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Telecom Regulatory Authority of India

Consultation Paper

on

Allocation and pricing of spectrum for 3G services and Broadband Wireless Access

New Delhi

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Preface

The Government has sought TRAI's recommendations on the methodology for allotment of spectrum for 3G services and its pricing aspects.

India stands at the threshold of future technology, which offers an opportunity to extend telecommunications services including triple play to all its citizens. Third Generation (3G) service or International Mobile Telecommunications – 2000 (IMT-2000) facilitates high-speed data, mobile Internet access and entertainment such as games, music and video programs using image, video and sound for mobile users. It provides high data rates at a minimum of 144 kbit/s in all use scenarios and going up to 2 Mbit/s in low-mobility and indoor environments. In addition these systems have higher capacity and improved spectrum efficiency.

TRAI had earlier forwarded its recommendations to the Government on spectrum related issues on May 13, 2005. Since then, some developments have taken place with regard to spectrum availability in certain specific bands. The stakeholders have also articulated their views on issues relating to spectrum allocation and pricing.

The main objective of the TRAI is to enable that service providers have adequate and appropriate spectrum to deploy high quality advanced wireless networks. We hope that this paper will facilitate an informed discussion on how to ensure the availability of spectrum for 3G services in an equitable and transparent manner to the service providers.

TRAI in its recommendations on broadband services, rural telecom, and spectrum issues, has recognized the importance of wireless broadband technologies such as Wi-Fi and WiMAX. Such technologies hold great potential for the rapid and inexpensive deployment of broadband services in both urban and rural India. Therefore, in addition to the 3G spectrum allocation and pricing related issues, this paper also discusses issues related to spectrum for Broadband Wireless Access.

We invite all stakeholders to respond to the issues raised in this Consultation Paper. The paper has been placed on TRAI's website (www.trai.gov.in). Written comments may please be furnished to Secretary, TRAI by June 30, 2006. For any further clarification on the matter please contact the Secretary, TRAI or Advisor (MN) at rstrai@gmail.com (Ph.No.26167448) or sgupta09@gmail.com (Ph.No.26106118) respectively. We request you to also submit your response via email at sgupta09@gmail.com. Comments will be posted on TRAI's website.

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Chairman, TRAI

List of Abbreviations Used

S.No.	Abbreviation	Expansion
1.	2G	Second Generation
2.	3G	Third Generation
3.	AAS	Adaptive Antenna Systems
4.	AGR	Adjusted Gross Revenue
5.	AIP	Administrative Incentive Pricing
6.	ARCEP	French Telecommunication Regulator
7.	BPL	Broadband over Power Line
8.	BRAN	Broadband Radio Access Network
9.	BWA	Broadband Wireless Access
10.	CDMA	Code Division Multiple Access
11.	CEPT	European Conference of Postal and Telecommunications Administrations
12.	CPE	Customer Premise Equipment
13.	DECT	Digital Enhanced Cordless Telecommunications
14.	DOT	Department of Telecommunications
15.	DSL	Digital Subscriber Line
16.	ETRI	Electronics and Telecommunication Research Institute
17.	ETSI	European Telecommunications Standards Institute
18.	EV DO	Evolution Data Only
19.	FCC	Federal Communications Commission
20.	FDD	Frequency Division Duplex
21.	FSS	Fixed Satellite Service
22.	FTTC	Fibre to the Curb
23.	FTTH	Fibre to the Home
24.	FWA	Fixed Wireless Access
25.	GDP	Gross Domestic Product
26.	GHz	Gigahertz
27.	GSM	Global System for Mobile Communication
28.	IDA	Infocomm Development Authority, Singapore
29.	IEEE	Institute of Electrical and Electronics Engineers
30.	IMT	International Mobile Telecommunications
31.	INSAT	Indian National Satellite
32.	IP	Internet Protocol
33.	ISI	Inter-Symbol Interference
34.	ITU	International Telecommunication Union
35.	LMDS	Local multipoint distribution system
36.	LOS	Line of sight
37.	Mbps	Mega Bits Per Second
38.	M-Commerce	Mobile Commerce Services
39.	MHz	Megahertz
40.	MIMO	Multiple Input Multiple Output
41.	MMDS	Multichannel Multipoint Distribution Service
42.	MVNOs	Mobile Virtual Network Operators
43.	NFAP	National Frequency Allocation Plan
44.	NLOS	Non Line of sight
45.	NRFAT	National Radio Frequency Allocation Table
46.	OECD	Organisation for Economic Cooperation and

		Development
47.	OFDM	Orthogonal frequency-division multiplexing
48.	OFDMA	Orthogonal Frequency Division Multiple Access
49.	OFTA	Office of the Telecommunications Authority, Hong Kong
50.	PTE	Public Telecommunication Entities
51.	PTS	Post and Telecom Agency, Sweden
52.	QAM	Quadrature Amplitude Modulation
53.	QPSK	Quadrature Phase Shift Keying
54.	RF	Radio Frequency
55.	SOFDMA	Scalable OFDM Access
56.	SUF	Spectrum User Fees
57.	TA	Telecommunications Authority
58.	TDD	Time Division Duplex
59.	TDMA	Time Division Multiple Access
60.	TRAI	Telecom Regulatory Authority of India
61.	UMTS	Universal Mobile Telecommunication System
62.	VSAT	Very Small Aperture Terminal
63.	WCDMA	Wideband Code Division Multiple Access
64.	WiBro	Wireless Broadband
65.	WiFi	Wireless Fidelity
66.	WiMax	Worldwide Interoperability for Microwave Access
67.	WPC	Wireless Planning & Coordination Wing under DoT
68.	WARC	World Administrative Radio Conference
69.	WRC	World Radio Conference

Chapter 1. Introduction

Background

1.1 The Government vide their letter D.O. No. L-14047/09/2005-NTG dated May 22, 2006 has sought TRAI's recommendations on the methodology for allotment of spectrum for 3G services and its pricing aspects (Refer Annex A).

1.2 3G is one of the most important development in the mobile industry in the recent times. It promises high speed data services based on Internet Protocol (IP) as well as greater capacity and efficiency. The 3G platform provides converged voice, data, Internet and multimedia services supported by a high data rate. 3G standard is based on the International Telecommunication Union (ITU) initiative for a single global wireless standard called International Mobile Telecommunications – 2000 (IMT-2000) which stands for third generation wireless technology and network. In this consultation paper CDMA-2000 1X EVDO and Wideband Code Division Multiple Access (WCDMA) (Universal Mobile Telecommunication System (UMTS)) have been considered for 3G services.

1.3 On spectrum related issues, TRAI had submitted its recommendations to the Government in May 2005. The salient points of TRAI's recommendations concerning the 3G spectrum are following:

- Third generation (3G) spectrum allocation to the existing operators should be viewed as extension of second generation (2G) spectrum allocations.
- No one time spectrum charges for allocation of IMT-2000 spectrum to the existing service providers.
- To avoid hoarding of spectrum, a valuable resource, a minimum of spectrum charge be taken for the period till the service provider rolls out IMT-2000 services.
- 2GHz spectrum should be allocated to both (Global system for Mobile Communication (GSM) and Code Division Multiple Access (CDMA)) for offering 3G services.

- Each existing operator who demands spectrum should be allocated 2 x 5 MHz in IMT-2000 2GHz band.
- Annual spectrum charge based on Percentage of Adjusted Gross Revenue (AGR) to continue.

1.4 During recent months following comments/suggestions have been made by various stakeholders:

i. There should be a one-time entry fee for 3G spectrum. One of the stakeholders has even quoted Rs. 1500 crore as the amount to be charged for an all India license.

ii. Though not specifically linked to 3G spectrum, some of the service providers have pointed out that for allocation of additional spectrum for mobile services, the present subscriber base criterion is not the correct method. The operators may inflate the subscriber base to get additional spectrum. Therefore, if this criterion is to be followed for allocation of spectrum then an independent 3rd party should do the auditing of number of subscribers.

iii. GSM operators have also pointed out that the allocation criteria for additional spectrum to CDMA operators should take into account the spectral efficiency factor of CDMA technology. Wireless Planning & Coordination (WPC) Wing in March, 2006 had issued a subscriber base criterion for allocation of 5th and 6th carrier to CDMA operators and from this criterion it is apparent that for allocation of almost same quantum of spectrum, the CDMA subscriber base should be double of GSM subscribers. This criterion is being opposed by some CDMA operators.

iv. CDMA operators have advocated that Evolution Data Only (EVDO) equipment is mainly available in 1900 MHz band and is not available on the same terms in 2 GHz band. Therefore, in case 1900 MHz is not allocated to them then it would adversely affect the level playing field.

v. TRAI had earlier recommended that if spectrum is available and there is sufficient competition in the market, then the Government should not hold the spectrum and make it available to the service providers. GSM operators have reservations on grounds of level playing field. Since EV-DO equipment is available in 800 MHz band, CDMA operators would be in position to offer 3G services, if additional spectrum is allocated. However, as W-CDMA equipment is not available in 900 MHz and 1800 MHz band (present GSM spectrum), hence the GSM operators would not be able to offer 3G services till they are allocated spectrum in 2 GHz. This, in the perception of GSM operators would disturb the level playing field. The issue for consideration is that whether the allocation of additional carrier in 800 MHz to CDMA operators should be held back till IMT-2000 spectrum in 2GHz band is available to GSM operators or keeping in mind the technology neutral approach, the available spectrum in 800 MHz band is allocated to CDMA operators and efforts are made so that 2GHz spectrum for IMT-2000 is available to GSM operators also at the earliest.

1.5 In a technology neutral regime, the market forces should determine the deployment of a particular technology. TRAI in its earlier recommendations on spectrum related issues had recommended that the subscriber based spectrum allocation criteria should be made to gradually move in the direction wherein no particular technology has an edge over others.

1.6 The vacation and availability of spectrum for mobile services is being addressed by Government separately and therefore, this matter has not been discussed in this consultation paper.

1.7 The Indian telecom sector is one of the most intensely competitive markets in the world. Unlike most countries, where one of the two technologies (CDMA and GSM) has been adopted, in the Indian market, both the technologies are firmly entrenched with large subscriber base and multiple operators in each license service area. There are more operators here than most other countries, and as a result, there is great demand for scarce spectrum. Because of this particular condition, the issue

of allocation of spectrum for 3G services has become a complex issue. Given these conditions, this consultation paper will address three major issues with respect to 3G spectrum. First, it discusses the identification of preferred bands for IMT 2000 and second the possible methods of allocating spectrum given the present and future needs of a growing and competitive market. A fair and equitable spectrum allocation regime will ensure growth and high quality of service for both CDMA and GSM operators. Since spectrum is a scarce resource, pricing mechanisms must ensure that allocated spectrum is efficiently used. Spectrum pricing is the third issue that this consultation paper seeks to address.

1.8 Apart from IMT 2000 technologies, high data rate services like 3G services could also be provided by some of the broadband technologies like Wi-Fi, Wi MAX, etc. Therefore, there is a need to address the spectrum requirements for these broadband wireless technologies also. With this aspect in mind, the paper also explores the availability of spectrum for other wireless broadband technologies like WiMAX, etc. This is important for the growth of broadband services using various technologies, as this will accelerate competition leading to affordable broadband services. TRAI also has to ensure that regulatory hindrance including non-availability of suitable and adequate spectrum should not come in the way of deployment of any technology. It's techno-economic suitability is to be judged by the market forces. It is in this context that the issue of availability of spectrum for wireless broadband services is included in this consultation paper. This issue was briefly covered in TRAI's recommendations on Spectrum related issues dated May 2005 and also in its recommendations on growth of telecom services in rural India to emphasize the growth of telecom services in rural India using wireless technologies.

