A STUDY ON INTERFERING SIGNALS: A CASE STUDY OF FREQUENCY USAGE WITHIN THE THAI-LAO PDR COMMON BORDER

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Abstract - Spectrum is a resource which is greatly valuable and beneficial to the country as a whole. So, efficient spectrum management is therefore required to yield the greatest benefits to the country as a whole. Besides this, spectrum is considered a resource available to everyone because it can be found everywhere and doesn't belong to any country in particular. Though countries vary in terms of how they benefit from frequency usage due to certain limitations like technical factors; each reserves the right to engage in frequency-related activities so long as there is no interference with the frequency usage of other countries. IN addition to this, compliance with the International Telecommunication Convention is necessary. It is also important to note that international telecommunication law is implemented by the International Telecommunication Union (ITU) [1]. Therefore, management of spectrum needs to be performed under concrete assignment and regulatory planning so that they can run at their maximum capacity without causing interference and defects then resulting in a balanced frequency usage dimension [2]. Signal propagation, which often results in the inability to limit the distance of frequency distribution within Thailand's borders, has given rise to frequency usage coordination within the common borders of Thailand and neighboring countries thus preventing RF interference [3]. Consequently, the Joint Technical Committee on Coordination and Assignment of Frequencies otherwise known as the JTC Meeting was established to prevent and solve problems concerning frequency usage within the common borders of Thailand and Laos. This has led to the enhancement of frequency usage efficiency within Thailand and Laos' common borders. However, The interfering signal inspection results in this report are from the internal reports of the Office of the NBTC.

Keywords - Common Border, Frequency, Interference, Signal, Spectrum.

I. INTRODUCTION

'Spectrum' is a valuable national resource which greatly benefits the nation and its population, especially in a digital era when it is typically used as a transmission medium for wireless communication; causing disruption to lifestyles, society, business operations, and various industries [2][4]. Though spectrum can be used for other numerous purposes apart from telecommunications, such as in disease treatment or scientific experimentation, frequency propagation characteristics make it impossible to limit the distance at which it is distributed within a specific country's borders. This has given rise to the coordination and establishment of the Joint Technical Committee on Coordination and Assignment of Frequencies (or JTC Meeting) which was first held in Malaysia in 1992. The objective of this particular meeting, in cooperation with Malaysia, was to seek preventive methods and mitigation techniques to frequency usage along the common border of both countries. However, this research paper will primarily focus on the exploration of the spectrum assignment within Thailand and Laos' common borders so as to enhance the frequency usage efficiency in such areas.

The objective of the JTC meeting has been to come to a consensus on spectrum assignments for mobile phone, radio, and television operations as well as mitigation techniques for radio frequency interference within neighboring countries. This particular meeting has been underway for many years with the goal of which being to seek out guidelines when it comes to solving a previous years' problem such as issues concerning signal leakage across Thailand's border to Malaysia or from Malaysia's border to Thailand which has resulted in unwanted cross-border calls in the past [5].

Another is the problems caused by different means of frequency usage among specific countries; for example, the 900 MHz frequency is used for mobile phone service in Thailand but for radio broadcasting in neighboring countries, leading to cross-border interference. Previously, there had never been such a meeting held because each country holds its fundamental right to assign spectrum for specific purposes. Ultimately, however; NBTC has managed to engage in talks with neighboring countries that share common borders to schedule this form of meeting so as to tackle and solve such frequency-related problems.

Generally, meetings like JTC are attended by people in related sectors, including spectrum regulators and users from each country. In cases like these, NBTC is responsible for representing Thailand in holding meetings with the following neighboring countries [6]:

1. Thailand - Malaysia JTC Meeting
2. Thailand - Laos JTC Meeting
3. Thailand - Cambodia JTC Meeting
4. Thailand - Myanmar JTC Meeting

This is a technical meeting which relies on collaboration between related sectors under the NBTC's regulation: Spectrum Management Bureau, Broadcasting Technology and Engineering Bureau, International Affairs Office, Radio communication Licensing and Regulation Bureau, and Regional and District Offices of NBTC.

