路連結，由於新加坡為全球航運轉運大城，過去船隻主要透過衛星進行通訊，成本昂貴，因此，新加坡樟宜港首度採用 TVWS 技術提供船隻連網通訊需求。

Jeffrey Yan 最後提到，未來物聯網（Internet of Thing, IoT）的興起，預估 2020 年約有 500 億裝置連網，在頻譜資源有限情況下，由頻譜使用技術勢必由目前的避免干擾朝向容忍干擾及未來的消除干擾，監理機制亦須由目前的頻譜使用排他性朝向頻譜共享以及未來的動態頻譜共享（Dynamic Spectrum Sharing, DSS）方

式。

Technology Paradigm Shifts

Old	New	Future
Interference Avoidance	Interference Tolerance	Interference Cancellation
Exclusive (Licensed) Access	Shared (Un/License) Access	Dynamic Shared Access
Connection Oriented	Connectionless	
Asymmetrical Traffic	Symmetrical Traffic	Dynamically Configurable UL/DL
Synchronous Networks	Asynchronous Networks	
Hierarchical Architecture	Flat Topology	Self-configurable Mesh Networks
Multiple, Single-band, Single-mode Radios	Combo, Multi-band, Multi-mode Radios	Integrated, Tunable-band, Software-defined Raios
High Power, High Tower, Macro Cell	Low Power, Low Tower, Small Cell	Lower Power, Portable, Elastic Cell
Homogenous Network	Heterogeneous Networks (HetNet)	

Regulatory Model Shifts

Old	New	Future
Exclusive Access	Shared Access	Dynamic Sharing
Predominantly licensed access	Increased unlicensed access	More balanced Licensed/Unlicensed access both incorporating Dynamic Sharing
Allocation tied to technology	Technology Neutral	Adaptable to Technology Changes
Manual, Command and Control Allocation (easily politicized, regulator loses control once allocated)	Beauty Contest, Auction (more market driven, but subject to market power abuse, regulator has little control once allocated)	Computerized, database-assisted real-time dynamic and temporal allocation (lowest entry barrier, regulator has greater control)
Allocation tied to technology	Technology Neutral	Adaptable to Technology Changes
Static, Long Cycle (10+ years)	Periodical Refarming, Shorter Cycle (still in years)	Real-time, Dynamic, and Shared Access (can be in fine granularity of seconds)
Regulated Monopolies	Pro Competition	Pro Co-opetition, Pro-Efficiency (e.g., infrastructure sharing, spectrum sharing)
Assume Spectrum Scarcity, Minimize Interference	Maximizing Spectrum Efficiency, Tolerates Interference	Assume Spectrum Abundance

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資料來源：本次會議微軟新加坡科技政策處處長 Jeffrey Yan 簡報資料

(九) 菲律賓 TVWS 應用概況

菲律賓科技部資通科技辦公室執行董事 Louis Casambre 分享菲律賓 TVWS 的經驗，菲律賓全國平均網路速率為 3.6Mbps，低於東協各國，更低於全球平均網路速率 17.5 Mbps，主要原因是菲律賓國土地形破碎且超過 7000 座島嶼，網路基礎建設不易，鋪設銅纜或光纜成本過高，全國 83%地區無法連接寬頻網路，因此，菲律賓利用 TV 頻段具有優於目前行動通訊頻段之長距離、非視距（NLOS）、高穿透性等優良傳播特性，解決菲律賓地形導致網路無法普及之最後一哩問題與災難救援時的通訊障礙。

菲律賓在 Bohol 地區建置 3 個 TVWS 發射站臺，每個站臺可涵蓋 20 公里，

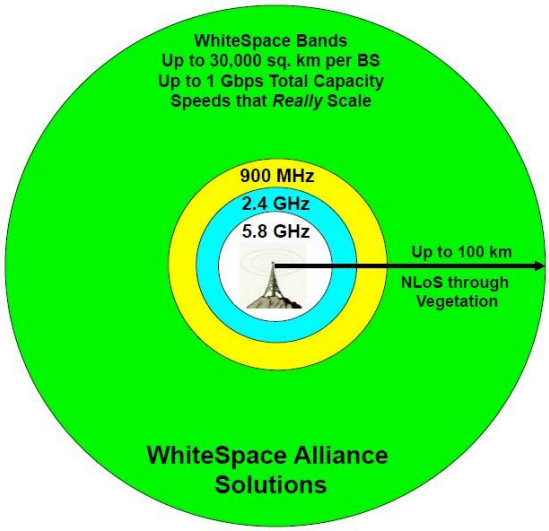
提供將近 85 所公立中小學免費 Wi-Fi 使用，其國內使用 TVWS 作為網路普及服務下，提供將近 20000 戶漁民家庭網路服務及 16000 個偏鄉醫護診所使用 TVWS 網路連結處理醫療資訊傳遞與管理，另外因為 TVWS 之用戶端設備（Customer Premise Equipment, CPE）安裝簡易，在地震、颱風等救災中可發揮網路資訊連結的重要角色。

(十) 已開發與開發中國家之 TVWS 需求

WhiteSpace Alliance 主席 Apurva N. Mody 說明全世界 70 億人口有 73%（51 億）無法接取網路，49.5%（35 億）居住在農村地區，而在人口密度低的地區鋪設光纖或銅纜成本過高，因此，利用無線接取解決上網問題是最具經濟效益的方法，對於都市地區而言，則可利用空白頻段（white space）技術來卸載行動通訊數據流量、建置智慧電網、智慧家庭與環境監測等應用。

到 2020 年前，已開發國家還需增加 500MHz 頻寬供無線寬頻服務與應用，對於開發中國家而言，如何在農村地區建置低成本的無線寬頻接取服務則是一大挑戰，但取得執照頻譜的營運商通常不願意利用該頻譜做 backhaul 使用，並盡可能用其它頻譜卸載數據流量，而目前 TVWS 每 6MHz 頻寬的 TV 頻道傳輸速率約 22 至 29 Mbps，未來可達 40 Mbps，非視距（Non Line of Sight, NLoS）傳播距離可達 100 公里，單一個站臺電波涵蓋率約 30000 平方公里，因此，空白頻段頻譜共享對已開發和開發中國家達成上述目的是一個很大的機會。