1.9 The issues that this consultation paper attempts to address are as follows:

- The identification of appropriate band for 3G spectrum.
- The criteria for allocating the spectrum for 3G services in India
- The pricing mechanism for the 3G spectrum
- Spectrum for Wireless broadband services using technologies like Wi MAX, etc.

Chapter 2. Spectrum allocation

2.1 ITU has identified various frequency bands for IMT-2000 services. The World Administrative Radiocommunication Conference – 92 (WARC-92) identified the bands:

-1885-2025 MHz
-2110-2200 MHz

and the World Radiocommunication Conference –2000 (WRC-2000) identified the bands:

-806-960 MHz**
-1710-1885 MHz
-2500-2690 MHz

** The whole band 806-960 MHz is not identified on a global basis for IMT-2000 due to variation in the primary mobile service allocations and uses across the three ITU Regions.

2.2 According to National Frequency Allocation Plan 2002 (NFAP 2002), the requirements of IMT-2000 (3G) applications in the frequency bands 1885-2025 MHz paired with 2110-2200 MHz may be coordinated with existing users initially for 1920-1980 MHz paired with 2110-2170 MHz (Frequency Division Duplex(FDD) mode) and 2010-2025 MHz (Time Division Duplex (TDD) mode) depending on the market needs and availability, as far as possible.

2.3 While selecting the frequency band for IMT-2000 services, the guiding principle could be

- The frequency bands should achieve the objective of International roaming
- Inter-operability amongst various systems.
- Global trend of manufacturing as it has price implications.

- Availability of frequency band in the Indian context and harmonise construction with telecom manufacturers globally.
- Long term objective of technological up gradation.

2.4 Presently the GSM operators have their operations in 900 MHz and 1800 MHz bands. As mentioned earlier, these bands have also been identified by WRC-2000 for 3G services. However, in 900 MHz, additional spectrum is not presently available and the part vacation of 1800 MHz band has been mostly allocated for 2G operations in GSM technology. Moreover, the WCDMA equipment is presently not available in the 900 MHz and 1800 MHz bands. Therefore, it is not feasible to consider these bands for the allocation of 3 G services.

2.5 The CDMA operations are in 800 MHz band in which a total of 2X20 MHz is available. Out of this, 2X15 MHz in Mumbai and 2X13.75 MHz in Delhi stands assigned to CDMA operators, and the remaining carriers are yet to be allocated. In other service areas, equal or more carriers are available. The unassigned carriers available in the 800 MHz band are reserved for future use for CDMA operations. Today these carriers are to be allocated to the CDMA operators following the subscriber-base criteria. However, there is also a possibility that some of these available carriers could be allocated to CDMA operators for offering EVDO (3G) services. We are aware that WCDMA requires a minimum of 2X5 MHz spectrum in the IMT-2000 band. Therefore, if for 3G services, we allocate 2X5 MHz band to GSM and only 2X1.25/2.5 MHz to CDMA operators, the inequality would lead to a non-level playing field. The issue that needs deliberation is whether some 800 MHz carriers should be allocated for 3G services to CDMA operators even though it leads to the creation of a non-level playing field. Even if it is presumed that 800 MHz could be allocated on some principles to CDMA operators for 3G services, another consideration to be kept in mind is that additional spectrum in 800 MHz band is also required for the growth of 2G CDMA operations.

2.6 Another candidate band for CDMA service is 1900 MHz. However, as already discussed in detail in TRAI's earlier recommendation on spectrum related issues, because of the non feasibility of its vacation by the Defence, it is not possible to

allocate 1900 MHz to CDMA operators. Moreover both 2 GHZ and 1900 MHz band can't co-exist due to the interference problem. As per information available with TRAI, allocation in both the bands together i.e. 1900 MHz and 2 GHz has not been done in any of the countries. CorDECT operations are also there in 1880-1900 MHz band. Therefore, TRAI had earlier recommended that IMT-2000 spectrum allocations should be made to GSM and CDMA operators in 2 GHz band.

2.7 As per Cl. No. 43.5 of the Unified Access Services License Agreement, spectrum allocation shall be made in 800 and 900/1800 MHz bands for CDMA and Time Division Multiple Access (TDMA) (GSM) based systems, respectively. In addition, the license agreement also has provision for use of micro cellular architecture based systems (CorDECT) in 1880-1900 MHz band. The licence agreement does not mention anything about other bands. Identification of any other band for 3G operations is outside the earlier commitment made in the license.

2.8 One option could be, that the allocation of spectrum in IMT 2000 (3G) bands is treated differently as an altogether separate service, as has been done in a number of other countries. Another option could be that the IMT-2000 band is allocated to the existing operators as a continuation of 2G mobile services based on some criteria as decided by the Government. The International practice for the allocation of 3G spectrum is enclosed at Annex B. In UK, for example, in addition to the existing operators new operators were allowed to enter the market to offer 3G services, while in some other countries, for example, Malaysia, even all the existing operators were not offered 3G spectrum, initially. This raises the question as to whether allocation of 3G spectrum should be treated differently than the 2G spectrum. One could argue that with the availability of in-band 3G equipment, it is difficult to link the spectrum to 2G or 3G services. For example, in 800 MHz spectrum a CDMA operator could offer both 2G and 3G services. Similarly, in future if WCDMA equipment is available in 900/1800 MHz frequency band then will it become 3G spectrum. Is it just because a particular service can offer high-speed data/video service, so it should be treated differently. These are the issues, which also needs examination in this consultation process.

2.9 It is well recognised that for the CDMA operators, the EVDO equipment in 2 GHz band and the dual band handsets (for both 800 MHz and 2 GHz band) are not readily available in the same volumes as that for WCDMA technology in 2GHz band. The key aspect is availability of dual band handset in 800 MHz and 2GHz band because as far as equipment in 2GHz is concerned, some operators like KDDI Japan have already deployed EVDO equipment in 2GHz band. The discussions with handset developers had indicated that for a market like India, development of dual band handsets will not take more than 6 months and size of Indian market would also provide economy of scale advantage both for equipment and the handset vendors.

TRAI would endeavour to have exhaustive consultation with all stakeholders for identification of allocation of appropriate spectrum for IMT-2000 services.

2.10 In it's earlier recommendations on spectrum related issues regarding 3G services TRAI had recommended that each existing operator who demands it should be allocated 2 x 5 MHz in IMT-2000 2GHz band. However, this spectrum band is yet to be vacated by Defence. If adequate spectrum is available for allocation to all interested operators then perhaps, the allocation criterion would have to ensure efficient utilisation of this scarce resource only. However, in case adequate spectrum is not available, then a suitable allocation criterion would have to be decided so as to assign the available spectrum to the operators in a fair and transparent way. The different methods, which can be used, are bidding process, auction, beauty contest, etc. These issues are discussed in subsequent paragraphs.

2.11 So far, the spectrum is being allocated to mobile operators as per the subscriber base criterion. One option is to allocate the 3G spectrum to all the existing operators on the same criterion. In case the existing subscriber base criterion is used for the allocation of IMT 2000 spectrum, then possibly a re-look would be required at the existing criterion keeping in mind increased data centric traffic in 3G services. Moreover, this may also raise the issue of level playing field amongst service providers. Large mobile operators with high subscriber base will get the spectrum for offering 3G services, while some of the later entrants may not meet the required subscriber base criterion and therefore would not be able to offer the 3G services. The other option is to allocate the 3G spectrum to all the operators irrespective of

their subscriber base. One major argument against this option could be that this may lead to bypass of present spectrum allocation criterion, for those service providers who do not qualify for additional spectrum allocation. There is also a possibility that some of the operators may not be interested in offering 3G services and therefore this may lead to hoarding of spectrum, which is a scarce resource. So it needs consideration as to what should be the criterion for allocation of 3G spectrum.

2.12 In a number of countries, for eg. Malaysia, Hong Kong, Singapore, Japan, Korea, New Zealand, Switzerland, Sweden, Poland, Norway, Finland, Italy, Greece, France, Denmark, Belgium, Czech Republic, Ireland, Norway, etc. the number of 3G licenses awarded were four or even less. In UK and Canada the number of 3G licenses are 5. As per the information available with TRAI, there are very few countries where 6 or more 3G licenses have been awarded.

2.13 Given the spectrum constraint, countries like Hong Kong decided to issue four 3G licences**.** Here 2X15 MHz was allocated to each 3G operator. Similarly in Singapore, Infocomm Development Authority (IDA) announced that the UMTS Forum had recommended that 3G operator would require 2 X 15 MHz paired spectrum to support high bandwidth and full multimedia capability. 2X60 MHz of spectrum was available in Singapore, therefore, IDA decided that a total of four Third Generation (3G) mobile licences would be awarded via an auction, though subsequently only 3 licenses were awarded. Similarly, in Sweden also, the IMT-2000 2 GHz spectrum was allocated to four 3G operators. Other mobile operators viz. Telia, Telenordia and ReachOut Mobile, who did not get the 3G licences, appealed against the decision to the Country Administrative Court. The Court confirmed the Post and Telestyrelsen's (PTS) decision and no one appealed against that decision.

2.14 As per the International practice, in most of the countries, the 3G spectrum was allocated to the operators in blocks of either 10MHz or 15 MHz. This was done, keeping the future requirements for enhanced multimedia capacity of 3G services in mind. In India, there are generally 6 operators in each service area and therefore, with only 2X60 MHZ available in the 2GHz band, it would not be possible to allocate 2X15 MHZ to all the existing operators. (The number of licensed operators in each service area is shown in the Annex C). The issue which needs deliberation is, in

case 2X5MHz spectrum is available for all the operators then should it be allocated to all or limit the number of operators so that at least 2X15 MHz of 3G spectrum is given to each operator now or later for providing full suit of 3G services.

2.15 In many countries like Australia, Canada, Hong Kong, New Zealand, UK, Switzerland, Germany, Italy, Austria, Belgium, Netherlands, etc. the licensing methodology for 3G licenses was Auction. In some countries eg. Sweden, Spain, Portugal, Poland, France, Korea, Singapore, etc. beauty contest along with a fixed fee was used as a methodology for awarding 3G licenses. International practice on method of allocation is placed at Annex D.

2.16 Another issue is that if initially only one/two carriers is/are available and are awarded through bidding process to any operator then should these operators be eligible to again participate in the bidding process for the next carrier, whenever available. In Mexico, a similar situation led to lot of litigations when an operator was not permitted to participate in auction process. There could be a situation that initially only one or two carriers are available and are awarded to operator/s through some process like auction, beauty contest, etc. When additional carriers are available at a later date then it needs consideration whether to allocate these carriers to existing 3G operators or to those mobile service providers who could not get spectrum for 3G services. In case additional 3G spectrum is not allocated to existing 3G operators then their growth may suffer. On the other hand, competition will suffer if there are not sufficient (3-4) 3G operators. It also needs to be considered as to what should be the method of allocation of IMT 2000 spectrum when available at a later date in order to achieve the reasonable competition in 3G services.