The Broadcasting Technology and Engineering Bureau is responsible for representing the country in TJC meetings as well as conducting technical negotiations with working groups on Broadcasting Services. Currently, key points of technical agreements and negotiations concluded from the meetings can be divided into 3 key points [6] as follows:

1. Technical Agreements which include segmentation of frequency bands along common borders (Band Plan) or coordination parameters.
2. Establishment of coordination zones for radio and television broadcasting stations set-up.
3. Frequency registration and notification along common borders.

II. JOINT TECHNICAL COMMITTEE ON COORDINATION AND ASSIGNMENT OF FREQUENCIES ALONG THAILAND - LAOS PDR COMMON BORDER (JTC)

It is an international collaboration between the Office of the NBTC, Thailand, and the Ministry of Post and Telecommunications (MPT), Laos; with the aim of discussing issues such as radio and television frequency interference as well as problems along the Thai-Laotian common border, the scope of responsibilities concerning frequency coordination and assignment along the common border, boundaries for radio frequency coordination and usage along the common border, as well as guidelines on strengthening relationships between telecommunications agencies in Thailand and Laos PDR. [7]. The previous TJC meetings engaged participating countries in exchanging frequency usage status and gave rise to 2 working groups on Broadcasting Services and Mobile and Non-broadcasting Services. Laos PDR had been calling for solutions to such problems for almost 2 years before being able to eventually bring up the issue concerning interference with Laos's GSM 900 MHZ frequency band caused by Thailand's HSPA 850 MHz band which resulted in lower quality of services and a great fall in customer numbers at an international level.
This led to guidelines being created on problem solving and frequency usage terms and conditions to facilitate service provisions among operators in both countries discussed, which was then warmly embraced by every related sector. Moreover, there was a discussion regarding the regulatory principle on frequency distribution to prevent leakage of each other's frequency over the agreed border areas which brings about unwanted cross-border calls. There was also an approved principle on registration of frequency usage along the common border of the two countries to prevent future issues.

As for the issue concerning radio broadcasting, the committee finally came to a conclusion concerning the assignment of a specific frequency band for the digital TV system to prevent interference, a solution to the interference with Laos PDR's aviation activities caused by local radio services, and a suggestion on an Exchange Visit Program which encourages officials of the two countries to continue to exchange both knowledge and various points of view.

III. THE 10TH MEETING OF THE JOINT TECHNICAL COMMITTEE ON COORDINATION AND ASSIGNMENT OF FREQUENCIES ALONG THAILAND - LAOS PDR COMMON BORDER (JCT-10)

It was scheduled during October 16-18, 2019 in Vientiane, Laos PDR. The key points considered by the committee can be summarized as follows [8]:

- Notification of Thailand's 2100 MHz frequency band
- A performance report regarding signal strength level measurement for the 850 MHZ, 900 MHz, 1800 MHz, and 2100 MHz frequency bands along the Thai – Laotian common border and special areas: Here, the committee acknowledged the signal strength levels measured in 2019 and called for additional measurements of the signal strength levels in specific common areas: Chiang Khong, Chaing Rai - Huay Sai, Bo Kaew, Laos PDR and Chiang Saen, Chiang Rai - Muang Ton Phung, Bo Keaw, Laos PDR in 2020.
- RF Interference along the Thai-Laotian common border: The committee acknowledged solutions to the interference with the 168.850 MHz frequency band of the Bank of Thailand, Ubon Ratchathani branch while the cause has not yet been concluded by the Ministry of Post and Telecommunications (MPT) of Laos PDR.
- Radio and Television Broadcasting Services: The committee acknowledged the data related to frequency usage, coordinate sound and television broadcasting services between the two countries. Here, Laos PDR confirmed the acknowledgement regarding segmentation of radio frequency bands for the television broadcasting of its operators along the common border. Intentional adjustments so that everything might be in line with the agreements made before January 1, 2011 were set in

motion, and any and all progress was to be reported by the next meeting.

