Motorola and SpectraPoint Reply to IDA Request for Comments on the document Proposed Approach to Fixed-Wireless Broadband Network Deployment and Service Provisioning in Singapore

Introduction

Motorola and SpectraPoint are pleased to provide joint comments to IDA on their paper *Proposed Approach to Fixed-Wireless Broadband Network Deployment and Service Provisioning in Singapore.*

A fixed wireless broadband network service (FWBNS) can provide subscriber access to public and private voice, video, and data services. The systems provide the "last few kilometres" link between networks offering various telecommunications services and the buildings that house subscribers. The wireless systems are an alternative or extension to copper, coax, fibre, satellite, or point-to-point radio systems. These systems, if implemented under a liberal regulatory policy, can stimulate competition and make available advanced telecommunications services to most of the population in a country.

We suggest that the concepts of block (un-channelled) spectrum assignment and issuing a limited number of licenses (2 to 5) per geographic area[1] provide the best scenario for accomplishing the competitive and advanced telecommunications goals of the administration. We also suggest that, while broadband services may dominate the use of the spectrum, narrow band services and services of all types should be allowed.

2.1 Potential of Fixed-Wireless Broadband Technology

(a) the potential of and benefits arising from the deployment of fixed-wireless broadband network, the likely services/applications to be deployed and the potential demand from business and consumers. [2]

Fixed wireless systems are capable of offering the full array of fixed telecommunication services. These include high-speed data, voice, video, video-on-demand and Internet access at speeds equalling or exceeding today's wired Internet access.

The benefits to users are reflected in increased productivity and lower costs. Increased productivity comes about as a consequence of nearly instantaneous delivery of requested data. Lower costs are a consequence of the ability to hold high-speed, electronic meetings using shared Internet and video conferencing facilities, integrate business systems in real time and the lower overall data costs of a broadband environment. These gains in productivity directly translate to an increase in gross domestic product per capita.

Increasing demand for broadband services is evidenced by the rapid advance of the Internet, personal computer technology, and telecommunications services in general. All of these products and applications drive the need for more bandwidth at all points in networks. Fixed broadband wireless radio systems are ideally suited for operation in the access portion of networks and can provide a solution to the increased demand for telecommunications services.

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[1] We note that because of the relatively small size of Singapore and its high density, it may not be practical or desirable to divide the country into license areas, as has been done in some other countries.

[2] Excerpts from the consultation are in *italics* followed by reply comments.

Corporate users demand services such as local area networks (LANs), high-speed Internet connections, and video conferencing. Many business districts contain clusters of potential subscribers whose locations make broadband wireless extremely economically viable.

In the residential environment, a fixed wireless broadband network service brings the ability to have the same services in the home and small-office-home-office business environment as that enjoyed by large corporations. As prices fall due to economies of scale, one can expect entertainment use to emerge.

In the residential segment, we expect the most profitable application of broadband wireless upon initial deployments to be multi-dwelling units. We expect further penetration of broadband wireless into the residential sector in single-family dwellings with consecutive generations of products, and as prices fall due to economies of scale. While these deployments may not occur with the initial generation of broadband wireless, they represent a significant opportunity to bring a competitive alternative in telecommunications to the mass market.

We believe that a fixed wireless broadband network service is a diverse service that can be rolled out in different manners. It is not merely the extension of the wired telephone or cable television (TV) systems, although those are two of the things that it can be used for. Beyond providing wireless, last-mile solutions, it has the potential to be a complete stand-alone broadband system with links to all other wired and wireless distributions systems.

The demand for broadband services will be roughly proportionate to the use of personal computers in a country. Thus, in Singapore, the demand is likely to be ahead of the curve because it is one of the worlds fastest-growing computer markets in both homes and in business. On the other hand, a fixed wireless broadband network service is especially useful in countries where wired broadband infrastructure is sub-optimum, clearly not the case in Singapore. Finally, a fixed wireless broadband network service is ideally suited to areas with significant business and residential populations located in high-rise buildings, a profile that Singapore meets perfectly. Consequently, we anticipate that the Singapore market will approximate that for large urban cores of developed countries, such as the US or Western Europe. In these markets, we expect the demand for wireless broadband access to double every four years.

One potential benefit of a wireless solution is its ability to reallocate core resources as the demand changes (over time). System capacity can be shifted from business users to residential users as their usage patterns are different. Systems can be re-deployed more easily than cabled systems.

