MINISTRY OF TRANSPORT AND COMMUNICATIONS

POSTS AND TELECOMMUNICATIONS DEPARTMENT

FREQUENCY ARRANGEMENT IN 2.6 GHz SPECTRUM AND NETWORK SYNCHRONIZATION FOR TDD FOR MYANMAR

March 2020

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Posts and Telecommunications Department (PTD) issued “Frequency Arrangement in 2.6 GHz Spectrum and Network Synchronization for TDD for Myanmar”:

Frequency Arrangement in 2.6 GHz Spectrum and Network Synchronization for TDD for Myanmar

1. Executive Summary

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. Then, PTD provides 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 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.

This frequency arrangement applies to all operators in 2.6 GHz spectrum.

2. Background

2.1 2.6 GHz Spectrum in Myanmar

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:

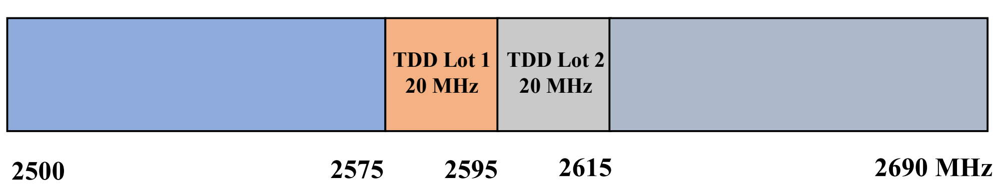
> The frequency bands 1 710-1 885 MHz, 2 300-2 400 MHz and 2 500-2690 MHz, or portions thereof, are identified for use by administrations wishing to implement International Mobile Telecommunications (IMT) in accordance with Resolution 223 (Rev.WRC-15).

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)".

In Myanmar, all radio spectrum is regulated with the Telecommunications Law (2013) and Spectrum Rules (2016). A part of 2600 MHz 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 1 and Table 1.

Figure 1

2.6 GHz Band Frequency Assignment Plan for Public Broadband Data Services



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

Table 1

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 Technology Co., Ltd, with 13 years licensing period. Table 2 shows current 2.6 GHz spectrum assignments for each licensee.

Table 2

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 Technology Co., Ltd	Wireless Broadband	2 595 - 2 615	Region 1	2017 - 2030

3. Channelling Plan of 2.6 GHz Spectrum Band

The frequency band 2500-2690MHz provides a total bandwidth of 190 MHz for the IMT service. Channel arrangements are indicated in ITU Recommendations: Rec. ITU-R M. 1036-5. The ITU has recommended a list of channel arrangement shown below:

Frequency arrange-ments	Paired arrangements					Un-paired arrangement (e.g. for TDD) MHz
	Mobile station transmitter (MHz)	Centre gap (MHz)	Base station transmitter (MHz)	Duplex separation (MHz)	Centre gap usage	
C1	2500-2570	50	2620-2690	120	TDD	2570-2620 TDD
C2	2500-2570	50	2620-2690	120	FDD	2570-2620 FDD DL external
C3	Flexible FDD/TDD					

Option C1 is the current channel arrangement as depicted in the figure below:

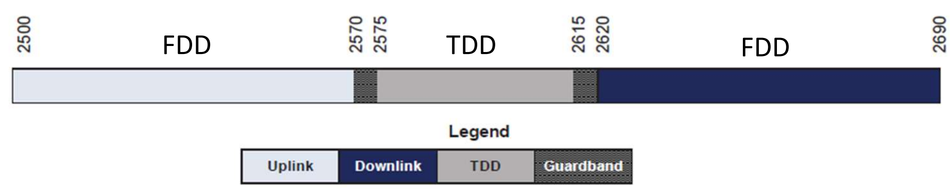


Figure 2: Current Band Plan for IMT 2600 MHz

In June 2019, PTD released its sequel consultation paper on Myanmar's IMT and 5G Spectrum Roadmap preliminary position 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).