2.17 A number of countries e.g. Austria, Belgium, Czech Republic, Denmark, France, Germany, Greece, Ireland, Italy, Japan, Netherlands, Sweden, Switzerland, etc. have specified minimum coverage requirements in awarding 3G licenses. In countries like Sweden the operators were awarded points according to the extent and speed at which they offered coverage. Minimum coverage requirements for 3G licensing in some countries are shown in the Annex E. It needs consideration whether any roll out obligations should be specified for 3G services and in case of failure to meet the obligation, what criterion should be used for imposing the penalty.

2.18 Another candidate band for future 3G spectrum is 2500-2690 MHz which is presently being used by Indian National Satellite (INSAT) applications such as mobile satellite in the frequency sub band 2500-2520 MHz paired with 2670-2690 MHz and 2550-2630 MHz for Broadcasting satellite applications. However, Local Multipoint Distribution System (LMDS) and Microwave Multipoint Distribution System (MMDS) services in the frequency band 2535-2650 MHz are being coordinated on case-by-case basis. The Task Group 6-8-9 of ITU study group is examining sharing criteria between fixed/mobile services and satellite-based services. This band is also being considered for WiMAX applications as the WiMax Forum is also seeking to implement mobile WiMax in this band. The issue for consideration is how should the spectrum be allocated in 2.5-2.69 GHz band.

2.19 The issues for consultation are as follows:

- **i) What principles and criteria should be taken into consideration for identification of specific bands for 3G services in India?**
- **ii) Whether spectrum in 2GHz should be given to all the operators?**
- **iii) What should be the quantum of spectrum, which should be allocated to each operator?**
- **iv) Should the spectrum in 2GHz be allocated only after ensuring that at least 2 X 5MHz is available to all operators in a service area.**
- **v) If the available spectrum is less than the demand then what should be the criteria of allocation of spectrum to existing mobile operators in 2GHz band?**
- **vi) Should the present spectrum allocation criteria be modified so that available spectrum is immediately allocated?**
- **vii) Should roll-out obligations be specified for IMT-2000 (3G) services. If yes, please specify the roll out obligations to be imposed. Please also indicate, the penalty to be imposed in case of failure to meet the obligation.**
- **viii) Should allocation of spectrum in IMT-2000 band be linked to Infrastructure sharing? If yes, please specify the conditions to be imposed?**

ix) Keeping in mind the requirement of IMT-2000 and Wi-MAX what should be the criteria for allocation of spectrum in 2500-2690 MHz band?

Chapter 3. Spectrum pricing

3.1 In the existing licensing framework in India, the licensee is required to pay one time entry fees for the license which also includes fees for usage of spectrum. The licensee also pays annual spectrum charges and annual licence fees, which are on revenue share basis as a percentage of AGR.

3.2 In the previous chapter, we have discussed possible allocation regimes for 3G spectrum. Once an allocation regime is determined, the next step is to decide on an appropriate spectrum pricing mechanism. The two components of the spectrum pricing could be a) entry fee (one time) and b) annual spectrum charge. Keeping in view the fact that the spectrum is a scarce resource, the issue for consideration is whether the operators who are allocated IMT-2000 (3G) spectrum be charged no one time entry fee or should we treat it as a separate spectrum band and charge an one-time entry fee.

3.3 Essentially, the question boils down to whether 3G Spectrum pricing should reflect the availability and demand thereof or should it consider the economic and social benefits that the range of application services that the 3G Spectrum is capable of offering to the society at large. The additional objective that often finds a mention in this context is whether the revenue potential arising out of the sale of the spectrum be kept as the criterion for the pricing policy. These three sets of views on this issue of pricing 3-G spectrum are discussed below.

3.4 It is well recognized that under the 3G technology, a range of services including application services are deliverable to the consumers. Important among them, from the economic point of view, are the services that relate to commercial activities i.e. Mobile Commerce Services (M-Commerce). India is a price sensitive market having very high price elasticity for various goods and services. Once available at an affordable price, it can be expected that the addressable market for that service would grow at phenomenal rates. This has been the experience of the 2G mobile services in India. The limited experience with the E-Commerce shows that the productivity enhancement in economic activities could be very high if M-Commerce is incentivised. The impact of productivity enhancement could benefit

even an ordinary man directly, if M-Commerce becomes the common way of doing business. With the mobile telephony set to enter into rural India in a big way shortly, the benefits of 3G services, as explained above, would reach the rural consumers. These kinds of benefits have a multiplier effect in the economy. If this proposition is acceptable, then it follows that the criterion for pricing the Spectrum, which is the critical raw material for the 3G services should not be related to the demand / availability of 3G spectrum.

3.5 One can argue that if a very high level of cost is imposed on the 3G spectrum, the service providers will have no other alternative but to pass that cost on the consumers of these services. Affordability is the key question for the Indian consumer. If the service is not affordable, there would not be any takers for such services and as a result volume will not grow, resulting in further hike in the cost of such services for the existing customers. The ripple effect is therefore, clear. Lastly, if the price for spectrum is to reflect the scarcity of the resource, it is quite likely that, such a policy is most likely to run counter to the objective of accelerating penetration of telephony in rural areas. The question also arises whether scarcity of the spectrum is through out the country or in major cities or even in some areas like CBDs in cities.

3.6 The proponents of revenue as the criterion for the pricing policy argue that, the Government should not forego the revenue arising out of the sale of spectrum because the services like 3-G are elitist and the services to which the spectrum is to be used are commercial in nature. Therefore there is no harm in pricing such inputs keeping the revenue consideration in mind and also the fact that the spectrum is a scarce resource and therefore should only be given to those who value it the most and would use it optimally.

3.7 In this context, one important issue that needs consideration is the requirement of funds for refarming i.e. funds required to be given to the existing users for vacating spectrum for 3G services. The existing users will have to invest in procuring the equipments etc. for shifting to either another frequency band or some other media, hence it can be argued that the funds required for refarming, should be recovered from the licensees as one-time entry fee for 3G services. In that case, an estimate of

the quantum of such amount is required to be determined for deciding the one time entry fee for spectrum for 3G services.

3.8 The question then arises as to the alternative available to ensure that the spectrum is utilized in an efficient manner because the resource is scarce. Should the answer to this lies in evolving an appropriate allocation / release mechanism and not in its pricing?

3.9 The various methods, to determine the one time entry fee for IMT-2000 spectrum could be Auctions, Cost Recovery, Market based benchmarks, etc. The details of the above methods are discussed at Annex F.

ANNUAL SPECTRUM CHARGE

3.10 As per the existing spectrum policy, the Annual Spectrum Charge for GSM Service Providers varies from 2-6% of AGR depending upon the quantum of spectrum that the operator has been assigned. The spectrum charge varies as follows:-

S.No.	Quantum of Spectrum	Annual spectrum charge (% of AGR)
1	2 X 4.4 MHz	2%
2	2 X 6.2 MHz	3%
3	2 X 10 MHz	4%
4	2 X 12.5 MHz	5%
5	2 X 15 MHz	6%

3.11 In the case of CDMA operators, the Annual Spectrum Charge is 2% of AGR upto 5MHz of spectrum. The annual spectrum charges beyond 2 x 5 MHz is yet to be decided.

3.12 In case IMT-2000 spectrum is allocated to existing operators, then one option for determining the annual charge could be that the quantum of IMT-2000 spectrum assigned is added to the spectrum already available to the operator in 800/900 & 1800 MHz bands, to determine the annual spectrum charges. Another option could be to charge the annual spectrum fees separately for both the services. However, in

this case if the annual spectrum fees is levied as percentage of AGR, then the segregation of 2G and 3G revenues would be difficult. Third option could be a fixed amount may be levied as an annual spectrum charge for 3G spectrum.

3.13 In case the spectrum for IMT-2000 is not co-ordinated sufficient enough which can cater to the need of all the existing operator and only few operators are allocated 3G spectrum using some allocation criteria like auction, beauty contest, etc. then it needs consideration as to what should be the allocation criteria for remaining IMT2000 spectrum vacated at a later date. In this scenario one option could be to allocate spectrum to the remaining existing operators, if interested, at the benchmark price of earlier allocations. Another option could be that a fresh criteria or using the same criteria like auction, beauty contest, etc. the spectrum is allocated.

3.14 To avoid hoarding of spectrum, a valuable and scarce resource, TRAI also earlier recommended that the operators shall pay an additional per MHz charge till the operator rolls out IMT-2000 services. TRAI had recommended that the additional per MHz charge for IMT-2000 spectrum should be on the basis of highest charge per MHz per annum paid by any operator in different service areas and these charges will be separate for different service areas.

3.15 International practises on 3G pricing is discussed at Annex B and D.

3.16 **The issue for consultation are as follows:-**

i. Which of the following criteria should determine the 3G spectrum pricing?

- **Demand and supply situation i.e. reflecting scarcity**
- **Economic and social benefits of the 3G services**
- **Revenue to the Government and requirement of the funds for refarming**
- **Combination of the above**

ii. Should the service provider pay additional one time charge for IMT-2000 spectrum? If yes, then how should this additional charge be determined e.g. should it be based on

auction, bidding process, etc. or should it be based on the cost of refarming of the spectrum?

iii. **What should be the amount of annual spectrum charge on IMT-2000 spectrum?**

iv. **Should the existing criterion of annual spectrum charge based on percentage of AGR continue for IMT2000 spectrum?**

Chapter 4. Spectrum issues for Wireless Broadband Access

Introduction

4.1 Broadband internet access is widely recognized as one of the catalysts for economic development of a country in the long run. Availability of Broadband access encourages greater availability and usage of information leading to increase in productivity and efficiency. The multiplier effect arising out of increased investment in this segment also lead to positive impact on gross domestic product (GDP).

4.2 Though the Authority has focused on issues related to 3G services in this consultation paper, it has also considered issues related to wireless broadband access because of its relevance in Indian context, due to similarity with 3G specially in respect of high data rates / throughput delivered. World over also various emerging technologies for Broadband Wireless Access are viewed as an extension of 3G services.

4.3 In accordance with the powers conferred in Clause 11 (1) (a) v, vii & viii of TRAI ACT, 2000 the Authority has a mandate to recommend various measures for the development of telecommunication technologies and efficient management of available spectrum. In view of this, it is considered appropriate to include issues related to spectrum for Broadband Wireless Access also as a part of this consultation.

4.4 TRAI in its recommendations on Accelerating Growth of Internet and Broadband Penetration dated 29th April 2004, envisaged deployment of following technologies for fostering faster rollout of Broadband services. They are:

- Digital Subscriber Line (DSL) system on copper local loops
- Cable Modem access:- Making use of 60 million cable TV connections in the country.
- Fibre to the Home (FTTH) /Fibre to the curb (FTTC)
- Broadband over Power Line (BPL) -Existing electrical power line as a local loop for delivering of Broadband services
- VSAT based Broadband access

- Terrestrial Wireless based access - promoting usage of unlicensed bands for Wireless Fidelity (WiFi) applications for indoor and outdoor usage in the frequency band 2.4-2.4835 GHz (unlicensed for indoor and outdoor on technology-neutral basis) and 5.15-5.35 GHz (unlicensed for indoor usage at present) and identification of additional licensed spectrum for WiMAX applications.

Many of these technology options have already been recognised in the Broadband Policy 2004, announced by Department of Telecom.