2.2 Competing Demands for Fixed-Wireless Broadband Technology

(b) the possible uses for the fixed-wireless broadband technology, and how the competing demands for the spectrum should be managed, including the allocation process, the timing of the process and criteria to be used. IDA also seeks comments on whether there are interconnection and access issues that may pose problems to achieving IDA's objective of transparent and seamless interconnection and open access; and how these may be practically and realistically addressed. IDA further seeks comments on the type

and level of QOS standards, including both network and customer QOS standards, that would be appropriate to benchmark the quality of the network and services deployed.

To encourage competition, we suggest that the regulatory policy allow delivery of services that include voice, video and data in any combination. With the inevitable proliferation of internet protocol (IP) and asynchronous transfer mode (ATM) networks, transmission methods for various applications (voice, data, or video) are converging to a common method. Along with this trend is the increasing market demand for bundled service offerings that include all of these applications. Given the compatibility of the convergence trend in terms of both its technology and market, subscribers would benefit from enabling, and not restricting, the type of services available.

Broadband fixed wireless technology will compete with other platforms in the access portion of the network, including various digital subscriber line (xDSL), fibre, and hybrid fibre-coax transmission systems. In order to maximise the contribution of broadband fixed wireless to the competitive landscape of telecommunications, two things are essential. First, spectrum assignment on the order of 1 GHz per licensee and secondly, exclusive use of the assigned spectrum block within a geographic area of at least metropolitan size.

In keeping with a policy of promoting competition, broadband wireless technology must be enabled to compete with alternative access technologies on price as well as service. The ideal way to promote this is to license one broadband wireless carrier per block of spectrum per given geographic area. Such an approach strengthens each licensee's competitive viability in the context of other technologies in a given area.

Eventually, competition must be ubiquitous in all points in a network for the industry to maximise market potential. Competition in the access portion of the network is an important step. Regulators must also promote competition throughout the entire network in order for competition in the access portion of the network to realise maximum benefit.

An alternative to restricting providers, and a powerful tool for regulators, is to promote the broadband fixed wireless industry with subsidies as opposed to restrictions. Government subsidies encourage providers to target otherwise unprofitable markets. Examples of this type of regulation would include subsidising service to public service and educational institutions as well as rural markets.

In terms of standardization in Singapore, there is no single worldwide fixed wireless broadband network service standard, nor need there be. The fixed wireless broadband network service lends itself to scaled systems both by virtue of the engineering of the systems themselves and by the selection of technology appropriate to the needs of the licensee. We note that IDA has declared Singapore's spectrum management to be undertaken on a technology-neutral basis. We agree with this precept and point out that it will lead to greater innovation and uptake of new and exciting technologies.

From the perspective of the licensee, a fixed wireless broadband network service is not a "natural monopoly", either by the nature of the service or due to the technologies employed. Multiple licensees are entirely possible and desirable both from a technology and a competitive point of view. We note that this is in line with IDA's stated views of the development of telecommunication in the country.

The license should support all services including voice, video, and data, but there should neither be mandatory services required as a condition of license nor should there be any restriction on the type, quantity or speed of services allowed. Specifically, interconnection to or with local telephone, data transmission and Internet access must be facilitated by the policy.

Systems that provide access services over a metropolitan-sized area are expected to consist of multiple transmitters each covering a sub-set of the overall coverage area. When providing coverage using point-to-multipoint (P-MP) radios, a hub transmitter is located at the centre of each cell. The hub provides subscribers with connection to network services, and the hub must therefore connect to one or more networks. A network connection can use one or more transmission technologies including fibre, copper, satellite, or fixed radio. The fixed radio can use point-to-point (P-P) or other architectures, and can use either the same band as the distribution system or other bands.

It is envisioned that P-P radios will provide high bandwidth "backhaul" connections between the base station and the network. These P-P radios can also provide access services within the same band as point-to-multipoint (P-MP) radios. While the P-P radios may be tuned to frequencies different than the P-MP radios, the P-P radios allow service to customers who might require higher capacity or higher availability links than available from a P-MP radio. We suggest that the regulation permit use of P-P and P-MP radios for providing access and backhaul (interlink) services.

The Telecommunication Sector (ITU-T) of the International Telecommunication Union (ITU) and other bodies have established quality of service (QoS) standards that are widely accepted by the public. We expect that in order to compete, wireless alternatives will generally need to provide QoS that is comparable to wired alternatives. Some subscribers will demand and pay for equivalent performance. Other subscribers may be willing to accept relaxed QoS commitments at a reduced price. An operator should have the flexibility to adjust the QoS to best support the local market. We suggest that the fixed wireless broadband network policy not specify QoS requirements.

