



**CONSULTATION PAPER ON DEPLOYMENT OF WIRELESS BROADBAND
TECHNOLOGIES ISSUED BY THE INFO-COMMUNICATIONS
DEVELOPMENT AUTHORITY OF SINGAPORE**

**EXPLANATORY MEMORANDUM REGARDING THE WIRELESS
BROADBAND SPECTRUM ALLOCATION FRAMEWORK**

25 February 2005

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PART I: INTRODUCTION

1. On 23 February 2004, IDA announced its intention to assign the 2.3 GHz and 2.5 GHz spectrum frequency bands for Wireless Broadband Access (“WBA”) deployment. Following the announcement, IDA undertook a public consultation on 2 April 2004 to seek comments on the technical aspects of the spectrum allocation framework. The consultation closed on 21 May 2004.
2. IDA has finalised the WBA spectrum allocation framework, and has today released the Information Memorandum on the Auction of Wireless Broadband Spectrum. IDA invites operators and companies to participate in the WBA spectrum allocation process.

**PART II: OVERVIEW OF COMMENTS RECEIVED ON THE WBA
SPECTRUM ALLOCATION FRAMEWORK**

3. Wireless broadband technologies have been gaining traction in recent months. There are various proprietary solutions that have been developed for wireless broadband technologies and several local and foreign companies have expressed significant interest to deploy these technologies in Singapore. The aim of allocating spectrum for WBA is to facilitate the deployment of such innovative broadband technologies, thereby offering consumers a wider variety of broadband options.
4. At the close of the public consultation, IDA received comments from 16 respondents: ArrayComm/ArrayAsia/Kyocera (joint submission), Flarion Technologies, Lucent Technologies, Microsoft, MobileOne, Motorola, Nokia Networks, nex-G Systems, Pacific Internet, Singapore Telecommunications Ltd, Soma Networks/Cadmus Technologies (joint submission), SurgoSystems, StarHub Pte Ltd, Telstra Corporation Ltd,

WiMAX¹ Forum and Dr Ong Jin Teong. IDA would like to thank the commenters for their inputs.

5. IDA notes that the commenters in general welcomed IDA's move to allocate spectrum for WBA deployment. However, there were diverging views on the technical aspects of the spectrum allocation framework. IDA has reviewed the comments and has given extensive consideration to the views and proposals submitted.

PART III: POLICY OBJECTIVES AND APPROACH

6. One of IDA's policy objectives is to ensure the efficient use of our scarce spectrum resources to promote the growth of a vibrant infocomm industry in Singapore. Given wireless broadband's potential to provide competing broadband network access and services, IDA's key objective of allocating spectrum for WBA is to facilitate the deployment of this alternative broadband technology, thereby enhancing the competitiveness of the broadband market. In allocating the WBA spectrum, IDA hopes to encourage new infrastructure players to enter the broadband market. Most commenters were supportive of IDA's proposed market-based allocation framework, stressing the importance of a fair and transparent auction process with strict rules against anti-competitive bidding. However, some commenters suggested a "beauty contest" approach, as they viewed the auction mechanism to favour incumbents or established players with deep financial resources.
7. IDA believes that a market-based allocation process is still the most fair and efficient method to allocate a scarce and finite resource, by allowing the market to value the spectrum according to commercial considerations. Under a "beauty contest" approach, IDA would have had to ensure spectrum efficiency usage by operators based on a technical assessment, which may be challenged on the basis that it is subjective as there is no single accepted industry benchmark used to assess optimal spectrum efficiency/usage. An auction, on the other hand, allows the market to value the spectrum and provides the economic incentive for the successful bidder to optimise the use of the spectrum for maximum return on its investment. The auction approach is not intended to maximise revenue for the Government, but to ensure

¹ WiMAX means World Interoperability for Microwave Access.

that the spectrum resource is allocated in the most efficient and transparent manner.

8. IDA has developed a spectrum allocation framework with the above key objectives in mind. The sections below summarise IDA's position on the key issues raised on the spectrum allocation framework, explain the rationale behind IDA's position, and highlight the key amendments made.