Apurva N. Mody 主席最後提到，頻譜共享技術可利用感知無線電與資料庫達成，但監理政策與規範也應同時並進。



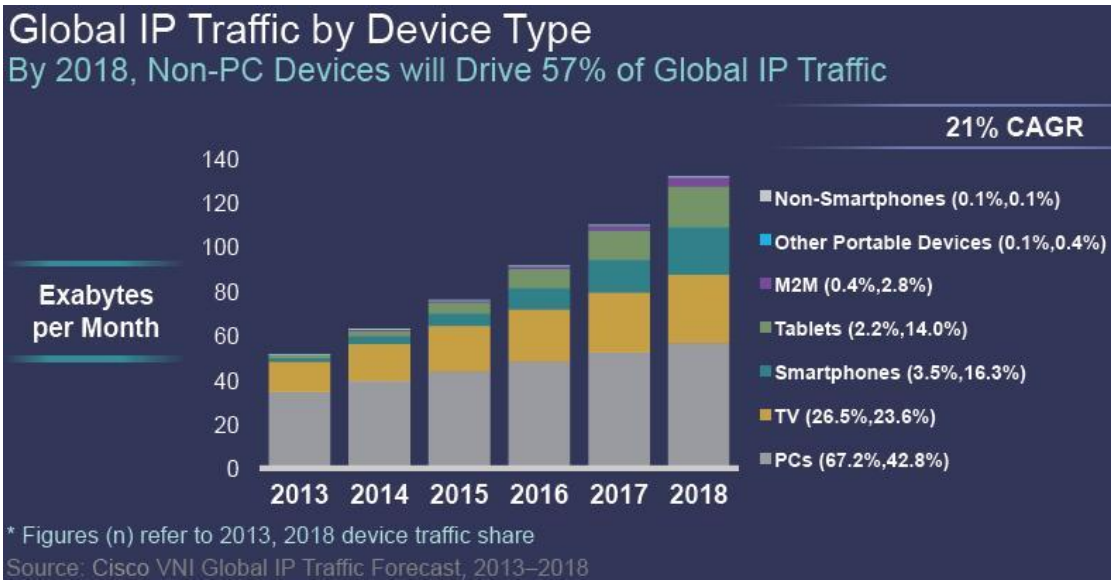
資料來源：本次會議 WhiteSpace Alliance 主席 Apurva N. Mody 簡報資料

(十一) 全球數據流量成長與無線接取需求

Cisco 公司副總裁 Robert Pepper 說明頻譜的需求來自於無線寬頻與萬物互聯（Internet of Everything, IoE），IoE 顧名思義就是所有東西全部連上網路，除了涵蓋 M2M(機器對機器互聯)的層面之外，還進一步包含 M2P2M（人與機器互聯）與 P2P（人與人互聯），IoE 不僅著重在人與機器的互聯，亦包括流程與資料的串聯。

IP 數據流量：

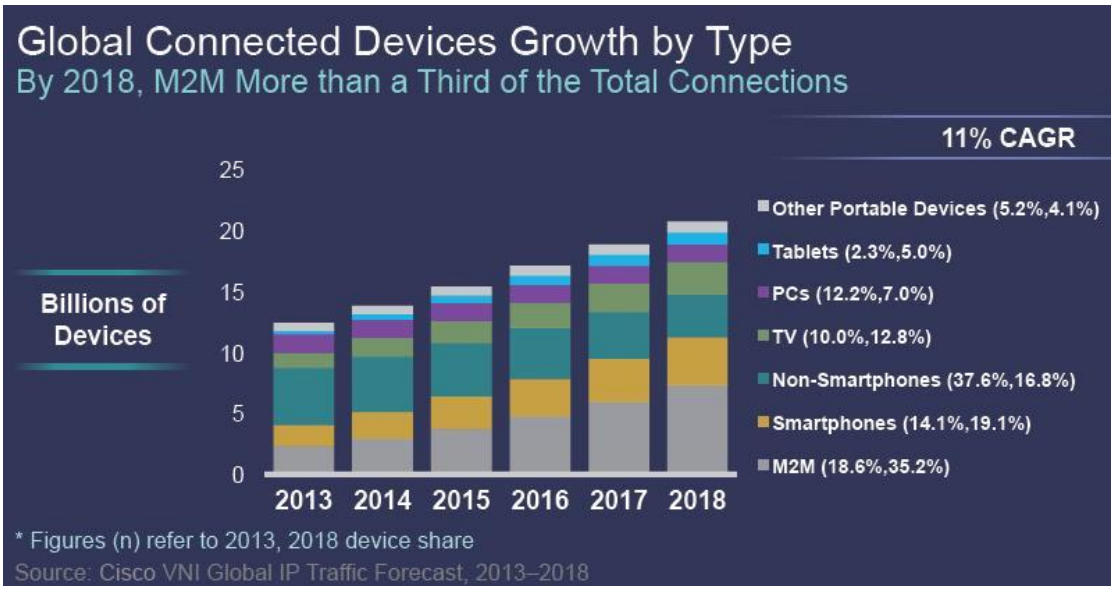
依據 Cisco 視覺網路指標全球 IP 流量預測報告，全球 IP 數據流量從 2013 年每月 51 Exabytes 至 2018 年每月 132 Exabytes，5 年內成長將近 3 倍，年複合增長率（Compound Annual Growth Rate, CAGR）為 21%，主要原因包括網路用戶與裝置增加、寬頻連線速度提升、以及觀看影片次數攀升等。到 2018 年，IP 數據流量主要來自於 PC 以外的行動與可攜式裝置，比重將成長到 57%，其中包括電視、平板、智慧型手機以及 M2M 連結。



資料來源：本次會議 Cisco 公司副總裁 Robert Pepper 簡報資料

IP 數據流量存取類型、裝置與連線：

依據Cisco 的預估，Wi-Fi與行動網路裝置到2018年將產生76%的網路流量，其中 Wi-Fi 的比重為 61%，行動網路裝置則是 15%，固網流量則僅佔所有網路數據流量比重的 24%，屆時，全球將有 210 億台裝置連至網際網路，萬物互聯（IoE）的發展持續增溫，其中全球機器對機器(M2M)的連線裝置將超過所有連線裝置的三分之一（約 70 億），直逼全球人口數量。



