Regulations on Implementation of Small Cell in Thailand

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***Abstract*—Theexponential demand for high speed and high bandwidth data has increased pressure on cellular networks. Macro cell base station is large and has high power consumption base stations that are appropriate in catering to a vast geographical area but emanates low bandwidth data, hence its output is insufficient to satisfy high speed and high bandwidth needs of Thai consumers. The need for small cell is a result of its ability to cater to high speed and high bandwidth data in areas considered as blind spots and having weak signal strength. Small cell is a flexible network tool that is small in size, run on small base stations and are suitable in providing signals in short communication range but at a high speed and high bandwidth. Contrary to macro cellular network, for efficient utilization of bandwidth through small cells, flexible policies and regulations is critical. NBTC (National Broadcasting and Telecommunications Commission) therefore propose regulations for small cell implementation in Thailand. This research paper presents the advantages and uses of small cell and provides policies and regulations that Mobile Network Operators (MNO) should follow in order to employ small cell base stations in Thailand.**

***Index Terms*—Femto cell, small cell, blind spot, macro cell, mobile network operators (MNO).**

I. Introduction

The proliferation of internet-connected multimedia devices has resulted in exponential demand for data which is insatiable [1]. Contrary to the traditional cellular age where users only expect ubiquitous voice, in the present day users have nomadic behavior and expect ubiquitous cellular connectivity for both voice and data [2]. In the past, traditional macro cells with high power base stations have been suitable in satisfying voice coverage and low-speed data [2] but now has insufficient capacity to satiate high speed and high bandwidth data requirements [1].

Although WiFi networks are capable of providing highspeed and high bandwidth data for the current multi-media age, WiFi network is incapable of providing the mobility and coverage afforded by cellular network [3]. So, technological advancements were made in order to increase the utilization of bandwidth from the cellular network [4]. The need for small cell arises from its ability to fill in the void from existing traditional mobile towers namely macro cell which is insufficient to cater to nomadic users since it cannot eliminate all blind and weak signal spots particularly within residential buildings [5]. Small cells are low-power cellular base stations which can cover especially small area particularly a blind spot area that has weak signal [5]. It is also flexible technology because it is designed to be portable, easy to setup and also able to disassemble. Contrary to macro-cell which can service vast geographical coverage for low bandwidth and voice uses, small cell has a small communication range but is capable of emanating high speed and high bandwidth data [5].

A complete form of small cell has been used globally, namely in countries and regions like America, Europe, Japan, New Zealand and Singapore [6]. Since it is small, inexpensive, and has low powered tower, it is cost effective for offloading data to mitigate the data traffic faced by the less efficient and high power consuming traditional macro cell [7]. It is evident that macro-cell and small cell are different in nature. Therefore, policies and regulations that govern the use of small cell should also vary from that of macro cell. Since macro cell are large and high power consumption base stations, they are also inflexible in terms of reallocation. On the other hand, small cells are small and low power base stations that require flexibility in terms of setup and reallocation of base stations and as a result, should be governed by flexible policies and regulations.

The Office of the National Broadcasting and Telecommunications Commission (NBTC) which is the broadcasting and telecommunications regulator in Thailand, hereby, creates the criteria for allowing use of the small low-power cellular base stations. These criteria are used to ease the establishment of small cell operations and to reduce unnecessary obstacles and procedures in deploying small cell base station in order to cater more efficiently to high speed and high bandwidth data needs of consumers in Thailand.

II. Small Cell

A. Small Cell

Small cell is a small cellular base station, designed for use inside the residential or small business buildings or outdoor in order to extend the coverage area [3], [5]. Primarily, datausage occurs in doors therefore, most of the data traffic usage originates from residential areas [3], [7].

It has a low-power operation of about 50-200 milliwatts (mW) and covers the radius of 20-30 meters. Small cell can simultaneously accommodate 2-4 cellular devices within the residential area and 8-16 devices within the office by connecting mobile network to the user's broadband IP network such as through ADSL modem.

B. Characteristic of Operations and Connections of Small Cell

The distinctive characteristics of small cells comparing to the traditional macro cell cellular base stations is that small cell is small in size, consumes low-power with small coverage area, and handles only limited number of users. Small cells are mostly used indoor particularly in residential

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areas and are easy to setup and remove [3]. It can take advantage of the broadband IP network of the users in order to connect to the user's mobile network. Small cell is exceptionally beneficial for network operators for several reasons.