4.5 The penetration of Broadband has reached only 1.5 million connections by May 2006. One of the reasons for slow progress could be that the focus of various service providers till now has been on Wired Broadband Access by making use of existing copper loops as well as Cable TV access network. Amongst the various technologies mentioned above, wireless has a great potential because of ease of its installation, operation & maintenance, flexibility for the service providers and convenience to the end users. Moreover, penetration of copper loops is not widely spread in rural areas. Therefore, wireless based access could be one of the ideal solutions for last mile connectivity through a combination of different technologies like WiMAX, WiFi etc. These technologies have the added advantage of interoperability and economy of scale due to international standardisation. For the deployment of any wireless technology, suitable & sufficient spectrum availability and its efficient allocation and utilisation is a must. It is in this background that the availability and allocation of spectrum for wireless technologies like WiMAX has been discussed in the following paragraphs.

4.6 The term WiMAX refers to Worldwide Interoperability for Microwave Access, an IEEE 802.16 air interface standard. It is a broadband wireless technology that supports fixed, nomadic, portable and mobile access. It can support data rates more than those delivered by DSL or cable modem technology. Two technology standards for WiMAX, IEEE 802.16d and IEEE 802.16e have been developed which provide fixed & nomadic access and mobility respectively. These are Orthogonal frequency-division multiplexing (OFDM) based technologies which are considered spectrum efficient. Details of these standards and technical features are enclosed at Annex-G.

4.7 TRAI in its recommendations dated October 3, 2005 on "Growth of Telecom services in Rural India –The way forward" had recognised WiMax as one of the possible technology/ solutions for extending rural coverage. WiMAX systems are ideally suited for the provision of Broadband access, especially in remote & rural areas in combination with WiFi systems. The typical rural area connectivity using Wi-Fi/ WiMax is given in figure 4.1:

Typical Rural area connectivity using Wimax/ WiFi

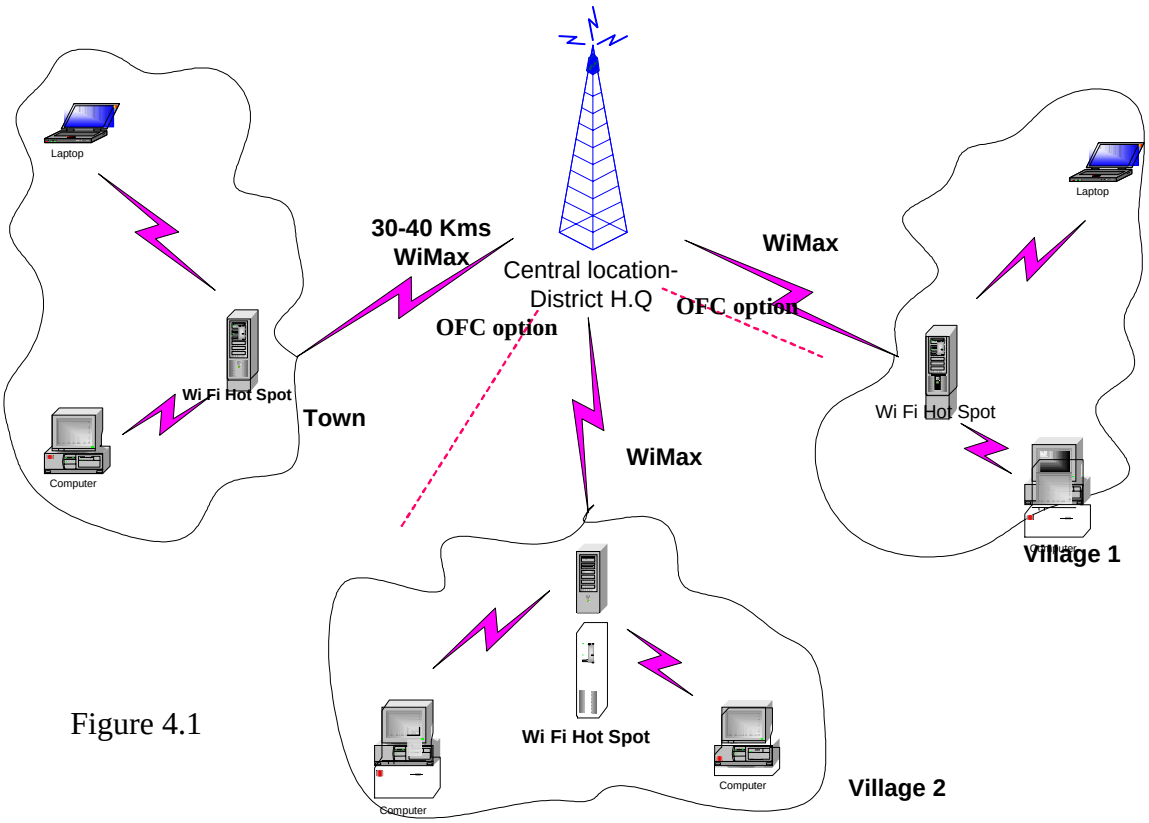

Figure 4.1

Spectrum for Broadband wireless access based on WiMax

4.8 As per the information available from WiMAX-Forum, frequency bands identified worldwide for WiMAX (IEEE 802.16d & 802.16e) are given in Table 4.1:

Table 4.1

a) **IEEE 802.16d - Fixed WiMAX**

Approved Certification Profiles		
FREQUENCY BAND (MHz)	**DUPLEXING**	**CHANNELIZATION (MHz)**
3400 to 3600	TDD	3.5
		7.0
	FDD	3.5
		7.0
5725 to 5825	TDD	10.0

b) **IEEE 802.16e - Mobile WiMAX**

Proposed Certification Profiles		
FREQUENCY BAND (MHz)	**DUPLEXING**	**CHANNELIZATION (MHz)**
2300 to 2400	TDD	5.0
		8.75
		10.0
2469 to 2690	TDD	5.0
		10.0
3300 to 3400	TDD	5.0
		7.0
3400 to 3800	TDD	5.0
		7.0
		10.0

The international practices for spectrum assignment for Broadband Wireless Access is given in Annex-H. A summary of International efforts for Broadband wireless frequency allocation, as recognized in TRAI recommendations on spectrum issues in May 2005 is given in table 4.2:

Table 4.2

Frequency	**Comments**
700-800 MHz	Being considered for future allocations, especially in USA and Philippines
2.3-2.4 GHz	Being used in USA, Korea, Malaysia, Singapore for wireless mobile services, including broadband
2.5-2.69 GHz	Recommended for expansion of IMT-2000 services by ITU. Being considered by some countries for technology neutral allocation-USA, Brazil, Maxico, Canada,Australia, New Zealand, Hong Kong, Singapore
3.4-3.6 GHz	Strong support to shift satellite and other users from this band to allow for mixed TDD and FDD allocations for WiMAX and other 4G platforms-US, UK, France, Malaysia, China,Germany, Hongkong, Australia, New Zealand, Africa and some parts of Latin America
5.15-5.35, 5.725-5.85 GHz	Being considered for unlicensed usage by broadband wireless technologies including WiMAX

Status of spectrum for Broadband Wireless Access in India

4.9 The current utilisation of various frequency bands which can be considered for broadband wireless access including WiMAX applications and their allocation as per ITU and NFAP 2002 is given in Annex-I.

4.10 Regarding WiMAX, currently the frequency band 3.3 - 3.4 GHz which is available for LMDS / MMDS as per NFAP 2002, is being considered. From this band the frequencies are assigned in 2 x 7 MHz FDD mode and 7 MHz in TDD mode to Service Providers on 'first-come-first-serve' basis. The available spectrum of 100 MHz in this band is not considered sufficient keeping in view the demands of large number of Service Providers. Therefore, there is an urgent need to identify more spectrum in different frequency bands. This is discussed in the following paragraphs.

4.11 Another frequency band of immediate importance for WiMAX which is internationally used and for which equipment is also known to be available is band 3.4 - 3.6 GHz. In India this band is being used for INSAT downlink by Department of Space for various applications. It is worth pointing out that most of the operations in this band involve satellite downlinks, which are of low signal strength. Consequently, WiMAX operations in this band could cause interference and disruption to the existing operations. In such situation, the whole of 3.4 – 3.6GHz frequency band cannot be considered for WiMAX deployments. However, some underutilised portion of this frequency band may be coordinated for WiMAX deployments especially in those areas where satellite operations do not exist, for example most of the rural areas. In addition, efforts need to be made to make alternate spectrum available for deployment of WiMAX systems either on location basis or regional basis / national basis.

4.12 Another possible frequency band for WiMAX is 5.15-5.35 GHz. Presently this band is being used for WiFi applications on delicensed basis for indoor usage. TRAI has already recommended in its broadband recommendation for delicensing of this band for out door usage also along with band 5.725-5.85 GHz. For this purpose

coordination with Department of Space is required so that this band can be provisionally delicensed on the basis of non-interference and any possible interference can be monitored and dealt with even after delicensing. The delicensing of this band for out door usage will help easing the deployment of this band for WiMAX application also in future, when equipment becomes available.

4.13 Other bands, which are internationally recognised for deployment of fixed and Mobile WiMAX systems are 2.3-2.4 GHz and 2.5-2.690 GHz. Regarding 2.3-2.4 GHz band, it is presently being used by some utility companies for their fixed point to point data links and it would be difficult to coordinate the band for WiMAX applications. As regards, frequency band 2.5-2.69 GHz, it is being used by Department of Space for INSAT applications at some locations. The band is also used for LMDS, MMDS deployments on case-to-case basis as per NFAP 2002. As per ITU, this band is also been considered for provision of IMT 2000 services, therefore, a cautious approach need to be taken for its allocation for any particular service. It is learnt that the deployment of LMDS and MMDS systems in this frequency band is limited to few cities.As such the same spectrum could be utilised for WiMAX wherever feasible and therefore efforts could be made to coordinate more spectrum in the band 2.5-2.69 GHz.

4.14 In addition, recently a great interest has developed for 700MHz band specially for mobile WiMAX applications because of its favourable propagational characteristics which enables it to provide longer coverage particularly in rural and remote areas. The importance of this band has already been recognised in TRAI's recommendations for Growth of Telecom Services in Rural India. The equipment is not known to be available presently in this band but there is need for earmarking of this band for WiMAX deployment in advance so that service providers and vendors can plan their future operations / productions.

Issues pertaining to spectrum allocation and pricing for WiMAX

Spectrum Allocation

4.15 It may be seen from the table 4.3 that the minimum spectrum, which can be assigned for WiMAX usage, is 1.75 MHz. enabling data rates from 1 Mbps to 6 Mbps based on different modulation techniques and coding. Requirement of optimum

quantum of spectrum for a service provider will depend on the business plan (number of customers to be served), total bit rate required and also the capability of equipment being used.

Table 4.3- Data rate per cell for various coding techniques (in Mbps)

Modulation/ code rate	QPSK ½	QPSK ¾	16 QAM ½	16 QAM ¾	64 QAM 2/3	64 QAM 3/4
1.75 MHz	1.04	2.18	2.91	4.36	5.94	6.55
3.5 MHz	2.08	4.37	5.82	8.73	11.88	13.09
7 MHz	4.15	8.73	11.64	17.45	23.75	26.18
10 MHz	8.31	12.47	16.63	24.94	33.25	37.40
20 MHz	16.62	24.94	33.25	49.87	66.49	74.81

4.16 It is expected that rural area access may require data rate of the order of 10 Mbps per cell whereas Business centre in big cities may need data rate beyond the order of 20 Mbps per cell. With the assignment of 7 MHz using 16 QAM modulation with coding rate of ½, one can achieve data rate of the order of 10 Mbps, which may be sufficient for rural areas. As there are large number of service providers desirous of providing broadband access through out the country, the demand on spectrum for deployment of WiMAX is likely to be more than the presently being assigned. In such case a suitable spectrum allocation criteria needs to be developed keeping in view the limited spectrum available.