PART IV: POSITION ON KEY ISSUES ON THE SPECTRUM ALLOCATION FRAMEWORK

Spectrum to be allocated

9. IDA had proposed to allocate the 2.3 GHz and 2.5 GHz bands for WBA. Most commenters supported IDA's choice of the 2.3 GHz and 2.5 GHz frequency bands, highlighting that these bands have been allocated for WBA in other countries, and have propagation characteristics suitable for wide area wireless services. However, one commenter felt that the allocation of WBA spectrum is premature and inappropriate, as the use of WBA technologies is still in the early stages, and the 2.3 GHz and 2.5 GHz bands have also not been identified by WiMAX Forum as priority spectrum for equipment standardisation.
10. IDA believes that although WBA technologies are still evolving, there are currently credible proprietary WBA technologies available in the market for deployment. Some of the equipment vendors have already deployed their networks successfully in countries like the US and Australia. We recognise that WiMAX Forum has identified the 3.5 GHz band as the priority spectrum and has started standardisation work for this band. However, the 3.5 GHz band in Singapore is currently allocated to Fixed Satellite service (space-to-Earth) on a primary basis. IDA will be studying the possibility of co-existence between WBA and Fixed Satellite services in the 3.5 GHz band. On the other hand, we note that WiMAX Forum has also identified the 2.5 GHz band for its next phase of standardisation work, and aims to cover the 2.3 GHz band as well. South Korea has also allocated the 2.3 GHz band for the deployment of WiBro, a WBA technology. Based on the current situation, IDA believes that the allocation of the 2.3 GHz and 2.5 GHz bands are most appropriate for the deployment of WBA in Singapore. IDA will allocate

the 2.3 GHz and 2.5 GHz spectrum at the same time to ensure that there is sufficient spectrum to meet industry's demand.

Mobile speed limitation of WBA services due to 3G moratorium

11. IDA made a commitment in the 3G auction to *“not grant any spectrum rights for 3G mobile communication services before 1 January 2006”*. Therefore, IDA had stated that successful bidders of the WBA spectrum will not be allowed to deploy technologies belonging to the International Mobile Telecommunications-2000 (“IMT-2000”) family of 3G standards prior to 1 January 2006. Some commenters highlighted that WBA and 3G services are becoming similar, if they are not so already, with some WBA technologies offering 3G-like mobility capabilities. One commenter also questioned if the use of the IMT-2000 definition is sufficient to differentiate WBA from 3G services.
12. IDA recognises that while 3G promises to deliver high speed data communications, because of its mobility functionality and the use of mobile handsets for service delivery, it is seen as a closer alternative to, or an upgrade of, the existing suite of 2G mobile services rather than broadband services, which are usually fixed or nomadic in nature. Most WBA technologies today only offer fixed or nomadic wireless services and, therefore, are seen as an alternative platform for delivering services in the broadband markets. Nonetheless, we recognise that the line distinguishing WBA and 3G is blurring and both technologies could converge down the road.
13. IDA acknowledges that if WBA is similar to 3G services in terms of data and voice transmission functionalities, using a technology-specific definition would not sufficiently differentiate the two services. The IMT-2000 definition also unnecessarily restricts the technology choice of WBA service providers. Thus, IDA has decided to use the “fixed” versus “mobile” distinction as the key differentiating factor to preserve IDA's commitment in the 3G auction of not granting any spectrum rights for 3G **mobile** communication services before 1 January 2006.
14. Accordingly, WBA operators will not be allowed to offer **mobile or restricted mobile services at vehicular speeds above 10 km/hour before 1 January 2006**. This technical speed limit is adopted from the International Telecommunication Union's (ITU) recommendation

document on IMT-2000 3G technologies². This means that any WBA service deployed in the 2.3 GHz and 2.5 GHz bands will not be able to offer any voice or data communication to users travelling above 10 km/hour, prior to 1 January 2006.

15. IDA will therefore remove the non-IMT-2000 technology restriction because a fixed or nomadic WBA service will not possess 3G-equivalent capabilities as stated in the IMT-2000 standards. With the non-IMT-2000 restriction removed, WBA providers will benefit from wider WBA technology choices including those that fall within the IMT-2000 family so long as they observe the mobility limitation. After 31 December 2005, subject to licensing requirements, the WBA operators will be allowed to offer **any** type of fixed or mobile wireless services.

