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General Information on APT Online Training Course

1.	**Title of Training Course:**	**Broadband Wireless Network Integration and Transition to 5th Generation of Mobile Network Phase 1 (Online): Fundamental Concept of Broadband Wireless Network**
2.	**Organization (hosted by):**	**TOT Academy of the TOT Public Company Limited**
3.	**Duration:**	**15 September – 10 October, 2014 (4 weeks)**
4.	**Place:**	**Online**

5. Abstract of the Course

Nowadays, wireless technology is being developed continuously and progressively. This has led to new innovations on various types of wireless networks, namely WiFi, 2G, 3G, 4G, 5G, and also a new conceptual usage of communications as “connected anywhere, anytime, and with any equipment”.

Wireless voice networks have been experienced in the past two decades, but recently there are number of demands to migrate to the data domain. This explosive demand of wireless services requires even greater spectrum efficient networks, and also the need for wireless data networks integration so that the conceptual of “connected anywhere, anytime, and with any equipment wirelessly” could be implemented. 3G technology, having been developed to meet this demand, is the extension of old voice switched network and provides relatively medium data speed compared to terrestrial networks. With these technologies, higher speed was compromised in distance due to multipath effects. 4G technology, including WLAN, WiMAX, and LTE, is the first to break the high speed limitation for long distances by using OFDM technology. At the same time, these technologies have the advantage of being conceived as IP-based from the start. With these new technologies, telecom regulators and governments face new challenges of policy and regulation in telecommunications.

This course is divided into two consecutive phases, called Phase 1 and Phase 2. While Phase 1, the pre-requisite of Phase 2, is the one month program describing each of the various wireless networks fundamental concepts and knowledge, the trend of future wireless technology and the regulatory/policy concepts in the age of emerging technologies. Phase 2 is a one week face-to-face program discussing in more in-depth technical and regulatory/policy concepts for the design and implementation of the wireless networks, and especially how to select or integrate them to provide broadband wireless services that meet market demands.

6. Objectives:

The objective of the course is that at the end of the course, the participants should be able to:

- To provide participants with knowledge and understanding of the concepts of mobile cellular networks such as WiFi,3G, 4G, and also the new coming 5G
- To provide participants with knowledge of network standard, radio wave propagation, and also regulatory/policy strategies to efficiently launch broadband wireless services that meet market demands by using up-to-date developed wireless networks

- To be able to understand the concepts of mobile cellular networks and explain the differences between the technologies.
- To fulfill experiences with company visit and group discussion.

7. Learning method

- Phase 1 (Online): Fundamental Concept of Broadband Wireless Network
  - Lecture and reading assignment
  - Chat session
  - Individual assignment

- Phase 2 (Face-to-Face): Broadband Wireless Network Integration and Transition to 5G
  - Lecture
  - Learning case and discussion
  - Company visit

8. Course Schedule and Outlines:

All sessions will be held at TOT Academy Website. The details of schedule are shown in the following:

Phase 1 (Online): Fundamental Concept of Broadband Wireless Network

Schedule	Topic	Speaker
Week1 Sep. 15 - 21	• **Basics on Radio Propagation & Modulation** The mechanism of radio wave propagation affecting the wireless communication channel will be explored, so that the engineer could design radio communication channel parameter to meet required performance. The digital modulation scheme is a method to vary one or more properties of the carrier signal that typically contains information to be transmitted, such as QPSK, 16 QAM, etc. A desired modulation scheme provides low bit error rates at low received signal-to noise ratio, performs well in multipath and fading conditions, occupies a minimum bandwidth, and is easy and cost effective to implement. • **Wireless System Evolution and Standard** The evolution of mobile network and also wireless data network will be reviewed. The standard of mobile and wireless data system are explained and compared. These standards include GSM, IS-95, CDMA 2000, WCDMA/UMTS, LTE, WiMAX/IEEE 802.16, as well as wireless in research and industrial upcoming.	• Pongthiti Pongsilamanee, Ph.D (Senior Instructor, TOT Academy)
Sep. 19	Assignment Distribution	• Pongthiti Pongsilamanee, Ph.D

