DECISION ISSUED BY THE
INFO-COMMUNICATIONS DEVELOPMENT AUTHORITY OF SINGAPORE

FRAMEWORK FOR THE REALLOCATION OF SPECTRUM FOR FOURTH GENERATION ("4G") TELECOMMUNICATION SYSTEMS AND SERVICES

16 January 2013

PART I: INTRODUCTION

1 In the ITU report M.2072, it was predicted that the total worldwide mobile data traffic would grow from around 450 Petabytes in 2008 to around 1,000 Petabytes in 2015 with a Compound Annual Growth Rate (CAGR) of 12%[1]. IDA has conducted its own internal assessment and forecasts that the mobile data traffic in Singapore would grow exponentially from around 3.1 Petabytes in 2010 to around 37 Petabytes in 2015, representing a CAGR of 64%. In parallel with the surge in mobile data traffic, global adoption of '4G' technologies such as Long Term Evolution ("**LTE**") is gathering pace. This is reflected in the mobile landscape in Singapore, where mobile operators have progressively ramped up the deployment of LTE systems and services.

2 IDA has been monitoring market developments and recognises the importance of providing greater certainty to operators looking to deploy 4G systems and services, particularly with respect to spectrum availability. On 10 April 2012, IDA issued a public consultation on its proposed framework for the reallocation of spectrum for 4G telecommunication systems and services ("**Consultation**"). Views were sought on the following:

(a) The available spectrum for reallocation, notably:

i. The proposal to reallocate the 1800 MHz, 2.3 GHz and 2.5 GHz spectrum bands[2], and the amount of spectrum to allocate in each band;

ii. The start date for the full-band sharing arrangement in the 2.5 GHz band and spectrum availability in that band;

iii. Block size, number and arrangement of spectrum lots to be made available for reallocation; and

iv. Whether to set aside guard bands at the frequency boundaries between spectrum lots used for FDD and TDD technologies in the 2.5 GHz band;

(b) Allowable uses for the spectrum, including the definition of 4G telecommunication services;

(c) Key proposed spectrum right conditions, notably nationwide systems and service coverage requirements;

(d) Proposed auction format and parameters, including the spectrum lot sizes and spectrum caps;

(e) Interest in new entry into the market for provision of 4G telecommunications services;

(f) Cross-border co-ordination measures; and

[1] ITU-R M.2243 "Assessment of the global mobile broadband deployments and forecasts for International Mobile Telecommunications".

[2] The "1800 MHz band" refers to the paired spectrum bands from 1710 MHz to 1785 MHz and 1805 MHz to 1880 MHz. The "2.3 GHz band" refers to the spectrum band from 2300 MHz to 2400 MHz while the "2.5 GHz band" (also more commonly known as the "2.6 GHz band" in Europe) refers to the spectrum band from 2500 MHz to 2690 MHz.

(g) Use of spectrum for 2G systems and services.

3 Comments from eight respondents were received at the close of the Consultation on 8 June 2012:

(a) Ericsson Telecommunications Ltd

(b) Lock Spectrum Consultancy

(c) M1 Limited

(d) Nokia Siemens Networks Singapore Pte Ltd

(e) Packet One Singapore Pte Ltd;

(f) Qualcomm International;

(g) SingTel Mobile Singapore Pte Ltd; and

(h) StarHub Mobile Pte Ltd.

4 IDA thanks all respondents for their inputs. Respondents were broadly supportive of the framework, while making suggestions for improvements to certain aspects. The subsequent parts of this paper discuss the key issues raised during the Consultation, comments received from respondents, and IDA's Decision on the final allocation framework.

PART II: SUMMARY OF RESPONSES AND IDA'S DECISION

AVAILABLE SPECTRUM AND TREATMENT OF NEW ENTRANTS

Spectrum to be allocated

5 In the Consultation, IDA proposed allocating the 1800 MHz, 2.3 GHz and 2.5 GHz bands, but not the 900 MHz band, in this reallocation exercise. IDA noted that allocating the three bands together may facilitate more efficient network planning, as there may be complementarities between the 1800 MHz, 2.3 GHz and 2.5 GHz bands, and the propagation characteristics of all three bands are suited for urban deployment for mobile data capacity. IDA proposed not to allocate the 900 MHz band as the technology path is less certain and equipment for the band is currently geared mainly towards re-farming the band for 3G purposes. Delaying the allocation would allow IDA and industry to monitor technology developments in this band.

6 Respondents generally agreed with the allocation of the 1800 MHz, 2.3 GHz and 2.5 GHz bands. Some respondents also asked for the 900 MHz band to be allocated to aid network planning and provide certainty for provision of 2G services. There were also requests for more certainty on the availability of spectrum in the 700 MHz band.

7 IDA notes industry's support for the allocation of the three bands. In relation to the allocation of the 900 MHz band, IDA recognises that there may be synergies in including the 900 MHz band in this reallocation exercise. For example, for operators' network planning purposes, the amount of 1800 MHz band to be re-farmed for 4G may depend on the amount of 900 MHz spectrum available to them to contain the residual demand for 2G. There may also be dependencies between the amount of spectrum an operator may desire for 4G and the spectrum it has for other mobile data services like 3G. However, as in any spectrum allocation exercise, the amount of certainty that IDA can provide to interested bidders has to be balanced by other considerations. While the spectrum rights in the 1800 MHz and 900 MHz bands expire synchronously, there is clearer value in providing certainty for the use of the 1800 MHz band much earlier than the expiration of the existing spectrum rights, given that 4G services are already being deployed in the band today. The case is less strong for the 900 MHz band since the technological pathway for 4G is still relatively uncertain, and the industry trend has been to re-farm it for 3G services. As such, IDA has decided to include the 1800 MHz band in this reallocation exercise, and not the 900 MHz band. The 900 MHz band will be allocated in a separate exercise prior to expiry of the existing PCMTS spectrum rights. In this regard, IDA notes the comments for an earlier reallocation of the 900 MHz band to provide existing operators with greater certainty of spectrum holdings and will incorporate the consideration in deciding when to reallocate the 900 MHz band.

8 In relation to the 700 MHz band, IDA notes that co-ordination on re-farming and use of the band will continue in the near term. The availability of the band for 4G services is dependent on the date for analogue switch-off agreed to between Singapore and its immediate neighbours. Currently the switch-off date for Singapore is slated for no later than 2020. Therefore, the 700 MHz band will also not be made available in this reallocation exercise.

9 In relation to the amount of spectrum to be made available in each spectrum band, IDA proposed the following spectrum supply after considering the need to make sufficient spectrum available while reserving some for future needs and temporary assignments:

Spectrum band	1800 MHz	2.3 GHz	2.5 GHz
Amount to be allocated (MHz)	140 (2 x 70 MHz paired)	30 (unpaired)	150* (2 x 60 MHz paired and 30 MHz unpaired)
Reserved (MHz)**	10 (2 x 5 MHz paired)	20 (unpaired)	40 (2 x 10 MHz paired and 20 MHz unpaired)

* including 2 x 20 MHz set aside for a new entrant.
** for uses such as trials for new technologies, or future increases in demand for capacity.