4.17 In India, mobile operators are allocated spectrum on the basis of service area. However, data applications have typically been identified as point-to-point or point-to-multi-point links and spectrum utilization was optimized by only allowing usage along the designated links. The emergence of wireless broadband technologies that can act increasingly like cellular networks may require allocation on the basis of entire geographical regions. Therefore, for the efficient deployment of wireless broadband technologies and to enable operators in advance planning for geographical expansion, wireless broadband spectrum may also be considered for allocation in similar fashion as is being done for mobile operators. Various spectrum allocation mechanisms which could be considered apart from ‘first-come-first-serve’ are Auction, Beauty contest, hybrid approach, etc which are discussed in Annex J .

Spectrum Pricing

4.18 Presently, the model used for pricing of spectrum for point to point and point to multi point digital links is based on the equation R=MxWxC, where R is the upfront annual payable royalty amount, M is determined by the distance for which the spectrum is being sought, W is determined by the quantum of frequency being allocated, and C is the number of RF channels used. The spectrum charges as per this are dependent on the specific characteristics of such links. Details of this are enclosed at Annex K. In addition to payment for spectrum, there is also an additional charge of Rs. 500 annually per antenna. For WiMAX assignments also this formula is applicable.

4.19 As wireless Broadband is likely to emerge as cellular like deployments in future, therefore, there is a need for modifying the existing spectrum charging mechanism. One mechanism could be levy of revenue share as is done for cellular mobile services because of large number of spectrum assignments and BTSs deployed to serve a particular geographical area. Another mechanism could be reviewing of multiplier factors in MWC Formula keeping in view the vast usage of spectrum throughout the country, specially in rural and remote areas.

4. 20 In view of the above, issues for consultation in this regard are:

1. **a) What should be the ideal frequency bands for WiMAX (both for 802.16d / 802.16e) for India?**

   b) Is it possible to indicate any hierarchy of preference for the frequency bands in the context of availability of spectrum and global manufacturing plans? If yes please indicate.
2. **What should be the optimum / minimum quantum of spectrum to be assigned per operator for WiMAX for efficient network deployment and business viability point of view?**
3. **How the spectrum allocation for WiMAX deployment is to be done if sufficient spectrum is not available?**
4. **Whether the existing pricing formula (MCW) for WiMAX deployments should continue or needs modification? What should be alternative pricing methodology?**

Chapter 5. Issues for consultation

Spectrum allocation

i) What principles and criterion should be taken into consideration for identification of specific bands for 3G services in India?

ii) Whether spectrum in 2GHz should be given to all the operators?

iii) What should be the quantum of spectrum, which should be allocated to each operator?

iv) Should the spectrum in 2GHz be allocated only after ensuring that at least 2 X 5MHz is available to all operators in a service area.

v) If the available spectrum is less than the demand then what should be the criteria of allocation of spectrum to existing mobile operators in 2GHz band?

vi) Should the present spectrum allocation criteria be modified so that available spectrum is immediately allocated?

vii) Should roll-out obligations be specified for IMT-2000 (3G) services. If yes, please specify the roll out obligations to be imposed. Please also indicate, the penalty to be imposed in case of failure to meet the obligation.

viii) Should allocation of spectrum in IMT-2000 band be linked to Infrastructure sharing? If yes, please specify the conditions to be imposed?

ix) Keeping in mind the requirement of IMT-2000 and Wi-MAX what should be the criteria for allocation of spectrum in 2500-2690 MHz band?

Spectrum Pricing

x) Which of the following criteria should determine the 3G spectrum pricing?

- Demand and supply situation i.e. reflecting scarcity
- Economic and social benefits of the 3G services
- Revenue to the Government and requirement of the funds for refarming
- Combination of the above

xi) Should the service provider pay additional one time charge for IMT-2000 spectrum? If yes, then how should this additional charge be determined

e.g. should it be based on auction, bidding process, etc. or should it be based on the cost of refarming of the spectrum?

xii) What should be the amount of annual spectrum charge on IMT-2000 spectrum?

xiii) Should the existing criterion of annual spectrum charge based on percentage of AGR continue for IMT2000 spectrum?

Spectrum for Wireless broadband services

xiv) a) What should be the ideal frequency bands for WiMAX (both for 802.16d / 802.16e) for India?

b) Is it possible to indicate any hierarchy of preference for the frequency bands in the context of availability of spectrum and global manufacturing plans? If yes please indicate.

xv) What should be the optimum / minimum quantum of spectrum to be assigned per operator for WiMAX for efficient network deployment and business viability point of view?

xvi) How the spectrum allocation for WiMAX deployment is to be done if sufficient spectrum is not available?

xvii) Whether the existing pricing formula (MCW) for WiMAX deployments should continue or needs modification? What should be alternative pricing methodology?

Annex-A

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Secretary

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Government of India
Ministry of Communications & Information Technology
Department of Telecommunications
Sanchar Bhawan, New Delhi-110 001

D.O.No. L-14047/09/2005-NTG
May 22, 2006

Dear Shri Misra,

Please refer to the recommendations on spectrum related issues, released by TRAI in May, 2005.

2. Some of the recommendations relate to IMT-2000 (3G) services. As you are aware, Government is trying to make additional spectrum available for the introduction of 3G services in the country. In this context, we would like to have TRAI's recommendations on the methodology for allotment of spectrum for 3G services and its pricing aspects.

With kind regards,
Yours sincerely,

(*J.S. Sarma*)

Shri Nripendra Misra
Chairman
Telecom Regulatory Authority of India
New Delhi

Annex – B

International Practice

1. Australia[1]

Australia adopted Auction Licensing Methodology for the 3G license. Six operators were awarded 3G license out of which two licenses were awarded on National and four on regional basis. The spectrum allocated to operators was ranging from 5MHz to 15 MHz, details of which are mentioned below.

On the 21st of March'01 3G auction had ended after nineteen rounds of bidding.

Winner	Spectrum allocation	Price
3G Investments (Australia) Pty Ltd	10 MHz of paired spectrum in all capital cities	US$78,108,750
Telstra 3G Spectrum Holdings Pty Ltd	15 MHz of paired spectrum in all capital cities, 10 MHz paired in regional areas and 5 MHz of unpaired spectrum in all capital cities	US$148,474,752
Vodafone Pacific Pty Ltd	10 MHz of paired spectrum in all capital cities, 5 MHz paired in regional areas, plus 5MHz of unpaired spectrum in all capital cities	US$12,477,195
CKW Wireless Pty Ltd	5 MHz of unpaired spectrum in all capital cities	US$4,652,235
Optus Mobile Pty Ltd	10 MHz paired in all capital cities, 5 MHz paired in regional areas, and 5 MHz of unpaired spectrum in Sydney, Melbourne, Brisbane, Adelaide and Perth	US$12,239,426

[1] Source: http://www.3g-generation.com/license_australia.htm, ITU trends 2004/05

Hutchison Telecommunications Australia Limited	15 MHz of paired spectrum in Sydney and Melbourne, 10 MHz of paired in Brisbane, Adelaide and Perth	US$96,432,175

2. Malaysia[2]

Malaysian Communication and Multimedia Commission had adopted beauty contest plus fixed fee licensing methodology for awarding 3G license. Two operators: Telekom Malaysia and UMTS Malasiya were awarded 3 G license for a period of 15 years in July 2002.

Among others, applicants for 3G licenses were also evaluated on their proposals for service roll-out and coverage, infrastructure sharing, roaming, financial consideration, industry development, and management and technical experience. Criteria for Infrastructure sharing includes the following

i. Sharing or allowing access to the use of airtime and network facilities with other licenses; and

ii. Maximising the use of existing network facilities including existing network capacity and capabilities, existing base station sites, backbone, radio links, etc. to enhance sharing and reduce duplication of network facilities.

3. Singapore[3]

In Singapore, Beauty contest plus fixed fee licensing methodology was adopted for the 3G license. Three operators were awarded 3G license for a period of 20 years, The spectrum allocated to each operators was 2X15 MHz and 5MHz for FDD and TDD operations. Details of which are mentioned below.

	Operator	Awarded	Price	Years	Type	Spectrum
Singapore	MobileOne	11/4/2001	SG$100M	20	FDD, TDD	2x15MHz, 5MHz

[2] Source: ITU trends 2004/05, www.umtsworld.com, MCMC website

[3] Source: ITU trends 2004/05, www. umtsworld.com, ITU document on Ubiquitous Network Societies: The case of the Republic of Singapore, IDA press release dated 20 October 2000

	Starhub Mobile	11/4/2001	SG$100M	20	FDD, TDD	2x15MHz, 5MHz
	STM	11/4/2001	SG$100M	20	FDD, TDD	2x15MHz, 5MHz

In October 2000 IDA had announced that a total of four Third Generation (3G) mobile licences will be awarded via an auction in Singapore. The number of 3G licenses was determined by both technical and market consideration. The UMTS Forum had recommended to IDA that 3G operator would require 2 X 15 MHz paired spectrum to support high bandwidth and full multimedia capability. 2X60 MHz of spectrum was available in Singapore, therefore, IDA decided that four 3G licenses may be supported.

Before the auction date, however, IDA was forced to drastically alter its 3G licensing strategy. At the last minute, the only outside bidder, Sunday Communications Ltd. of Hong Kong, China withdrew from the auction, having failed to submit the required bank guarantee. That left only three bidders, the incumbent Singaporean 2G licensees, as contenders for the licences, negating the need for an auction. As a result, IDA announced on 11 April 2001 that it would simply allow the incumbents to receive the 3G licences in return for a payment of the reserve price.

4. Philippines

As per Memorandum Circular No. 07-08-2005 on ‘ RULES AND REGULATIONS ON THE ALLOCATION AND ASSIGNMENT OF 3G RADIO FREQUENCY BANDS’ the following radio frequency bands as identified by the International Telecommunications Union (ITU) are hereby re-allocated for the use of international mobile telecommunications (IMT2000) or 3G mobile telecommunications in the Philippines and shall form part of the National Radio Frequency Allocation Table (NRFAT), namely:

825 – 845MHz*

870 – 890MHz*

*These frequencies are currently assigned to existing CMTS operators.

1880 – 1900MHz

1920 – 1980MHz

2110 – 2170MHz

2010 -2025MHz

The above-allocated frequency bands shall be made available for assignment to not more than five (5) qualified public telecommunications entities (PTE).