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Schedule	Topic	Speaker
Week2 Sep. 22 - 28	• **Review of 2G and Introduction to 3G and LTE Networks** This session starts with review of existing 2G and then introduces 3G and LTE, including their objectives, services and architecture, air interface concepts, and 3GGP standard.	• Pongthiti Pongsilamanee, Ph.D
	• **Local Content and Telecom-Like Services on Mobile Cellular Technologies** •This session introduces Local Content that is the parallel-issue with deploying the broadband network. The local Content is the key issue to raise the broadband adoption. Another issue is the OTT (over-the-top) that can provide the Telecom-Like Services. They provide the service globally without any license and each country can't regulate them. Many telecom operators request the regulator to do something on OTT due to they get the benefit by threatening the licensed operators.	• Jesada Sivaraks, Ph.D (Secretary to the Vice Chairman, Telecommunications Sector, at the Office of The National Broadcasting and Telecommunications Commission (NBTC))
	• **Introduction to WiFi Networks.** This session introduces WiFi, including its objectives, services and architecture, air interface concepts, and IEEE802.11 standard series.	• Pongthiti Pongsilamanee, Ph.D
Sep. 29	Discussion and Chat Session 1	• Pongthiti Pongsilamanee, Ph.D • Jessada Siwaraks, Ph.D
Week3 Sep. 29 – Oct. 5	• **Introduction to Telecomm Policy and Regulation for Emerging Wireless Technologies** This session covers the policy and regulatory challenge that government faces because of the emerging technologies. That includes the policy strategies on migration from 2G to the new technologies with respect to radio spectrum allocation, technology selection and licensing. • Pave the way to "open" Frequency for concept of Sharing Spectrum This session proposes the "commons model" of open spectrum advocate a future where all the spectrum is shared, and in which people use Internet protocols to communicate with each other, and smart devices, which would find the most effective energy level, frequency, and mechanism Previous government-imposed limits on who can have stations and who cannot would be removed and everyone	• Jesada Sivaraks, Ph.D

Schedule	Topic	Speaker
	would be given equal opportunity to use the airwaves for their own radio station, television station, or even broadcast their own website	
	• **Thailand Case: Roadmap for mobile spectrum (2014-2023)** It is the explicit guideline for the spectrum assignment. The roadmap has details in the timeline which spectrum and how much the size will be released. This one will be benefit to the industry that operator can plan for spectrum acquisition.	• Jessada Siwaraks, Ph.D
Oct. 6	Discussion and Chat Session 2	• Pongthiti Pongsilamanee, Ph.D • Jessada Siwaraks, Ph.D
Oct. 10	Assignment submission	• Pongthiti Pongsilamanee, Ph.D • Jessada Siwaraks, Ph.D

Remark: Summary report will be submitted to APT by October 18th, 2014.

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Phase 2 (Face-to-Face): Broadband Wireless Network Integration and Transition to 5G

Schedule	Topic	Speaker	Venue
Arrival : December 7, 2014			
Day 1: December 8, 2014			
Morning	**Welcoming Address** **Opening Address**	APT	TOT Academy

	• **The future trend of wireless networks**
	  • **LTE Introduction**
	  ◦ Evolution & high level requirements
	  ◦ High level architecture for the evolved system
	  ◦ LTE-SAE nodes and interface
	  ◦ Functional architecture E-UTRAN EPC
	  • **Air Interface Physical Layer and Functions**
	  ◦ Frame structures, Frequency spectrum
	  ◦ Physical and Logical channels
	  ◦ Transport channels and Channel mappings
	  • **Towards 4G: LTE Advanced**
	This session discusses about the forward looking at how LTE will be developed further into LTE-Advanced, in anticipation of being adopted as a 4G standard by ITU-R. Other ideas and new concepts in implementing the 4G mobile network are also discussed.
		Pongthiti Pongsilamanee, Ph.D (Senior Instructor, TOT Academy)	

	Lunch		
Afternoon	• **LTE QoS & Security** • **Wireless security practices**	Pongthiti Pongsilamanee, Ph.D	TOT Academy
Day 2: December 9, 2014			
Morning	• **5G Mobile Network** This session defines the contours and understanding the implications of the next generation of wireless technologies. This also includes Cognitive Radio, Software Defined Radio (SDR), Dynamic Spectrum Access (DSA), and the emerging standards for 5G Wireless (IEEE802.22): in-research and industrial upcoming.	Pongthiti Pongsilamanee, Ph.D	TOT Academy
	• **What will be the evolution of "5G"?** 5G" is the term used to refer to the next "big" step in the evolution of wireless communications. There is variety of interpretations of "5G"	Jesada Sivaraks, Ph.D (Secretary to the Vice Chairman, Telecommunications	

