



**INTERIM DECISION ISSUED BY THE  
INFO-COMMUNICATIONS DEVELOPMENT AUTHORITY OF SINGAPORE**

**SPECTRUM FRAMEWORK FOR FOURTH GENERATION (4G)  
MOBILE COMMUNICATION SYSTEMS IN SINGAPORE**

**24 January 2011**

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## **PART I: INTRODUCTION**

1 The deployment of 3G systems has brought about a paradigm shift in mobile communications. The next stage is now underway globally for the introduction of the next generation of ultra high-speed mobile communication system – the 4<sup>th</sup> Generation or 4G mobile communication system – that will offer end users higher data rates and shorter latency. Mobile technologies capable of delivering performances in line with market expectations have already been announced. Amongst them, LTE (Long Term Evolution) and WiMAX (Worldwide Interoperability for Microwave Access) have received the most attention. LTE and WiMAX systems are capable of achieving peak data rates in excess of 100Mbps and offer better user experiences and quality of service over existing 3G systems. Their advanced versions, LTE-Advanced and WiMAX 2 have also been ratified by the ITU as 4G technologies.

2 Globally, LTE in particular has been gaining much industry support. Mobile operators in the US and parts of Europe have commenced LTE deployment. In Singapore, mobile operators have also announced LTE trials.

3 IDA has been monitoring global developments so as to prepare and facilitate the deployment of ultra high-speed mobile communication systems in Singapore that will meet end users' increasing mobile communication needs going forward. On 29 March 2010, IDA conducted a public consultation on "Spectrum Framework for Fourth Generation (4G) Mobile Communication Systems in Singapore" ("Consultation"). The Consultation primarily focused on seeking the views and comments of the stakeholders and the public on the technology and market trends for the 2300-2400 MHz radio frequency spectrum ("2.3 GHz band") and 2500-2690 MHz radio frequency spectrum ("2.5 GHz band") as well as IDA's proposed approach to make available the 2.3 GHz and 2.5 GHz bands for 4G mobile communication systems and services after 2015.

4 At the close of the Consultation, IDA received comments from eight respondents:

- i. Ericsson Telecommunications Pte Ltd
- ii. Intel Technology Asia Pte Ltd
- iii. M1 Limited
- iv. Nokia Siemens Network
- v. QMax Communications Pte Ltd
- vi. Qualcomm International
- vii. Singapore Telecom Mobile Pte Ltd
- viii. StarHub Mobile Pte Ltd

5 IDA thanks all respondents for their inputs. The respondents generally urged IDA to complete the coordination with neighbouring countries so as to make available more spectrum resources for allocation in view of the growing demand for wireless broadband services. Respondents were generally also in favour of IDA re-allocating the 2.3 GHz and 2.5 GHz bands, and allocating the 700 MHz band early to provide greater investment certainty to the industry.

6 IDA agrees that an early allocation of the bands will provide more certainty to market participants. However, while IDA will strive to complete spectrum coordination

as soon as possible, IDA is mindful that the process may be time-consuming. Without certainty over the spectrum coordination process, it would be difficult for IDA to finalise a framework and timeframe for the allocation of the bands. Nonetheless, IDA will seek to provide more clarity over the spectrum coordination process and the timeframe for re-allocation of the bands as early as 2012. In the interim, IDA will consider the possible frameworks for the re-allocation of the bands, taking all comments provided by the industry through the Consultation.

7 At this stage, while IDA is not in a position to conduct a re-allocation of the 2.3 GHz and 2.5 GHz bands, IDA notes that commercial LTE deployments are gaining speed internationally, and that some respondents in the Consultation have indicated interest to deploy LTE systems prior to 2015. IDA is thus clarifying the use of the existing spectrum rights for wireless and mobile services, in particular the 880-915 MHz/925-960 MHz (“900MHz band”) and 1710-1785 MHz/1805-1880 MHz (“1800 MHz band”) which are typically used for 2G systems, and the Wireless Broadband Access (“WBA”) spectrum in the 2.3 GHz/2.5 GHz bands. IDA will also provide our preliminary positions on the responses to the Consultation at this juncture, to guide and assist industry in their investment and network planning.