10 Respondents generally urged IDA to reallocate as much available spectrum in the 1800 MHz, 2.3 GHz and 2.5 GHz bands as possible, instead of reserving the spectrum for trial or experimental uses.

11 In relation to the Frequency Division Duplex ("**FDD**") spectrum in the 1800 MHz and 2.5 GHz bands, taking the industry's comments into consideration, IDA agrees that it may be more efficient to release the reserved spectrum in the 1800 MHz band for allocation, considering that temporary or trial use of spectrum in this band has typically been localised and shielded. Therefore, IDA will avail the last 2 x 5 MHz lot in the 1800 MHz band, currently held by IDA in reserve, to the market. However, in relation to the 2.5 GHz band, IDA notes that the higher end of the band may be subject to potential interference from radar services operating in the adjacent band (please refer to the section on "Co-existence of mobile services and radar services"). As such, IDA will continue to retain 2 x 10 MHz in the 2.5 GHz band for trial, temporary and other uses.

12 While respondents urged IDA to allocate all available spectrum, IDA noted low industry interest in deploying 4G services in the Time Division Duplex ("**TDD**") segments of the 2.3 GHz and 2.5 GHz bands, even though parts of the bands are currently assigned. Industry discussions have also revealed that more time might be needed to garner more interest in the TDD bands. IDA has thus decided to de-link the allocation of the TDD segment of the 2.5 GHz band and the 2.3 GHz band from this reallocation exercise.

13 IDA will continue to monitor market interest and technology developments, and will allocate the relevant TDD spectrum bands subsequently when there is greater market interest in deploying TDD technologies in Singapore. Such allocation could be for the provision of localised or nationwide services, or structured along frameworks different from that of this current reallocation exercise, depending on market interest expressed by operators.

"Set-aside" spectrum for new entrant

14 In the Consultation, IDA mooted the idea of preferential terms for a new entrant, in particular, setting aside 2 x 20 MHz of spectrum in the 2.5 GHz band which only operators that do not currently provide nationwide mobile system and service coverage in Singapore are eligible to bid for. Most of the respondents objected to the "set-aside", for reasons such as the "set-aside" being an arbitrage opportunity for new operators, the detrimental impact on quality of 4G deployment, and the denial of sufficient spectrum for existing mobile operators. There were also suggestions for IDA to set aside spectrum in the TDD bands, rather than in the 2.5 GHz FDD band.

15 IDA recognises that subjecting all interested bidders to the same allocation framework would serve the objective of allocating spectrum to the bidders that value it highest. However, providing an incentive for new entrants, such as a "set-aside", would be more aligned with IDA's policy aim of facilitating more competition and innovation in the longer term, subject to market interest. IDA also considered that the mobile market today is already mature[3], and incumbent players may be willing to pay a premium for spectrum to secure their position and reap the value of services already being offered.

16 However, while incentivising new entry, IDA is cognisant of the need to ensure that existing mobile operators providing nationwide mobile systems and services continue to have access to a reasonable amount of spectrum. Therefore, IDA will maintain the "set-aside" of 2 x 20 MHz of the 2.5 GHz FDD spectrum band, which in IDA's view is a reasonable amount for any new entrant to deploy a viable nationwide network offering publicly available retail 4G services to end users. This "set-aside" spectrum will be allocated at the same reserve price as the other spectrum lots in the 2.5 GHz band. The new entrant may procure any additional spectrum by participating in the subsequent main auction for the remaining spectrum as a bidder. The exact placement of the "set-aside" spectrum, as well as any additional spectrum procured by the new entrant in the main auction, will be assigned together with the spectrum holdings of the rest of the bidders in the assignment stage of the main auction (please refer to the section on "Auction Format"). For avoidance of doubt, IDA will consider any operator that does not currently provide nationwide mobile system and service coverage in Singapore to be a new entrant. Further, operators interested to enter the market should note that all operators wishing to deploy telecommunication systems or provide telecommunication services in Singapore are required to obtain the relevant licences from IDA. The new entrant will be required to obtain a Facilities Based Operator ("**FBO**") licence from IDA, among other licences, to roll out its nationwide mobile system. Among other conditions, IDA will require FBO licensees to roll out their networks and provide services in accordance with their offers and proposals as stated in their applications. Each licensee is required to provide IDA with a performance bond for its infrastructure rollout commitment, for a sum amounting to 5% of its total budgeted capital investment as committed in its application[4].

17 IDA does not intend to set aside spectrum for more than one new entrant. If there is more than one prospective new entrant, IDA will use a single-round second

[3] As reflected by indicators such as mobile penetration rate, which was almost 150% as of October 2012.

[4] More details may be found in the document "Guidelines on Submission of Application for Facilities-Based Operator Licence" at IDA's website

price sealed bid auction to determine the prospective new entrant that will be allocated the "set-aside" spectrum and the price of the spectrum. Briefly, this means that each prospective new entrant will submit a sealed bid above the reserve price for the set-aside spectrum. The winning bidder will be the one that submits the highest bid, but will pay the second-highest bid submitted.

18 Based on industry responses to the Consultation, IDA notes that the likelihood of new entrant interest may not be high. However, to provide a definitive test of market interest, IDA intends to provide a window for new entrants to submit a binding expression of interest before proceeding to the main auction[5]. If one or more parties express interest, the 'set-aside' spectrum quantity will be allocated before the main auction proceeds. The successful bidder of the 'set-aside' spectrum, and all other interested new entrants will be able to participate in the main auction. For avoidance of doubt, if there is no expression of interest by new entrants, the "set-aside" spectrum will be included in the main auction.

Summary of spectrum supply

19 The revised spectrum supply for this reallocation exercise is summarised in the table below. The spectrum lots to be allocated are shown in **Annex A**.

Spectrum band	1800 MHz (expiring Mar 2017)	2.3 GHz (expiring Jun 2015)	2.5 GHz (expiring Jun 2015)
Amount to be allocated	150 MHz (2x75 MHz paired)	-	120 MHz* (2x60 MHz paired)
Reserved	-	50 MHz (unpaired)	70 MHz (2x10 MHz paired and 50 MHz unpaired)

* including 2 x 20 MHz initially set aside for a new entrant.

First Rights of Refusal

20 IDA received several requests to grant First Rights of Refusal ("**FROR**") to current spectrum right holders either prior to the reallocation exercise or at the assignment stage of the auction to minimise disruption to existing services and facilitate network planning.