As per the above memorandum, in addition to other criteria, the qualified applicants shall be determined using the following criteria:

a. Must submit a written undertaking that it shall interconnect with all 3G networks, cellular mobile telephone networks, local exchange networks and all other public networks pursuant to existing laws, rules and regulations on mandatory interconnection.

b. Must submit a written undertaking that is shall allow the sharing of its network and facilities with other 3G players in areas where demand does not allow more than one (1) 3G network.

c. Must submit written undertaking that it shall negotiate roaming agreements with other 3G networks or existing duly authorized CMTS service providers.

d. Must submit a 5-year roll-out plan to cover at least 80% of the provincial capital towns/cities and 80% of the chartered cities.

e Must submit schedule of rates for the different types of 3G services to be offered. The schedule of rates shall be the maximum rates that can be charged within the first twenty four (24) months from start of commercial operations which shall not be later than thirty (30) months from date of award of the 3G radio frequency bands. Other 3G services not included in the submitted list may be offered subject to prior approval by the Commission;

The annual spectrum user fees (SUF) for the allocated and assigned 3G radio frequency bands shall be:

FOR PAIRED 3G RADIO FREQUENCY BANDS

a. for the first 5MHz, the SUF shall be PhP5,000,000.00 per MHz;

b. for each additional 1MHz or fraction thereof in excess of the first 5MHz but not exceeding 10MHz, the SUF shall be PhP8,000,000.00 per MHz;

c. for each additional 1MHz or fraction thereof in excess of the first 10MHz but not exceeding 15MHz, the SUF shall be PhP10,000,000.00 per MHz;

d. for each additional 1MHz or fraction thereof in excess of the first 15MHz, the SUF shall be PhP15,000,000.00 per MHz.

FOR UNPAIRED 3G RADIO FREQUENCY BANDS

a. for the first 5MHz, the SUF shall be PhP3,000,000.00 per MHz;

b. for each additional 1MHz or fraction thereof in excess of the first 5MHz but not exceeding 10MHz, the SUF shall be PhP6,000,000.00 per MHz;

c. for each additional 1MHz or fraction thereof in excess of the first 10MHz but not exceeding 15MHz, the SUF shall be PhP8,000,000.00 per MHz;

d. for each additional 1MHz or fraction thereof in excess of the first 15MHz, the SUF shall be PhP12,000,000.00 per MHz.

5. Korea[4]

In Korea, license methodology for award of 3G license was Beauty contest plus fixed fee. Three 3G licenses have been awarded for a period of 15 years. Each 3G licensee has been awarded 2X 20 MHz of spectrum. Details are mentioned below:

	Operator	Awarded	Price	Type	Spectrum
South Korea	Korea Telecom	15/12/2000	KRW1.3T	FDD	2x20MHz
	SK Telecom	15/12/2000	KRW1.3T	FDD	2x20MHz
	LG Telecom	25/8/2001	KRW1.15T	cdma2000	2x20MHz

6. Japan[5]

In Japan licensing methodology for 3G was Direct Award. Three 3G license were awarded and no initial license fee was levied.

	Operator	Awarded	Price	Type	Spectrum
Japan	NTT DoCoMo	22/6/2000	None	WCDMA	2x20MHz
	KDDI	22/6/2000	None	cdma2000	2x20MHz

[4] Source: ITU trends 2004/05, www. umtsworld.com
[5] Source: ITU trends 2004/05, www. umtsworld.com

	J-Phone	22/6/2000	None	FDD	2x20MHz

7. UK[6]

Licensing methodology was Auction in case of UK. Five 3G license were awarded and initial license fee USD per license varied from 6.3-9 billion.

	Operator	Awarded	Price	Years	Type	Spectrum
UK	Hutchison (TIW)	27/4/2000	£4.385B	20	FDD, TDD	2x15MHz, 5MHz
	Vodafone	27/4/2000	£5.964B	20	FDD	2x15MHz
	O_2 (ex-BT3G)	27/4/2000	£4.030B	20	FDD, TDD	2x10MHz, 5MHz
	One2One	27/4/2000	£4.004B	20	FDD, TDD	2x10MHz, 5MHz
	Orange	27/4/2000	£4.095B	20	FDD, TDD	2x10MHz,

8. Hong Kong[7]

The Government announced on 13 February 2001, the licensing framework for Third Generation Mobile Services (3G). OFTA decided to conduct a pre-qualification exercise followed by spectrum auctioning, to select four 3G licensees. Given the spectrum constraint, Hong Kong decided to issue four 3G licences. Here 2X15 MHz was allocated to each 3G operator.

The Government has chosen a royalty-based proposal which requires the bidders to pay a certain percentage of their annual 3G revenue turnover determined by the auction. The royalty payment will be subject to a guaranteed, minimum payment.

	Operator	Awarded	Years	Type	Band
Hong Kong	CSL	19/9/2001	15	FDD, TDD	2x15MHz, 5MHz
	Hutchison 3G	19/9/2001	15	FDD, TDD	2x15MHz, 5MHz

[6] Source: ITU trends 2004/05, www. umtsworld.com

[7] Source: http://www.ofta.gov.hk, www. umtsworld.com

	SmarTone 3G	19/9/2001	15	FDD, TDD	2x15MHz, 5MHz
	SUNDAY 3G	19/9/2001	15	FDD, TDD	2x15MHz, 5MHz

Policy objective for the licensing process remain unchanged and are to (a) promote the development of the telecommunications industry; (b) protect consumers' interests; and (c) to maximize the benefits to the economy as a whole.

The Government has also announced a number of important regulatory conditions decided by the Telecommunications Authority (TA), including the requirement that the 3G network licencees should make available at least 30% of their network capacity for access by non-affiliated Mobile Virtual Network Operators (MVNOs) and/or content providers.

9. Sweden[8]

In Sweden, the 3G licences were issued through a so-called 'beauty contest'. Applications were assessed by an initial consideration in which financial capacity, technical and commercial feasibility and access to appropriate expertise and experience were investigated. Following this, there was an in-depth consideration of the applications that had passed the initial consideration. At the second stage of the review, the operators were awarded points according to the extent and speed at which they offered coverage by the end of 2003, 2006 and 2009. Coverage was defined on the basis of three factors: proportion of population, territorial coverage and distribution throughout Sweden.

On the final date for applications, 1 September 2000, ten applications had been received from companies and consortiums. On 16 December 2000, PTS decided that Europolitan (now Vodafone), HI3G (3), Orange and Tele2 should each get a licence. All four undertook to cover at least 8 860 000 people by the end of 2003. These licences apply up to and including 31 December 2015. PTS decided on radio licences on 15 August 2001. All 3G operators have been granted 2x15 MHz radio frequencies

[8] www.pts.se, www. umtsworld.com

in the bands 1920–1980 MHz paired with the bands 2110–2170 MHz and also 5 MHz in the bands 1900–1920 MHz.

	Operator	Awarded	Price	Years	Type	Spectrum
Sweden	Europolitan	16/12/2000	SEK0.1M	15	FDD, TDD	2x15MHz, 5MHz
	HI3G	16/12/2000	SEK0.1M	15	FDD, TDD	2x15MHz, 5MHz
	Orange	16/12/2000	SEK0.1M	15	FDD, TDD	2x15MHz, 5MHz
	Tele 2	16/12/2000	SEK0.1M	15	FDD, TDD	2x15MHz, 5MHz

Appeal against the allocation decision

Telia, Telenordia and ReachOut Mobile, which did not get any 3G licences, appealed against the decision to the County Administrative Court. The County Administrative Court confirmed PTS's decision on 27 June 2001. No one appealed against that decision.

Annex C

Number of licensed service providers

SLNO	Service Area	Operators
1	Delhi	6
2	Mumbai	6
3	Chennai	6
4	Kolkatta	5
5	Maharashtra	6
6	Gujarat	6
7	Andhra Pradesh	6
8	Karnataka	6
9	Tamil Nadu	6
10	Kerala	6
11	Punjab	7
12	Haryana	6
13	UP - W	6
14	UP - E	6
15	Rajasthan	7
16	Madhya Pradesh	5
17	West Bengal	6
18	Himchal Pradesh	5
19	Bihar	5
20	Orissa	5
21	Assam	4
22	North East	4
23	Jammu & Kashmir	4

Note: If an operator has both GSM and CDMA operations then they have been counted as one operator.

Annex – D (i)

International Practice on Method of Allocation[9]

Country	Population	Licensing methodology	Number of licences offered	Number of licences awarded	Initial licence fee (USD) per licence	Initial duration of licence
2002						
Malaysia	2.2 million	Beauty contest plus fixed fee	3	2	13.2 million	15 years
Taiwan, P. of China	22.4 million	Auction	5	5	220-302 million	16 years
2001						
Australia	19.4 Million	Auction	6 [3]	6	4.6-96.4 million	15 years
Canada	30.0 million	Auction	5	5	11.4-720.5 million	20 years
Hong Kong, China	7.2 million	Auction	4	4	Var.annual royalties [1, 2]	15 years
Singapore	4.3 million	Beauty contest plus fixed fee	4	3	50 million	20 years
2000						
Japan	126.8 million	Direct award	3	3	None	N/A
Korea (Rep. of)	47.9 million	Beauty contest plus fixed fee	3	3 [4]	898-994 million	15 years
New Zealand	3.9 million	Auction	4	4	10.3-16.7 million	20 years
Notes:						
1 Government excepted 6 bidders for 4 licences but this did not occur, so awarded licences based on minimum reserved price.						
2. Royalities (revenue sharing) with pre-established minimum payments for 15 years.						
3. Two national and four regional licences.						
4. Government initially awarded two licences and deferred award of third licence until 2002.						

[9] ITU trends 2004-05

Annex – D (ii)

International Practice on Method of Allocation (Contd)[10]

Country	Population	Licensing Methodology	Number of Licences offered	Number of licences awarded	Initial Licence fee USD per licence	Initial duration of licence
2003						
Luxembourg	0.4 million	Direct award	1 [1]	1	0	15 years
Norway	4.5 million	Auction	2	1	8.2 million	12 years
2002						
Ireland	3.8 million	Beauty contest with fee component	4	3	11.5-40 million	20 years
Luxembourg	0.4 million	Beauty contest	4	3	0	15 years
Slovak Republic	5.4 million	Beauty contest with mixed fee	3	2 [2]	33.7 million	15 years
2001						
Belgium	10.3 million	Auction	3	3	139.6-139.8 million	20 years
Czech Republic	10.3 million	Direct award	3	2 [4]	97-106 million	20 years
Denmark	5.3 million	Auction	4	4	118 million	15 years
France	59.5 million	Beauty contest plus fixed fee	3	2 [3]	570 million	20 years
Greece	10.6 million	Auction	4	3	125.6 million	20 years
Slovenia	1.9 million	Auction	2	1	87.5 million	20 years
2000						
Austria	8.2 million	Auction	6	6	98-105 million	20 years
Finland	5.2 million	Beauty contest	4	4	0	20 years
Germany	83.0 million	Auction	6	6 [5]	7.6-7.7 illion	20 years
Italy	57.7 million	Auction	5	4 [6]	2-2.03 billion	20 years
Liechtenstein	32,538	No contest	4	3	0	TBD
Netherlands	16.0 million	Auction	5	5	401-666.8 million	15 years
Norway	4.5 million	Beauty contest plus fixed fee	4	4 [7]	11.2 million	12 years
Poland	38.6 million	Beauty contest plus fixed fee	5	3 [8]	223 million	15 years
Portugal	10.1 million	Beauty contest plus fixed fee	4	4	90 million	15 years
Spain	40.0 million	Beauty contest plus fixed fee	4	4	110 million	20 years
Sweden	8.9 million	Beauty contest plus fixed fee	4	4	10,700	15 years
Switzerland	7.3 million	Auction	4	4	29-32 million	15 years
UK	59.6 million	Auction	2	5	6.3-9 billion	20 years