2.4.1 Spectrum Availability

(c) the amount of spectrum that should be made available for terrestrial fixed-wireless broadband and satellite services, including the timing for review of spectrum reservation and allocation, where appropriate.

We commend the IDA for proposing the assignment of a relatively large amount of spectrum (3,550 MHz) to the fixed wireless broadband network service and view the proposal as a strong commitment for providing advance communications services to the people of Singapore.

We suggest that in the information age, the bandwidth per person is an important factor driving many aspects of a country and its people. Based on UN projections, Singapore is expected to be have a population of about 4 million in the year 2015. The area of Singapore is 581 km^2, which yields a population density of 6,884 people per km^2. A hub covering 2 km radius covers about 13 km^2 or 89,500 people. With 3,550 MHz of spectrum for the service, and assuming 1 bit/sec/Hz effective spectral efficiency, then each person is effectively allocated about 40 kbps (3,550 MHz/89,500 people). While other technologies can also provide bandwidth, we believe that an allocation of 40 kbps per person represents a progressive view relative to other nations. We also believe that over time, 40 kbps per person will be insufficient to compete with other nations.

The simple model can be refined in several areas. The actual requirement may be determined by peak density area (not average population density) during peak usage hours. Furthermore, bandwidth requirement will increase if the service is accepted in the market, and new (more bandwidth-demanding) services are introduced. The point here is that initial allocation should be sufficient for service introduction, with spectrum reserved for growth.

Our studies indicate that greater than sixty percent of the projected world market for P-MP data devices will utilise bands in the range 27.5 to 29.5 GHz. The second largest demand will be in bands in the range 24.5 to 26.5 GHz. The higher bands (e.g., 40 GHz) are likely to have the lowest demand. In addition, they are likely to suffer from significant rain attenuation in tropical regions, making them unsuitable for fixed wireless broadband network service use, at least as envisioned at the present.

We note that IDA has not earmarked the range 27.0 to 27.50 GHz for the fixed wireless broadband network service. While this range is outside the US and European allocations for similar services, there is no particular reason to avoid using it, unless it is already occupied in Singapore.

We also note and agree with IDA's proposal to set aside the 28.6-29.1 GHz band for use by Non-Geostationary Fixed Satellite Service (NGSO FSS) networks consistent with decisions reached at the last two World Radiocommunication Conferences. We believe this is the most sound approach from a spectrum management standpoint because both fixed wireless broadband network service and NGSO FSS terminals will be deployed on a ubiquitous basis, rendering site-by-site coordination impossible. Indeed, the success of both services will depend to a large extent on the degree of flexibility users have in determining where to install their terminals, and on being able to do so without having to obtain a license for each installation.

In additions to making the spectrum available, we suggest that policy address the following topics.

Permissible Data Rates

While the proposed service will deliver broadband services to many subscribers, the systems are also capable of simultaneously delivering lower data rate services. We expect that operators will establish networks based on high data rate customers, and then maximise use of the spectrum by filling in otherwise under utilised portions of their spectrum with lower data rate services. We suggest that the policy place no restriction on the data rate that can be provided by the fixed wireless broadband network service.

Operating Power Limitations

We support the requirement that transmission power be the minimum necessary for the service.

A sharing study in the band 25.25-27.5 GHz has been conducted by the Radio Communications Sector (ITU-R) of the ITU in Joint Rapporteurs Group 7D-9D. The sharing study has recently concluded (See ITU-R Document JRG7D-9D/68) with the result that sharing is practical. The JRG7D-9D has adopted Draft New Recommendation (DNR) ITU-R F.[PMP] titled "Technical and Operational Requirements that Facilitate sharing between point-to-multipoint Systems in the Fixed Service and the Inter-Satellite Service in the Band 25.25-27.5 GHz."

The *recommends* from DNR F.[PMP] follow:

> 1. that for each transmitter of a hub station of a point-to-multipoint FS network operating in the 25.25-27.5 GHz band (see Annex 1 for the background of the e.i.r.p. limits):
>
> 1.1. the e.i.r.p. spectral density of the emission in the direction of any GSO location specified in Recommendation ITU-R SA.1276 should not exceed the following values in any 1 MHz band for the elevation angle q above the local horizontal plane (see NOTES 1, 2 and 3):
>
> +8 dBW for $0° \leq q \leq 20°$
>
> +14 – 10 log(q/5) dBW for $20° < q \leq 90°$
>
> 1.2. the e.i.r.p. spectral density of the emission should not exceed the following values in any 1 MHz band for the elevation angle q above the local horizontal plane (see NOTE 3):
>
> +14 dBW for $0° \leq q \leq 5°$
>
> +14 – 10 log(q/5) dBW for $5° < q \leq 90°$
>
> 1.3. during conditions when precipitation attenuation is experienced between the FS hub transmitting and receiving stations, the transmitting hub station may use Automatic Transmit Power Control (ATPC) to increase its transmitted power, by an amount not exceeding the precipitation attenuation such that its e.i.r.p. spectral density in the direction of any GSO location specified in Recommendation ITU-R SA.1276 does not exceed +17 dBW in any 1 MHz band;
>
> 2. that the e.i.r.p. spectral density of the emission of each subscriber station of a point-to-multipoint FS network operating in the band 25.25-27.5 GHz should comply with *recommends* 3 and 4 of Recommendation ITU-R F.1249;

(See DNR F.[PMP] for additional details and explanation of the Notes). As noted in ITU-R Document JRG7D-9D/68, the DNR may complete ITU-R approval by about February, 2001.

For the bands common to the band 25.25-27.5 GHz, we suggest that the text of ITU-R F.[PMP] be used.

For other bands, we suggest that in any 1 MHz, a maximum e.i.r.p. spectral density of at least +30 dBW/MHz for hubs and at least +42 dBW/MHz for subscriber terminals may be adopted.

Use of Automatic Transmit Power Control

The use of automatic transmit power control (ATPC) should be encouraged as a means to minimize transmission power. In a P-MP radio, the subscriber terminals normally implement power control for technical reasons, but most hub stations transmit with a constant power. The practicality of hub ATPC is being studied by equipment suppliers, but does not look feasible over more than a few dB, especially for systems that are optimised for maximum frequency reuse. We suggest that ATPC should be implemented for terminal stations, but ATPC should not be mandatory for hub stations.

Antenna Polarity

We suggest that the policy place no restriction on antenna polarity. Most P-MP, full-duplex systems use both horizontal and vertical linear polarity, simultaneously, to facilitate frequency reuse. The polarity of both hubs and subscriber terminals alternate between adjacent sectors of a hub coverage area. Slant or circulator polarity, although not currently implemented by most suppliers, may have advantages in areas with high rain rates, such as Singapore.

2.4.2 Spectrum Bandwidth Per Operator and the No. of Operators to License

(d) the optimal amount of spectrum to be allocated to each operator, including the detailed assumptions/basis/calculations used to derive the proposed spectrum bandwidth, and the timing of allocation where appropriate. IDA also seeks comments on the optimal number of operators that can be licensed, bearing in mind the growth of the broadband market in Singapore.

Relatively large blocks of spectrum of about 1,000 MHz per license enable radio systems to compete with (and/or supplement) coaxial and fibre distribution technologies that have comparable bandwidth for access services. Licensing more than one operator prevents a monopoly situation, but licensing too many inhibits the business viability of any one operator.

Business case studies indicated that small spectrum licenses (e.g. 300 MHz) are very difficult to show profitability. In addition, such an operator is vulnerable to price cuts from operators with wired solutions having more aggregate bandwidth from their distribution point (e.g. central office). To compete with coax, fibre, and xDSL over twisted pair, and to provide for a financially viable service, we suggest a spectrum assignment of about 1,000 MHz per license.

Suggested Bandplan

While there are many alternatives and considerations in determining a licensing plan, we suggest that:

Considering

A) The total spectrum being considered is 3,550 MHz (Figure 1a), which can support three licenses of about 1,000 MHz each.

B) Compatibility with U.S. licensing and equipment in the band 27.5 to 28.35 and 29.1 to 29.25 GHz.

C) That the duplex spacing block ITU-R Rec. 748 for the bands 29.1 to 29.5 and 28.1 to 28.5 GHz, the probable use of the band by European countries[3] (notably the UK and Israel), and the compatibility with equipment for the European market.

D) Incompatibility with ITU-R Rec. 748 for the band 24.5 to 26.5 GHz with regard to possible duplex blocks in the band 25.25 to 27.0 GHz and thus the incompatibility with equipment developed for the band 24.5 to 26.5 GHz.

E) Equipment compatibility with a 26.35 GHz license boundary, which is used in Canada, Brazil, Argentina and other countries in the Americas.

F) The lack of need for the policy to provide for duplex blocks provided a license has a contiguous block of about 1000 MHz.