資料來源：本次會議 Cisco 公司副總裁 Robert Pepper 簡報資料

伍、心得與建議事項

一、積極參與國際間對 OTT 監理方式相關議題

雲端服務（OTT）拜行動通信及智慧行動裝置快速發展之賜迅速崛起，然而 OTT 蓬勃發展卻反過來卻造成行動通信頻寬不足的問題，而且 OTT 的獲利通常無法讓電信業共享，導致電信業對 OTT 的反彈。此外 OTT 業者通常無需特許即可營業，因此當發生其所提供之服務內容違反法規或遊走法律邊緣時，通常不易受到管制。相對而言，電信業者則受到主管機關較嚴格的監理，並且需負擔建設網路的義務。因此，各國均在研究是否及如何監理 OTT 的問題。有鑒於 OTT 通常能提供跨境服務（例如 Google、LINE 等），單一國家實際上很難規管 OTT，較可行的方法應是透過國際合作來達成。所以我國應積極參與國際間對 OTT 相關議題的討論，並尋求國際合作、共同解決 OTT 所帶來的問題。

二、IoT/M2M 趨勢之資源分配及法規檢視

越來越多機構對行動寬頻流量預測呈現數百數千倍的成長，2018 年，IoT/M2M 連網數將達到 210 億，為因應此成長趨勢，除做好未來頻譜及號碼之資源分配規劃，亦應思考如何調整監理措施及修正相關法規等，創造有利我國通傳產業發展之環境。

三、關注國際頻譜共享技術發展趨勢

因應行動數據流量持續快速的成長，頻譜資源如何有效的運用已成了各國所關注的議題，特別是在傳統類比電視轉換為數位電視後，因「數位紅利」帶來相關無線電視頻譜共享（TVWS）的機制，更是各國積極發展的方向，近期美國、英國、新加坡、日本等國家，陸續推動 TVWS 相關實驗計畫，廣泛應用於智慧公共能源監控、國土安全監控、智慧防災即時傳輸、智慧交通監控、港口管理及行動頻寬分流等面向，其中新加坡於 2011 年成立產官學小組試驗 TVWS 的應用

及服務，2013 年將 TVWS 的法規架構對外公開徵詢意見，2014 年正式公告 TVWS 的法規；菲律賓利用 TVWS 具有優於目前行動通訊頻段之長距離、非視距、高穿透性等優良傳播特性，解決菲律賓地形導致網路無法普及之最後一哩問題與災難救援時的通訊障礙，惟我國是全世界少數使用單一頻率建置數位無線電視網的國家，是否有 TVWS 頻譜共享使用之空間，可進一步研析；如要建構頻譜共享機制，需將每一無線電視廣播保護範圍、傳輸功率、地理位置等資料註冊於地理資料庫中，而共享設備需配備位置感測技術或定位系統，將相關地理資料連結至地理資料庫系統，避免頻譜共享後的互相干擾。在 TVWS 仍處於萌芽階段時，我國可進行資源及相關技術之研析，評估未來可能的應用發展，並適時參與國際合作，以掌握未來商機。

四、頻譜規劃及釋照方式等寶貴資訊可供政策制定之參考

參與本次會議的過程中，獲得許多鄰近國家對有關電信市場及未來頻譜規劃相關的資訊，非常值得我國在制定相關政策時參考。另外有關頻率釋照制度及目前各國相關資通訊發展的經驗，也值得我國借鏡。因此，我國應持續加強通訊傳播監理之國際交流，以促進我國通訊傳播監理之發展。

陸、活動相片

本會與 MDA 會面

本會副主任委員頻譜未來會議報告我國頻譜規劃進程

PTC 2014 頻譜未來會議合照

柒、附件

附件一：虞副主任委員孝成「Spectrum Planning Progress in Taiwan」簡報。

附件二：新加坡 TV White Space 管制架構。

附件一

The Spectrum Future Conference

Pacific Telecommunications Council

Spectrum Planning Progress in Taiwan

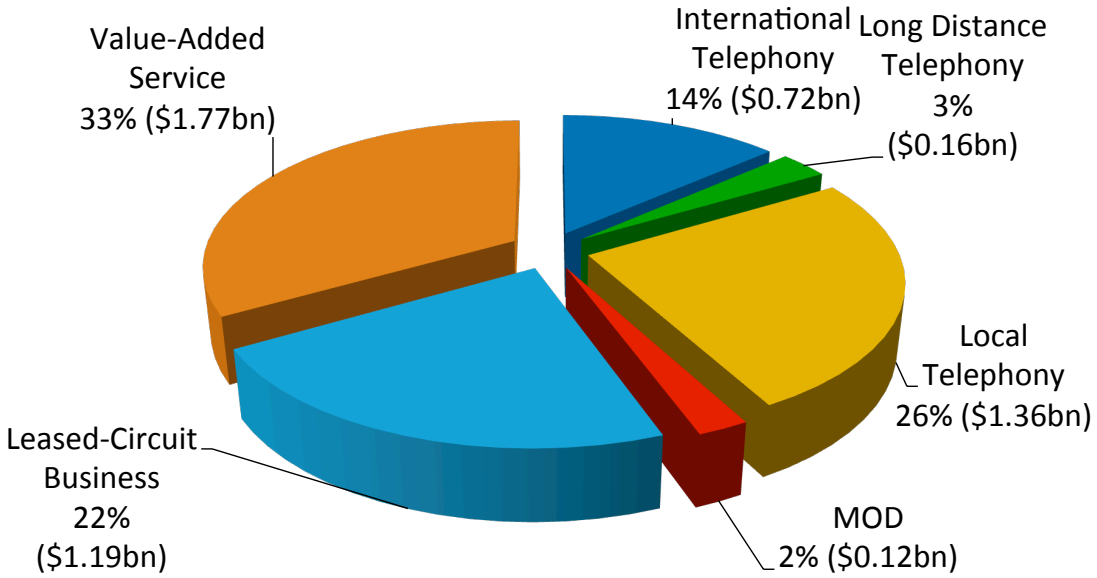
Vice Chairman, Yu, Hsiao-Cheng
National Communications Commission
Taiwan
Oct. 30, 2014

Spectrum Allocation in Taiwan

- Telecom Market Status
- Existing Mobile Comm. Spectrum
- Upcoming Mobile Comm. Spectrum
- UHF Spectrum
- Unlicensed Spectrum
- Low-Power Wireless Microphone
- Short-Range Radar for Automobile
- Personal Locator Beacon