21 As a matter of principle, IDA is not inclined towards granting FROR, as it strengthens incumbency and distorts the market mechanism in ensuring that the scarce spectrum resources are allocated to parties that are best able to make use of them. However, IDA has previously recognised that there may be situations where granting FROR may be a practical approach that would avoid large-scale disruption of services, such as for the reallocation of the 1800 MHz spectrum rights in 2008, primarily to allow continuity of existing services. The granting of FROR has so far been limited to the assignment stage of the spectrum auction.

[5] Details of the documents to be provided by prospective new entrants in submitting an expression of interest will be provided in the Information Memorandum to be published subsequently.

22 The main considerations for IDA in relation to the issue of FROR for this reallocation exercise are the potential disruption to existing 2G/4G services over the 1800 MHz band, and the technical feasibility and impact of granting FROR in both bands. IDA finds the argument for FROR to be weak on both aspects.

23 In relation to the impact on existing services in the 1800 MHz band, IDA is of the opinion that disruption may be mitigated by the long lead time (about four years) between allocation of the new spectrum rights and expiry of the existing PCMTS spectrum rights, which will allow operators to make the necessary network adjustments if required. At the same time, while 4G systems have already been deployed using both the 1800 MHz and 2.5 GHz bands, their nascent nature and relatively limited deployment also mitigate the disruptive impact of spectrum reallocation.

24 IDA finds the case for FROR to be similarly weak when considering the technical feasibility and impact of granting FROR. In the 2.5 GHz band, the shift to 4G would mean realigning the spectrum from 6 MHz to 5 MHz blocks. This implies difficulties in determining which of the new 5 MHz spectrum blocks operators should have FROR. Even if FROR was technically feasible in the 2.5 GHz band, it would disadvantage operators with existing spectrum rights over the TDD part of the band.

25 While the technical challenges are milder for the 1800 MHz band, FROR could lead to spectral inefficiency. FROR could potentially perpetuate existing allocation inefficiencies, or, in the case where operators win more than their existing spectrum holdings, hinder the deployment of the additional spectrum in a contiguous manner.

26 IDA recognises that the calls for FROR are primarily driven by concerns over the fragmentation of existing spectrum holdings due to frivolous or freak bidding outcomes. IDA does not intend to grant FROR at the main auction. However, given respondents' feedback that contiguous spectrum holdings will be more technically efficient, IDA will only consider combinations of contiguous spectrum blocks for every successful bidder during the spectrum assignment stage to address operators' concerns, and will also allow successful bidders the opportunity to agree on the assignment of the bands. The details of the spectrum assignment stage will be discussed in the section "Auction format and parameters".

ALLOWABLE USES FOR THE SPECTRUM

27 IDA proposed in the Consultation that the spectrum be used for the deployment of 4G systems and services, with 4G defined as *"an all-IP packet switched cellular mobile communications system capable of evolving to achieve the targeted peak data rates of 100 Mbits/s for high mobility and 1 Gbit/s for low mobility as defined by ITU-IMT-Advanced; meeting at minimum the standards and specifications of either LTE (i.e. 3GPP Release 8), or WiMax (i.e. IEEE 802.16-2009)."*

28 Respondents generally agreed with the use of the spectrum in accordance with the proposed definition of 4G services, with some indicating that the proposed approach is both flexible and practical. Others, however, cautioned IDA against being too prescriptive, as it could potentially hinder future technology rollout. In particular, one respondent highlighted that the target peak rate specified in the definition would not be achievable if an operator only obtained 2 x 20 MHz of spectrum. There were also comments that IDA should not adopt a strict definition of 4G technologies and

services given that 4G technologies are still evolving, as well as suggestions that IDA use the ITU's requirements that define the capabilities of IMT-Advanced technology.

29 IDA agrees that taking a flexible approach towards defining 4G is important, since 4G technologies are still evolving. It was for this reason that IDA proposed to assess alternative technologies to be deployed in the 4G spectrum bands on a case-by-case basis. With regard to the suggestion of relying on the ITU's requirements for IMT-Advanced, IDA had previously assessed that doing so would not be a holistic approach, since the ITU has recognised LTE and WiMAX as 4G technologies, despite not meeting the technical specifications for IMT-Advanced.

30 IDA will thus maintain the approach of a case-by-case assessment for deployment of alternative technologies in the bands allocated for 4G services. To further ensure that the definition is technology neutral, however, the definition of 4G will be further refined to be: *"a cellular mobile communications system capable of evolving to achieve the targeted peak data rates of 100 Mbits/s for high mobility and 1 Gbit/s for low mobility as defined by ITU-IMT-Advanced; meeting at the minimum the standards and specifications of either LTE (i.e. 3GPP Release 8), or WiMax (i.e. IEEE 802.16-2009) or standards/specifications recognised as ITU-IMT-Advanced by the ITU."*

31 IDA notes that under this definition, operators may be able to meet the requirement to deploy 4G systems and services while providing data-only services. IDA notes that holders of PCMTS spectrum rights today, which include all rights to spectrum in the 1800 MHz band, are required to provide, as a minimum, a publicly available mobile voice telephony service which meets the requirements for level "8" and "9" telephone numbers, within the service scope and obligations under their existing FBO licences. 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. Given that mobile voice telephony services are still prevalent today, IDA intends to retain this requirement for successful bidders of spectrum in the 1800 MHz band. To be clear, operators may satisfy this requirement using only a portion of the spectrum in the new spectrum right. Also, at this juncture, operators are not required to satisfy this requirement to provide mobile voice telephony services through the use of 4G technologies only in the 1800 MHz band, and may consider using other technologies to meet this obligation.

KEY PROPOSED SPECTRUM RIGHT CONDITIONS

Spectrum right commencement and duration

32 In the Consultation, IDA proposed that the spectrum rights for the allocated spectrum be valid until 30 June 2030 (i.e. about 13 years for the 1800 MHz spectrum rights, and 15 years for the 2.5 GHz spectrum rights). This was intended to balance the need to make spectrum available for new uses and the provision of investment certainty for spectrum right holders. Two respondents commented on IDA's proposal. One agreed with the proposal, while the other proposed that the spectrum right duration should be between 20 to 25 years to give sufficient time for the spectrum right holder to deploy the 4G network and recover its costs.

33 Having considered these views, IDA will maintain the proposed spectrum right duration, which strikes a balance between investment certainty and catering for technological change. IDA deems this to be a reasonable period that is consistent with the duration of previous spectrum rights. While IDA had previously set a longer duration (20 years) for the 3G spectrum rights, these spectrum rights had been issued at a time when the technology trends and equipment availability for 3G were less certain. In contrast, there is greater certainty over the technological pathways and equipment availability for the 1800 MHz and 2.5 GHz FDD bands, as operators worldwide are already deploying 4G services in these bands today. IDA is also mindful that the spectrum right duration should not be as short as that of the WBA spectrum rights (10 years) since operators would be expected to invest relatively large amounts of resources into the deployment of 4G networks nationwide.