G) A minimum duplex spacing on the order of 160 MHz is necessary for full duplex systems and a licensee can in some cases use the transition band for backhaul links.

That IDA adopt the following plan (Figure 1b):

License A, 27.5 to 28.6 GHz and 29.1 to 29.5 GHz for 1,500 MHz

License B, 25.25 to 26.35 GHz for 1,100 MHz

License C, 26.35 to 27.0 GHz and 31.0 to 31.3 for 950 MHz.

[3] See European Conference of Postal and Telecommunications Administrations (ERC) document FM34(2000)12 rev 2, “Draft ERC decision on the band 27.5-29.5 GHz, 8-9 February, 2000.

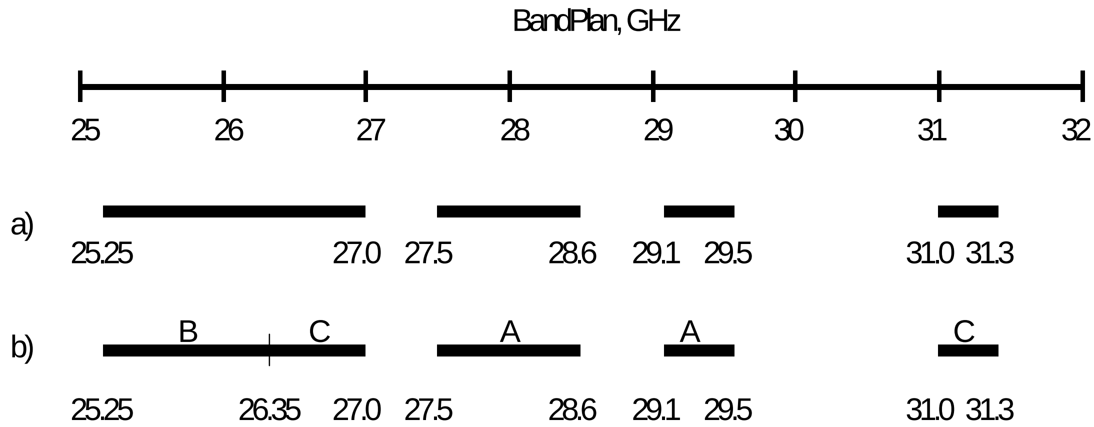

Figure 1: Spectrum proposed by IDA for broadband fixed wireless access (a) and a suggested band segmentation plan (a) for three licenses (A, B, and C).

If the IDA decided to include the band 27.0 to 27.5 GHz in the fixed wireless access policy, then we would suggest assigning the band to the C license.

We suggest that the above band plan is an optimum solution that allows competition between a few wireless operators who each have sufficient spectrum to compete with operators who provide wired access services.

We suggest that all bands be awarded as soon as possible in order to provide a stable regulatory situation for operators to prepare business plans, arrange financing, design networks, select equipment suppliers, and deploy service.

Un-channelled Spectrum

We recommend that the licensees be allowed to channel their designated spectrum in order to optimise the service revenue for a given licensed area. Given that the operators will offer multiple services, it is important that the operator have the flexibility to work with the equipment provider to optimise the size and position of channels within the licensed band for the actual market conditions.

To accomplish maximum flexibility, the licensee should be issued a block of spectrum in which the details of channel bandwidths, duplex spacing, and channel pairing are left to the discretion of the licensee.

The expected market requires delivery of various services needing a wide range of bandwidth. The mix of services and necessary bandwidths will vary as subscribers enroll or terminate. In addition, the bandwidth needs of subscribers vary daily, hourly, or even as quickly as a burst of a few milliseconds. The proportion of downstream and upstream bandwidth will also vary. The operational approach of a licensee is expected to involve selling access to his block of spectrum bandwidth to a large number of subscribers to maximize revenue. From an economically efficient perspective, the licensee needs the flexibility to manage the channel arrangements in real time.

Conventional channel arrangements, such as in ITU-R Recommendation F.748, are necessary when the agency issues licenses on a channel-by-channel basis, and the administration is responsible for assuring that equipment from different licensees works when co-located in the same geographic area. When block spectrum assignments and area licenses are implemented, conventional channel arrangements are unnecessary and encumber the spectrum. A requirement to meet specific channel arrangements restricts a licensee's ability to manage access to the spectrum, and paired channel arrangements bias the licensee toward delivering only symmetrical services. Just as bandwidth management in fibre networks is the key to profitability, bandwidth management in wireless broadband networks is also basic in the businesses operational model. A licensee should be free to implement and continually optimise channel arrangements to provide the best possible service to the local market.