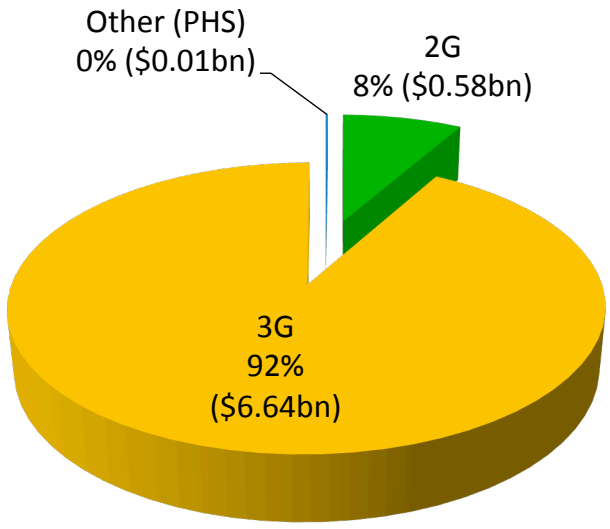
附件一

2013 Revenues of Fixed-Line Services



Total: USD 5.3 billion

2013 Revenue of Mobile Services



Total: USD 7.2 billion

附件一

4G Spectrum Auction

- SMRA
- Auction sessions start on 9/3 end on 10/30, 2013

Winning Bidders	Bandwidth	Total Price
Chunghwa Telecom	70 MHz	USD 1,302 m
Far Eastone Telecom	60 MHz	USD 1,043 m
Taiwan Mobile	60 MHz	USD 967 m
Taiwan Star Cellular (Ting Hing)	20 MHz	USD 121 m
Asia Pacific Telecom	20 MHz	USD 214 m
Ambit Microsystem (Foxconn)	40 MHz	USD 306 m

4G Service Status

- There are five 4G operators. The top three operators launched 4G LTE services in end of May 2014, after fulfillment of the minimum requirement of 250 LTE BSs.
- Taiwan Star Telecom launched 4G service on 8/25, 2014.
- Asia Pacific Telecom has been granted permission to launch service on 10/22,2014.
- There are 2.7m 2G users and 25.5 m 3G users.
- There are 1.7 m 4G users and the number is expected to reach 3m by end of 2014.

附件一

4G Signal Coverage

- Total of 6697 LTE BSs have been in operation and 5567 LTE BSs are under construction by 10/24 2014.
- 95% of population will be covered by LTE signal by end of 2014.

Existing Mobile Comm. Spectrum

- 540 MHz spectrum have been assigned for 2G, 3G, 4G, WiMAX and PHS mobile services.

Band	Expiration Date	Band	Expiration Date	Band	Expiration Date
700 MHz (703-748、758-803)	4G (2030.12.31)	800 MHz (825-845、870-890)	3G (2018.12.31)	900 MHz (885-915、930-960)	4G (2030.12.31)
1800 MHz (1710-1770、1805-1865)	4G (2030.12.31)	1900 MHz (1885-1915)	PHS (1905-1915) (2016.4)	2100 MHz (1915-1975、2110-2165)	3G (2018.12.31)
2100 MHz (2010-2025)	3G TDD (2018.12.31)	2600 MHz (2565-2625、2660-2690)	WiMAX (2016)		

2G licenses expire on June 30, 2017.
4G spectrum auction in 2013 includes existing 2G spectrum.

附件一

Upcoming Mobile Comm. Spectrum

- Releasing 190 MHz spectrum in 2.6 GHz band (2500 - 2690 MHz) in 2015. Existing WiMAX operators currently are using 90 MHz.
- Auctioning, in 2016 - 2017 time frame, 205 MHz spectrum in 800 MHz, 1900 MHz and 2000 MHz bands after 3G and PHS licenses expire.
- Will comply to ITU spectrum allotment in 2.3 - 2.4 GHz and 3.4 - 3.6 GHz bands for 4G mobile service.
- Will comply to international standards in SDL(supplemental downlink) and LTE-U technologies.

UHF Spectrum

- 530 - 608 MHz is allocated for six 6 MHz Single Frequency TV Networks.
- Other spectrum in UHF band (300 - 700 MHz) are under utilized and have potential for spectrum sharing.
- Transmitting at the same power level, an UHF BS can cover an area of 6 Km radius while a GSM (1800 MHz) BS can only cover an area of 2.5 Km radius.
- An indoor UHF band AP can replace 9 WiFi APs.

附件一

Unlicensed Spectrum

Band	Technologies	Band Width
2.4 GHz (2400-2483.5 MHz)	IEEE802.11b/g/n	83.5 MHz
5 GHz (5250-5350 MHz、5470-5825 MHz)	IEEE802.11a/n/ac	455 MHz

Will allocate 5150 - 5250 MHz and 5825 - 5850 MHz for unlicensed wireless LAN use.

Will allocate 57 - 66 GHz for unlicensed small cell BS backhaul and WiGig use.

Low-Power Wireless Microphone

- Wireless microphone operating in 794 - 806 MHz band causes interference with 4G.
- New shared-use spectrum will be allocated for low-power wireless microphone.
  - 485 - 530 MHz：Share use with police, fire department, taxi and other users.
  - 753 - 758 MHz：4G guard band. Must tolerate interference from 4G.
  - 1790 - 1805 MHz：4G guard band. Must tolerate interference from 4G.

附件一

Short-Range Radar for Automobile

- 25.9 - 26.65 GHz is existing spectrum for SRR.
- Expanding 24.25 - 25.9 GHz spectrum for SRR.

Personal Locator Beacon

- Frequency at 406 MHz is allocated for PLB use.
- PLB equipment must conform to message format defined by COSPAS-SARSAT and pass type-approval by NCC.
- Must register at the Rescue Coordination Organization.
- No license or fee requirement imposed by NCC.

附件一

Questions or Suggestions?

yu@ncc.gov.tw

PART III: FINALISED REGULATORY FRAMEWORK FOR TV WHITE SPACE OPERATIONS

117. Based on the responses from the public consultation, IDA has fine-tuned the TVWS regulatory framework to incorporate recommendations from the industry. The following summarises IDA's decision on the various key issues and also the way forward.

Licensing Framework for WSD

118. WSD operations will be on a licence-exempt basis. However, its technical and operational parameters will be subject to the technical specifications as defined by IDA.

119. To give effect to the opening up of the TVWS channels for the operation of WSD on a licence-exempt basis, IDA will be amending the Telecommunications (Exemption From Section 33, 34(1)(*b*) and 35) Notification.

