**APT Expert Mission for Myanmar in 2019**

# Spectrum for future IMT system in Myanmar

**October 2019**

## Disclaimer

This is the outcome of APT Expert Mission partnered with NBTC (the National Broadcasting and Telecommunications Commision of Thailand), Thailand. The views and recommendation contained in this report might not represent the view of respective organizations who have been participating to the Expert Mission.

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## 1. Executive Summary

This report is an outcome of APT Expert Mission for Myanmar in 2019 on "Spectrum for future IMT system in Myanmar." This Mission aims to study for future IMT system by providing recommendations for Network Synchronization in 2.6 GHz Spectrum with Time Division Duplex (TDD) frequency arrangements. The duration of the Mission was July – October 2019.

The 2500 - 2690 MHz band, also known as 2.6 GHz spectrum, was identified for International Mobile Telecommunications (IMT) in all regions in the Radio Regulations (RR) of International Telecommunication Union (ITU). In March 2019, Posts and Telecommunications Department (PTD), Myanmar released a consultation paper on "Review of IMT Aspects of Myanmar's Spectrum Roadmap" which proposed to adopt entire TDD band plan (3GPP band 41) in 2.6 GHz spectrum and released its sequel consultation paper on Myanmar's IMT and 5G Spectrum Roadmap preliminary position in June 2019. The paper strengthened the initial idea of entire TDD arrangement in 2.6 GHz spectrum and elaborated more on the synchronization of the 2.6 GHz regional licensees. This Mission is responding to PTD request for assistance on Network Synchronization framework to prevent interference between operators and support the policy of entire TDD arrangement in 2.6 GHz spectrum without the use of guard bands.

For TDD use of spectrum, Network Synchronization is an effective way to prevent interference between networks of different operators in the same frequency band, without the need to use guard bands. The frameworks for Network Synchronization should include two main elements: Common clock reference and compatible frame structure. A common accurate reference clock should be agreed, including accuracy/performance constraints. Moreover, the holdover period should be defined based on quality of the oscillator (internal clock generator) for the system to operate properly when the primary

reference time clock (PRTC) is lost. The frame structure, including frame length, with specific downlink to uplink (DL/UL) ratio should be carefully determined taking into account of traffic.

It is recommended for PTD of Myanmar to adopt a regulation for Network Synchronization for TDD in 2.6 GHz Spectrum. The status of this regulation should be sufficiently flexible to allow for future revision (e.g. due to technology development). The regulation should apply to all operators in 2.6 GHz spectrum. The recommended regulation is as follows:

**Phase Clock Synchronization**

1) For primary reference time clock (PRTC), Global Positioning System (GPS) or other Global Navigation Satellite System (GNSS) should be used. (In case of other GNSS, the clock signal should be converted into timescale of GPS.) If GPS/GNSS cannot be used (e.g. for indoor sites), Precision Time Protocol (PTP) for transmission of clock signal in the network (according to standard IEEE 1588 version 2) should be used with error within ±1.5 microseconds relative to GPS.

2) If a site cannot receive clock signal for synchronization either by GPS/GNSS or PTP, site should maintain clock signal using internal clock generator with error within ±1.5 microseconds relative to GPS until it can receive clock signal for synchronization again. The minimum period of time that sites can maintain clock signal using internal clock generator (holdover period) should be at least 2 hours.

3) If a site cannot receive clock signal for synchronization and cannot maintain clock signal using internal clock generator, as a last resort, site should be shut off until it can receive clock signal for synchronization again.

**Frame Structures**

For LTE technology with sub-carrier spacing of 15 kHz, the downlink to uplink ratio should be 4:1. For NR technology with sub-carrier spacing of 30 kHz, the downlink to uplink ratio should be 8:2. An operator may use frame structure different from specified, provided that agreements with PTD and other operators in the same frequency band are reached.