- Reduce or eliminate the blind and weak signal spots inside residential buildings caused by the blockage or impenetratable of the main cellular signal.
- It reduces the cost of investment for expanding the main cellular network. Set up of small cells imposes lower cost for MNO than set up of large macro base stations.
- Increase effectiveness in re-utilizing the licensed radio frequency (frequency reuse) that is not in use around the base station of the Mobile Network Operator. It will not result in higher interference in the current network as the small cell is a small base station which has low-power emission of signal.
- Reduce the traffic in the macrocell Base station in the nearby area. This is called traffic offloading which is a mechanism that reduces traffic overload of the macro-cell station in the area simply by setting up small cells in outdoor area.
- Reduce data traffic through the backhaul network by transferring of data service to the public IP network of the users devoid of sending through network of mobile operator.
- Small cell base station is a form of premium service for users in the area as the signal will be enhancedby small cell in comparison with depending only on traditional macro cellular base station. The advantages of adopting small cell base stations are summarized in the Table I.

TABLE I: SMALL CELL VS. MACRO CELL

	Traditional Base Station	**Small Cell**
Setup	Mobile Network Operator	Mobile Network Operator/User
Data transmission to the MNO's network	Use MNO's network	Use user's network
Radio frequency usage plan	Centrally planned	Locally determined
Right to own property of station	MNO	User
Service Coverage Area	Large (KMs)	Small (20-30 m)
Transmission power	High (up to 60W)	Low 50-200 mW
Capacity of Usage	Serve 100 users @ a time	Serve 2-16 users @ a time

C. Types of Permission for Small Cell Usage

Mobile Network Operators (MNO) needs to use small cell as a solution for blind or weak signal spots. Therefore, the types of permission for small cell usage in the country are to permit Mobile Network Operators to acquire and setup the small cell for the users and small cell is a property of MNO. MNO has the right to control the operations and use the frequency. It is responsible if signal interference should occur. Users are not permitted to acquire and setup small cell for personal use without the permission of MNO for the following reasons.

- Incorrect setup by users when not conforming to the standard of MNO's network can cause various types of interference and disruption to mobile and wireless services.
- MNO do not encourage users to acquire and setup a small cell by themselves. This refers to both acquiring without approval of MNO and acquiring from MNOs for the purpose of selling to a third party.
- There is no clarity on the status of telecommunications network asset and properties after the concessionaire ends. Therefore, as small cell is the property of the MNO, it could lead to concessionaires claiming it is their property after the agreement ends.
- There is also no clarity in the responsibility of the MNO in case of the interference with other networks or interference between their own networks.

D. License Exemption for Establishment of Cellular Base Station

The National Broadcasting and Telecommunications Commission (NBTC) issued criteria or conditions for mobile network operators to submit along with application requesting for a license to establish small cellular base stations. The criteria and conditions should also to build credibility and help MNOs and parties involved understand conditions in providing small cell networks and also to prevent the unforeseen concerns in regards to the Acts including the announcement of the National Telecommunications Commission (NTC) on "Criteria and approaches for monitoring the safety of human's health from the use of radio communication" in B.E.2550 and announcement of "Ownership, Usage of Radio Communication Devices and Establishment of Cellular Base Station" in B.E.2554.In regards to the establishment of small cell, the aforementioned criteria and conditions create obstacles for utilizing small cell. This is because small cell is a small base station with low-power transmission and has been designed for easy setup and removal in short period of time. Also, small cells are easy to acquire and operate. In order to solve the problems mentioned and reduce the procedures for setup of small cell, the Mobile Network Operators that request to establish small cells are thus exempted from obtaining a license and do not have to follow the criteria or conditions for submission of license application.

E. Frequency Technical Specifications

Cellular technology or Broadband Wireless Access technology and frequencies NBTC permits MNOs to utilize small cellular networks for is shown in Table II – Table IV.

TABLE II: GSM TECHNOLOGY

Technology	**Transmission Frequency Range**	**Reception Frequency Range**
E-GSM900	925 – 960 MHz	880 – 915 MHz
GSM1800 or DCS1800	1805 – 1880 MHz	1710 – 1785 MHz

TABLE III: IMT-2000 CDMA DIRECT SPREAD TECHNOLOGY

Radio Frequency Channel	**Transmission Frequency Range**	**Reception Frequency Range**
I	2110 - 2170 MHz	1920 – 1980 MHz
V	869 - 894 MHz	824 – 849 MHz
VIII	925 – 960 MHz	880 – 915 MHz