34 For the avoidance of doubt, the spectrum rights to be allocated in this allocation exercise will commence on 1 July 2015 for spectrum in the 2.5 GHz band and 1 April 2017 for spectrum in the 1800 MHz band.

Proposed timeline for nationwide coverage requirements

35 IDA recognised in the Consultation that the new spectrum rights should be more effectively used to provide nationwide 4G services, rather than used by operators solely to deploy niche or geographically-limited services. IDA therefore proposed the following timelines for deployment of nationwide 4G systems and services by mobile operators using spectrum in the 1800 MHz and 2.5 GHz bands to be allocated in the main auction:

Bidders which have been allocated:	Nationwide coverage requirements (except MRT underground stations/lines and road tunnels)	Coverage requirements for MRT underground stations/lines and road tunnels
At least 2 x 15 MHz of spectrum in the 2.5 GHz bands	by 30 June 2016 (i.e., 12 months after the commencement of new spectrum rights in the 2.5 GHz band)	by 30 June 2018 (i.e., 36 months after the commencement of new spectrum rights in the 2.5 GHz band)
Any other combination of spectrum in the 1800 MHz band and/or the 2.5 GHz band (E.g., spectrum in the 1800 MHz band only; or less than 2 x 15 MHz of spectrum in the 2.5 GHz band)	by 31 March 2018 (i.e., 12 months after the commencement of new spectrum rights in the 1800 MHz band)	by 31 March 2020[6] (i.e., 36 months after the commencement of new spectrum rights in the 1800 MHz band)

36 There was general support for the nationwide 4G systems and service coverage requirements, but several respondents objected to the timeline for

[6] This date has been corrected from 30 June 2020 as stated in the Consultation paper.

underground MRT line/road tunnel coverage. Some noted that the deployment in tunnels would be dependent on multiple parties, and would not be within operators' full control. Others commented that the 36-month timeline for MRT tunnels was unrealistic given that mobile operators took almost three years to provide 3G in the North-South-East-West MRT tunnels. IDA also received suggestions that the timeline for 4G rollout in MRT lines/road tunnels should be set after engaging the relevant stakeholders.

37 After consideration, IDA has decided to maintain the deadlines for nationwide coverage, including coverage of MRT lines/road tunnels proposed in the above mentioned table for existing mobile operators. On concerns over the coverage of MRT lines/road tunnels, IDA notes that while the deadline is 36 months from the commencement of the new spectrum right, existing mobile operators who will be holders of the new spectrum rights are not precluded from undertaking works prior to the commencement of their respective spectrum rights. In fact, all three mobile operators have already started the deployment of 4G systems and offering 4G services using their existing spectrum holdings in the 1800 MHz and 2.5 GHz bands. With certainty of spectrum holdings by the conclusion of this reallocation exercise, successful bidders will have approximately five to seven years to achieve coverage for underground MRT lines/road tunnels. Nonetheless, IDA is cognisant of the operational challenges involved in ensuring underground 4G coverage and is prepared to allow extensions to the deadline for tunnel coverage on a case-by-case basis where justified.

38 IDA will similarly require the new entrant that obtains the "set-aside" spectrum to comply with a set of nationwide coverage timelines, as proposed in the consultation. These timelines will continue to apply even if this new entrant obtains any additional spectrum in the main auction, as IDA considers the additional spectrum to be supplementary to the "set-aside" spectrum. The timelines for the new entrant are shown in the table below:

	Nationwide coverage requirements (except MRT underground stations/lines and road tunnels)	**Coverage requirements for MRT underground stations/lines and road tunnels**
Timeline	by 30 June 2018 (i.e., 36 months after the commencement of new spectrum rights in the 2.5 GHz band)	by 30 June 2020 (i.e., 60 months after the commencement of new spectrum rights in the 2.5 GHz band)

Quality of Service

39 IDA also received comments that there should be greater clarity over 4G Quality of Service ("**QoS**") standards. While IDA agrees that there should be clear QoS standards for 4G, time is needed to develop meaningful QoS standards for 4G services as such services are relatively nascent. IDA therefore does not intend to impose such standards currently. However, interested bidders should note that QoS standards are likely to be imposed as 4G services become more prevalent and consumers expect better 4G coverage (be it street level, underground or in-building). Any future QoS standards for 4G services are likely to set standards aligned to

consumer expectations. As per IDA's existing practice, IDA will consult the industry and the public before establishing any 4G QoS standards.

Coverage beyond shoreline

40 One respondent suggested that instead of requiring coverage to be extended to 15km beyond the shoreline, the requirement could be limited to 5km from the shoreline and extended to specific offshore islands/ areas beyond the 5km limit as necessary. This would mitigate mutual interference with the neighbouring countries arising from full-band sharing. IDA intends to maintain the 15km condition for now for consistency with the coverage requirements imposed on other nationwide mobile services. However, IDA notes the consideration of cross-border interference and will consider interference risks and any minimum QoS requirements in enforcing this requirement. For the avoidance of doubt, where operators are unable to meet this coverage requirement for certain areas from the shoreline because of technical requirements imposed by IDA, particularly those to minimise interference with neighbouring countries as elaborated on in paragraph 68, IDA will not enforce this requirement in relation to the affected areas. IDA may also separately review the need for this requirement in the future.

Spectrum co-ordination during national events

41 IDA noted in the Consultation that certain national events such as the Formula One ("**F1**") races, the National Day Parade and Chingay may place significant demands on spectrum. For example, the event organiser may require up to 1 GHz of spectrum during F1 races. IDA stated that in such cases, it may make arrangements with spectrum holders to cater to the needs of the event organiser. To be clear, while IDA has reserved the 2.3 GHz and 2.5 GHz TDD bands and 2 x 10 MHz in the 2.5 GHz FDD band in this reallocation exercise, there may still be insufficient spectrum to meet demand for national events. Therefore, IDA will continue to reserve the right to temporarily re-assign the spectrum in such instances.

Wholesale obligations

42 IDA separately considered whether mandatory wholesale obligations should be imposed on one or all of the new spectrum right holders to further promote mobile competition at the retail level, through access to services or infrastructure at the wholesale level. IDA notes that none of the existing mobile operators have been classified as dominant licensees under the Telecom Competition Code. In addition, IDA notes that several Mobile Virtual Network Operators ("**MVNOs**") exist today through wholesale arrangements with existing mobile operators which have been commercially negotiated.

43 Balancing these considerations, and noting that this allocation exercise is intended to provide spectrum for deployment of nationwide retail 4G services, IDA will not mandate wholesale obligations but will require successful bidders to negotiate in good faith to provide wholesale network access upon reasonable request, as a condition of the new spectrum right.