Schedule	Topic	Speaker	Venue
	definitions. For example, in February 2014, IEEE Communications Magazine published articles on 5G wireless communication systems: prospects and challenges. In February 2013, the International Telecommunications Union Radio Sector (ITU-R) Working Party 5D started two study items: "Study on IMT Vision for 2020 and beyond", and "Study on future technology trends for terrestrial IMT systems", both aiming at having a better understanding of future technical aspects of mobile communications towards the definition of the next generation mobile. In Europe, Mobile and wireless communications Enablers for the Twenty-twenty Information Society (METIS) has commissioned studies in late 2012, aiming at defining a system concept beyond 2020 for the next generation 5G mobile network. 5G networks are required because the growth of mobile and wireless traffic volume is predicted to increase a thousand-fold over the next decade with coexistence of human-centric and machine type communications.	Sector, at the Office of The National Broadcasting and Telecommunications Commission (NBTC))	
	Lunch		
Afternoon	• **Policy and Regulatory Challenges** • **Free Spectrum for advanced mobile Technology : LTE-U (LTE on Unlicensed Spectrum)** This session will floated the idea of deploying LTE in unlicensed bands, particularly focusing on the 5GHz band, which is currently used mostly for WiFi • **ASA(Authorized Shared Access)** A new licensed model, called Authorized Shared Access (ASA), will allow operators to access the underutilized spectrum on a shared basis without interfering with incumbent spectrum holders. Moreover, this session points out the example(s) of wrong-doing lawmakers (Thailand Case). They enact the law which prohibits the spectrum sharing. • **E-Band and V-Band : Ugly duckling Spectrum** In the mm-wave bands (E-Band and V-band) atmospheric losses due to water vapor and	Jesada Sivaraks, Ph.D	TOT Academy

Schedule	Topic	Speaker	Venue
	oxygen absorption come into play and can easily exceed the usual free space losses. In the E-Band and V-Band spectrum, wireless systems can utilize the significantly larger allocated spectrum and channels to deliver multi-Gigabit data rates. This enables a simple, robust, and low cost modem and radio design. Both of them take the important role to be the most flexible and inexpensive Backhaul for the small cell of 3G and 4G.		
Day 3: December 10, 2014			
Morning	• **IPv6 Implementation on Wireless Network** However, with technology as a way to communicate the IPv6 protocol is enabled on 3G, 4G, 5G. However, most mobile operators still use IPv4 to provide access to legacy systems. The approach concept provided to have a connection service to the Internet is a mix of both IPv4 and IPv6. Previous, dual stack technique and also Network Address Translator device is used for such implementation. Nowadays, we have new concept by taking the side of the user-end (smart device or smart phone) to manage for the transition to full IPv6 service. • **Business Model for Network Integration** (3G + WiFi) • **WiFi hotspot, Seamless WiFi off-load** To provide the broadband, the mobile operation would add the WiFi network to become an additional choice for the user to get the broadband service. In this part, we will explore how to introduce the WiFi hotspots to the network so that we can create the seamless service even in the area where there have no mobile cellsite installed.	Peera Pacharintanakul, Ph.D (Senior Engineer, Mobile Engineering Department, TOT Public Company Limited)	TOT Academy
	Lunch		
Afternoon	• **MVNO business model** MVNO concept and its implementation will be explored in detail so that we would understand and efficiently implement the MVNO concept into the mobile business.	Natthapol Pongthaipat, Ph.D (Senior Engineer, Corporate Strategic Department, TOT Public Company Limited)	TOT Academy

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Schedule	Topic	Speaker	Venue
Day 4: December 11, 2014			
Morning	• **TOT Network Management System for 3G and WiFi Networks**	Peera Pacharintanakul, Ph.D	TOT Headquarter
	Lunch		
Afternoon	• **Company visit: TOT3G Network management system**	Peera Pacharintanakul, Ph.D	TOT Headquarter
Day 5: December 12, 2014			
Morning	• **Thailand Case: Roadmap for mobile spectrum (2014-2023)** It is the explicit guideline for the spectrum assignment. The roadmap has details in the timeline which spectrum and how much the size will be released. This one will be benefit to the industry that operator can plan for spectrum acquisition.	Jesada Sivaraks, Ph.D	TOT Academy
	Lunch		
Afternoon	• **Course Discussion and Conclusion** ◦ Ecosystem and Technology Selection Criteria • **Closing ceremony.**	Jesada Sivaraks, Ph.D	TOT Academy
Departure : December 13, 2014			

Note: This tentative schedule can be adjusted to accommodate the APT's needs.

9. System Requirement

- OS: Windows XP or higher
- Browser: Comply with Internet Explorer 7 or higher
- Additional Software: Flash Player
- Internet Connection: Broadband Internet is strongly recommended as part of course material will be provided as movie.

10. Regulation:

Selected trainees are required to actively participate in the course from the beginning to the end.

11. It is estimated that training works such as viewing the course slides, doing the assignments, joining the chat session will take an average of 5 hours per week. **Contact person for online training host:**

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