## **PART II: SUMMARY OF RESPONSES AND IDA’S PRELIMINARY POSITIONS**

### Candidate Technologies and Spectrum Bands for 4G Systems

8 All the respondents agreed that the existing spectrum resource allocated for mobile and wireless networks is unlikely to be able to support market demand over the next five years. They generally agreed that LTE and WiMAX are likely technologies to be adopted for 4G systems. While a number of spectrum bands have been identified for deployment, the 690-862 MHz (“700 MHz band”), 2.3 GHz and 2.5 GHz bands have been highlighted as strong candidate bands for WiMAX/LTE deployment. The 700 MHz band is especially attractive because network equipment and terminal devices are already available for commercial use today. In addition, the 700 MHz band has better penetration into buildings and requires fewer cell sites for deployment due to the better propagation characteristics of the band.

9 IDA is aware that to-date, only LTE-Advanced and WiMAX 2 have been established by the ITU as meeting the technical specifications for IMT-Advanced technologies, also commonly referred to as 4G technologies. IDA is also aware that the ITU is expected to release the detailed specifications of the IMT-Advanced technologies in early 2012. In the interim, the ITU has not disputed the likelihood that LTE and WiMAX, forerunners of the LTE-Advanced and WiMAX 2 technologies respectively, may also be recognised as 4G technologies as they provide a substantial level of improvement in performance and capabilities with respect to 3G systems. The Consultation has confirmed strong interest in deploying LTE and WiMAX systems for the provision of wireless broadband services in the 2.3 GHz and 2.5 GHz bands to meet end users’ mobile communication needs going forward. IDA is therefore prepared to allow the deployment of 4G technologies including LTE and WiMAX and their advanced versions in the 2.3 GHz and 2.5 GHz bands when the bands are re-farmed and reallocated.

10 IDA also notes industry's interest for the 700 MHz band to complement network deployments in the 2.5 GHz band for better coverage, especially in enclosed spaces or in-building areas where the 700 MHz spectrum has better penetration characteristics. IDA agrees that it would be beneficial to allocate the 700 MHz band together with the 2.3 GHz and 2.5 GHz bands. However, as noted in the Consultation, the availability of the 700 MHz band is dependent on spectrum coordination with neighboring countries and their timeline for analogue TV switch-off. IDA also notes the ongoing effort by the APT Wireless Forum to harmonise use of the 698-806 MHz sub-band across Asia-Pacific to support wireless broadband services. These activities may delay the availability of the 700 MHz spectrum. Nonetheless, IDA will endeavour to complete spectrum coordination for the 700 MHz band and consider the risks and benefits of conducting joint allocation with the 2.3 GHz and 2.5 GHz bands.

### Technical Specifications for 2.5 GHz

11 The Consultation proposed two options for the 2.5 GHz band plan (reproduced in **Annex A**): Option A is based on full-band sharing and is consistent with the ECC/DEC/(05)05 Decision where the band is segmented for paired and unpaired spectrum, based on 2x70 MHz of paired spectrum with a 120 MHz duplex spacing and 50 MHz of unpaired spectrum. Option B is based on half-band sharing using an interleaved band plan with a combination of 15 MHz and 20 MHz paired spectrum blocks, and a 25 MHz unpaired spectrum block.

12 All the respondents supported Option A for the 2.5 GHz band plan. Most also supported a 5 MHz guard block between the paired and unpaired spectrum. The respondents generally agreed that no guard block is required between licensees using the same Time Division Duplex ("TDD") or Frequency Division Duplex ("FDD") bands. Conversely, the respondents rejected Option B. The main objections for Option B include the likelihood of compromised service by one or more operators, and unlevel playing field due to the unequal distribution of FDD spectrum in the band.

13 All the respondents noted that at least 20 MHz paired spectrum per operator would be needed to deliver the full benefits of LTE. However, views differed as to the block sizes for allocation. One respondent supported allocation in 5 MHz spectrum blocks so that operators have the flexibility to combine multiple blocks in a contiguous manner to form a larger carrier size. Some others suggested allocating in 10 MHz blocks as anything smaller would not be spectrally efficient for OFDMA-based technologies such as LTE and WiMAX, and allocating in 10 MHz spectrum blocks would also create less fragmentation and complexity for those operators keen to combine multiple blocks together to form a larger carrier size. One other respondent suggested allocating the paired spectrum in three 20 MHz blocks and one 10 MHz block.