Auction parameters and design

16. IDA first adopted an auction as the method to allocate spectrum in the 3G spectrum allocation process. The 3G auction sets a reserve price that included the spectrum and licence fees for the entire tenure of the 3G spectrum, payable as a lump-sum upfront. Following the 3G auction, IDA also used the auction method for allocating the 2G and LMDS³ spectrum, but had modified the auction framework to separate spectrum fees from licensing fees, payable on an annual basis. IDA had earlier proposed a framework for the WBA auction that would follow the 2G and LMDS approach.
17. Some commenters opined that the WBA spectrum allocation approach, including pricing, licensing and roll-out requirements, should be equivalent to those adopted in the previous 3G auction.
18. Taking into consideration feedback from the consultation, IDA believes that the 2G and LMDS auction framework, by-and-large, will better serve IDA's policy goal of enhancing competition in the broadband market. IDA, in its further review, has also refined the auction framework to better reflect the desired economic effects of an auction. The key parameters for the WBA spectrum auction are summarised below

² Under the ITU-R Recommendation M.1034-1 for IMT-2000 3G technologies, the speed for: (a) stationary fixed services is defined at 0 km/hr; (b) pedestrian mobile services is defined at up to 10 km/hr; (c) typical vehicular services is defined at up to 100 km/hr; and (d) high-speed vehicular services is defined at up to 500 km/hr.

³ LMDS (local multipoint distribution system) is a broadband wireless point-to-multipoint communication system that provides digital two-way voice, data, Internet and video services.

Technology neutral – TDD and FDD

- (a) Currently, there are Time Division Duplex (TDD) and Frequency Division Duplex (FDD) technologies available in the market. In line with our technology neutral stand, IDA had proposed that bidders be given the flexibility to deploy either type of systems. This position remains unchanged. Although there are potential co-existence interference problems between TDD and FDD systems, operators can minimise such interference with careful frequency planning, coordination, and the use of mitigation techniques. To reduce interference problems, IDA will provide technical guidelines on ways to mitigate inter-operator interference.

Lot size of 6 MHz for the 2.5GHz band and 5 MHz for the 2.3 GHz band

- (b) Base on developments in WBA technologies and developments in other countries⁴, IDA has decided to set lot sizes of 5 MHz and 6 MHz in the 2.3 GHz and 2.5 GHz bands, respectively, to allow better harmonisation of channel lot size for equipment use.

Auctioning of specific lots

- (c) IDA had recommended auctioning the spectrum in generic lots, as we assessed that there was no technical advantage in using different frequencies within a specific band. However, responses from the industry suggest that the specific frequency band does matter for those using the FDD technologies because of the need for frequency separation for the FDD band pairs. This separation could range from 30 MHz to 100 MHz and there is no firm consensus among industry players. Therefore, IDA has decided to allow bidders to auction for specific lots to give them full flexibility to determine the FDD duplex separation and to make adjustments for different technologies and equipment during the auction process.

Maximum spectrum caps

- (d) IDA had proposed to limit the maximum amount of spectrum bidders can bid for, to no higher than the optimum amount

⁴ For instance, in the US, the FCC has recently adopted lot sizes of 5.5 MHz and 6 MHz in the 2.5 GHz band for WBA services.

required for nationwide deployment. This is to prevent unnecessary spectrum hoarding. Suggestions from the consultation range from 10 – 62 MHz for nationwide rollout. Based on IDA's assessment of the WBA technologies available, IDA believes that it is reasonable to place a spectrum cap of 6 lots (each lot of 5 MHz or 6 MHz), sufficient for nationwide deployment, for the WBA spectrum auction.

Spectrum caps on broadband infrastructure players

- (e) IDA had earlier proposed to subject existing broadband infrastructure providers (with nation-wide operations) and 3G infrastructure providers, namely SingTel Group, StarHub Group and M1, to a lower cap on the amount of spectrum they could acquire. This is in support of IDA's policy objective of injecting further competition into the broadband market. Most commenters supported this proposal. IDA believes that the additional cap is necessary and it is consistent with overseas practices.
- (f) Upon further review of industry comments, IDA has decided to narrow the scope of this restriction to only existing broadband players with nation-wide operations, namely the SingTel and StarHub Groups, but not M1. IDA had earlier included 3G operators because IDA had also proposed to allow them to use their 3G spectrum for WBA deployment (see Part V below). Hence, the 3G operators would only need to bid for incremental spectrum to complement the spectrum in their 3G bands. However, IDA has assessed that it is technically and commercially impractical to deploy the same WBA equipment in the 3G and WBA bands. 3G players will need to deploy different WBA equipment or make substantial technical adjustments to their WBA network to offer the same WBA services across different frequency bands. Hence, the 3G spectrum cannot complement the WBA spectrum fully and effectively. Moreover, as M1 is not a player in the broadband market and 3G is not yet seen as a substitute for existing broadband services, there is no justifiable basis to place the additional cap on M1.
- (g) IDA therefore has decided to limit only the existing broadband infrastructure providers (with nation-wide operations), the SingTel and StarHub Groups, to a lower spectrum cap of 4 lots, for them to complement their existing networks which already have

extensive geographical reach. IDA believes that 4 spectrum lots are sufficient for specific geographical WBA deployment in Singapore.