120. WSD equipment will be required to register under the GER scheme.

121. Subject to administrative and gazetting process, the above amendments for publication in the Government *Gazette* are expected to take effect by **1 November 2014**. IDA may postpone the effective date if industry needs more time to prepare for commercial operation. IDA will inform the industry in advance should there be a change in the effective date.

Frequencies for TVWS operations

(i) Common TVWS Frequencies

122. The following channels highlighted in Table 2 are available for TVWS operations, subject to IDA's requirements and regulations. Please note that when ASO occurs, there will be further amendments to the available TVWS channels. The 700MHz band (694 – 806MHz) will be allocated for IMT services and will no longer be available for TVWS operations. Prior to the allocation for IMT services, IDA will remove 14 channels (Channel 49 – 62) from TVWS usage and notify the industry accordingly.

Table 2: TVWS Channels of Operations

	TVWS Channels	Total No. of Channels	Total Bandwidth
VHF Band	i) 181 - 188MHz (Channel 6) ii) 209 - 223MHz (Channel 10 and 11)	3	21MHz
UHF Band	i) 502 – 518MHz (Channel 25 to 26) ii) 614 - 622MHz (Channel 39) iii) 630 – 710MHz (Channel 41 to 50) iv) 718 – 742MHz (Channel 52 to 54) v) 750 – 774MHz (Channel 56 to 58) vi) 790 - 806MHz (Channel 61 and 62)	21	168MHz

123. Channels 25 and 26 will be blocked from TVWS operations through the Geo-location Database until further field tests have been conducted on adjacent channel interference. Channels 25 and 47 will be utilised for safe harbour operations of licence-exempt wireless microphones operating in accordance to the IDA Short Range Device Technical Specification. Thus, Channel 47 will also be blocked from TVWS operations through the Geo-location Database.

(ii) High Priority Channels

124. Two channels will be designated as HPCs[22]. These channels can only be activated when there are no common TVWS channels available at a WSD location.

125. The HPC access will be managed by the Geo-location Database and the allocation method (including any fees to be imposed) will be left to the commercial decisions of the Geo-location Database providers. However, Geo-location Database providers will have to inform IDA of its intended HPC allocation method as part of the licensing process and the allocation method should be transparent.

126. Allocation and management of the HPCs will not be a mandatory requirement for Geo-location Database providers. Geo-location Database providers that choose not to include HPC allocation as part of their Geo-location Database service will have to block out these HPCs from their Geo-location Databases. While, interested Geo-location Database providers should synchronise the HPC usage amongst themselves to ensure the effective usage of HPCs.

WSD General Operating Parameters

(i) Categories of WSD

127. Three categories of WSD will be allowed in Singapore. These are summarised in Table 3 and the details are provided below:

Table 3: Categories of WSD

	Fixed WSD	**Mode I WSD (Portable)**	**Mode II WSD (Portable)**
Ability to Query the Geo-location Database	Yes	No	Yes
In-built Geo-location Capability	Optional	No	Yes
Maximum Power Level	4W EIRP	100mW EIRP	100mW EIRP
Tuneable Power Level	Optional	Optional	Optional

a) Fixed WSD: Fixed WSDs shall transmit and receive at a specified fixed location. Such WSDs should have the ability to query the Geo-location Database and select a TVWS channel for operation based on the list of available TVWS channels provided by the Geo-location Database. A Fixed

[22] It should be noted that HPCs availability is subject to the utilisation of these channels. For example, if a company uses HPCs at a specific location, then these channels will no longer be available to other companies at that location.

WSD shall have the ability to transmit at a power level capped at a maximum of 4W EIRP. Fixed WSDs are able to initiate a network by sending enabling signals to other client WSDs. IDA will require all TVWS networks to have at least one Fixed WSD or Mode II WSD (see below) at all times.

b) Mode I WSD (Portable): Operation by the Mode I WSD will only be allowed with the presence of a Fixed WSD or Mode II WSD in the same TVWS network. Due to its mobility, IDA will require the transmission power of such WSDs to be capped at a maximum of 100mW EIRP. This mode of operation does not require the use of geo-location capabilities and will not require access to the Geo-location Database, but will determine its operating channel through a Fixed or Mode II WSD.

c) Mode II WSD (Portable): Mode II WSDs will be required to have an in-built geo-location capability and the ability to query the Geo-location Database to select a TVWS channel for operation based on the list of available TVWS channels provided by the Geo-location Database. Due to its mobility, IDA will require the transmission power of such WSDs to be capped at a maximum of 100mW EIRP. IDA will require all TVWS networks to have at least one Fixed WSD or Mode II WSD at all times.

128. The transmission output power[23] is characterised as the total transmit power in the entire emission bandwidth (i.e. 7MHz for VHF channels and 8MHz for UHF channels) measured at the antennas.

(ii) Antenna Requirements

129. All transmit and receive antenna(s) of personal/portable WSDs shall be permanently attached. The height of the antenna is defined as the height above ground, which will enable a Geo-location Database to generate operational parameters based on the height of the WSD.

(iii) Out-of-Band ("OOB") Emission

130. The OOB emission limits for WSDs operating in channels adjacent to local broadcast channel shall be -56.8dBm EIRP.

131. Emission measurements in the adjacent channels shall be performed using a minimum resolution bandwidth of 100 kHz with an average detector. A narrower resolution bandwidth may be employed near the band edge, when necessary, provided the measured energy is integrated to show the total power over 100 kHz.

(iii) Unique WSD Identifier

132. Each WSD should have a unique identifier for tracking and verification purposes. The format for the identifier should be based on recognised standards (e.g. ETSI BRAN, TSAC Working Group) and international/industry practices (e.g. FCC

[23] Power must be aggregated across all antennas and antenna elements and if multiple modes of operation are possible (*e.g.*, alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

defined identifier).The Geo-location Database will then be required to incorporate the flexibility to accept different types of Unique WSD Identifiers.

Geo-location Database Access Requirements

133. Prior to accessing the Geo-location Database, all WSDs will have to ensure that the Geo-location Database they are accessing is authorised by IDA. The list of authorised Geo-location Databases will be published on IDA's website when ready.

(i) Fixed WSDs

134. Prior to transmission, a Fixed WSD shall query a Geo-location Database to determine channel availability and transmission power levels at its fixed geographic location. This will be the primary approach for accessing the Geo-location Database. Operation of a Fixed WSD is only permitted on these available channels and power levels as indicated by the Geo-location Database, for a specified validity period. Additionally, a Fixed WSD that is equipped with spectrum sensing capability can also use spectrum sensing as a complementary method, so long as it does not cause interference issues to other devices and users.