Notes:-

1 Award of licence that was previously not awarded in 2002

2 Third licence was joint GSM/UMTS licence-no takers.

3 Third licence eventually awarded to incumbent GSM operator.

4 Third incumbent declined to take licence

5 Two licences abandoned/surrendered to regulatory authorities.

6 One licence abandoned immediately after award.

7 One of three licences subsequently surrendered/revoked.

8 No applicants other than incumbent mobile operators

[10] ITU trends 2004-05

Annex E

Minimum coverage requirements for 3G Licensing[11]

Australia	No requirement
Austria	25% of population by December 2003 and 50% by the end of 2005
Belgium	30% of population within three years, increasing to 85% of population after six years.
Canada`	No requirement
Czech Republic	Licensees must launch a commercial public service with a UMTS system in Prague by 1 January 2006. The service shall be available in at least 90% of that area
Denmark	30% of population by the end of 2004 and 80% of population by the end of 2008
Finalnd	No requirement
France	80% of population within eight years following the issue of the license
Germany	25% of population by December 2003 and then 50% of population by December 2005
Greece	At least 25% of population by December 2003, coverage of the Olympic Games facilities, venues and main connecting routes in the Attica region by February 2004 and coverage of at least 50% of population by December 2006
Hungary	No requirement
Iceland	No 3G licensing
Ireland	A license: 53% of population (equivalent to the five major cities) by the end of 2005 and with the fulfillment of the minimum 80% population requirement by the end of 2007. B License: 33% of population by the end of June 2006 and 54% by the end of June 2008
Italy	Regional capitals within 30 months and provincial cities within 60 months
Japan	50% of population within five years
Korea	No requirement (Operators are supposed to deploy networks each year according to their business plan submitted to the government when they applied for a license)
Luxembourg	Not known
Mexico	No requirement
Netherlands	60% of population by the end of 2007
New Zealand	Not known
Norway	For Telnor 80% of population by 2008 for NetCom 76% of population by 2005, for Hi3G 30% of population by 2009
Poland	For voice services, 25% of population by the end of 2003, 60% by the end of 2005 and 80% by the end of 2009, slightly less for 144kbps data services
Portugal	20% of population at the end of the first year of the validity period of the license, 40% at the end of the third year, and 6)% at the end of the fifth year

[11] Organisation for Economic Cooperation and Development (OECD) – Development of 3G mobile services in the OECD.

Slovak Republic	Not known
Spain	UMTS operators are free to decide the date of the commercial launching. Initial coverage should be, at least, cities with a population greater than 250000
Sweden	Licensees have made commitments to cover at least 8 860 000 people (i.e 99.98% of the population in December) by the end of 2003.
Switzerland	50% of population by the end of 2004
Turkey	No 3G licensing
United Kingdom	80% of population by the end of 2007
United States	The government is not assigning spectrum specifically for 3G but is allowing mobile operators to implement 3G services using allocate spectrum

Annex F

Methodologies for Spectrum Pricing

1. Auctions

A well-designed auction should treat all potential bidders fairly and transparently and should achieve a realistic market price for the spectrum and encourage efficient use of the spectrum. Efficient use of the spectrum in this context means maximising the economic value of the spectrum, providing good grade of service at an economic cost but with the minimum of spectrum and ensuring that the number of Service Providers who are accommodated in the spectrum maximise competition.

There is no single auction design that can be used in all cases of spectrum allocation because the quantum of spectrum, number of potential bidders, geographic coverage (regional or national) and policy objectives are all likely to differ. The main types of auctions are:

- Ascending-price
- Sealed-bid
- Anglo-Dutch

1.1 Ascending-price

Simultaneous ascending price auctions[12] have been demonstrated to be effective where a number of licences are to be awarded and they cover, for example, different geographic areas. In this case there are a number of sequential rounds of bidding and each bidder must increase the previous bid on a "lot" by more than a pre-set amount. When there is no more bidding the auction ends and the bidders with the highest bids on each "lot" will be the winners. The fact that bidders can see how their opponents are bidding and derive information on how they value spectrum in the different geographic areas will allow them to win more efficient allocations than might happen in a sealed bid. Ascending price auctions are also ideal for conducting through electronic means.

[12] For example ascending price auctions have been used in the US, Canada, Australia, UK, Germany and Austria.

Others

1.2 Sealed-bid

Sealed-bid auctions involves each bidder only making one single offer. They are more attractive to new entrants than the ascending auction as there is always the possibility that they might outbid an incumbent who has under-estimated the value of the spectrum.

1.3 Anglo-Dutch

This is a mixture of the two auction types above. Initially there is an ascending price auction and then when the number of bidders has been reduced to one more than the number of licences available[13] there is a sealed-bid. The sealed-bid has to be the same or more than the final price reached through the ascending auction.

2. Based on Market Indicators

An alternative approach is to attempt to set levels based on market indications, such as the prices paid at auction in comparable frequency bands and geographic territories, however such prices are subject to wide fluctuation as was the case in the European 3G mobile auctions, which may result in fees that are widely out of line with the least cost alternative approach and so may fail to have the desired impact on investment decisions. If the price is set too high, Service Providers will be deterred from entering the market or, if they do, may be deterred from acquiring sufficient spectrum to address a wide market, choosing instead to concentrate on high spending, non-price sensitive users. If too low, there will be no incentive to use spectrum in the most efficient manner.

3. Cost recovery

In the case of cost recovery the fees are generally set on a service by service basis and depend on the actual costs incurred by the regulatory authority in the licensing of the networks / services concerned and associated management of the radio

[13] The licences would need to be in the same geographic area.

spectrum. There will be additional "indirect" costs such as international activities or work on licence-exempt services that cannot be directly attributed to a service that is licensed. These costs will have to be spread across the different services according to some transparent basis. Cost based pricing is appropriate where there is no excess demand for spectrum and may be applied as a minimum fee where AIP is deployed, to ensure that the regulator's costs are always covered.

Annexure G

Technical Details-WiMAX

(Source: Intel)

The standard IEEE 802.16-2004 (802.16d) was focused on fixed and nomadic applications in the 2-11 GHz frequencies. Two multi-carrier modulation techniques are supported in 802.16-2004; OFDM with 256 carriers and Orthogonal Frequency Division Multiple Access (OFDMA) with 2048 carriers. The first WiMAX Forum certification profiles are based on OFDM as defined in this version of the standard.

IEEE 802.16e offers improved support for Multiple Input Multiple Output (MIMO) and Adaptive Antenna Systems (AAS), as well as hard and soft handoffs. It also has improved power-saving capabilities for mobile devices and more extensive security features. Various technical parameters are compared in the following table:

Technical Parameters	802.16d	802.16e
Spectrum Band	2-11 GHz	<6 GHz
Data rate	70-100 Mbps	Upto 15 Mbps
Configuration	NLOS	NLOS
Modulation/ Radio technique	OFDM	OFDM
Channel Bandwidth	1.75 – 20 MHz	1.75 – 20 MHz
Mobility	Nil (Fixed)	Upto 120 Kmph
Typical range	15 Km	10 Km

Samsung and LG Electronics of Republic of Korea have developed a WiMAX styled technology called WiBro (Wireless Broadband) which is designed for the 2.3 GHz band. It offers 512-1024kbit/s per user, and allows users to travel at near vehicular speeds (around 60 km per hour). The system has emerged with assistance from the government of Korea which was eager to see a locally produced technology and had promoted WiBro as the basis for the 802.16e mobile WiMAX standard. Other

important stakeholders, however, were not supportive of WiBro as a standard setting technology for technical reasons.

The European Telecommunications Standards Institute (ETSI) has also developed broadband metropolitan area network standards under the name HiperMAN. Like WiBro and other related technologies, these systems allow for long range transmissions (over tens of kilometers) and high bandwidth. The WiMAX Forum has been working with the HiperMAN, WiBro and IEEE 802.16 standards to try to ensure interoperability among all of these various systems.

The new version of the standard introduces support for Scalable OFDM Access (SOFDMA), a variation on OFDMA which allows for a variable number of carriers, in addition to the previously-defined OFDM and OFDMA modes. SOFDAMA is considered efficient for asymmetric data transmission. The carrier allocation in OFDMA modes is designed to minimize the effect of the interference on user devices with omni directional antennae.

As with 802.16d, 802.16e will incorporate previous versions of the standard and add support for fixed and mobile access. However, 802.16e is often used to refer to the changes introduced to support mobility and, in particular, SOFDMA. The new version of the 802.16 standard is backwards-compatible, so new specifications of the OFDM mode are compatible with previous versions. However, OFDM and SOFDMA modes are not compatible as they are based on two distinct modulation techniques. As a result, a single-mode OFDM CPE will not work within a SOFDMA network and, conversely, an SOFDMA CPE will not work within an OFDM network.

WiMAX's technology for LOS and NLOS environments

While many technologies currently available for fixed broadband wireless can only provide line of sight (LOS) coverage, the technology behind WiMAX has been optimized to provide excellent non line of sight (NLOS) coverage. WiMAX's advanced technology provides the best of both worlds –

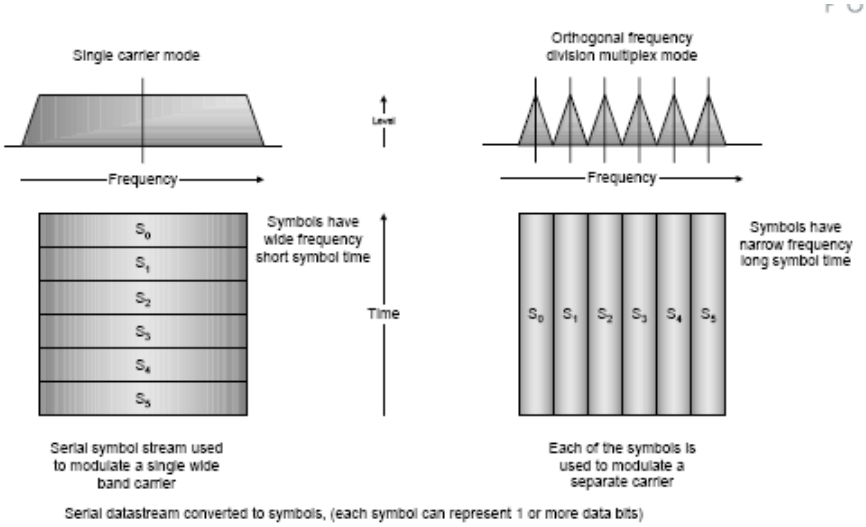
- large coverage distances of up to 50 kilometers under LOS conditions

- typical cell radii of upto 5 miles/8 km under NLOS conditions.

The NLOS technology and the enhanced features in WiMAX make it possible to use indoor customer premise equipment (CPE). This has two main challenges; firstly overcoming the building penetration losses and secondly, covering reasonable distances with the lower transmit powers and antenna gains.