WBA spectrum auction pricing

- (h) IDA had proposed setting the spectrum reserve price based on administrative cost recovery. The spectrum fees (i.e., the final bid prices to be determined through the auction) will be paid on an annual basis with a 2.5 per cent annual escalation factor. Separately, successful bidders will have to apply for a Facilities-Based Operator (“FBO”) licence (if they are not currently holding an FBO licence) and will pay an FBO licence fee of 1 per cent Annual Gross Turnover (“AGTO”), subject to a minimum of S\$100,000.00 a year.
- (i) Upon further review, IDA has decided to separate the administrative cost for IDA’s spectrum management activities from the economic value which operators are willing to pay for the right to use the WBA spectrum resource. Under the revised model, there will be 2 spectrum pricing components:
 - I. An annual spectrum fee based on administrative cost recovery, plus a 2.5 per cent annual escalation factor every year to account for inflation⁵; and
 - II. A one-time lump sum successful auction bid price, to be paid at the completion of the auction, to reflect the economic value of the scarce resource that is allocated to bidders who value them the most. The auction will start at a minimum starting bid of S\$1,000.00 per spectrum lot, to be bid up through the auction process.

Separately, successful bidders will apply for an FBO licence (if they are not currently holding an FBO licence) and will pay the FBO licence fee of 1 per cent AGTO, subject to a minimum of S\$100,000.00 a year.

- (j) This refinement is made to allow the economic value of the spectrum or the “premium” to more likely remain as a sunk cost⁶

⁵ Each bidder must also pay a one-time application and processing fee of S\$2,700.00 for use of the spectrum, for each successful lot acquired.

and not be passed on to consumers. A one-time lump sum collection also better reflects the market-clearing price of spectrum based on the current supply and demand conditions.

- (k) If an auction proceeds, a successful bidder will pay all 3 fee components in paragraph 18(i). If the auction does not proceed (where total demand for spectrum is less than total supply of spectrum), successful applicants will pay only 2 fee components, namely, the annual spectrum fee and the FBO licence fee.

10-year spectrum rights duration

- (l) Some commenters felt that the IDA's proposed 7-year spectrum right was too short to recoup their investments, and does not provide sufficient business certainty. IDA recognises that the commercial deployment of WBA may require a longer payback period for operators, due to the still-evolving standards of this technology. Operators may need to upgrade or change their networks in a few years' time when common standards are achieved. Hence, IDA has decided to extend the WBA spectrum right to a 10-year duration, to provide greater investment certainty to bidders.

Roll-out obligations

- (m) Some commenters felt that IDA's proposed roll-out obligation of within 2 years is reasonable. To strike a balance between ensuring efficient use of the spectrum and a reasonable timeframe for operators to deploy their WBA network, IDA has decided to accelerate the roll-out obligation for the 2.5 GHz band to 18 months, and delay the roll-out obligation for the 2.3 GHz band to 36 months. This is in view of the fact that most WBA equipment currently available can readily operate in the 2.5 GHz band, while equipment for the 2.3 GHz band are not as readily available and operators may require more time to configure equipment for use in the 2.3 GHz band. Successful bidders will be required to offer publicly available WBA services within 18 months of being awarded their 2.5 GHz spectrum lots and/or within 36 months of being awarded the 2.3 GHz spectrum lots.

⁶ This is premised on the economic theory that sunk costs do not enter into the pricing decisions of operators.

- (n) IDA will also maintain the proposal to not impose any nationwide roll-out obligation, and will allow operators to commercially decide on the areas for deployment.

Spectrum trading allowed and no moratorium

- (o) IDA will allow spectrum trading for WBA service provision, subject to IDA's approval and applicable licensing and regulatory requirements. There will be no moratorium on future allocation of WBA spectrum.