- Signals interference issues caused by Thailand's HSPA 850 MHz technology and Laos' E-GSM P x-GSM 900 MHz and LTE 850 MHz technologies: Here, the committee requested for agreed solutions to the problem of RF interference between mobile operators in Thailand and Laos within 1 month after the meeting.
- Revising determination of related parameters and current frequency usage adjustments of both countries to the 850 MHz, 1800 MHz, and 2100 MHz frequency bands: The committee acknowledged the agreements on common frequency usage by the two countries and approved the determination of signal strength levels for coordination within a boundary of 700 meters away from the referential borderline of the two countries: Chiang Khong, Chaing Rai - Huay Sai, Bo Kaew, Laos PDR and Chiang Saen, Chiang Rai - Muang Ton Phung, Bo Keaw, Laos PDR.
- Determination of parameters for the 700 MHz frequency band: The committee then approved the study and determination of appropriate parameters by related mobile phone operators in the next meeting.
- Determination of parameters for the 2300 MHz and 2600 MHz frequency bands: The committee acknowledged improvement plans for the 2300 MHz and 2600 MHz frequency bands and possible guidelines on determination of Thailand's related parameters for frequency coordination along the Thai-Laotian common border.
- Issues concerning Illegal data connectivity across the border: The committee acknowledged illegal data connectivity across the border in the areas of Mukdahan, Thailand - Savannakhet, Laos PDR and approved an exchange of knowledge between the two countries coordinators to help solve said problems.
- Bilateral coordination in terms of the policies and regulatory methods related to telecommunications services between Thailand and Laos.

The JTC-10 committee acknowledged the requests that the Laos PDR's Ministry of Post and Telecommunications (MPT) submitted to NBTC to support telecommunications activities-related trainings such as Quality of Service (QoS) in order to promote coordination between the two countries through the bilateral meetings.

IV. WORKING GROUP ON MOBILE AND NON-BROADCASTING SERVICE OF THE 10TH JTC

The meeting results achieved by Telecommunications working groups on Mobile and Non-Broadcasting Services in Thailand and Laos PDR can be concluded as follows:

A. Discussion on Interference cases between HSPA850 MHz (Thailand) & E-GSM, P-GSM 900 MHz and LTE 850MHz (Lao PDR)

1) NBTC presented a report on the "Implementation of the Agreement of JTC-9 Meeting", which summarized the Thai mobile operators' actions to solve the interference cases as well as adjustment of signal levels in special areas.
2) LTC and CAT Telecom/ Truemove H
2.1) LTC presented a paper on "Investigate signals received from CAT (850MHz) by LTC", which could be summarized LTC found signal 7 cells overshoot from CAT Telecom at Sikhai Plaza, 103 Hospital, Dongphosy1 and Dongphosy2 as shown in Table 1:

No	Network	Point	Channel	PSC	RSPC	EC/No	MCC	MNC	LAC	Cell ID	Distant	Latt	Long
1	3G	Sikhai Plaza	4408	202	-95.7	-6.7	520	0	7032	46728951	1.4 km	17.978516	102.55442
2	3G		4408	242	-100.8	-11.9	520	0	7032	46727916			
3	3G		4408	314	-104.9	-15.9	520	0	7032	46732059			
4	3G	103 Hospital	4408	175	-107.6	-18.6	520	0	7032	46727883	2.24 km	17.946905	102.632362
5	3G		4408	330	-97.2	-9.6	520	0	7032	46742081			
6	3G		4408	214	-101.5	-13.9	520	0	7032	46742079			
7	3G	Dongphosy1	4408	207	-102.4	-14.8	520	0	7032	46728951	2.11 km	17.900619	102.707184
8	3G		4408	20	-88.2	-15.4	520	0	7032	46739930			
9	3G		4408	165	-89.1	-16.3	520	0	7032	46727896			
10	3G	Dongphosy2	4408	250	-90	-17.2	520	0	7032	46740794	3.31 km	17.908802	102.703026
11	3G		4408	250	-90	-13.4	520	0	7032	13626			
12	3G		4408	310	-98.7	-13.1	520	0	7032	13702			

Table 1: Investigate signals received from CAT (850MHz) by LTC

2.2) CAT Telecom had completed the adjustment of technical characteristics which included mitigation techniques as well as antenna direction and transmit power adjustment within 3 months after JTC 9 as agreed at the JTC-9 Meeting;
2.3) CAT Telecom further informed the Meeting that to further resolve the issue as shown in the new measurements from LTC, CAT Telecom would press forward with both the timeline and method as agreed at JTC-9 meeting;
2.4) LTC suggested that CAT Telecom also turn off 879 - 884 MHz band to solve this issue;
2.5) LTC and CAT Telecom agreed on the following solutions:

- CAT Telecom would turn off 879 - 884 MHz band in the area of Nong Khai (Amphoe Mueang, Amphoe Tha Bo and Amphoe Si Chiang Mai) within 1 month after JTC-10meeting;
- After CAT Telecom had completed the 879 - 884 MHz band turn off, CAT Telecom will inform NBTC and LTC so that LTC can verify the result, then NBTC would inform MPT if there is still interference, LTC will send additional information (Example : measurement results, ICM band and base station information such as PSC and Cell ID) within 2 weeks to CAT Telecom for further adjustment;
- If there is still interference (including other areas), CAT Telecom will consider the use of mitigation techniques such as reducing transmit power, adjusting antenna direction and down-tilting as well as turning off additional 879 - 884 MHz frequency.

3) ETL & DTAC
3.1 ETL presented a report on Cases ETL and DTAC interference along Lao PDR Thailand borders, which could be summarized as follow:

- DTAC had turned off 844-849/889-894 MHz band for 27 cells on 20 October 2018 and all DTAC's cells, that using 844-849/889-894 MHz band on 15 December 2018;
- Interference case between ETL and DTAC has been resolved;

3.2) The Meeting agreed to close this agenda item.

B. Update on implementation of the Signal Level Threshold for 2G (900 MHz/1800 MHz), HSPA 850 MHz and 3G (2100 MHz) in Special Zone and border areas

1) Refer to plenary agenda on "result from Joint driving test along common border", MPT and NBTC invited the meeting to consider the results of the joint drive tests;
2) MPT presented a paper on "Signal Investigation in special zones", which could be summarized MPT re-investigated the signal level in special zones at Wattay Airport and Horkham, there are 5 cells of Thai operators with strong signal level as table2:

Location	850 (UMTS)	900 (GSM)
Horkham	-	2 Channel of AWN
Wattay International Airport	1 Channel of CAT 1 Channel of DTAC	1 Channel of TUC

Table 2 : Five cells of Thai operators with strong signal level

3) STL presented a paper on "The result change frequency BCCH at the border by STL", which could be summarized as follows:
3.1) STL had implemented change so that BCCH would comply with spectrum agreement for mobile operators from both sides and the associated agreement for each frequency band of JTC-9 agreement coming to a total of 616 cells in 9 provinces;
4) LTC presented a paper on "Investigate signals received from TUC (900MHz) by LTC", which in short, it could be found that TUC is using BCCH and strong power which do not comply with JTC-9 agreement as shown in Table 3:

Route Test	Network	BCCH	Rx level (Max)	MCC	MNC	LAC	Cell ID	Lat	Long
Sikhai to Thadue	2G	120	-32.8	520	99	7606	40546	17.822	102.688
	2G	122	-63	520	99	7606	10726	17.866	102.679

Table 3 : Investigate signals received from TUC (900MHz) by LTC

5) The Meeting also took note of all presentations and agreed to take actions on the following issues:
5.1) Special Zone: Horkham and Wattay airport
Thai mobile operators agreed to adjust the signal level from the following sites (to be completed by the end of October 2019). The details of the sites are as follows:

- 3 cells (1 CAT cell, 1 DTAC cell and 1 TUC cell, which affect the signal level at Wattay Airport;
- 2 cells (2 AWN cells) which affect the signal level at Horkham;

After adjustment, all operators agreed to send information updates to NBTC which will then forward the update to MPT.

5.2) STL and AWN (BCCH adjustment)

The Meeting agreed to close this issue as STL had completed the BCCH adjustment as agreed at JTC-9.

5.3) LTC and TUC (BCCH 120 and 122)

TUC agreed to adjust the signal level and BCCH within 2 weeks after JTC-10 and will send an information update to NBTC, MPT and LTC. Then, LTC will verify the result and inform NBTC, MPT and TUC,

C. Review of Frequency Usage and Coordination Parameters (850 MHz, 900 MHz, 1800 MHz, and 2100 MHz) including PCI and PSC

1) As there were adjustments to the spectrum arrangement in several frequency bands, Thailand and Laos PDR's operators agreed on the updated spectrum arrangement and associated agreement;