Recently, Option C3 is proposed as the best option for Myanmar to align with the Myanmar's Spectrum Roadmap 2016 and the Myanmar's IMT and 5G Spectrum Roadmap Consultation, June 2019 and to increase the usable bandwidth of IMT2600 (2500 – 2690 MHz). Posts and Telecommunications Department changed the band plan of 2600 MHz spectrum and adopted the band 41 (All TDD) for the whole band as the figure below:

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

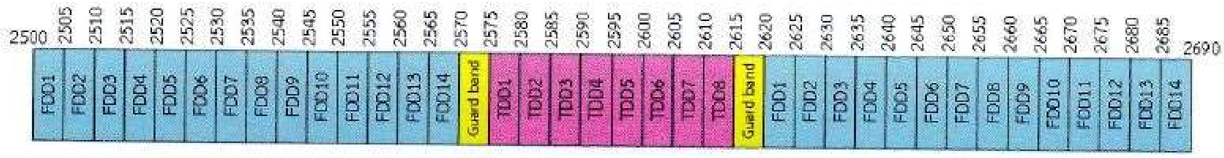


Figure 1: Existing band plan

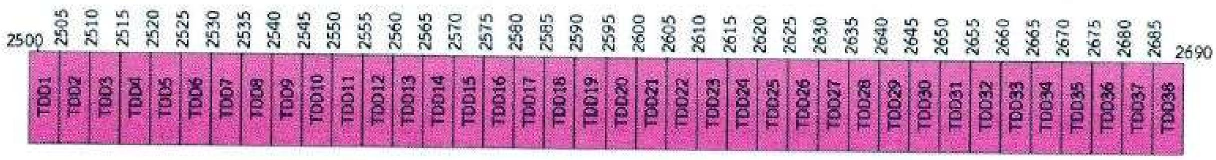


Figure 2: Band plan under consideration for IMT-Advanced and IMT-2020

4. Network Synchronization Framework

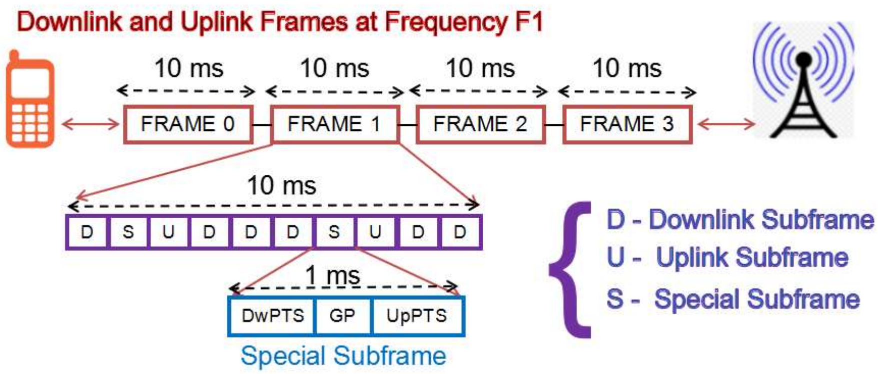
4.1 Overview

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.

4.2 LTE TDD Frame Structure

In TDD, the transmission is divided into time domain, means at one moment of time either downlink subframe is transmitted or uplink.



Each radio frame of length 10ms consists of 10 subframes of length 1ms each, and that subframe can be either downlink "D", uplink "U" or special subframe "S".

The sequence of these subframes has been defined by 3GPP with the name TDD Frame Configurations. There are fixed patterns of these configurations and network operator has to choose out of these defined patters. There are total 7 LTE TDD configurations as shown below:

Configuration	3GPP release	Downlink to uplink switch point periodicity (ms)	Subframe number										Number of subframes / frame		
			0	1	2	3	4	5	6	7	8	9	D [DL]	U [UL]	S [SSF]
0	8	5	D	S	U	U	U	D	S	U	U	U	2	6	2
1	8	5	D	S	U	U	D	D	S	U	U	D	4	4	2
2	8	5	D	S	U	D	D	D	S	U	D	D	6	2	2
3	8	10	D	S	U	U	U	D	D	D	D	D	6	3	1
4	8	10	D	S	U	U	D	D	D	D	D	D	7	2	1
5	8	10	D	S	U	D	D	D	D	D	D	D	8	1	1
6	8	5	D	S	U	U	U	D	S	U	U	D	3	5	2

And there comes a Special subframe which comes when there is transition from downlink subframe to uplink subframe. It has three parts – DwPTS (Downlink Pilot Time Slot), GP (Guard Period) and UpPTS (Uplink Pilot Time Slot) and all of these have configurable lengths, which depends upon Special subframe configuration.

- DwPTS is considered as a "normal" DL subframe and carries reference signals and control information as well as data for those cases when sufficient duration is configured. It also carries PSS.
- GP is used to control the switching between the UL and DL transmission. Switching between transmission directions has a small hardware delay for both UE and eNodeB and needs to be compensated by GP. GP has to

be large enough to cover the propagation delay of DL interferes. Its length determines the maximum supportable cell size.