# 2. Introduction

## 2.1 Scope

Asia-Pacific Telecommunity (APT) Expert Mission for Myanmar in 2019 is an activity under Capacity Building Program to provide expert's assistance to address specific needs of APT Members on ICT policy and regulation in order to build capacity in ICT development in the region. In this mission, APT has identified experts from the office of National Broadcasting and Telecommunications Commission (NBTC), Thailand to assist Posts and Telecommunications Department (PTD), Ministry of Transport and Communication (MoTC), Myanmar. This mission aims to provide recommendations for Network Synchronization in 2.6 GHz Spectrum with Time Division Duplex (TDD) frequency arrangements.

It is noted that the policy for band plan is out of scope of this report. In addition, coordination of spectrum with neighboring countries is not covered in this report.

## 2.2 Activities and Schedule

APT Expert Mission for Myanmar in 2019 started in July and completed in October 2019. In order to successfully deliver the outcome of this mission, the experts from the office of NBTC, APT coordinator, and PTD team has arranged working activities which can be summarized as follows:

| Date | Activity |
|---|---|
| 5 July 2019 | First meeting (online) between APT coordinator, NBTC Experts and PTD team |
| 12 July 2019 | Technical Arrangement/Network Synchronization for TDD in 2.6 GHz Spectrum questionnaire sent to Myanmar |
| 29 July 2019 | Responses to Questionnaire submitted to NBTC Experts |

| Date | Activity |
|---|---|
| | |
| 20 - 21 August 2019 | Second meeting (face to face in Myanmar)<br>- Meeting between NBTC experts, APT coordinator and PTD team<br>- Meeting with stakeholders (Myanmar telecommunications operators and vendors) |
| 13 September 2019 | Draft Report submitted to APT and MoTC for comments |
| 20 September 2019 | MoTC comments received |
| 15 October 2019 | Final report submitted to APT |

## 3. Background

### 3.1 International Situations of 2.6 GHz Spectrum

The 2500 - 2690 MHz band, also known as 2.6 GHz or 2600 MHz spectrum, was identified for International Mobile Telecommunications (IMT) in all regions since the World Radio Conference 2007 (WRC-07), as stated in the Radio Regulations (RR) footnote 5.384A:

> The frequency bands 1 710-1 885 MHz, 2 300-2 400 MHz and 2 500-2 690 MHz, or portions thereof, are identified for use by administrations wishing to implement International Mobile Telecommunications (IMT) in accordance with Resolution **223 (Rev.WRC-15)**. This identification does not preclude the use of these frequency bands by any application of the services to which they are allocated and does not establish priority in the Radio Regulations. (WRC-15)

Possible frequency arrangements in 2.6 GHz spectrum can be Frequency Division Duplex (FDD) and TDD, FDD only, or flexible FDD/TDD, as described in the ITU-R Recommendations “Frequency arrangements for implementation of the terrestrial component of International Mobile Telecommunications (IMT) in the bands identified for IMT in the Radio Regulations (RR) (ITU-R M.1036-5)” and shown in Table 1 and Figure 1.