Spectrum trading

44 IDA does not intend to allow the new spectrum rights to be traded until the holder of the spectrum rights has met its applicable nationwide coverage timeline (excluding MRT underground stations/lines and road tunnels). This serves to deter speculation on the spectrum by winning bidders. An exception may be made where successful bidders are mutually swapping their spectrum, without monetary compensation, to enhance efficiency and usage, subject to approval by IDA. For the avoidance of doubt, any trading of the new spectrum rights will be subject to IDA's approval under the Telecommunications (Radio-Communication) Regulations. In assessing applications for IDA's approval to trade any spectrum right, whether in full or in part, IDA will consider, among others, the impact of the spectrum trade on competition in the market.

AUCTION FORMAT AND PARAMETERS

Administrative allocation or auction

45 In relation to the allocation mechanism, IDA had proposed conducting an auction to allocate the spectrum given that the market-based approach of allocation would be a fair and efficient method to allocate such a scarce and finite resource. Most of the respondents did not comment on whether the spectrum should be allocated via auction. However, one respondent proposed that IDA assess whether sufficient spectrum is available to meet demand, and consider 'a collegial approach' towards spectrum allocation if spectrum is available to meet demand.

46 IDA will maintain the position of allocating the spectrum via auction rather than administrative allocation for greater efficiency. Compared to administrative allocation, the auction mechanism provides a more effective means of allocating a scarce resource like spectrum at a price that accurately reflects the value placed on it by the market. Even if demand meets supply, an auction approach, albeit clearing at the reserve price, would still accord greater process transparency to the allocation framework.

Auction format

47 IDA had proposed adopting the Clock Plus format for the bidding in the auction in order to provide an efficient auction outcome that would also eliminate aggregation risks within categories of spectrum. Not all respondents commented on the proposed auction format. Among those that did, some stated a preference for the Clock Plus format. One respondent commented that if the Simultaneous Multi-Round Ascending ("**SMRA**") format had to be used, the auction should be based on generic lots to avoid spectrum fragmentation.

48 As the feedback has generally been positive, IDA will retain the decision to use the Clock Plus auction format for the main auction. This means that IDA will conduct a main auction that involves two bidding stages – the first stage to allocate the number of spectrum lots to each bidder (the "**Quantity Stage**"), and the second stage to assign the placement of the bidders' spectrum holdings (the "**Assignment Stage**").

49 In IDA's proposed auction format, spectrum lots in each of the 1800 MHz and 2.5 GHz bands are considered to be generic. While more details of the auction

process will be available in the Auction Rules which IDA will subsequently publish, the main auction is envisioned to take place after the registration of new entrant interest and the allocation of the "set-aside" spectrum (if any), and follow the process outlined below:

(a) Initial Offer Stage: Interested bidders will first be required to submit an Initial Offer in respect of the quantity of spectrum lots they demand in each spectrum band – the 1800 MHz band and the 2.5 GHz band. Should the quantity demanded by all bidders exceed the overall quantity available for allocation for either band, the auction will proceed to the Quantity Stage. If the quantity of spectrum lots demanded does not exceed the overall quantity available for allocation, bidders will be allocated the quantity demanded at the reserve price and proceed to the Assignment Stage.[7]

(b) Quantity Stage: IDA will use the Clock Plus format to conduct the Quantity Stage of the auction. There will be a price 'clock' for each category of spectrum (the 1800 MHz band and 2.5 GHz band). At the start of each round, bidders will submit their demand for the quantities of lots in each category, subject to eligibility rules and spectrum caps. The price of lots in each category will 'tick' up by a predetermined value if there is excess demand at the end of the round, and the auction will proceed to the next round. The bidding will continue until there is no longer any excess demand for either spectrum category, at which point the Quantity Stage will conclude.

(c) Assignment Stage: Once the quantity of lots allocated to each successful bidder has been determined, the auction will proceed to the assignment stage. Only for this stage, IDA is prepared to allow and accept a joint proposal for the actual assignment of the spectrum lots from the successful bidders of the Initial Offer Stage or Quantity Stage, as the case may be[8]. This may include a proposal for IDA to assign the spectrum lots, or (if bidders agree on the assignment of part of the spectrum band only) to implement a bidding stage for the contended segment of the spectrum bands only. If bidders fail to submit a joint proposal by IDA's specified date, IDA will implement a single-round, sealed-bid auction to determine the assignment. Bidders will indicate their willingness to pay for each possible assignment listed by IDA (which will comprise all possible combinations made up of contiguous spectrum holdings for every successful bidder of the quantity stage), and the final assignment of the spectrum will be the result that yields the highest total value.

50 IDA believes that the proposed auction format is simple for bidders to follow, yet effective, as it allows the simultaneous reallocation of categories of spectrum lots even if the lots have non-generic features or bidders have preferences for specific lots.

[7] If the quantity of spectrum lots demanded is lower than the overall quantity available for allocation, the remaining spectrum will be reallocated at a later date taking into account market interest.
[8] This stage will also include any new entrant allocated the "set-aside" spectrum.

Spectrum lots

51 IDA proposed having lot sizes of 2 x 5 MHz for the FDD spectrum in the 1800 MHz and 2.5 GHz bands to provide flexibility for bidders to decide how much spectrum they would want to bid for. Respondents suggested lot sizes ranging from 2 x 5 MHz to 2 x 10 MHz or larger. On balance, IDA will maintain lot sizes of 2 x 5 MHz for the FDD spectrum, in view of the greater potential for efficiency in allocation. There will thus be 15 and 12 lots of 2 x 5 MHz each in the 1800 MHz and 2.5 GHz FDD bands respectively (including the 2 x 20 MHz "set-aside"). The lots available are summarised in the table below:

Category	Lots available	Spectrum range (MHz)	
1800 MHz	15 lots (total 2 x 75 MHz)	**Lower Band**	**Upper Band**
		1710 – 1785	1805 – 1880
2.5 GHz FDD	12 lots* (total 2 x 60 MHz)	**Lower Band**	**Upper Band**
		2500 – 2560	2620 – 2680

* Including the 4 lots initially set aside for new entrant.

Spectrum caps

52 For each bidder, IDA proposed, in the Consultation, a cap of 2 x 45 MHz in total for spectrum in the 1800 MHz and 2.5 GHz FDD bands, and no cap for spectrum in the TDD bands. Two respondents opined that the proposed 2 x 45 MHz cap on FDD spectrum was too restrictive. One of the two opined that it would not allow operators to achieve the expected data throughput for 4G, as each operator would need at least 2 x 40 MHz of spectrum to deploy and support the anticipated growth in mobile services. The same respondent also suggested that there be sub-caps in each of the frequency bands to ensure that no single operator would obtain a majority or the entire spectrum in the band. The other respondent who objected also opined that future IMT-Advanced deployment will require contiguous blocks of at least 2 x 20 MHz each in the 1800 MHz and 2.5 GHz frequency spectrum bands to allow for inter-frequency aggregation and to achieve an optimal throughput as close to the peak 4G-Advanced throughput as possible.