Unlike the radios and policies used when channelled band plans were common, radios are now capable of tremendous frequency agility. Agility enables load and spectrum management, and allows an operator to mitigate interference. Such agility is necessary to mitigate self-interference in P-MP systems consisting of multiple cells. The ability to shift frequencies also allows some tolerance to interference between systems in other areas or other services.

2.4.4 Licensing Approach

(e) the most appropriate licensing and spectrum allocation approach to adopt. Views are also sought on whether spectrum should be assigned in a phased manner or allocated fully to the operator at the grant of licence. Should there be a separate component for licence fees payable in addition to spectrum fees payable?

We have no strong preference to the use of auctions, beauty contest, or other method. However, we suggest the method should be chosen with a view toward maximum long-term spectrum utilisation and a stable financial environment.

Auctions

Auctions are a good way to determine who the licensees should be. Auctions provide licensees an objective, quantifiable process. There is little room for participants in an auction to claim any other bidder was given preferential consideration or treatment in the bidding process.

Auctions also emphasize financial perspectives and increase the capital required for a start-up company. Discounts for new companies can ease the financial burden. Auctions can also make some services such as distance learning, rural service, or even video service appear unattractive. If auctions are used, then discounts and weighting factors may be necessary to achieve the desired policy balance.

Geographic Area of license

In addition to assignment of a block of spectrum, we believe that a licensee can provide the most competitive service if the license is for a geographic area of at least metropolitan proportions. The area license allows the licensee to secure network access agreements, hub site authorizations, equipment purchase agreements, and business financing on a larger scale than if many licenses were issued within a geographic area.

For Singapore we would suggest that each license be a national license.

Coordination at International boundaries

Based on the relatively small geographic area of Singapore, we have recommended that the licenses be national instead of partitioning Singapore into regions. Coordination may be necessary at international boundaries. If the IDA decides to issue regional licenses, then coordination may also be necessary at the regional boundaries.

In any case, the frequency and radiated power may need to be coordinated between licensees that have geographically adjacent areas. If the license areas are too small, then excessive coordination agreements are needed, which increases operator cost. Coordination is likely to be necessary if stations are within approximately 20 km of the license boundary. If a license area is less than approximately 40 km across, then the operator will need to limit e.i.r.p. across the entire license area.

We suggest that, at a minimum, the power flux density (PFD) at a license boundary caused by a proposed hub or terminal station be documented. We suggest that operators simply retain the analysis for use in coordination discussions, but not necessarily submit the documents to the IDA. If the PFD at a license boundary exceeds -115 dBW/MHz-m^2 or if the proposed station is within 20 km of a license boundary, then we suggest that licensees should agree to coordinate[4]. The value of -115 dBW/MHz-m^2 is consistent with the maximum PFD allowed from some satellite services that share some of the bands and is sufficient to protect P-MP hub stations. We also suggest the regulatory requirements should define coordination triggers and the framework for coordination. But, the regulation should allow coordinating parties to negotiate operating levels, even if the levels substantially exceed the trigger PFD value.

Licensees should be allowed to work out the details. For example, if two licensees choose to use equipment from a common supplier, interference management becomes the responsibility of the supplier and is no different than managing interference from cell-to-cell within an array of cells. Such an arrangement is one way to implement contiguous coverage across a license boundary. With P-MP radios, some amount of interference is likely to be reciprocal, and both licensees are motivated to work out an equitable arrangement.

Spectrum Aggregation, Dis-aggregation, and Tradability

With appropriate regulatory restrictions to meet national competitive objectives and prevent hoarding of spectrum, we suggest that a licensee should be allowed to trade portions of his assigned block of spectrum (dis-aggregation) or be allowed to secure agreements for additional spectrum (aggregation). The licensee should also be allowed to aggregate and dis-aggregate based on a geographic area.

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[4] Additional details are available, on request, in a document we submitted to the US Federal Communications Commission (FCC) and to Industry Canada to aid in the cross border coordination agreement. The document title is "Interference Considerations at LMDS/LMCS License Boundaries, 6 July 1998."

We believe that the ability to trade pieces of spectrum substantially enhances the likely utilization of the spectrum. Licensees may choose to sell part of their license in order to finance operations in another portion of their assigned spectrum. If spectrum trading is not permitted, then from a financial accounting perspective, the cost of a license would normally be considered a sunk cost. If spectrum can be traded, then a licensee may list the spectrum as a company asset, use the license to secure financing, and manage the license asset so as to enhance the success of the business, which in turn enhances the services delivered to the public. It is noted that the concept of trading spectrum has been permitted in the U.S. for some radio services.