**TABLE 1**
**Frequency arrangements in the band 2 500-2 690 MHz**
**(not including the satellite component)**

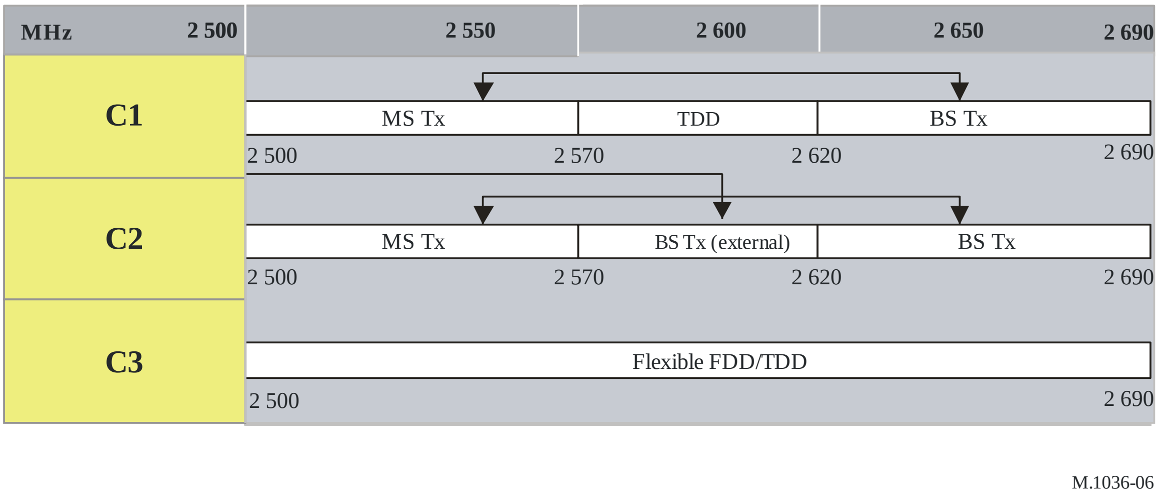
| Frequency arrangements | Paired arrangements | | | | | Un-paired arrangements (e.g. for TDD) (MHz) |
|---|---|---|---|---|---|---|
| | Mobile station transmitter (MHz) | Centre gap (MHz) | Base station transmitter (MHz) | Duplex separation (MHz) | Centre gap usage | |
| C1 | 2 500-2 570 | 50 | 2 620-2 690 | 120 | TDD | 2 570-2 620 TDD |
| C2 | 2 500-2 570 | 50 | 2 620-2 690 | 120 | FDD | 2 570-2 620 FDD DL external |
| C3 | Flexible FDD/TDD | | | | | |

*Notes to Table 1:*

NOTE 1 – In C1, in order to facilitate deployment of FDD equipment, any guard bands required to ensure adjacent band compatibility at the 2 570 MHz and 2 620 MHz boundaries will be decided on a national basis and will be taken within the band 2 570-2 620 MHz and should be kept to the minimum necessary, based on Report ITU-R M.2045.

NOTE 2 – In C3, administrations can use the band solely for FDD or TDD or some combination of TDD and FDD. Administrations can use any FDD duplex spacing or FDD duplex direction. However, when administrations choose to deploy mixed FDD/TDD channels with a fixed duplex separation for FDD, the duplex separation and duplex direction as shown in C1 are preferred.

**FIGURE 1**
**Frequency arrangements in the band 2 500-2 690 MHz**
**(not including the satellite component)**
**(See notes to Table 1)**




The 3rd Generation Partnership Project (3GPP) has specified 2.6 GHz spectrum as one of their New Radio (NR) operating bands and provided channel arrangements and technical standards to support 4G and 5G technologies as indicated in Table 2.

**TABLE 2**
**NR Operating Band**

| **NR operating band** | **Uplink (UL)** ***operating band*** **BS receive / UE transmit FUL_low – FUL_high** | **Downlink (DL)** ***operating band*** **BS transmit / UE receive FDL_low – FDL_high** | **Duplex Mode** |
|---|---|---|---|
| n7 | 2 500 – 2 570 MHz | 2 620 – 2 690 MHz | FDD |
| n38 | 2 570 – 2 620 MHz | 2 570 – 2 620 MHz | TDD |
| n41 | 2 496 – 2 690 MHz | 2 496 – 2 690 MHz | TDD |

Source: 3GPP TS 38.104 version 15.2.0 Release 15

Since the 2.6 GHz spectrum was identified for IMT in 2007, this band has been implemented in all ITU regions. The frequency arrangements trend is moving towards

TDD (i.e. 3GPP band n41) instead of FDD to accommodate 5G technology. (LS Telcom AG 2019)

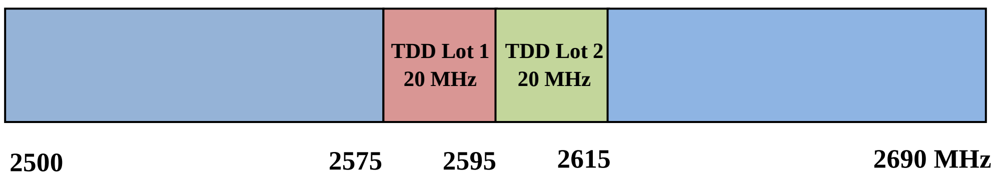
### 3.2 Myanmar Situations of 2.6 GHz Spectrum

All radio spectrum is regulated with the Telecommunications Law (2013) and Spectrum Rules.