Quality of Service (QoS)

- (p) Based on commenters' feedback, IDA has decided not to impose mandatory QoS standards on WBA operators. As WBA technologies are still evolving, requiring operators to comply with QoS may restrict their choice of technology, impose additional costs, and deter potential bidders. Moreover, consumers may be willing to choose between costs and level of service, and have the option of using ADSL or cable modem broadband if they wish to have a guaranteed level of service. Nonetheless, IDA will maintain the right to impose any QoS requirements in future.

PART V: DEPLOYMENT OF WIRELESS BROADBAND TECHNOLOGIES IN 3G SPECTRUM BANDS

- 19. In addition to seeking comments on the WBA spectrum allocation framework, IDA had also proposed to give all existing 3G licensees the *additional* flexibility to deploy any technology that is non-IMT-2000⁷ in the 3G bands they were awarded under the 3G auction *as long as they satisfy their 3G licence obligations* on nation-wide rollout of systems and services. This will give greater flexibility to existing 3G operators to optimise usage of the auctioned spectrum and to introduce innovations using new WBA technologies. IDA had observed that some countries already allow for flexibility in the use of 3G spectrum⁸.

⁷ IDA had specified in the 3G Auction that the technology deployed in the 3G spectrum must belong to the IMT-2000 family of standards endorsed by the ITU.

⁸ In the US, the FCC has adopted flexible service rules for the use of the 2.1 GHz band, allowing licensees to deploy any fixed or mobile services, including, but not limited to those associated with 3G or IMT-2000 technologies. In Australia, Arraycomm (a WBA vendor) is using the 3G unpaired bands for broadband access.

20. Most commenters supported IDA's proposal to allow 3G operators to deploy any non-IMT-2000 technologies in their auctioned 3G spectrum. The commenters agreed that this would accord the 3G operators greater flexibility in offering a broad range of services to meet customer needs. This approach is also consistent with IDA's technology neutral stand. However, one commenter responded that the use of 3G spectrum to deploy WBA technologies should not be recommended as the 3G operators may require their full 3G band for future expansion, and there is currently a lack of WBA service and equipment development for the 3G bands.
21. IDA notes that there are currently some vendors providing WBA equipment for use in the 3G spectrum bands. IDA will allow 3G operators the commercial flexibility to decide whether to deploy WBA technologies using the 3G spectrum they have acquired or to use the spectrum solely for 3G expansion purposes. The flexibility to deploy WBA technologies is an *additional option* for 3G operators to take up, to help them further optimise the use of their 3G spectrum, which IDA assesses to be more of a benefit than a disadvantage for them, and in turn, the consumers. Hence IDA maintains the proposal to give existing 3G licensees the *additional flexibility* to deploy any non-IMT-2000 technology in their 3G bands *as long as they satisfy their 3G licence obligations* on nation-wide rollout of systems and services.

Interference issues

22. Some commenters proposed that IDA should consider potential interference between WBA systems and IMT-2000 3G systems in the 3G bands. The commenters suggested that service rules or technical specifications (e.g., spectrum emission masks requirements) should be imposed to ensure that there would be no excessive interference introduced by WBA technologies to the IMT-2000 systems.
23. IDA's agrees with the industry that there could be interference issues in the 3G bands that may need to be addressed. However, service rules developed for IMT-2000 technologies cannot be directly applied on other technologies as they are built on different standards. Although the WiMAX Forum is currently developing technical specifications for WBA technologies based on the IEEE 802.16 standard, there remain various proprietary WBA technologies available in the market. Hence, it is not feasible for IDA to impose, for conformity, one specific set of service rules or technical specifications to govern different WBA technologies,

each developed using different standards. IDA also cannot require WBA technologies deployed in the 3G bands to conform to the 3G systems' service rules. Instead, IDA will provide flexibility for the 3G operators to deploy whichever WBA technologies they consider suitable⁹, subject to the condition that they do not cause interference to any other telecommunication systems and networks in their own bands or other bands. If a 3G operator's WBA deployment causes interference to the other operators' networks and systems, the operator would be required to take all necessary steps to solve the interference problems.

PART VI: WBA SPECTRUM ALLOCATION RULES AND PROCESS

24. IDA has today released the "Auction of Wireless Broadband Spectrum Rights – Information Memorandum" containing information on application process for the 2.3 GHz and 2.5 GHz auction, as well as the auction rules and other relevant documents. These documents can be found on the IDA website at www.ida.gov.sg, under the 'Policy and Regulation' section.

⁹ The WBA equipment will also need to be type-approved by IDA.