135. The geographic coordinates of Fixed WSDs shall be determined to an accuracy of ±50 m by either an incorporated geo-location capability or through a manual method of keying in the geographical coordinates.

136. A Fixed WSD may indirectly access an authorised Geo-location Database through another Fixed WSD. The Fixed WSD requiring indirect access to a Geo-location Database may transmit to another Fixed WSD on a channel which is indicated as available for use, to access the Geo-location Database to register its location and receive channel availability and transmission power level information. Subsequently, the newly registered Fixed WSD must only use the TVWS channels that the Geo-location Database indicates are available and transmit according to the maximum power level indicated by the Geo-location Database.

137. In the event where the Fixed WSD is unable to establish contact with an authorised Geo-location Database or when the authorised Geo-location Database becomes unavailable, the WSD must cease transmission. The Fixed WSD shall query the Geo-location Database for the channel availability and transmission power information in the three situations highlighted below. In these three situations, the Fixed WSDs will have to adjust its transmission parameters according to those provided by the Geo-location Database.

a) Activation from a power-off condition;
b) Change in its fixed location; and
c) Expiration of channel validity period.

(ii) Mode II WSDs

138. Prior to transmission, a Mode II personal/portable WSD shall primarily rely on a Geo-location Database to determine channel availability and transmission power levels at its geographic location to an accuracy of ±50 meters. Operations of a Mode II WSD is only permitted on these available channels and power levels as indicated by the Geo-location Database for a specified validity period and spectrum sensing can be

used as a complementary measure, so long as it does not cause interference issues to other devices and users.

139. In the event where the Mode II WSD is unable to establish contact with an authorised Geo-location Database or when the authorised Geo-location Database becomes unavailable, the WSD must cease transmission. The Mode II WSD shall query the Geo-location Database for the channel availability and transmission power information in the three situations highlighted below. In these three situations, the Mode II WSDs will have to adjust its transmission parameters according to those provided by the Geo-location Database.

a) Activation from a power-off condition;
b) Change of more than 100 meters from its original location; and
c) Expiration of channel validity period.

140. A Mode II WSD may query the Geo-location Database for channel availability and transmission power information for multiple locations around or in the vicinity of its current location and use that information in its operation. A Mode II WSD may use such available channel information to define a geographic area within which it can operate on the same available channels at all locations. A Mode II WSD using such channel availability information for multiple locations must contact the Geo-location Database again if/when it moves beyond the boundary of the area where the channel availability data is valid, and must access the Geo-location Database daily even if it has not moved beyond that range to verify that the operating channel(s) continue to be available. Operation must cease immediately if the Geo-location Database indicates that the channel is no longer available.

(iii) Mode I WSDs

141. A Mode I personal/portable WSD need not query the Geo-location Database, however channel availability and transmission power information shall be obtained from a Master WSD, which could be either a Fixed or Mode II WSD with direct access to the Geo-location Database.

142. A Mode I WSD shall only transmit on receiving the transmission of a Master WSD. To initiate contact with a Master WSD, a Mode I WSD may transmit on a channel the Master WSD indicates as available for use by a Mode I WSD. Once the Mode I WSD receives contact verification signal from the Master WSD, it can commence transmission on channels that have been identified as available by the Master WSD. The Master WSD must provide the list of available channels to the Mode I WSD that is the same as the list of channels available to the Master WSD itself.

143. At least once every 60 seconds, except when the WSD is in power-off or sleep mode[24], a Mode I WSD must either receive a contact verification signal from the Mode II or Fixed WSD that provided its current list of available channels or contact a Mode II or Fixed WSD to re-verify/re-establish channel availability. A Mode I WSD must cease operation immediately if it does not receive a contact verification signal or is not able to re-establish a list of available channels through contact with a Fixed or Mode II WSD. Consequently, if a Fixed or Mode II WSD loses power and obtains new channel

[24] A mode in which the device is inactive but is not powered-down.

availability information, it must signal all Mode I WSDs it is serving to acquire and use a new channel list.

(iv) Channel Validity Period

144. At a minimum, WSDs shall query the Geo-location Database every 6 hours to obtain updated information of channel availability and transmission power level at its location. IDA will require this channel validity period of 6 hours to be configurable and the Geo-location Database should incorporate this flexibility for IDA to amend the channel validity period.

(v) Security Requirements for WSDs

145. Security measures shall be incorporated to ensure that communications between WSDs and authorised Geo-location Databases will not be corrupted and will prevent unauthorised interception/modification of data. Upon obtaining information from the Geo-location Database and selecting a channel for operation, the WSD shall adhere to the maximum power level as defined by the Geo-location Database for its selected channel of operation. Secure methods shall be employed to ensure that such transmission power information will not be manually modified.

146. The above security measures shall also be applicable for communications between Mode I portable WSDs and Master WSDs for purposes of providing a list of available channels. Contact verification signals transmitted from a Master or Mode I WSDs are to be encoded with encryption to secure the identity of the transmitting device.

(vi) Optional Requirements

147. WSD manufacturers and Geo-location Database providers may implement a system that pushes updated channel availability and transmission power information from the Geo-location Database to WSDs. However, the use of such a system is not mandatory, and the requirements for WSDs to validate the operating channel upon expiry of channel validity continue to apply if such a system is used.

Coexistence of Service

(i) Co-channel Coexistence

148. All WSDs must not cause interference to the protected services that are operating within the TVWS band, these include licensed wireless microphones and private mobile radio services. The Geo-location Database provider, through the Geo-location Database, shall be responsible for ensuring coexistence through the methodology prescribe below:

a) The WSD will have to inform the Geo-location Database of its operating location and the height of its transmitting antenna. The Geo-location Database will determine the separation distance between the WSD and the receiver station of the protected services.

b) The Geo-location Database upon receiving the location and height information will calculate the path loss using Hata propagation model between the WSD and the receiver station of the protected services. To

avoid any interference issues, the Geo-location Database will have to ensure the signal level propagated from a WSD reaching the receiver station will be at the noise floor level of -115dBm.

c) On this basis, the Geo-location Database will use the path loss information to compute the maximum permissible transmission power level for the WSD for each available TVWS channel. The Geo-location Database will then return the spectrum availability information and the maximum transmission power for the respective channels to the WSD requesting this information.