14 IDA agrees that Option A is optimal as it strikes a good balance between enabling the coexistence of FDD and TDD systems while minimising undue guard bands needed in this band. Nonetheless, as explained in the Consultation, spectrum allocation for the 2.5 GHz band in Singapore is subject to coordination with our neighbouring countries to reduce interference in the border areas. Bearing in mind

that different countries may have different needs, IDA is therefore cognisant that the full 190 MHz in the 2.5 GHz band may not be available for assignment in the border areas. In that event, Singapore may have to be confined to half-band sharing arrangement with neighbouring countries under Option B. Nonetheless, IDA is mindful of the risk and cost of half-band sharing arrangement. IDA will continue to work towards full band-sharing for the 2.5 GHz band based on the adoption of the ECC/DEC/(05)05 Decision.

15 IDA recognises that it would be premature to determine the technical aspects of the 2.5 GHz band such as the block size for allocation and the guard band at this juncture. IDA will duly consider the benefits of allocating the 2.5 GHz band in different block sizes when there is greater clarity in the outcome of spectrum coordination with neighbouring countries.

#### Technical Specifications for 2.3 GHz

16 The respondents generally agreed with IDA's proposal to retain the existing channelling plan for the 2.3 GHz band based on 5 MHz blocks (reproduced in **Annex B**). It was noted that TD-LTE is emerging as the mobile broadband technology of choice for the 2.3 GHz band, with operators in China, India and Russia interested to rollout TD-LTE in the band from late 2010 onwards, notwithstanding the fact that WiMAX is already available and deployed in the band. Some respondents have also urged IDA to continue discussions with neighbouring countries to harmonise use of the 2.3 GHz band so as to make available more spectrum than currently available.

17 There were also differing views as to the spectrum block size for allocation. One respondent suggested that 10 MHz spectrum block size is preferable for TD-LTE to provide for the expected consumer experience, while another recommended allocating in 20 MHz blocks given that business plans are likely to structure around 20 MHz TD-LTE carriers. Two respondents opined that a minimum of 30 MHz is needed to enable an adequate business model for WiMAX deployment, while another suggested allocating in 20 MHz block sizes to give WiMAX operators the option of deploying a network based on a carrier size of 20 MHz, which will allow wireless broadband access speeds in excess of 100 Mbps.

18 IDA notes the emerging interest in deploying TD-LTE in the 2.3 GHz band, in competition with WiMAX. As the 2.3 GHz band will be used to meet similar industry demands as the 2.5 GHz band, IDA will consider the technical aspects of the 2.3 GHz band jointly with the 2.5 GHz band, once spectrum coordination is completed. IDA has also noted industry demand for more spectrum in the 2.3 GHz band to be made available. However, similar to the 2.5 GHz band, the allocation of the 2.3 GHz band must also be coordinated with neighbouring countries. While IDA will work towards harmonisation of the band, it is unlikely that additional spectrum beyond the current 50 MHz already assigned would be made available in the near future.

#### Timing of Allocation and Allocation Approach

19 The respondents generally supported re-allocation of the 2.3 GHz and 2.5 GHz bands for 4G services as soon as possible, noting that FDD-LTE products in the 2.5 GHz band are already in commercial operation and that commercial TD-LTE products

for both bands are expected to enter the market very soon. Some respondents were of the view that LTE deployment is likely to come earlier than 2015 and therefore supported allocating the 2.5 GHz band for LTE much sooner. Most respondents were of the view that the allocation of the 2.3 GHz band should not be delinked from the 2.5 GHz band, so as to provide industry with more visibility of the spectrum resource available and facilitate operators' decision to deploy a TDD or FDD network.

20 Views differed as to the allocation approach. Some respondents recommended that first rights of refusal ("FROR") be given to existing WBA spectrum right holders to prevent service disruption due to spectrum churning. On the other hand, one respondent submitted that it is not necessary for IDA to grant FROR but instead suggested that IDA recover and reallocate the spectrum earlier.