- UpPTS is primarily intended for sounding reference signals (SRS) transmission from UE. Mainly used for RACH transmission.

Special subframe configuration as shown below:

Configuration	3GPP release	Number of OFDM symbols / subframe		
		Dw	GP	Up
0	8	3	10	1
1	8	9	4	1
2	8	10	3	1
3	8	11	2	1
4	8	12	1	1
5	8	3	9	2
6	8	9	3	2
7	8	10	2	2
8	8	11	1	2
9	11	6	6	2

Selecting a synchronization option for LTE-TDD requires:

- Selection of a timing reference (beginning of the frame);
- Selection of a frame structure;
- Selection of special sub-frame configuration.

4.3 Compatibility of 5G-NR Frame with LTE-TDD Frame Structure

With the synchronized operation of 5G-NR and LTE-TDD, noting that every LTE-TDD frame configuration has at least one compatible 5G-NR equivalent configuration, the 5G-NR TDD pattern should be based on the following sequence of DL, UL and special slots: "DDDSUUDDDD". Two example variants may be considered:

- Variant 1: LTE-TDD and 5G-NR have an aligned frame start, e.g. "DDDSUUDDDD";
- Variant 2: non-zero frame start offset between LTE-TDD and 5G-NR, e.g. “DDDDDDDSUU”.

These variants, with 30 kHz subcarrier spacing (SCS) can be aligned to LTE-TDD “DSUDD” frame structure with 15 kHz SCS (LTE-TDD frame configuration #2).

It is to be noted that there should also be a compatible structure for the symbols within the LTE-TDD "S" sub-frame. For the studies considered, the “DDDDDDDSUU” frame configuration is used to represent the performance that 5G-NR would have in case of synchronised operation with a neighbour LTE-TDD network in the same band and in the same area using LTE-TDD frame configuration #2. Note that similar results apply in case the non-shifted variant, i.e. "DDDSUUDDDD", is used.

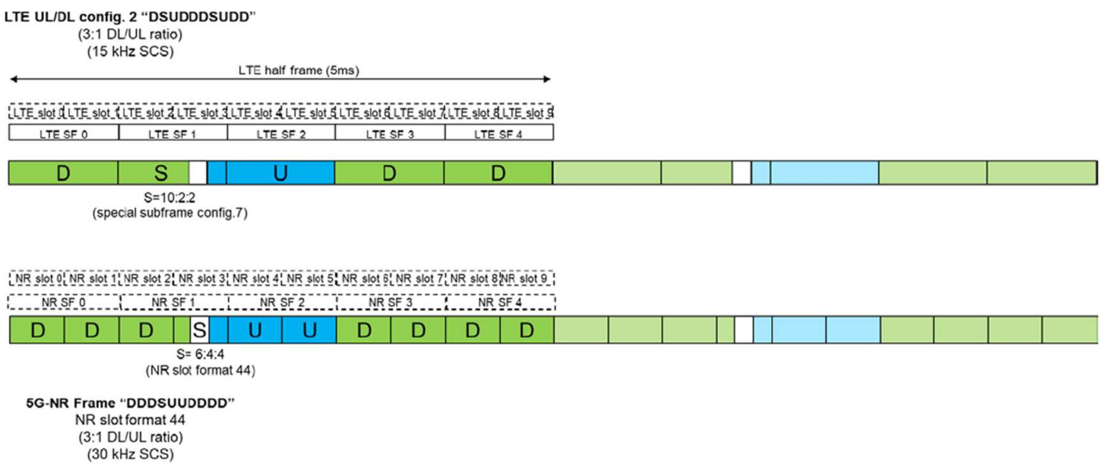


Figure 4: Varient 1 - Synchronised operation of 5G-NR ("DDDSUUDDDD" frame) and LTE-TDD (“DSUDD” frame)