(ii) Cross-border Coexistence

149. All WSDs must not cause interference to broadcasting and other services in the neighbouring countries. The Geo-location Database provider shall be responsible for ensuring cross-border coexistence through the methodology prescribe below[25]:

a) The WSD will have to inform the Geo-location Database of its operating location and the height of its transmitting antenna. The Geo-location Database will determine the separation distance between the WSD and borders of Singapore[26].

b) The Geo-location Database upon receiving the location and height information will calculate the path loss using Hata propagation model between the WSD and the borders of Singapore. To avoid any interference issues, the Geo-location Database will have to ensure the signal level propagated from a WSD reaching the Singapore borders will be at the noise floor level of -115dBm.

c) On this basis, the Geo-location Database will use the path loss information to compute the maximum permissible transmission power level for the WSD for each TVWS channel. The Geo-location Database will then return the spectrum availability information and the maximum transmission power for the respective channels to the WSD requesting this information.

(iii) Licence-Exempt Device Coexistence

150. The two designated safe harbour channels for licence-exempt wireless microphone operations are Channel 25 (502 – 510 MHz) and Channel 47 (678 – 686 MHz). In these safe harbour channels, there shall not be any TVWS operations.

151. In the event that users of licence-exempt wireless microphones require operations beyond the safe harbour channels, they shall seek approval from IDA with the necessary justifications. Subsequently, these users will need to register the approved wireless microphone operations with an authorised Geo-location Database for protection. The protection of these additional channel(s) is temporary and is valid only in the approved location and stipulated period.

[25] This methodology will only be needed for VHF channel 11, UHF channels 25, 39, 41, 43, 45, 47, 49, 51, 53, 55, 57, 59, and 61

[26] The Malaysia and Singapore border is defined in the Agreement between the Government of Malaysia and the Government of the Republic of Singapore to delimit precisely the territorial waters boundary in accordance with the Straits Settlement and Johor Territorial Waters Agreement 1927, signed on 7 August 1995.

Geo-location Database Operations and Registration

(i) General Requirements

152. The Geo-location Database shall determine and provide to a WSD, upon request, the available channels and maximum transmission power level at the WSD's location. The available channels are determined based on the co-existence requirements in earlier sections.

(ii) Update of Licensed Service Information

153. At a minimum, authorised Geo-location Databases shall query the Geo-location Database every 6 hours to obtain updated information of licensed services that are to be protected. IDA will require this refresh period of 6 hours to be configurable and the Geo-location Database should incorporate this flexibility for IDA to amend the refresh period.

(iii) Security Requirements for Geo-location Database Operations

154. Geo-location Databases shall be protected from unauthorised data input or alteration of stored data. To provide this protection, TV Geo-location Database providers shall establish communications authentication procedures that allow the Fixed or Mode II WSDs to be assured that the data they receive is from an authorised source.

155. In making the lists of available channels to the WSDs, the Geo-location Database shall ensure that all communications between the Geo-location Database and the WSDs include adequate security measures such that unauthorised parties cannot access or alter the Geo-location Database or the list sent to the WSDs or otherwise affect the Geo-location Database system or WSDs.

(iv) Registration of WSDs

156. Fixed WSDs are required to register with the Geo-location Database when it is first activated or after changing location by providing the information listed below. The network operator or service provider responsible for a Fixed WSD must ensure that the Geo-location Database has the most up-to-date information for the Fixed WSD.

a) Unique WSD Identifier
b) WSD's geographic coordinates (latitude and longitude)
c) Height of the WSD antenna
d) Name of individual or business that is responsible for the WSD
e) Name of a contact person responsible for the WSD's operation
f) Address for the contact person
g) Email address for the contact person
h) Phone number for the contact person

157. A portable WSD operating in Mode II shall provide the Geo-location Database its unique identifier and the WSD's geographic coordinates (latitude and longitude accurate to ±50 meters). The Geo-location Database shall have the mechanism to store the up-to-date information for Mode II WSDs for at least 6 months.

158. A portable WSD operating in Mode I shall provide the Geo-location Database its unique identifier through a Master WSD (i.e. either a Fixed or Mode II WSD). The Geo-location Database shall have the mechanism to store the unique identifier information of both the Mode I WSD and its Master WSDs for at least 6 months.

Licensing Framework for TVWS Geo-location Database Provider

159. Parties that are interested in developing and managing a TVWS Geo-location Database service in Singapore are invited to apply for an SBO (Individual) Licence from IDA.

160. With regard to licence fee, IDA will waive the annual SBO licence fee for the Geo-location Database providers in the first two years of implementation. Subsequently, IDA will assess whether to continue the waiver of the SBO licence fee.

161. There will be no limit set for the number of Geo-location Database providers to be licensed. However, in their application for the licences, IDA will require interested parties submit their vision for TVWS deployment in Singapore, and business plans, including plans on how they will ensure business continuity. More information of the SBO (Individual) Licence template can be found on the IDA website and the additional licence conditions[27] for a Geo-location Database provider are highlighted **Annex A**.

Effective Date of Regulatory Framework

162. The regulatory framework will take effect from **1 November 2014**. IDA may postpone the effective date if industry needs more time to prepare for commercial operation. IDA will inform the industry in advance should there be a change in the effective date.

[27] The licence conditions highlighted in Annex A are indicative and may be subject to further changes.

ANNEX A

LICENCE CONDITIONS FOR THE PROVISION OF WHITE SPACE GEO-LOCATION DATABASE SERVICES

1 Scope of Services

1.1 The Licence enables the Licensee to establish, install, maintain and operate a white space ("WS") geo-location database system for the provision of WS geo-location database services.

1.2 The Licensee shall ensure that the System is capable of the following functions:

(a) upon request by WS devices ("WSDs"), determine and provide to WSDs, the available channels and maximum transmission power level at the WSDs' locations; and

(b) provide a registration platform and repository for information relating to WSDs and the contact details of WSD users in accordance with Condition 8 of this Annex.