Unwanted Emission Limitations

The licensee should meet unwanted emission requirements outside the aggregated spectrum block assigned to a station, and meet intended emission limitations at license area boundaries. Within the assigned block and within the assigned geographic area, interference between stations is controlled by a single licensee.[5] The licensee is self-motivated to keep interference low enough so as to not degrade his own system.

We suggest that IDA anticipate ITU Radio Regulation, Appendix S3, and invoke the requirements that will be placed on stations installed after 2003. The regulation requires spurious emissions in any 1 MHz to be attenuated (relative to the power, P, into the antenna) to $43 + 10\log_{10}(P)$ or 70 dBc, whichever is least restrictive.[6]

We suggest that the frequency in which spurious emissions should be limited are frequencies removed from the block centre frequency by more than 250% of a block bandwidth. We suggest that block bandwidth be defined as any bandwidth up to a maximum of the frequency band assigned to a station.

We suggest that in any 1 MHz for frequencies removed from the block centre frequency by more than 50% but less than 250% of the block bandwidth, that unwanted emissions be attenuated (dB) relative to the mean output power by the greater of 11 or $11 + 0.4(Pct - 50) + 10\log_{10}(B)$, where Pct is the percent removed from the carrier frequency and B is the block bandwidth (MHz), but attenuation greater than 56 dB or to an absolute power level less than 50 microwatts should not be required.

2.4.5 Provision of Broadcasting Service

(f) whether the proposed spectrum band in para 2.4.1 should be reserved primarily for IBBMM services or whether they should be assigned for broadcasters' usage.

Fixed wireless broadband networks are capable of one-way transmission of video, data, and other information. In the sense that broadcasting is normally a one-way transmission, the proposed fixed wireless broadband network service is technically capable of

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[5] Details on the issue of Unwanted Emissions for block issued spectrum is contained in ITU-R Document 9B/121, "Preliminary Draft Revision of ITU-R Recommendation F.1191, Unwanted Emissions of Digital Radio-Relay Systems," 3 Feb 1999. In addition, Industry Canada Equipment Authorization Standard RSS-191, substantially follows the block allocation concept.

[6] With P defined as an antenna input power in watts, an attenuation of $43 + 10\log_{10}(P)$ is equivalent to an absolute level of 50 microwatts.

providing a broadcasting component. We suggest however, that operators be permitted to determine the mix of services that best match the needs of their customers.

As technology has advanced, the distinction between the services has blurred. There are fixed wireless broadband network service uses that might be construed by some as being "broadcasting." It is our experience that it is difficult to predict the mix of broadband services in a given market. For example, no one could have predicted that with the introduction of the World Wide Web browser that broadband demand would climb exponentially. Likewise, we see no way of predicting in the future what new services will emerge and drive broadband demand. For this reason, we believe that the spectrum should be allocated for broadband use without specific service functionality. The market can then drive the use of the spectrum through demand, and as the needs of the market change, the service delivered over the spectrum can flexibly change to meet the market need.

We point out that the ITU has not allocated the frequency bands being considered for the Broadcasting Service, either on a primary or secondary basis. Use solely as a broadcasting service may conflict with the intent of the ITU regulations.

2.5.1 Duration of License

(g) the appropriate licence duration for the provision of fixed-wireless broadband services.

We suggest that the license duration should be sufficient to assure stability in the market place. Stability aids licensees in securing capital investment and long term financing. Stability also allows potential subscribers to accept and adapt to the new service. A minimum license duration of ten years is longer than the diffusion curve of most successful technologies. Additionally, licenses might be renewable periodically. Licensees should expect to be granted a renewed license unless the licensee fails to comply with the policy governing the service.

2.5.2 License Award and Service Launch Date

(h) the timeframe for award of license as well as the time needed by the operators to roll-out their networks and offer commercial services to the public.

In a mature market, fixed wireless is expected to permit service installation much more quickly than wired access technologies because deployment of in-ground or overhead wiring is avoided. Deployment of fixed wireless is expected to be in months rather than years. After the infrastructure (hub and network connections) is operational, additional subscribers may be added in hours or days.

For a new service, the deployment time is likely to take longer than the time needed in a mature market. There needs to be some time between the award of license and the commencement of service. This period includes the time to secure financial backing, most of which will not be granted until after a license is awarded. Negotiating building and tower access can also take substantial time. In addition, an operator must either establish network access agreements or create a new backbone network. The attempt to establish network access agreements may encounter legal challenges from incumbent wired providers. Additional time is spent evaluating the various equipment offerings and making a selection. Equipment rollout can then be delayed by the availability of equipment, which often requires adjustment for a market and re-certification to meet country-specific standards.