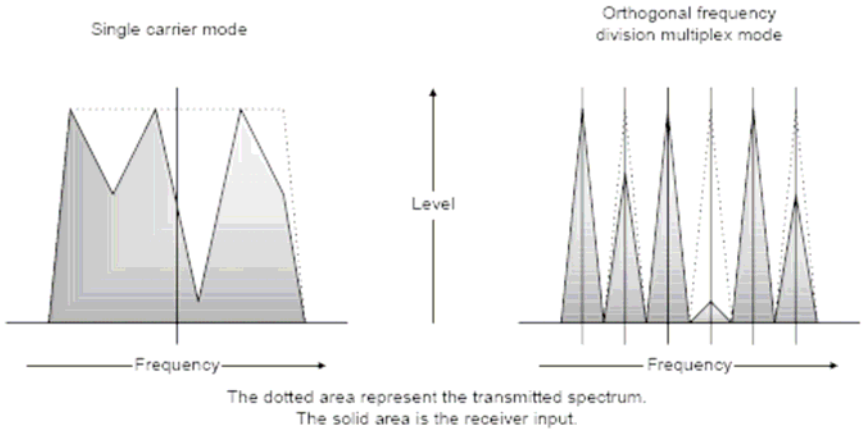
OFDM Technology

Orthogonal Frequency Division Multiplexing (OFDM) technology provides operators with an efficient means to overcome the challenges of NLOS propagation. The WiMAX OFDM waveform offers the advantage of being able to operate with the larger delay spread of the NLOS environment. By virtue of the OFDM symbol time and use of a cyclic prefix, the OFDM waveform eliminates the inter-symbol interference (ISI) problems and the complexities of adaptive equalization. Because the OFDM waveform is composed of multiple narrowband orthogonal carriers, selective fading is localized to a subset of carriers that are relatively easy to equalize. An example is shown below as a comparison between an OFDM signal and a single carrier signal, with the information being sent in parallel for OFDM and in series for single carrier.



The ability to overcome delay spread, multi-path, and ISI in an efficient manner allows for higher data rate throughput. As an example it is easier to equalize

the individual OFDM carriers than it is to equalize the broader single carrier signal.



Single-carrier and OFDM received signals

For all of these reasons recent international standards such as those set by IEEE 802.16, ETSI- Broadband Radio Access Network (BRAN), and Electronics and Telecommunication Research Institute (ETRI), have established OFDM as the preferred technology of choice.

Annexure H

International Spectrum Assignments for Broadband Wireless Access

i) USA:

On 10 March 2005 the FCC allocated the band 3650–3700 MHz to support Broadband Wireless Access (BWA) operation. An unlimited number of national, non-exclusive licences will be offered. All terrestrial operations in the band are required to use technology that includes a contention based protocol.

ii) UK:

In June 2003 the Radio Agency (RA) awarded 15 licences in the 3.4 GHz band for FWA services. Ofcom is considering making additional spectrum available in the 3.6–4.2 GHz band.

iii) Canada:

In Canada the band 953–960 MHz is shared by fixed studio-to-transmitter links and Fixed Wireless Access (FWA) systems on a geographical basis. FWA systems also operate in the 1427–1525 MHz bands in many rural areas of Canada to provide access to voice and data services.

iv) **European Conference of Postal and Telecommunications Administrations (CEPT)**

CEPT is the European regional organisation dealing with postal and telecommunications issues and currently has 45 member countries. CEPT Recommendation 13-04 recommends that the band 3400–3600 MHz be identified as a preferred band for FWA applications within CEPT.

v) **Switzerland**

Federal Communications Commission (ComCom) also plans to allocate the band 3600–3800 MHz for FWA systems, which will have co-primary use of the band with

the Fixed Satellite Service (FSS) (sufficient geographical separation between fixed links and FSS stations will be required).

vi) France

In July 2004, French Telecommunication Regulator, ARCEP granted 20 authorisations in the 3.4–3.8 GHz band to allow the testing of new WLL equipment using WiMAX technology. The testing was authorised until 31 January 2006.

vii) Republic of Korea

WiBro (wireless broadband) - In early 2005 licences were issued to three operators to deploy WiBro services (one operator has since cancelled its plans to launch a WiBro service, citing market saturation). Commercial WiBro services became available in November 2005.

viii) Singapore:

In February 2005 the IDA announced that it would study the possibility of co-existence of BWA and fixed satellite services in the 3.5 GHz band to support the possible deployment of WiMAX.

ix) Hong Kong:

In August 2005 OFTA announced it would offer 180 MHz of spectrum for BWA services in the 3.5 GHz band (3410–3500 MHz and 3510–3600 MHz). The spectrum will be divided into six frequency block-pairs and licences will be allocated for 15 years. Licensees will be required to start offering services within two years after being awarded the spectrum.

Annex-I

Current Status of frequency bands in India, internationally identified for Broadband Wireless Access

Frequency band	Allocations		Existing operations in India	Equipment Availability for WiMAX	Status of spectrum availability in India
	ITU (Region-3)	India (NFAP-2002)			
700 MHz	Fixed, Mobile, Broadcasting, Radio- astronomy	Fixed, Mobile, Broadcasting, Radio-astronomy	UHF links and other radio applications of various agencies	Yet to be developed	Needs co-ordination with the existing users
2.3-2.4 GHz	Fixed, Mobile, Radio-location	Fixed, Mobile, Radio location	Microwave links of utility companies	Yet to be developed	Needs co-ordination with the existing users
2.5-2.686 GHz	Fixed, Mobile, Mobile-satellite, Fixed-Satellite, Broadcasting-satellite	IND 54[1]	Satellite S Band, LMDS, MMDS	yet to be developed	Some of low usage bands may be coordinated with DOS
3.3. to 3.4 GHz	Radio location	IND 56[2]	Being used by ISPs	Modified equipment is Available	Being assigned for WiMAX applications
3.4 to 3.6 GHz	Fixed, Mobile, Fixed- Satellite	INSAT down link		Available	Possibility may be explored to earmark the spectrum for WiMAX
5.725 to 5.825 GHz	Radio location	De Licensed for indoor	Existing usages of DoS Yet to be	Yet to be developed	Some portion of the spectrum may be

			coordinated for out door applications		coordinated WiMAX application

1. IND54 – 2.53 to 2.65 GHz band is used for INSAT system. Requirement of LMDS (Local Multipoint Distribution System) and MMDS (Microwave Multipoint Distribution System) to be coordinated on a case by case basis.

2. IND56 – Requirement of LMDS & MMDS may be considered in frequency band 3.3 to 3.4 GHz on case to case basis.

Annexure J

Spectrum allocation Methods

Auctions

Auctioning of 3G spectrum licenses has, since mid-2000, raised substantial amounts of revenue for governments and has given rise to a fierce debate concerning the efficiency, competitive impact and social implications of this form of allocating 3G spectrum. Supporters of the auctioning approach argue that it allocates 3G spectrum to those operators that value the spectrum most highly and who can thus be expected to make the most economically efficient use of the spectrum. Auctions require that bidders estimate for themselves the true value to them of owning the relevant spectrum. Thus, assuming an environment of well-informed bidders, the winning bids should come from the companies that can find ways of maximising the stream of future benefits. It is true that an operator with the greatest capacity for monopolization might also be prepared to place a relatively high value on a mobile licence. Thus, if three mobile licences were up for auction, they would probably be perceived to be of the highest value by a single operator who could bid for all three in order to have the monopoly of the service. This would obviously be an undesirable outcome. It can however, be simply remedied through appropriate auction design.

Most of the European countries have followed auction method for awarding licences to 3G operators. In this connection the UK, USA, Canada, Germany, Switzerland, and Singapore cases may be referred.

Comparative selection (Beauty contests)

The beauty contest approach is quite different. Typically, the government invites applications that are rated according to some pre-set criteria. Licences are allocated to those whom the government believes best meet the stated requirements. This is widely seen to have several disadvantages in terms of process and efficiency.

The countries which have followed this method for awarding licences are Brazil, Finland, France, Ireland, Japan, Korea, Malaysia, Sweden and Turkey.

Hybrid Approach

A number of countries, like Austria, Italy, France and Hong Kong adopted a hybrid approach to 3G licence allocation. Tenderers have to pre-qualify in terms of criteria similar to those established for straight out beauty contests to bid. Licences are then allocated on the basis of an auction. Pre-qualification of potential operators involves the authorities screening potential license bidders prior to the auction according to qualitative non-financial and financial criteria determined by the government. Numerous policy goals including social, employment, technology transfer and environmental objectives could potentially be pursued under this approach with candidates being judged on their ability to fulfil policy objectives. Observations made earlier in regard to auctions and beauty contests pertain also to this hybrid approach. By their nature such pre-qualification processes can potentially be complex, time-consuming and contentious. Because selection at the pre-bidding stage is not solely based on quantifiable and objective financial and technical criteria the scope for subjective interpretation of the rules and requirements of the assessment process increases the risk of litigation and delay in introduction of the new service. Nevertheless, such processes can be used to help ensure that potential holders of 3G licenses have the expertise, capability and will to meet social and policy objectives required by Government.

Annexure K

Current Method for Pricing of other Terrestrial Wireless Links including WiMAX

1. The system for calculation of point-to-point and point-to-multi-point wireless links is governed by R=MxWxC, where R is the payable royalty amount, M is determined by the distance the clearance is being sought for, W is determined by the quantum of frequency being allocated, and C is the number of RF channels used (twice the number of duplex RF channel pairs). Both M and W are determined by range slabs, such that the multiplier increases significantly as soon as the requirements for the operator cross into the next slab.

2. The most recent definition of the applicable parameters was released by the DOT in Letter No.R-11014/26/2002-LR on April 1, 2003. This letter outlines the parameters as follows:

"5.1 Constant Multiplier M where:

M = 1200 for point to point Microwave Link(s) with end-to-end distance less than or equal to 05 Kms

M = 2400 for point-to-point Microwave Link(s) with end-to-end distance greater than 05 Kms but less than or equal to 25 Kms.

M = 4800 for point-to-point Microwave Link(s) with end-to-end distance greater than 25 Kms but less than or equal to 60 Kms.

M = 9000 for point-to-point Microwave Link(s) with end-to-end distance greater than 60 Kms but less than or equal to 120 Kms.

M = 15000 for point-to-point Microwave Link(s) with end-to-end distance greater than 120 Kms but less than or equal to 500 Kms.

M = 20000 for point-to-point Microwave Link(s) with end-to-end distance greater than 500 Kms.

5.2 Weighting Fact 'W' which is decided by the adjacent channel separation of the R.F. channeling plan deployed where

W = 30 for adjacent channel separation upto 2 MHz

W = 60 for adjacent channel separation greater than 2 MHz, but less than or equal to 7 MHz

W = 120 for adjacent channel separation greater than 7 MHz, but less than or equal to 28 MHz

W = (120) + (30 for each additional 7 MHz Bandwidth or part thereof) for adjacent channel separation greater than 28 MHz"

3. There are a few implications of this overall arrangement. One of these is that the same multiplier would apply to allocations requiring either 8 MHz or 27 MHz. Furthermore, TDD, which uses one channel, is inherently priced lower than FDD, which has one channel each for transmit and receive. For example, an application for TDD spectrum of 20 MHz for a range of 5 km would attract half the royalty payment of an application for FDD spectrum of 2 channels of 10 MHz each for a range of 5 km.

4. For M, the distance factor, implications of the selected slabs effects how operators plan their networks and operations. Today, operators are forcefully limiting their deployments to 5 km radius usage if their technology does not have the ability to reach close to the 25 km mark, as there are no intermediate slabs. Therefore, for a 6 km radius, he would have to pay fees that are the same as that for a 25 km radius.