2) STL proposed that the Meeting should consider and determine a new distance for signal measurement along the Laos PDR – Thailand's common border in the 3 northern provinces such as Vientiane, Xayabouly and Bokeo;

3) The provisional signal threshold values agreed at JTC-9 were as are shown in Table 4:

Frequency	Penetration of signal	Boundary
850 MHZ (UMTS)	-100 dBm	1 km from reference line
900 MHZ (GSM)	-85 dBm	1 km from reference line
900 MHz (UMTS)	-100 dBm	1 km from reference line
900 MHz (LTE)	-100 dBm	1 km from reference line
1800 MHz (GSM)	-95 dBm	1 km from reference line
1800 MHZ (LTE)	-100 dBm	1 km from reference line
2100 MHz (UMTS/LTE)	-100 dBm	1 km from reference line

Table 4 : The provisional signal threshold values agreed at JTC-9

4) In the meeting it was agreed upon that there would be continuation in the usage of the provisional signal level as mentioned in Table4;

5) Both sides also agreed that, in the area of Bokeo province, where the coordination distance from reference line may be lower than 1 km, special coordination parameters may be used;

6) For this case, Thai mobile operators suggested that the signal level thresholds should be used as reference, and in areas where the other distances should be used, the corresponding signal level threshold can then be calculated using free space path loss calculation;

7) After discussion, both sides agreed to use the provisional signal levels in Huay Xai - Chiang Khong and Ton Pheung - Chiang Saen as shown in Table5:

Frequency	Penetration of signal	Boundary
850 MHZ (UMTS)	-97 dBm	700 m from reference line
900 MHZ (GSM)	-82 dBm	700 m from reference line
900 MHz (UMTS)	-97 dBm	700 m from reference line
900 MHz (LTE)	-97 dBm	700 m from reference line
1800 MHz (GSM)	-92 dBm	700 m from reference line
1800 MHZ (LTE)	-97 dBm	700 m from reference line
2100 MHz (UMTS/LTE)	-97 dBm	700 m from reference line

Table 5 : The provisional signal levels in Huay Xai - Chiang Khong and Ton Pheung - Chiang Saen

8) Mobile operators in both countries agreed to continue Joint Drive Tests in Houay Xai, Chiang Khong, Ton Pheung and Chiang Saen. The meeting agreed to have at least two joint drive tests before the next meeting
- The first joint drive test was scheduled for the first week of February 2020;
- The second was scheduled for the first week of May 2020;
- It was also agreed upon to use MPT and NBTC equipment for these Joint Drive Tests.

9) Depending on the results of the Joint Drive Tests, the provisional signal threshold level as shown in Table 5 may be revisited in future JTC Meetings.

D. Frequency Usage and Coordination Parameters for 2300 MHz

1) TOT presented a paper on "Spectrum Usage and coordination Parameters of 2300 MHz", which could be summarized as follows:
- TOT informed the Meeting that currently TOT is using the TD-LTE configuration 2 as shown below:

Configuration	Downlink to uplink switch point periodicity (ms)	Subframe number										#of subframe		
		0	1	2	3	4	5	6	7	8	9	DL	UL	S
0	5	D	S	U	U	U	D	S	U	U	U	2	6	2
1	5	D	S	U	U	D	D	S	U	U	D	4	4	2
2	5	D	S	U	D	D	D	S	U	D	D	6	2	2
3	10	D	S	U	U	U	D	D	D	D	D	6	3	1
4	10	D	S	U	U	D	D	D	D	D	D	7	2	1
5	10	D	S	U	D	D	D	D	D	D	D	8	1	1
6	5	D	S	U	U	U	D	S	U	U	D	3	5	2

Table 6 :TOT used TD-LTE configuration 2 (DL:UL = 4:1)

- TOT also shared the experience on its coordination with 2300 MHz operators from Malaysia. Originally, Malaysia had interference issues with Thailand due to a different TD-LTE configurations as shown in Fig 1. However, interference was significantly reduced after Malaysia applied for the same configuration 2 profile as Thailand.