Given the long list of issues that an operator must resolve, we recommend that the policy have a liberal service requirement of at least 5 years. In addition, an expanded service requirement might be considered as a criteria for license renewal in perhaps 10 years.

We also note that fixed wireless at these frequencies requires predominantly a line-of-site visibility between transmitter and receiver antennas. Foliage provides substantial attenuation, and it is not normally possible to provide reliable links where the path includes foliage. Coverage to residential areas with one-story buildings may be limited due to foliage.

We suggest that the policy define the service requirement in terms of a few operating hubs or small number of subscribers, rather than a percentage such as of geographic area or of total population.

2.6.1 Climatic Considerations

(i) how the issues of rain attenuation and compliance with QOS standards would be addressed.

Noting that Singapore is in ITU-R rain zone P, the rain rate exceeded 0.01% of the time is 145 mm/hr (ITU-R Rec. PN.837). This relatively high rain rate requires that systems be designed for substantial fades (Table 1). For example, a system designed for 0.9995 availability at 25 GHz and 5 km will need a link margin of about 39 dB. Equipment from many suppliers is being designed for link margins on the order of 30 to 40 dB at 5 km. P-MP systems could be configured using high power transmitters to increase the link margin to perhaps 60 dB at 5 km, but such systems would be quite expensive. From the fade depths shown in Table 1, it is apparent that most P-MP systems in Singapore will need to be designed for links less that 2.5 km. Systems using P-P radios can have link margins of 45 to 55 dB at 5 km at these frequencies.

Table 1: Rain loss (dB) versus ITU-R Rain Climate Regions (probability rain rate is exceeded 0.01% of time), Path length, and Frequency per ITU-R Rec. P.530-7 Method and Horizontal Polarity

Prob. Loss not exceeded	Freq., GHz	M 63 mm/hr		N 95 mm/hr		P 145 mm/hr	
		2.5 km	5 km	2.5 km	5 km	2.5 km	5 km
0.99950	25	11	19	22	35	33	39
0.99950	32	16	27	30	49	46	52
0.99995	25	27	47	38	63	59	95
0.99995	32	39	67	54	87	80	129

2.6.2 In-building Coverage

(j) how operators plan to install their own internal wiring, the potential difficulties faced and the cost of doing so. IDA also seeks comments on how these difficulties can be practically and realistically addressed by potential operators and how IDA can facilitate the installation

We envision that the same in-building distribution that is used for LAN, telephone, and television will be re-used when access to the building is via fixed wireless. In-building distribution is not, strictly speaking, a fixed wireless broadband network service issue. In-building distribution can be solved in a number of ways: using DSL over copper twisted pair, using two-way cable data inside the building, using a category 5 wired Ethernet LAN, or by using some sort of wireless in-building distribution.

In-building distribution is an issue inherent to broadband in general. For example, even if one was to run fibre optic cable to a building, the in-building distribution problem exists. For this reason, the in-building distribution question has to be considered in the larger broadband context. That having been said, the operator deploying the fixed wireless broadband network service does not distinguish where the access system ends and the in-building distribution begins, since in some cases the operator is responsible for both access to the building and in-building distribution. The in-building distribution issue can be a significant impediment to the delivery of broadband service.

In all cases, right of way issues inside the building may become points of legal debate between building owners, incumbent wired operators, and the new wireless operators.

We suggest that the policy provide appropriate easement for the broadband utility to be delivered within the building. In any case, we recommend that the policy have provisions that assure an operator has access to in-building distribution wiring, rooftops, wiring closets, and conduits.

Conclusion

Fixed wireless radio systems can provide subscriber access to public and private voice, video, and data services. The systems provide the "last few kilometres" link between networks offering various telecommunications services and the buildings that house subscribers. The wireless systems are an alternative or extension to copper, coax, fibre, satellite, or point-to-point radio systems. These systems, if implemented under a liberal regulatory policy, can stimulate competition and make available advanced telecommunications services to most of the population in a country.

We suggest that the concepts of block (un-channelled) spectrum assignment and issuing a limited number of licenses per geographic area provide the best scenario for accomplishing the competitive and advanced telecommunications goals of the administration. We also suggest that, while broadband services may dominate the use of the spectrum, narrow band services and services of all types should be allowed.