21 IDA agrees that it would be preferable to allocate the 2.3 GHz and 2.5 GHz bands jointly, since both bands are likely to be used for the deployment of 4G technologies, so as to provide industry with greater visibility of the spectrum resource available. IDA also notes industry interest in the spectrum for LTE deployment, which is likely to come earlier than 2015. As mentioned in the Consultation, IDA hopes to conduct an early re-allocation of the 2.3 GHz and 2.5 GHz bands so as to provide greater certainty to industry on the availability of the spectrum resource after 2015, given that the WBA spectrum rights will be expiring on 30 Jun 2015. The re-allocation could take place as early as 2012, once spectrum coordination is completed. IDA notes that there were no objections from the respondents on the prospect of an early re-allocation of the 2.3 GHz and 2.5 GHz bands.

22 With regard to the allocation approach, as noted in the Consultation, IDA is mindful that the market-based allocation mechanism may run a risk of disrupting existing services, leading to inconvenience to end-users. It is on this basis that the Consultation had suggested the possibility of incorporating some element of FROR as part of the allocation process, should it be assessed that there is a high risk of service disruptions due to spectrum churning. IDA maintains the view that FROR should be viewed as an exception, rather than the norm, as it would result in an unlevel playing field by according some operators with an advantage over new entrants for access to the spectrum resource. Given the limited deployments in the 2.3 GHz and 2.5 GHz bands today, IDA's view is that the risk of significant service disruptions and inconvenience to end-users when the bands are re-allocated in 2015 is low at this juncture. The risk is further muted if the re-allocation can be conducted as early as 2012. As such, IDA does not see a need to grant existing WBA spectrum right holders FROR to their existing spectrum when the 2.3 GHz and 2.5 GHz bands are reallocated. In any case, with another 4 years until the expiry of the WBA spectrum rights, IDA is of the view that there are other measures that may be adopted to protect consumers against potential service disruptions, which may in turn obliterate the need for FROR during the re-allocation exercise.

### Rollout Commitments

23 The respondents offered different suggestions on incorporating rollout commitments, in terms of service provisioning and coverage obligations. IDA will take these suggestions into consideration when determining the spectrum allocation framework.

### **PART III: USE OF EXISTING 900 MHZ/1800 MHZ and 2.3 GHZ AND 2.5 GHZ SPECTRUM**

24 Today, the 2.3 GHz and 2.5 GHz bands have been allocated for the provision of WBA services and the spectrum rights will be expiring on 30 Jun 2015. The WBA spectrum right grants the holder the right to operate WBA systems for the provision of publicly available WBA telecom services to end-users using the WBA spectrum. IDA has not specified any limitations in the underlying technologies to be used for the deployment of WBA services in the 2.3 GHz and 2.5 GHz bands. IDA notes that some respondents have expressed interest to deploy LTE in the 2.5 GHz band before 2015. IDA considers it timely to clarify our position on use of the WBA spectrum in order to provide greater clarity to the industry.

25 As mentioned in para 24, IDA does not limit the technologies deployed by operators as long as the WBA spectrum is used for the provision of publicly available WBA telecom services to end-users. This means that operators may choose to deploy WiMAX or LTE or their advanced versions under their existing WBA spectrum rights as long as the spectrum is used for any part of a WBA network that provides publicly available WBA telecom services to end-users. Nonetheless, IDA reminds operators intending to deploy LTE systems using their WBA spectrum to seek IDA's approval before deploying such systems, as required under their licence conditions.