53 IDA's policy rationale for spectrum caps is to prevent any monopolisation of the spectrum. As such, the spectrum caps are intended to facilitate an outcome where at least three operators may reasonably be able to obtain sufficient spectrum holdings to deliver viable nationwide 4G services. The spectrum caps are summarised in the table below.

Scenario	Spectrum supply	Overall spectrum cap
No new entrant	2 x 135 MHz	2 x 55 MHz
With new entrant	2 x 115 MHz	2 x 45 MHz

54 IDA notes that sub-caps may be necessary particularly to avoid hoarding of the 1800 MHz band in view of the importance of the band in providing both 2G and 4G services. IDA will thus put in place a sub-cap of 2 x 30 MHz for the 1800 MHz band.

RESERVE PRICE AND FEES

55 The applicable fees for the new spectrum right include the upfront auction fee, annual spectrum management fees and a one-time application and processing fee. IDA will set the reserve price of the upfront auction fee at S$16M per 2 x 5 MHz lot for

the 1800 MHz band and S$10M per 2 x 5 MHz lot for the 2.5 GHz band, excluding Goods and Services Tax ("**GST**"). In setting the reserve prices, IDA considered the estimated value of the spectrum in light of market trends, international comparisons and other factors such as expected competition in the auction and the variability of spectrum valuations. A higher price is proposed for the 1800 MHz band in view of the higher value placed by operators due to its better propagation characteristics to better enable the mobility factor.

56 IDA notes that the spectrum rights to be awarded in this reallocation exercise will not commence immediately, and is prepared to allow successful bidders to have the option of deferring the payment of the upfront auction fee to a date no later than six months before the commencement of the relevant spectrum rights. The deferment will be subject to the successful bidder providing a Bank Guarantee for 75% of the total upfront auction fee due for the respective spectrum rights. More details of the payment schedule will be made available in the Information Memorandum to be published at a later date.

57 In addition to the upfront auction fee, IDA will also require the bidders to pay an annual spectrum management fee of S$26,400 per 2 x 5 MHz spectrum lot per year of each spectrum right, and a one-time application and processing fee of S$5,400 per 2 x 5 MHz spectrum lot.

58 Operators will also be subject to relevant fee frameworks imposed by IDA, including licence fees payable by FBOs in respect of the revenues from 4G services they provide.

COMMENCEMENT OF SERVICES BEFORE COMMENCEMENT OF SPECTRUM RIGHTS

59 Although the spectrum rights to be allocated will commence on 1 July 2015 and 1 April 2017 for spectrum in the 2.5 GHz and 1800 MHz bands respectively, IDA notes that successful bidders may be interested to commence the deployment of systems and services earlier if the spectrum in question is currently unassigned.

60 In relation to the currently unassigned 2 x 5 MHz lot in the 1800 MHz band (1730 MHz to 1735 MHz paired with 1825 MHz to 1830 MHz), IDA will provide an option for the successful bidder of that spectrum lot to commence earlier use of that lot should it decide to exercise the option. The winner will be granted an option to be administratively assigned a spectrum right to use that spectrum lot upon assignment until 31 March 2017 ("**Interim Spectrum Right**"), after which the corresponding new spectrum right will commence. For the avoidance of doubt, the conditions of the Interim Spectrum Right will be substantially similar to the conditions of the 1800 MHz Spectrum Right (2011) assigned to M1 Ltd[9], which is the most recent spectrum right granted for spectrum in the 1800 MHz band. Similar to the other existing spectrum rights assigned for use of spectrum in the 1800 MHz band, for the duration of the Interim Spectrum Right, the winner will also be required to provide a guard band of at least 200 kHz on the lower frequency boundary of the lot, unless it also holds the spectrum right for the spectrum lot on the other side of the boundary.

[9] http://www.ida.gov.sg/~/media/Files/PCDG/Licensees/SpectrumMgmt/RightsIssued/M1_1800MHz_2011.pdf

61 The price of the option will be set at S$15M, based on the value of recent bids for similar spectrum rights and taking into consideration the duration of this interim spectrum right. IDA will invite the winning bidder to exercise the option for the Interim Spectrum Right by a specified time. If, however, the winning bidder does not exercise the option within the time specified by IDA, IDA reserves the right to assign the lot (for use until 31 March 2017) at IDA's discretion.

62 In relation to spectrum in the 2.5 GHz band, IDA notes that there may be a need for operators to adjust existing networks in line with the new spectrum rights obtained. IDA is prepared to administratively assign the currently unassigned spectrum bands, including the bands currently classified as "constrained frequencies" [10], to facilitate such network adjustments where necessary. Administrative fees such as frequency fees and application and processing fees will continue to apply.

63 IDA also notes that respondents, including all existing spectrum right holders in the 2.5 GHz band, generally agreed that full-band sharing should start prior to the expiry of the existing WBA spectrum rights. That being the case, IDA intends to work with neighbouring countries to commence full-band sharing earlier than 2015.

TECHNICAL ISSUES

Guard bands in the 2.5 GHz band

64 In the Consultation, IDA proposed that operators co-ordinate the use of different technologies and not to set aside guard bands at the frequency boundaries between the FDD and TDD parts of the 2.5 GHz band. Respondents suggested that guard bands of 5 MHz or 10 MHz should be deployed at the frequency boundaries between the 2.5 GHz FDD and TDD bands.

65 The issue of guard bands will not be of immediate concern as the 2.5 GHz TDD band will not be allocated in this exercise. Nonetheless, should the TDD band be released for allocation in future, IDA will require adjacent operators in the FDD and TDD bands to co-ordinate with each other, and will take reference from international practices in prescribing any guard bands.

Cross-border co-ordination in 2.5 GHz band

66 IDA sought views on its proposal to adopt the recommendations stated in the ECC/REC/(11)05 for cross-border co-ordination in the 2.5 GHz band, which were considered adequate for operators to conduct such co-ordination. Respondents who commented were generally supportive. Nonetheless, one respondent suggested for IDA to also make reference to recommendations developed by other internationally recognised standards bodies such as the ITU, to ensure different systems are standardised and operate in a harmonised manner. Another respondent highlighted that other than adopting an appropriate recommendation, it is also important to

[10] These are frequencies where priority access is given to operators in neighbouring countries pursuant to frequency co-ordination agreements. Please refer to IDA's information paper titled "Framework for Assignment of Frequencies on Non-Interference and Unprotected Basis' for more details. This paper is available at:
http://www.ida.gov.sg/~/media/Files/PCDG/Licensees/SpectrumMgmt/SpectrumAuctAss/NonInterfUnprotBasis/Info%20Paper_8Mar10.pdf

establish a robust and effective mechanism to ensure co-ordination takes place. IDA notes the comments and will also consider the various international recommendations for border co-ordination. IDA will proceed to engage with neighbouring countries to establish the co-ordination procedures and requirement as set up in the recommendations of the ECC/REC/(11)05.