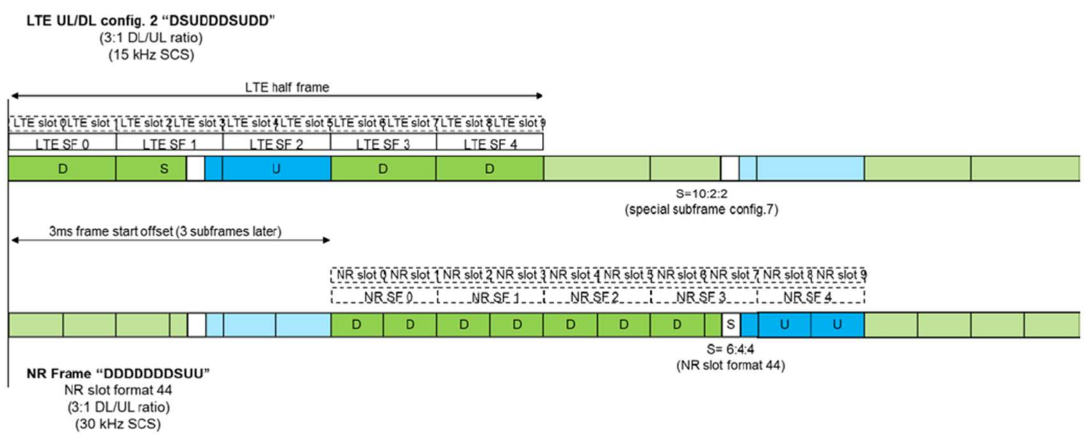


Figure 5: Variant 2 - Synchronised operation of 5G-NR (“DDDDDDDSUU” frame) and LTE-TDD (“DSUDD” frame)

Selecting a synchronisation / semi-synchronisation option for 5G-NR requests:

- Selection of a timing reference (beginning of the frame);
- Selection of normal or extended prefix;
- Selection of a subcarrier spacing configuration;
- Selection of a slot configuration.

4.4 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 3
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.

4.5 2.6 GHz 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.

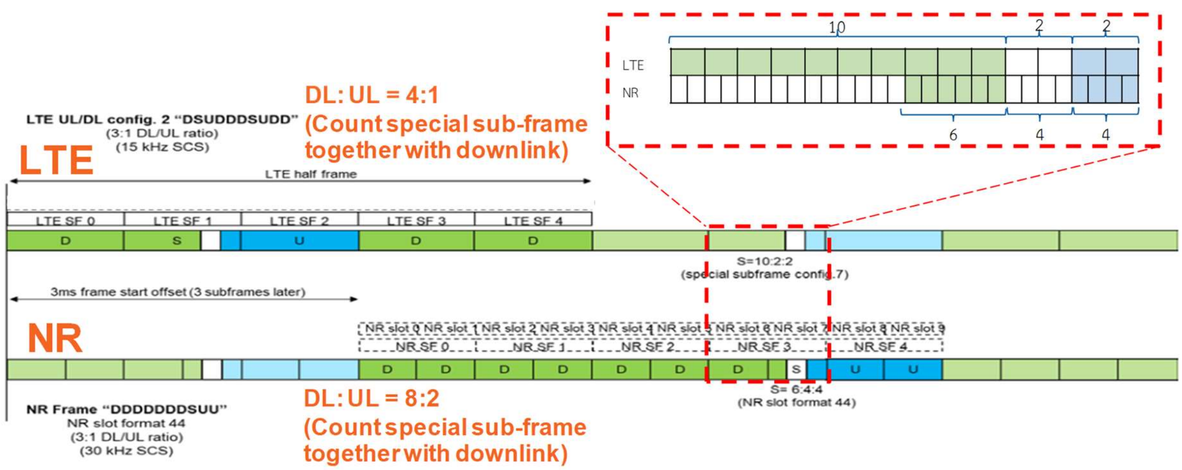
In order to avoid simultaneous UL/DL transmissions while assure network efficiency, each operator must determine an appropriate frame structure for their own network and agree on a compatible frame structure among operators.

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 4
Example of Frame Structures

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

Figure 6
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.

5 Recommended for the Network Synchronization for TDD

PTD adopts a mandatory Network Synchronization for TDD in 2.6 GHz Spectrum. The Network Synchronization shall apply to all operators in 2.6 GHz spectrum. The details of the recommended Network Synchronization are as follows.

5.1 Phase Clock Synchronization

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.

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.

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.

Clock reference: GPS for outdoor and PTP for indoor or small cell.

- 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.
- The obstruction of small-cells may have issue for both indoor and even outdoor (e.g. obstruction from trees).

Holdover period: Typically, 2 - 4 hours, though some equipment has longer holdover period.

5.2 Frame Structures

TABLE 5
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 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.

- Currently using Configuration No.2 for LTE.
- However, there is no strong opinion for future arrangement of frame structures (LTE – NR and NR –NR) at this time.
- 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.