TABLE IV: IMT-2000 CDMA MULTI-CARRIER (CDMA2000) TECHNOLOGY

Technology	Transmission Frequency Range	Reception Frequency
CDMA2000 (Band Class 6)	2110 - 2170 MHz	1920 – 1980 MHz
CDMA2000 (Band Class 0)	869 - 894 MHz	824 – 849 MHz
CDMA2000 (Band Class 5E)*	489 – 493.5 MHz	479 – 483.5 MHz

*No small cell equipment operates in this frequency

3rdGenerationPartnershipProgram(3GPP)isan organization that is responsible for creating UMTS standards and 3GPP specifies the highest transmission power of a small cell (or Home NodeB in 3GPP) to 20dBm or 100 milliWatts in order for it to be a small base station with low-power transmitting to only 20-30 meter in radius.

F. Assessment of Electromagnetic Radiation Level from Using Radio Communication Equipment: A Health and Safety Perspective

Announcement of the National Telecommunications Commission on "Safety Standards for Human Health from Using Radio Communication Equipment" specified the safety limit of electromagnetic radiation towards human health from using 9 KHz – 300 GHz radio communication equipment in order to prevent the effect of electromagnetic exposure that may be harmful to human and also to assure that the use of radio communication equipment is safe and will not produce side effects to human as well as to protect consumers. According to the aforementioned announcement of NBTC, small cells are classified as Class 2 radio communication equipment (radio communication equipment that has an electromagnetic radiation component positionedat least 20 centimeter away from human body in standardoperating position).

The safety perimeter of electromagnetic field density (in termsof electromagnetic density) for groups of people who get exposed to the general electromagnetic radiation according to the Safety Standards for Human Health from Using 10MHz – 300GHz Radio Communication Equipment is shown in Table V.

TABLE V: LEVEL OF ELECTROMAGNETIC DENSITY

Frequency	Level of Electromagnetic Density (W/m2)
10 MHz – 400 MHz	2
400 MHz – 2 GHz	f/200 (f = frequency and has unit of MHz)
2 GHz – 300 GHz	10

Point Source Model technique (according to recommendation of the International Telecommunication Union: ITU [1]) is used to assess the density level of electromagnetic field from using small cells. This model specifies that there should be of distance ofatleast 20 centimeters away from the antenna. For a small cell which has the transmission power of 100 milliWatts E.I.R.P. (Maximum value specified by 3GPP), the density of the electromagnetic field assessed was 0.2 W/m2 and would gradually decline as distance increased as shown in Fig. 1.

[1] ITU-T Recommendation K.70: Mitigation techniques to limit human exposure to EMFs in the vicinity of radiocommunication stations

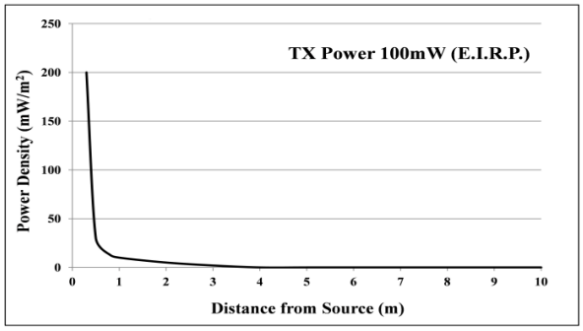

Fig. 1. Density Level of Electromagnetic Field of Small Cell that has 100 mW (E.I.R.P.) transmission power.

Table VI shows comparison of the density level of electromagnetic field from the assessment at a distance of 20 centimeters which is the standard in comparison with that of small cell trial conducted by NBTC. The ratio of values from the result of the test is less than 5% of the required standard as shown in a Table VI.

TABLE VI: COMPARING ELECTROMAGNETIC DENSITY FROM ASSESSMENT AT 20 CENTIMETERS AND LIMIT OF ELECTROMAGNETIC DENSITY SPECIFIED BY NTC

Frequency	Density of Electromagnetic from Assessment	Limit of Electromagnetic Density Specified by NTC/NBTC	Ratio of Electromagnetic Density Assessed to Density Limit
850 MHz	0.2 W/m2	4.41 W/m2	4.55%
900 MHz	0.2 W/m2	4.71 W/m2	4.26%
1800 MHz	0.2 W/m	9.21 W/m	2.18%
2100 MHz or more	0.2 W/m2	10.00 W/m2	2.00%

When the distance from small cell is increased, the ratio of electromagnetic density assessed to the limit of electromagnetic density declined rapidly as shown in Fig. 2.