The spectrum was released via auction to satisfy the demand of wireless broadband service in the country.

In October 2016, the auction was held, in accordance with the framework for 2600 MHz spectrum auction, to offer 2 x 20 MHz of TDD spectrum licensing in three regional service areas as shown in Figure 2 and Table 3.

**Figure 2**
**2.6 GHz Band Frequency Assignment Plan for Public Broadband Data Services**




Source: PTD, Framework for 2.6 GHz Spectrum Auction, October 2016

**Table 3**
**Regional Service Area**

| | |
|---|---|
| Region 1 | Nay Pyi Taw, Magwe, Bago, Mon, Kayin and Tanintharyi |
| Region 2 | Yangon, Ayeyarwady and Rakhine |
| Region 3 | Mandalay, Sagaing, Chin, Shan, Kachin and Kayah |

The auction results in 2016 has determined three regional licensees, Amara Communications Co., Ltd, Fortune Telecom Co., Ltd and Global Communications Co., Ltd, with 13 years licensing period. Table 4 shows current 2.6 GHz spectrum assignments for each licensee.

**Table 4**
**Current 2.6 GHz Spectrum Assignments in Myanmar**

| Licensee | Technology | Frequency (MHz) | Service Area | Licensing Period |
|---|---|---|---|---|
| Amara Communications Co., Ltd | Wireless Broadband | 2 575 - 2 595 | Region 2 | 2017 - 2030 |
| | | 2 595 - 2 615 | Region 3 | 2017 - 2030 |
| Fortune Telecom Co., Ltd | Wireless Broadband | 2 575 - 2 595 | Region 1 | 2017 - 2030 |
| Global Communications Co., Ltd | Wireless Broadband | 2 595 - 2 615 | Region 1 | 2017 - 2030 |

In March 2019, PTD released the consultation paper on Review of IMT Aspects of Myanmar's Spectrum Roadmap which proposed to adopt entire TDD band plan (n41) in 2.6 GHz spectrum. The key benefit was to support 5G transition in Myanmar as a substitution for pioneer 5G spectrum like C-band. (Although the Band 41 will be used as neutral technology, which can be used for LTE TDD or NR.) However, the current regional licensees have to relocate their frequency block by 5 MHz upward or downward, in order to align with the band configuration such as 10 MHz TDD lots.

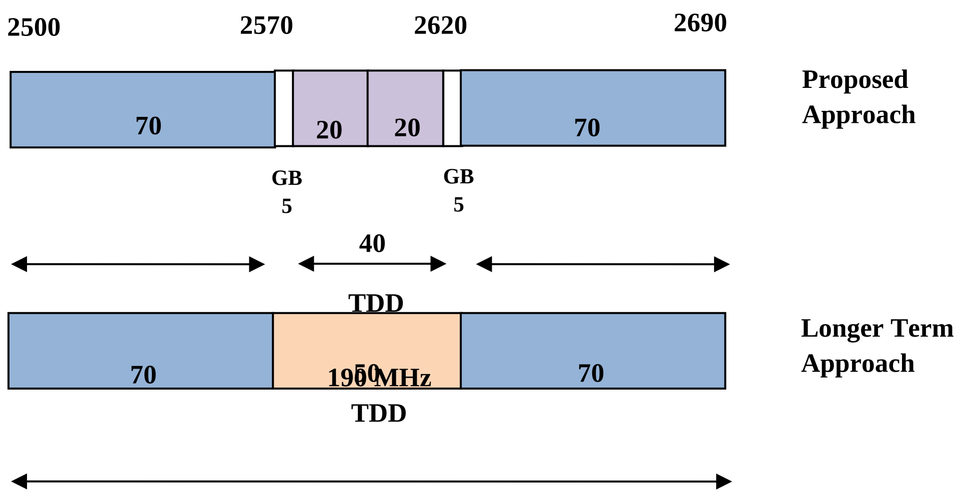
PTD released its sequel consultation paper on Myanmar's IMT and 5G Spectrum Roadmap preliminary position in June, 2019. This paper strengthened the initial idea of n41 adoption in 2.6 GHz spectrum and elaborated more on the following issues:

a) The current regional licensees will be encouraged to consolidate so as to ensure they have 50 MHz of spectrum (i.e. including allowing them to use the current two 5 MHz guard bands). Additional spectrum should increase their ability to compete and service their customers;

b) The 2.6 GHz spectrum in regions 2 and 3 not currently allocated should be discounted and offered to existing regional licensees so that it does not remain vacant; and

c) The synchronization of the 2.6 GHz regional licensee would also need to be broadened to include any new 2.6 GHz national spectrum licensees. For this additional effort the 2.6 GHz regional licensees would be compensated by the use of the guard bands so that proposed band would, over time look like that set out in Figure 3

**Figure 3**
**Proposed band plan for the 2.6 GHz band (n41)**



## 4. Review of Network Synchronization for TDD

Detailed information can be found in ECC Report 216 (August 2014) and ECC Report 296 (March 8, 2019). Although the contents in ECC Report 296 provide information and analysis based on frequency band 3400-3800 MHz, the framework can also be applied to other frequency bands with TDD frequency arrangements, including 2.6 GHz band.

### 4.1 Overview

In synchronized operation, each TDD network in the same frequency band does not transmit downlink and uplink at the same time. (If there are simultaneous uplink and downlink transmissions as in unsynchronized operation, networks may interfere with each other.)

In TDD network, time synchronization becomes vitally important as interference mitigation. The time synchronization not only reduces network performance degradation caused by BS-BS (Base Station) and MS-MS (Mobile Station) interference, but also simplifies network deployment process by lessen coordination for BS planning.

If the network is not operated as synchronized, there are also options to operate the network as semi-synchronized or unsynchronized in ECC Report 296, where other interference mitigations, such as inter-operator guard bands, additional filters or geographical separation distance, may be required; however, those are not included in this report.

### 4.2 Frameworks

Frameworks have to be defined prior to the synchronized operation. This has to be achieved at the national level either through agreements among multi-operators or appropriate regulations by administrations. The frameworks should include the following:

### 4.2.1 Common clock reference

A common accurate reference clock must be agreed, including accuracy/performance constraints. Operators may share clock infrastructure or set up clock solution within their own network. Available proper reference clock sources include, but not limited to the National Institute of Metrology and GPS. The clock system is required to be periodically monitored, and administrations and operators should take actions in order to ensure that the clock quality is met and there is no synchronization error.

The phase synchronization requirements are as shown below:

**TABLE 5**
**Phase Synchronization Requirement**

| Technology | Phase accuracy relatively to the reference clock |
|---|---|
| LTE | ±1.5µs for cell radius ≤ 3km |
| | ±5µs for cell radius > 3km |
| NR | ±1.5µs |

Moreover, the holdover period has to be defined based on quality of the oscillator (internal clock generator) for the system to operate properly when the primary reference time clock (PRTC) is lost. If there is no PRTC for the duration longer than the holdover period, the system must be shut off to prevent interference to other systems. Some equipment currently available in the market has holdover period of 2 – 4 hours.

### 4.2.2 Compatible frame structure

The frame structure, including frame length, with specific DL/UL ratio shall be carefully determined taking into account of traffic. The selection of frame structure will contribute to network performance. For example, the more frequent DL/UL and UL/DL switching allows shorter latency and improve spectral efficiency.