26 IDA is also aware of growing global interest to re-farm the 1800 MHz band for LTE deployment as the propagation characteristics are much better than the 2.5 GHz band. For instance, Polish operator, Mobyland, recently announced the first commercial LTE network in the 1800 MHz<sup>1</sup>. It is expected that all leading network equipment and device manufacturers will support LTE in the 1800 MHz. In Singapore, the 900 MHz/1800 MHz bands have been allocated for the provision of public cellular mobile telecommunication services ("PCMTS"). The PCMTS spectrum rights will expire in 2017. In IDA's 2008 decision on the re-allocation of spectrum in the 900 MHz/1800 MHz bands, IDA decided that there were no strong reasons to limit the use of the bands to existing 2G technologies, and that there is an international trend towards allowing the band to be used to provide 3G. Hence, IDA will allow 2G or 3G technologies, and other technologies which share a similar platform and allow higher speed data services, such as GPRS, EDGE or HSPA, to be deployed in these bands, as long as the spectrum is used for the provision of PCMTS. Further, IDA indicated that should operators wish to deploy other technologies that may not be classified as 2G or 3G technologies or their evolved versions, but yet are capable of providing PCMTS, operators will be required to seek IDA's approval before doing so. IDA will assess such requests on a case-by-case basis, taking into account issues such as the technical interference between these technologies, technologies deployed in the neighbouring frequency bands, and any other relevant considerations.

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<sup>1</sup> [http://www.mobyland.com/pdfs/Mobyland-Press-Event\\_MBL17\\_11\\_2010\\_v5f-en.pdf](http://www.mobyland.com/pdfs/Mobyland-Press-Event_MBL17_11_2010_v5f-en.pdf)

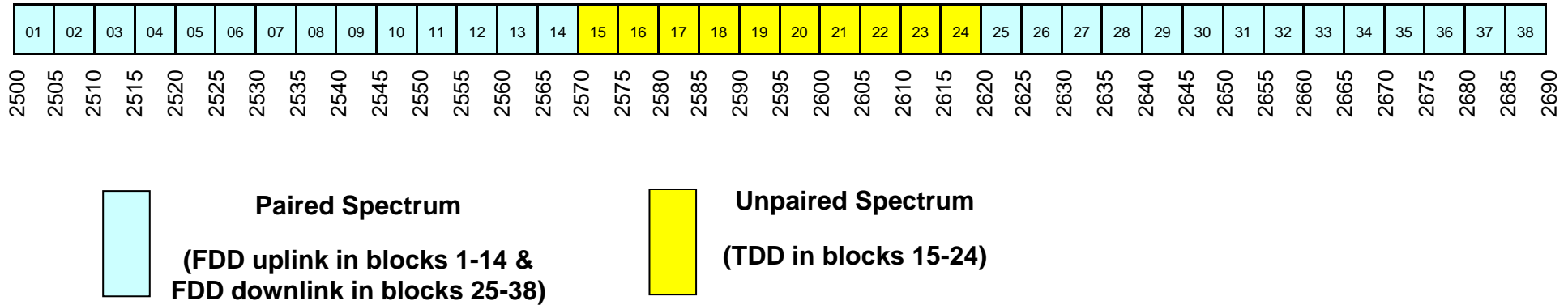
27 Consistent with IDA's position on use of the 900 MHz/1800 MHz spectrum, IDA will not prohibit operators from deploying LTE in the bands as long as operators meet the requirement to provide PCMTS using the bands. IDA clarifies that for an operator to meet the PCMTS requirement, it must offer, as a minimum, a publicly available mobile voice telephony service which meets the requirements for level "8" and "9" telephone numbers. This includes the requirements to provide nationwide coverage, free access to emergency services, and uninterrupted, seamless call handover when moving from location to location at a speed of up to 100km/h. The operator must also ensure that there is no degradation of existing services such as in the Quality Of Service standards for existing 2G services, when they implement their LTE systems and services over their PCMTS spectrum band. Beyond these minimum requirements, the operator may provide other forms of PCMTS (including PCMTS delivered over LTE systems) in addition to this voice service. IDA is aware that the coexistence of LTE and 2G systems in the bands may cause interference to the 2G systems. IDA expects operators that intend to deploy LTE with the 900 MHz/1800 MHz spectrum to coordinate with other operators in the band to reduce harmful interference. As a matter of principle, operators that deploy LTE may be required to set aside additional spectrum for larger guard bands between their LTE system and other operators' 2G systems, so as to ensure that they do not interfere with other operators' 2G systems. Operators are also reminded that they are required to seek IDA's approval to amend their FBO licence and Radio-Communications Network Licence before deploying new systems, such as LTE systems.