1.3 The Licensee shall ensure that the Services are hosted by servers that are physically located in Singapore.

2 Co-Channel and Cross-border Coexistence

2.1 To facilitate co-channel coexistence of WSDs with other radio-communication services, as well as cross-border coexistence of WSDs at or near the borders of Singapore, the Licensee shall comply with the following in the provision of the Services:

(a) determine the separation distance between the WSD and the receiver station of each protected service as obtained from IDA in accordance with Condition 5.1 of this Annex ("Protected Service"), as well as between the WSD and the coordinates set out in Schedule B;

(b) calculate the path loss using the propagation model as notified by IDA to the Licensee ("Propagation Model") between the WSD and the receiver station of each Protected Service, as well as between the WSD and the Coordinates;

(c) use the path loss information and noise floor level, which shall for the purposes herein be fixed at -115dBm or such other value as notified by

IDA to the Licensee, as the basis to compute the maximum permissible transmission power level for the WSD for each available WS channel; and

(d) return the spectrum availability information and the maximum transmission power for the respective channels to the WSD that is requesting this information.

3 Management of High Priority Channels

3.1 Where the Licensee has obtained IDA's prior written approval for the Licensee to manage access to the high priority channels as notified by IDA to the Licensee ("HPCs"), the Licensee shall comply with the following:

(a) Not allocate any HPC to any WSD unless there is no common WS channel[28] available to a WSD at the WSD's location at that point in time;

(b) Allocate all HPCs using a fair process and in accordance with the allocation method which has been notified by the Licensee to IDA;

(c) Notify IDA in writing prior to changing the allocation method of any HPC; and

(d) Take reasonable precautions to prevent interference between the Licensee's WSD users, and between the Licensee's WSD users and other licensees' WSD users. Without prejudice to the generality of the foregoing, the Licensee shall cooperate and coordinate with other licensees who are also managing access to the HPCs, to prevent any such interference.

3.2 Where the Licensee is managing access to the HPCs, the Licensee shall obtain IDA's prior written approval before ceasing to manage such access.

3.3 IDA reserves the right to require the Licensee to change its allocation method for any HPC as necessary.

3.4 Where the Licensee has not obtained IDA's prior written approval for the Licensee to manage access to the HPCs, the Licensee shall not provide any WSD with any access to any HPC.

[28] Common WS channels refer to the authorised radio frequency bands as set out for WSDs in the Telecommunications (Exemption from Sections 33, 34(1)(b) and 35) Notification but excluding the channels designated as HPCs as notified by IDA to the Licensee.

4 Accuracy of Information

4.1 The Licensee shall ensure that the information on available channels and maximum transmission power that the Licensee provides to any WSD is accurate.

4.2 Where there is any inaccuracy in respect of the information described in Condition 4.1 of this Annex, the Licensee shall act promptly to resolve the inaccuracy.

5 Obtaining Current Information relating to Protected Services

5.1 The Licensee shall obtain from IDA, once every 6 hours, current information in relation to the Protected Services.

5.2 IDA reserves the right to require the Licensee to obtain current information in relation to the Protected Services on a more frequent basis or at such specific timings as notified by IDA.

6 Pricing, Terms and Conditions

6.1 The Licensee shall inform IDA of their pricing, terms and conditions for the provision of the Services prior to any commercial launch or public announcement for the provision of the Services.

6.2 IDA reserves the right to regulate any of the pricing, terms and conditions as IDA deems fit.

7 Security Requirements

7.1 The Licensee shall establish communications authentication procedures, and notify IDA in writing of the communications authentication procedures adopted by the Licensee, for the purpose of ensuring that data received by any WSD in connection with the provision of the Services by the Licensee is from an authorised source.

7.2 The Licensee shall take all reasonable precautions to ensure that all communications between the System and the WSDs cannot be accessed, altered or otherwise affected by any unauthorised person.

7.3 IDA reserves the right to require the Licensee to comply with any other security requirement as necessary.

8 Registration and Repository of WSD Information

8.1 The Licensee shall provide and maintain a registry for users of Fixed WSDs[29] to register and store the following information:

(a) Unique Device Identifier ("Unique ID");

(b) Device geographic coordinates such as the latitude and longitude;

(c) Height of the WSD antenna;

(d) Name of individual or business that is responsible for the device;

(e) Name of a contact person responsible for the device's operation;

(f) Address of the contact person;

(g) Email address of the contact person; and

(h) Phone number of the contact person.

8.2 The Licensee shall provide and maintain a registry for users of Mode I WSDs[30] to register and store the Unique ID of the Mode I WSD, and the Unique ID of the relevant Fixed WSD or Mode II WSD[31] through which the Mode I WSD is accessing the Services provided by the Licensee.

8.3 The Licensee shall provide and maintain a registry for users of Mode II WSDs to register and store the Unique ID of the Mode II WSD.

8.4 The Licensee shall store and maintain the information in the registries described in Conditions 8.1, 8.2, 8.3 and 8.5 of this Annex for a period of not less than 6 calendar months from the date of termination of the Services to the customer, and the registries shall be made available for inspection by IDA.

8.5 IDA reserves the right to require the Licensee to record any other details as necessary in its registries.

[29] "Fixed WSD" refers to a device which is operating in a fixed geographic location and with a maximum transmission power of 4 W EIRP.
[30] "Mode I WSD" refers to a device which is operating on a portable basis, in conjunction with a Fixed or Mode II WSD, and with a maximum transmission power of 100 mW EIRP.
[31] "Mode II WSD" refers to a device which is operating on a portable basis and with a maximum transmission power of 100 mW EIRP.

9 Discontinuation of Operations

9.1 The Licensee shall not transfer the control or ownership of the System or any of its records to any other person unless prior written approval has been obtained from IDA.

9.2 The Licensee shall ensure that it has an adequate business continuity plan ("BCP") in place, and submit a copy of such BCP to IDA. Where the Licensee makes any change to its BCP, the Licensee shall also promptly provide IDA with an updated copy.

9.3 IDA reserves the right to require the Licensee to include additional steps, measures or precautions as part of the Licensee's BCP as necessary.

9.4 In any event where the business continuity of the Licensee is or may be affected, the Licensee shall follow its BCP to the fullest extent possible and as appropriate under the circumstances in order to ensure the continuity of the provision of its Services.

10 Access to WSD Information

10.1 The Licensee shall provide IDA with the relevant rights to obtain current WSD information that is stored within its System for the purpose of investigating any alleged or actual interference with the operation of any authorised station or network.

10.2 The Licensee shall, where required by IDA, restrict the availability of WS channels for WSDs that do not conform to the relevant IDA Technical Specifications, or that interfere with the operation of any authorised station or network.

ANNEX B

REVISED SEQUENCE OF OPERATIONS BETWEEN A WSD AND THE GEO-LOCATION DATABASE