Harmonisation of 4G base stations at border areas with BSS in Indonesia

67 IDA invited views on measures for harmonisation of 4G base stations deployed at the border areas with Broadcast Satellite Services ("**BSS**") in Indonesia. While respondents generally agreed to the need to harmonise the use of frequency at border areas, several respondents shared that there were some 4G base station deployment parameters besides those stated in the Consultation paper that could also be considered to co-exist with the BSS in the 2.5 GHz band. One respondent was of the view that Recommendations of the ECC/REC/(11)05 could be used for co-ordination, while another suggested to restrict the signal spillage to -110 dBm, instead of specifying the emission power and antenna down tilt angle. A third respondent expressed concern that the limiting of emission power and down-tilting the antenna, as proposed by IDA, would further aggravate the existing issue of Singapore customers roaming onto overseas networks.

68 IDA notes that the Recommendations of the ECC/REC/(11)05 are generally used for co-ordination between different mobile networks, and does not include parameters for co-ordination between BSS and 4G services. It may therefore not be suitable for the co-ordination with the BSS in Indonesia. Although IDA agrees that restricting the signal spillage provides greater flexibility for base station deployment, it would be difficult to assess the protection requirement for the existing BSS at Indonesia, particularly during the initial roll-out of the 4G networks. Hence, on the basis of co-ordinating with the BSS in Indonesia, IDA may require operators to comply with certain guidelines on mitigation measures when interference is deemed to be caused by 4G deployments in Singapore. A sample of possible measures can be found in **Annex B**. IDA (with operators) will also continue to discuss with the Indonesian regulator to identify a suitable signal spillage limit. IDA clarifies that as the restriction would only be imposed at the border areas with Indonesia, where the 2.5 GHz band is assigned for BSS, the concern over roaming onto overseas networks is not valid.

Co-existence of mobile services and radar services

69 IDA sought views on practical measures for operators to allow co-existence of mobile services in the 2.5 GHz band and radar services operating in the adjacent band. Respondents who commented agreed on the need to impose mitigation measures and supported the proposal to adopt the measures as outlined in the ECC Report 174. Two respondents indicated that increasing the guard bands between the two services is necessary, in addition to the imposition of radio frequency filters on both services. Another two suggested that IDA conduct further studies on the co-existence of both mobile and radar services in Singapore. A fifth respondent opined that IDA may want to require mobile equipment to comply with unwanted emissions levels specified for Region 1, as the ECC Report 174 is based on radio equipment that operates in Region 1. Separately, two of the respondents also noted that the 2700 MHz band is one of the potential candidate bands for IMT services in the next

WRC (WRC-15). Hence, the long term co-existence with S-band radars may no longer be an issue in the future if the S-band radars are phased out.

70 IDA's study on the co-existence between mobile systems in the 2.5 GHz band and radar systems operating in the adjacent band showed a high possibility of potential interference on both systems. Therefore, as stated in paragraph 10, IDA will reserve 2 x 10 MHz at the upper end of 2.5 GHz band. IDA notes that a 1km distance between the mobile and radar systems will generally be sufficient to mitigate interference. IDA has identified three sites, not located at the Central Business District and the downtown areas, that need to be protected from interference. IDA will generally prohibit the deployment of mobile base station(s) operating in the 2.5 GHz band in areas within these sites. IDA may, on a case-by-case basis, permit the deployment of mobile base stations within these sites subsequently, based on unique localised conditions, and subject to the agreement of the affected radar users. Interested bidders may apply to IDA for information on the sites prior to the expression of interest by a new entrant (for prospective new entrants) or the Initial Offer Stage (for participants in the main auction). For clarity, IDA will take into consideration operators' spectrum holdings in other spectrum bands when reviewing compliance with potential 4G QoS standards in the excluded sites.

Co-existence with broadcasting systems

71 For clarity, IDA notes that "television receive only" ("**TVRO**") systems are permitted to operate in the 2.5 GHz band. IDA does not currently intend to require holders of new spectrum rights in the 2.5 GHz band to co-ordinate with TVRO system owners to resolve interference problems. However, spectrum right holders would be expected to work in good faith with TVRO system users[11] to resolve any interference on TVRO systems that may occur.

USE OF 900 MHZ AND 1800 MHZ SPECTRUM FOR 2G SYSTEMS AND SERVICES

72 IDA noted that market trends indicate that 2G may increasingly become displaced by 3G and potentially 4G going forward, and sought industry views on whether IDA should facilitate the efficient winding down of 2G services in Singapore. Most of the seven respondents who commented on this issue (including the three existing mobile operators) opined that the decision on when to shut down 2G networks should be left to the market. Some respondents were also sceptical of the feasibility and benefits of sharing common resources or infrastructure for 2G services. In addition, a respondent also indicated that operators should be free to provide existing 2G services within the 1800 MHz band, and not be forced into providing only 4G services on that band.

73 IDA accepts the views expressed by the respondents that whether to shut down 2G networks should best be left to the market. In view of the sentiments expressed, IDA clarifies that it does not intend to intervene to manage the winding down of 2G networks at the current time. IDA also further clarifies that there is no intention to require operators to provide 4G services in place of 2G beyond what the market would dictate. Operators currently providing PCMTS in the 1800 MHz

[11] IDA is aware of only one TVRO user operating in the 2.5 GHz band currently. Interested bidders may apply to IDA for more information on TVRO users and the spectrum bands they operate in.

spectrum band may continue to provide PCMTS using 2G systems and services using any new spectrum rights they obtain from this allocation exercise. The deployment of other technologies other than 4G (as defined in paragraph 30) will be subject to IDA's approval.