28 While IDA allows the deployment of LTE systems in the abovementioned spectrum bands as a policy, IDA reminds operators intending to deploy LTE using their existing WBA or PCMTS spectrum bands that operators should consider the remaining duration of their spectrum rights, and associated consumer transition issues at the end of the spectrum rights, should they decide to deploy such systems. IDA emphasises that IDA is allowing the deployment of LTE within existing spectrum rights in consideration of market and technological developments that have made such technologies available for deployment in these bands. However, IDA's decision does not guarantee any form of preference to existing holders of spectrum rights in any future allocation exercise for spectrum rights for 4G systems and services in these spectrum bands. IDA's decision to allow LTE to be deployed within the 900 MHz/1800 MHz and 2.3GHz/2.5 GHz spectrum at this juncture should in no way be construed as binding or restricting IDA's flexibility to determine the relevant terms and conditions for the re-allocation of the bands for 4G or other systems or services in future. IDA will take into account its policy objectives, spectrum availability, spectrum right conditions, market conditions and other relevant factors in determining the re-allocation framework, including the reserve price. As explained in para 22 above, IDA is not in favour of FROR as a feature of spectrum re-allocation exercises in general. IDA's view is that FROR should be viewed as an exception, rather than the norm, as it is likely to distort the market in favour of incumbent operators. In addition, IDA reserves the right to impose additional measures for consumer protection to facilitate any envisaged customer migration resulting from the re-allocation of existing spectrum rights. Through an early re-allocation exercise for the spectrum bands, existing operators will have sufficient time to plan for any transition or migration of customers based on the spectrum rights that they obtain in the re-allocation exercise to minimise end user inconvenience.

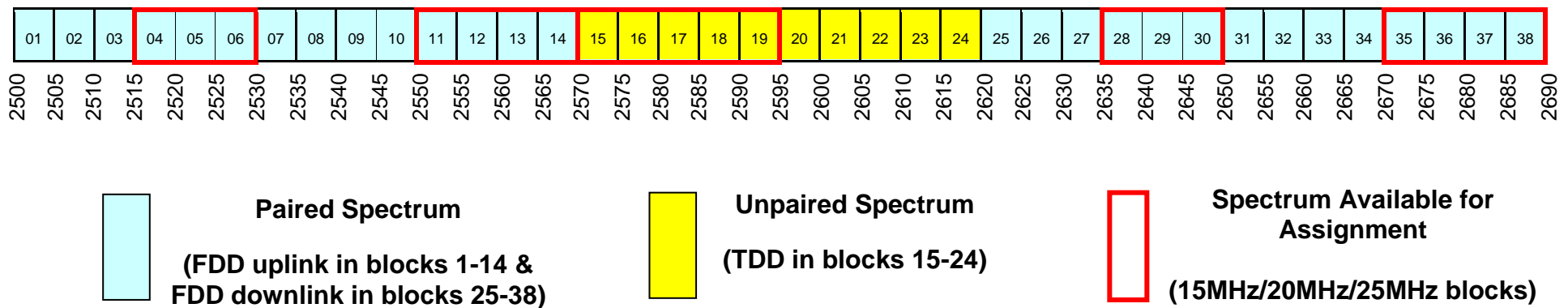


**POSSIBLE CHANNELLING PLAN FOR THE 2.5GHz BAND AFTER 2015**

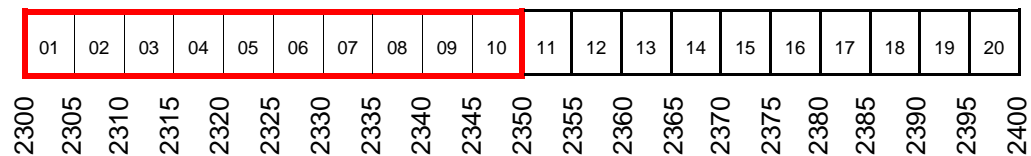
Option A



Option B



**POSSIBLE CHANNELLING PLAN FOR THE 2.3GHz BAND AFTER 2015**



**Spectrum Currently Available  
for Assignment**

**(Technology neutral blocks)**