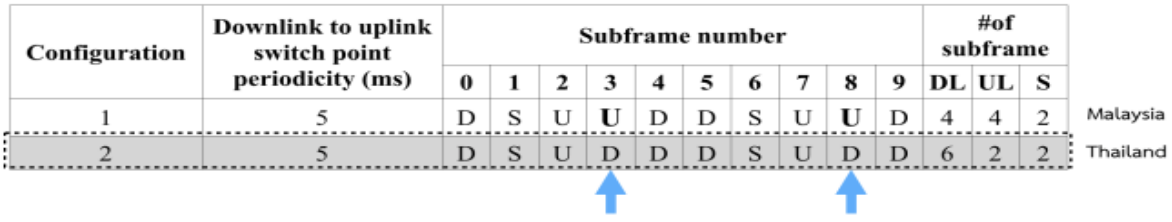


Fig. 1 : Interference issues Between Malaysia and Thailand

- TOT proposed the sharing of information on 2300 MHz usage especially on LAOSAT and LTC configuration as well, they invited LAOSAT and LTC to adopt the same TD-LTE configuration, signal levels and PCI partitioning policy;
- Currently, TOT, LAOSAT and LTC are using the same TD-LTE configuration (Config 2), however, STL informed the meeting that STL was not using this band at the moment;

E. Coordination parameter for IMT in the 700 MHz band

1) Thailand's NBTC informed the Meeting that the license for the use of 700 MHz band for IMT (2X30 MHz) will will come into effect as of October 1st 2020, while the rest of the band (2x15 MHz) will be auctioned tentatively during the first quarter of 2020;
2) Lao PDR's MPT informed the Meeting that Planet is also conducting trial on the 700 MHz band in Lao PDR;
3) Both countries agreed to study the appropriate coordination parameters for this band and will further discuss this issue in next meeting.

F. Band plan and coordination parameters for 2600 MHZ

1) Thailand's regulator, NBTC, presented a paper on "Coordination parameters for 2600 MHz band"

proposing coordination parameters in different cases of the 2600 MHz band where Laos PDR uses both FDD and TDD configuration while Thailand plans to use all TDD configuration,

2) As far as TDD-TDD is concerned, Thailand informed the meeting on the possible coordination parameters as shown in Table 7:

Frequency	Penetration of signal	Boundary
2600 MHZ (LTE/NR synchronized)	-80.6 dBm/5 MHz	0 km from border
2600 MHZ (LTE/NR without synchronized)	-114.4 dBm/5 MHz	0 km from border

Table 7 : The possible coordination parameters for TDD-TDD case

Thailand also informed the meeting of possible methods for network synchronization as follows:

- Synchronized clock signal of base stations with the Global Positioning System (GPS) or other systems signal that can be converted to the GPS time scale
- The usage of a common frame structure

3) In the case of TDD-FDD, Thailand informed the meeting on the possible coordination parameters as shown in Table 8:

Option	Reference	Penetration of signal	Boundary
1	Apply parameters from ECC Rec. (11)05, TDD-TDD without synchronized	-114.4 dBm/ 5 MHz	0 km from border
2	Example of a multilateral agreement between Austria, Croatia, Hungary and Slovenia	-134.9 dBm/ 5 MHz	0 km from border
3	A case study from an operator in China coordinated with Hong Kong	-116 dBm/ 5 MHz	At RX base station

Table 8 : The possible coordination parameters for TDD-FDD case

4) Lao PDR's mobile operators have proposed a value of -120 dBm/5 MHz at RX base stations as provisional protection parameters. This value is open to revisitation at the next JTC meeting;

5) After further discussion, no official consensus was reached. Both countries agreed to request the plenary meeting to consider this issue further.

V. CONCLUSION

As to the current state of things, NBTC has tried to solve RF interference issues along the Thai-Laotian common border which was caused by a leakage of frequencies across Thailand's border to the border of Laos PDR which then negatively affected service users in Laos. Consequently, the two countries have worked together to seek a solution to the problem, however, frequency bands are still lacking due to the fact that both countries provide similar broadcasting services.

Therefore, the Joint Technical Committee on Coordination and Assignment of Frequencies in Thailand - Laos Common Border (JTC)in collaboration with NBTC of Thailand and the Ministry of Post and Telecommunications (MPT) of Laos has continuously held meetings, discussed, and promoted continuous meetings on the coordination and assignment of frequencies along the Thai – Laotian common border in order to enhance better understanding and efficiency in television broadcasting and telecommunications for both of the nations in the future.

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