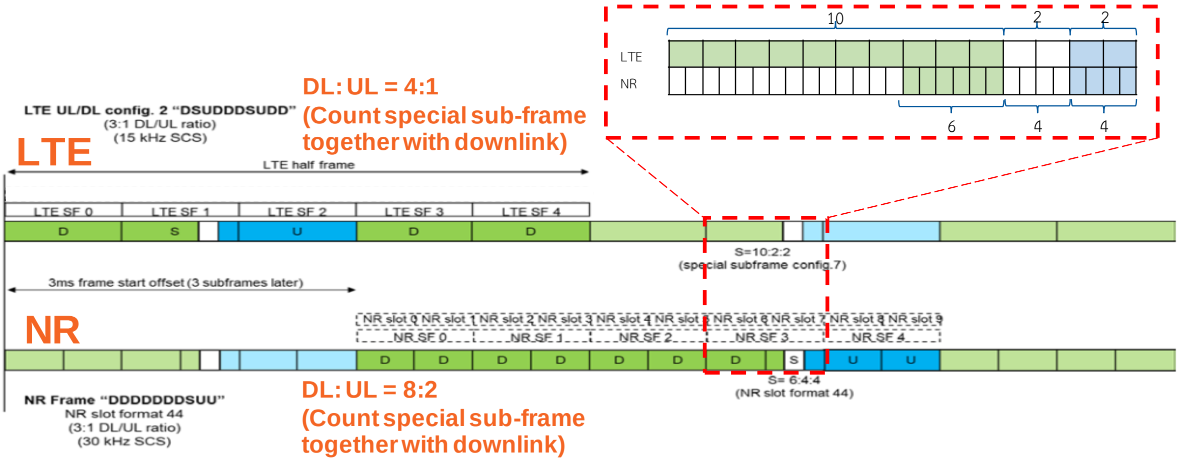
In order to avoid simultaneous UL/DL transmissions while assure network efficiency, each operator must determine an appropriate frame structure for their own network and agree on a compatible frame structure among operators.

It is feasible for cross technology synchronization LTE – NR if the frame structures are aligned. An example of LTE and NR equivalent configurations is as shown below:

**TABLE 6**
**Example of Frame Structures**

| Technology | sub-carrier spacing (kHz) | DL/UL ratio |
|---|---|---|
| LTE | 15 | 4:1 |
| NR | 30 | 8:2 |

**Figure 4**
**Example of LTE and NR Frame Structure Configurations**




Source: ECC Report 296

Notes on special subframe: The special subframe can be configured as symbols ratio for downlink : guard : uplink. For example, in the figure above, the symbol ratio of special subframe of LTE network is 10:2:2 and that of NR network is 6:4:4.

### 4.2.3 Conditions for synchronization and periodic review of agreed conditions

In general, to consider necessity of synchronization, some conditions (e.g. geographic location, etc.) should be considered to determine whether synchronization is required.

The agreed conditions should be periodically reviewed due to technology development, user behavior or market demand. The frame structure and DL/UL ratio may be adjusted to support traffic or flexibility of network operation.

## 4.3 Challenges

Some challenges for Network Synchronization are as follows:

i) Setting up an accurate common reference clock within the network or the shared clock infrastructure might be difficult to achieve in some cases. Nevertheless, operators will need to setup accurate clock solutions within their own networks whether or not they need to synchronize their network with other operators. Moreover, the clock quality is needed to be enforced and monitored to prevent synchronization errors.

ii) Selecting compatible frame structure has to take traffic and performance requirements of different technologies and services of all relevant operators into account.

iii) Regulatory framework stating preferred clock synchronization and frame structure in specific detail may restrict neutral technology (e.g. if there is new technology using different frame structure). On the other hand, regularly reviewing regulatory framework and negotiating among operators (e.g. to accommodate new technology) can be a complicate and lengthy process.

## 5. Fact Findings and Comments from Stakeholders

### 5.1 Current arrangement in 2.6 GHz spectrum

Currently, 40 MHz bandwidth of 2.6 GHz Band is released to three Regional broadband service providers. PTD does not currently have any arrangement for network synchronization. Regional broadband service providers in 2.6 GHz spectrum are using clock signals which are provided by GPS and frame structure configuration No. 2 for LTE. (DL/UL ratio is 4:1.) It is noted that there is no interference among LTE usages at this time due to no simultaneous transmission in the same area yet. (In Region 1, only one operator currently operates, while the other operator has not launched the service yet.)