NEXT STEPS

74 The tentative timeline for the steps following the issuance of this Decision is as follows:

Milestone	Tentative timeframe
Issuance of draft Information Memorandum and Auction Rules and submission of written queries	Mar/Apr 2013
Issuance of final Information Memorandum and Auction Rules	Apr/May 2013
Binding Expression of Interest by New Entrant	May/Jun 2013
Allocation of 'set-aside' spectrum to New Entrant (if any)	May/Jun 2013
Submission of Initial Offer and Bank Guarantee for Main Auction	May/Jun 2013
Announcement of whether Auction will proceed	To be announced
Information Session and Notification of Auction Details	
Auction Day	
Provisional Award Notice	

PART III: SUMMARY OF IDA'S DECISION

75 In summary, IDA has decided to:

a) Allocate the new spectrum rights in the 1800 MHz and 2.5 GHz band for 4G telecommunication systems and services via auction;

b) Provide the following amount of spectrum for allocation:

Spectrum band	1800 MHz	2.3 GHz	2.5 GHz
Amount to be allocated	150 MHz (2x75 MHz paired)	-	120 MHz* (2x60 MHz paired)
Reserved	-	50 MHz (unpaired)	70 MHz (2x10 MHz paired and 50 MHz unpaired)

* including 2 x 20 MHz set aside for a new entrant, which will be committed to the main auction should a new entrant not emerge.

c) Not provide FROR for the spectrum, but offer an assignment that is technically efficient during the spectrum assignment stage;

d) Set aside 2 x 20 MHz in the 2.5 GHz FDD band for a new entrant, and allocate the "set-aside" via a separate single second-price sealed-bid auction if there is more than one prospective new entrant;

e) Specify the following timelines for providing nationwide 4G systems and service coverage in MRT underground stations/lines and road tunnels for nationwide mobile operators acquiring spectrum through the main auction:

Bidders which have been allocated:	Nationwide coverage requirements (except MRT underground stations/lines and road tunnels)	Coverage requirements for MRT underground stations/lines and road tunnels
At least 2 x 15 MHz of spectrum in the 2.5 GHz bands	by 30 June 2016 (i.e., 12 months after the commencement of new spectrum rights in the 2.5 GHz band)	by 30 June 2018 (i.e., 36 months after the commencement of new spectrum rights in the 2.5 GHz band)
Any other combination of spectrum in the 1800 MHz band and/or the 2.5 GHz band	by 31 March 2018 (i.e., 12 months after the commencement of new spectrum rights in the 1800 MHz band)	by 31 March 2020[12] (i.e., 36 months after the commencement of new spectrum rights in the 1800 MHz band)

[12] This date has been corrected from 30 June 2020 as stated in the Consultation paper.

f) Specify the following timelines for providing nationwide 4G systems and service coverage in MRT underground stations/lines and road tunnels for a new entrant acquiring the "set-aside" spectrum in the 2.5 GHz band:

Nationwide coverage requirement	Nationwide coverage requirements (except MRT underground stations/lines and road tunnels)	Coverage requirements for MRT underground stations/lines and road tunnels
Timeline	by 30 June 2018 (i.e., 36 months after the commencement of new spectrum rights in the 2.5 GHz band)	by 30 June 2020 (i.e., 60 months after the commencement of new spectrum rights in the 2.5 GHz band)

g) Put in place a spectrum cap for the allocation as follows, with an additional sub-cap of 2 x 30 MHz in the 1800 MHz band:

Scenario	Total spectrum supply	Spectrum cap
No new entrant	2 x 135 MHz	2 x 55 MHz
At least one new entrant	2 x 115 MHz	2 x 45 MHz

h) Apply lot sizes of 2 x 5 MHz;

i) Maintain that the spectrum rights expire on 30 June 2030;

j) Set the reserve price at S$16M per 2 x 5 MHz lot for the 1800 MHz band and S$10M per 2 x 5 MHz lot for the 2.5 GHz band and impose an annual spectrum management fee of S$26,400 per 2 x 5 MHz spectrum lot per year, and a one-time application and processing fee of S$5,400 per 2 x 5 MHz spectrum lot;

k) Allow successful bidders to have the option of deferring the payment of the upfront auction fee to a date no later than six months before the commencement of the relevant spectrum rights, subject to the successful bidder providing a Bank Guarantee for 75% of the total upfront auction fee due for the respective spectrum rights;

l) Prohibit trading of the new spectrum rights until the holder of the spectrum rights has met its applicable nationwide coverage timeline (excluding MRT underground stations/lines and road tunnels);

m) Not intervene to manage the winding down of 2G networks at the current time and permit the continuation of 2G networks and services in 1800 MHz band by existing PCMTS operators; and

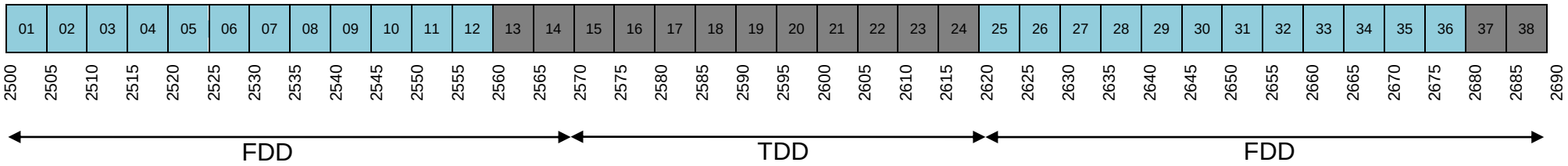
n) Provide an option for the winning bidder of the currently unassigned 1800 MHz lot to acquire an interim spectrum right to use that spectrum lot from mid-2013 to 31 March 2017, at a price of S$15M;

o) Facilitate operators' network adjustments in the 2.5 GHz band if necessary through administrative assignment of the currently unassigned spectrum bands, including the bands currently classified as "constrained frequencies", and continue to apply administrative fees for spectrum in this band.

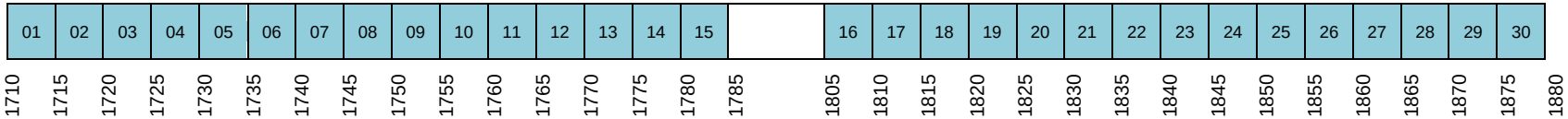
ANNEX A

SPECTRUM LOTS TO BE ALLOCATED

2.5 GHz



1800 MHz



Spectrum to be allocated

Reserved spectrum – 2x10 MHz paired for FDD and 50 MHz for TDD

ANNEX B

CONDITIONS FOR 4G DEPLOYMENTS

Considering the importance of harmonising the use of frequency spectrum at border areas with neighbouring countries, IDA requires operators to co-ordinate with the operators in the neighbouring countries operating in the same frequency bands. As such, IDA will require operators to co-ordinate with the BSS in Indonesia. However, IDA notes that co-ordination between mobile services and Broadcast Satellite Services ("**BSS**") is new to the operators. Thus, should operators not be able to achieve co-ordination with the BSS operator(s), and interference is received by the BSS operator(s), the involved operator(s) shall be required to deploy its base stations (with clear line of sight to the Indonesia's Riau islands) with the following conditions:

(i) Limit the transmission power (EIRP) of the affected base stations at 45W; and
(ii) Down-tilt the respective antennae by 6º.