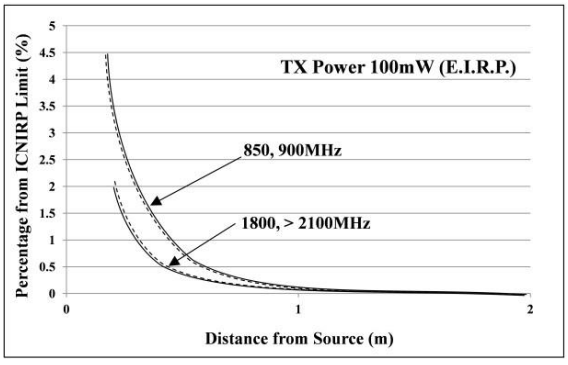

Fig. 2. Comparison of the ratio of electromagnetic density assessed to the limit of electromagnetic density versus distance from small cell.

From the above assessment of electromagnetic field density from using small cell, the graph evidently shows the use of small cell complies with that NBTC's standard on safety regarding human health from using radio communication equipment. Additionally, if the operation of small cell by MNOs complies with the specifications set by NBTC, the electromagnetic radiation should be lower than the safety limit that is considered to be unsafe (less than 5% of the standard limit that is set). Therefore, if MNOs comply with specifications set up by NBTC, it will not have adverse affect on the health of the general public.

G. Increasing Consumer Awareness

Mobile Network Operators (MNO) must inspect the quality of user's broadband IP network before considering the installation of a small cell in order to ensure that user's network is capable of handlingthe use of small cell and Internet services simultaneously. There is a possibility that the use of small cell may affect quality of broadband IP network (such as ADSL) and vice versa, if the user's broadband IP network does not have sufficient quality. This will also affect the quality of services from using small cell. In order for the effective and uninterrupted services from small cell and Internet services, MNO must have a well-defined mechanism in order to handle complaints from consumers. It is essential MNO to cooperate and work jointly withInternet Service Provider (ISP) to resolve customer complaints on the use of small cell.

For the installation of a small cell for the users, MNO must educate and create an understanding with the users that the small cell operations need to utilize some of the user's resources including bandwidth from broadband IP network, electricity, etc. This procedure is to ensure that users have been informed and acknowledged of the facts and any occurring consequences from using small cell in order to avoid any unforeseen future complaints.

Moreover, by using small cell for cellular services, the MNO must be responsible for all operations relating to small cell according to the announcement of the National Telecommunications Commission on "Standard and Quality of Voice Telecommunication Service, B.E. 2551"

III. Conclusion

The objective of these criteria is to allow the use of small cell to reduce obstacles and procedures in setting up small cell. This is to ease the installation of small cells in short period of time in responding to the needs of users in the country. The small cell regulations is summarized and concluded as follows

1) The cellular network includes small cell base stations by connecting between base stations and operator's main network (backhaul) through the public Internet Protocol.
2) Small cell is implemented on licensed frequencies that are granted to MNO which is shown in Table VII.

TABLE VII: Frequencies Granted for Operation to MNOs

Transmitting Frequency	Receiving Frequency
869 - 894 MHz	824 - 849 MHz
925 - 960 MHz	880 - 915 MHz
1805 - 1880 MHz	1710 - 1785 MHz
- 2170 MHz	1920 - 1980 MHz

1) Transmitting frequency must have maximum output power of not more than 100 milliWatts as required by 3GPP specification and the device must also have an integral antenna.
2) The device must be of Class II telecommunication and must pass the inspection and obtain a certification for meeting the requirements of criteria and related technical standards announced by the National Telecommunications Commission on "Standard Inspection and Certification of the Telecommunication Devices and Equipment, B.E.2551".
3) License to establish small radio communication base station is exempted, but the operator still needs to obtain other related radio communication licenses.
4) Other conditions

- Licensee of small cell operation must also have a license to utilize frequency for telecommunications affairs or granted a concession to operate telecommunications affairs from TOT Public Company Limited or CAT Telecom Public Company Limited prior to the Telecommunications Legislation Act B.E.2544.
- Licensee of small cell operation musthave a database of the location of stations including the relocation and removal of the equipment. Licensee must submit a report to the Office of theNational Broadcasting and Telecommunications Commission within 30 days of request.
- Licensee of small cell operation must be responsible for all interference to other base stations and complaints from the use of small cell base stations as well as be responsible for educating and creating an understanding with the consumers in order to create awareness of the conditions on safety issues and any concerns that could arise from use of small cell.

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