### 5.2 Comments on Network Synchronization framework from stakeholders

According to the outcomes from meeting with stakeholders, Myanmar stakeholders' comments on Network Synchronization framework are as follows:

| | |
|---|---|
| **Phase Clock synchronization** | **Clock reference**: GPS for outdoor and PTP for indoor or small cell.<br>- GNSS/GPS cannot be used for the indoor setting or ultra-dense urban area, so using PTP instead is necessary. External outdoor GPS can feed clock signal to indoor sites but there are limitations.<br>- The obstruction of small-cells may have issue for both indoor and even outdoor (e.g. obstruction from trees).<br><br>**Holdover period**: Typically 2 - 4 hours, though some equipment has longer holdover period. |
| **Frame structures** | - Currently using Configuration No.2 for LTE.<br>- However, there is no strong opinion for future arrangement of frame structures (LTE – NR and NR –NR) at this time.<br>- The frame structure should be flexible for revision to support possible changes in downlink/uplink traffic. Traffic pattern may change in the future, e.g. more uplink traffic for 5G applications that are not mobile broadband. |
| **Regulation needs** | - Stakeholders currently have no preference regarding whether regulatory framework is needed.<br>- However, PTD commented that it prefers having regulation for network synchronization. |

## 6. Recommendations

**To add the other countries experiences about the regulation of the Network Synchronization in 2.6 GHz Band as an Introduction of this section.**

PTD is recommended to adopt a regulation for Network Synchronization for TDD in 2.6 GHz Spectrum. The status of this regulation should be sufficiently flexible to allow for future revision (e.g. due to technology development). The regulation should apply to all operators in 2.6 GHz spectrum. The details of the recommended regulation are as follows.

### 6.1 Phase Clock Synchronization

1) For primary reference time clock (PRTC), Global Positioning System (GPS) or other Global Navigation Satellite System (GNSS) should be used. (In case of other GNSS, the clock signal should be converted into timescale of GPS.) If GPS/GNSS cannot be used (e.g. for indoor sites), Precision Time Protocol (PTP) for transmission of clock signal in the network (according to standard IEEE 1588 version 2) should be used with error within ±1.5 microseconds relative to GPS.

2) If a site cannot receive clock signal for synchronization either by GPS/GNSS or PTP, site should maintain clock signal using internal clock generator with error within ±1.5 microseconds relative to GPS until it can receive clock signal for synchronization again. The minimum period of time that sites can maintain clock signal using internal clock generator (holdover period) should be at least 2 hours.

3) If a site cannot receive clock signal for synchronization and cannot maintain clock signal using internal clock generator, as a last resort, site should be shut off until it can receive clock signal for synchronization again.

### 6.2 Frame Structures

**TABLE 7**
**Recommended Frame Structure**

| Technology | sub-carrier spacing (kHz) | DL*/UL ratio |
| --- | --- | --- |
| LTE | 15 | 4:1 |
| NR | 30 | 8:2 |

*Note: Downlink includes Special Sub-frame during the transition from Downlink to Uplink

It is noted that the recommended frame structure above is based on assumption that LTE will continue to be used in the foreseeable future.

An operator may use frame structure different from specified above, provided that agreements with PTD and other operators in the same frequency band are reached.

### 6.3 Comparison of Network Synchronization with other alternatives

If Network Synchronization is not implemented, other alternatives for interference mitigations would be required. In particular, guard bands would be required between operators. However, requiring guard bands would conflict with PTD policy on longer term approach for band plan, where no guard bands between operators are planned as described in Section 3.2 and shown in Figure 3. In addition, using guard band would result in spectrum resource not being utilized efficiently. Therefore, Network Synchronization is recommended rather than having guard bands between operators.

## 7. References

1) LS Telcom AG. (2019). Analysis of the Worldwide Licensing and Usage of IMTSpectrum.https://www.esoa.net/cmsdata/positions/2019_Study_LicensingUseofMobileSpectrum_1.pdf

2) PTD. (2019). Review of IMT Aspects of Myanmar's Spectrum Roadmap 8 March 2019.

3) PTD. (2019). Myanmar's IMT and 5G Spectrum Roadmap preliminary positions 25 June 2019.

4) ECC. (2014). ECC Report 216: Practical guidance for TDD networks synchronization.

5) ECC. (2019). ECC Report 296: National synchronization regulatory framework options in 3400-3800 MHz: a toolbox for coexistence of MFCNs in synchronised, unsynchronised and semi-synchronised operation in 3400-3800 MHz.