

TRAI's SPECTRUM ALLOCATION CONSULTATION

THIS DRAFT: December 25, 2004

David Salant
Principal, ERS Group Incorporated
And
Adjunct Senior Research Scholar
Columbia University

EXECUTIVE SUMMARY

India has experienced remarkable growth in the wireless telecommunications sector over the past few years. Allocation of spectrum to provide opportunity for private sector development of new and expanding services has contributed greatly toward this growth. Improved telecommunications access has the potential to transform the Indian economy and society. Key to continued growth of this sector is the availability of spectrum that is suitable for cost-effective provision of wireless voice and data services.

Unfortunately, spectrum which can provide immediate relief for 2G operators is extremely limited. TRAI's spectrum allocation policy contains provisions for each of seven operators to obtain a minimum of 2 x 10 MHz of spectrum. This would total 2 x 70 MHz, which may not be available. Further complicating the allocation problem is the overlap of the American, ITU Region 2, and the European ITU Region 1 2G band plans. In addition, India Defence Ministry requires use of large portions of the 2G spectrum, and 3G spectrum.

The largest block of spectrum which may be available in India, for the European 3G bands, 1920 – 1980 MHz x 2110 – 2180 MHz, may have very limited near term impact on tele-density in India. The European 3G bands may, in the future, be one of the best frequency bands of wireless data services; WCDMA is now being deployed in Europe. However, WCDMA still has limited penetration and terminal equipment is still limited and costly as compared to GSM, cdmaOne and CDMA 1X equipment.

Equipment availability, both in terms of variety as well as cost, especially on the consumer end, such as handsets, PDAs, etc, is a large determinant of the value of a spectrum allocation and how that allocation will affect penetration. Indeed, the limited success of wireless local loop (WLL) in achieving significant penetration for voice and data can be in part be attributed to the cost of the customer premise equipment having remained above the level at which very many end users would be willing to pay, and therefore limited penetration and success of many WLL offerings.

The policy of allocating individual spectrum blocks, 2.5 MHz at a time, as an operator reaches specified subscriber threshold levels has a number of effects. One is that it provides operators incentives to promote subscription, through low, or no, initial sign on fees, and to keep rates low. Another effect is that frequency has been assigned in non-contiguous blocks, creating needs for additional guard bands and reducing efficiency of spectrum utilization. Given the limited spectrum currently available for allocation for GSM and CDMA, maintaining the existing policy for allocating spectrum, at least until each operator has the opportunity to reach 2 x 10 MHz of spectrum, is likely the most prudent and practical approach.

In the longer run, market mechanisms should provide a better means of rationing scarce spectrum. Allowing operators to compete for incremental (and reductions) spectrum will achieve more efficient allocations than a regulatory agency is likely to achieve through time-consuming, information intensive, expensive and imprecise demand and cost studies. This is not to suggest that spectrum trading be unregulated. Markets can be inefficient, due to market power, externalities (such as interference), and many other factors. Regulatory effort to foster more competitive markets, through well-designed auctions for initial allocations, defining and monitoring spectrum power and emissions limitations for licensees and in monitoring spectrum reallocations so as to limit market power, are essential to ensure competitive market conditions.

For the wireless sector to grow, operators need access to spectrum. The Ministry of Defence currently utilizes much of the available frequency between 1710 MHz and 1990 MHz, including the 2G bands for both the ITU Regions 1 and 2. This spectrum is extremely valuable for commercial services. Means to encourage more parsimonious use of spectrum in the public sector as well as the private sector is essential to ensure efficient use of frequency. Defence relocation is not without costs. These costs are one measure of the opportunity cost of the spectrum. Indeed, an economic approach to expedite relocation would allow operators the opportunity to submit monetary offers as to the value of incremental spectrum. Defence could then decide whether the compensation could facilitate faster clearing of more spectrum.

The Defence frequency is critical for a technology neutral spectrum allocation policy. Four operators in most regions use GSM. The other three use CDMA. Terminal as well as network equipment is available for GSM in the 850, 900, 1800 and 1900 MHz bands. In addition, WCDMA equipment and terminals should soon be available in the 850 MHz, 1900 MHz and 2 GHz bands as well. However, as CDMA has been largely deployed in ITU Region 2, equipment is only available in the 850 MHz and 1900 MHz bands. Therefore, a technology neutral allocation would comply more with American band plan than the European one. The 2GHz should also be allocated soon. However, TRAI may wish to consider trying to coordinate the release of these bands with additional frequency for CDMA operators. The lack of equipment for CDMA 1X at 2GHz, and especially dual band 850 MHz/2 GHz, makes the 2 GHz frequency much less valuable for CDMA operators than for GSM ones. Never-the-less, more frequency should be allocated as soon as practical for 2G and 3G operators.

Many different frequency bands can be used for promoting service in niche or rural areas. Restrictions on use of a frequency band to rural areas, or for specific technologies, e.g., fixed point service, reduce investment incentives and therefore coverage. However, operators providing mobile services in non-niche areas should not be able to avoid spectrum charges of the type incurred by those using 2G or 3G frequency. Some discount should be applied to reflect coverage limitations and other differences. For example, 450 MHz frequency is quite useful for serving rural areas, but may not be nearly as valuable in serving urban areas. Therefore, any annual spectrum charge for 450 MHz should be lower than it is for frequency at 850, 900, 1800 or 1900 MHz. Economic principles suggest that direct procurement of niche service will likely result in lower overall costs for attaining any targeted level of service in rural or niche areas.

1. Introduction

India has experienced remarkable growth in the wireless telecommunications sector over the past few years. Spectrum availability is crucial for this growth to continue. This report is intended to provide specific responses to issues raised in the TRAI Consultation on Spectrum Related issues, Consultation Paper No. 11/2004. Of more immediate concern is determining what spectrum to allocate when, how best to allocate and price the additional spectrum so as to afford wireless operators as good of opportunities for growth as possible. As spectrum is a national resource, only governmental authority can determine initial allocations of spectrum and policy toward re-allocations. Consultations such as this can give interested parties an opportunity to provide TRAI information needed to evaluate the alternatives.

TRAI can recommend prices for spectrum, reserve prices for spectrum or rely on market forces to price spectrum appropriately. As I explain in more detail below, economic theory would suggest that TRAI rely on market forces in the long run to ensure efficient utilization of spectrum. However, for market forces to operate efficiently, governmental oversight and intervention may be needed to ensure competition. This means that market structure should be monitored. In addition, TRAI may wish to impose spectrum caps on any set of affiliate entities so as to limit the potential for market power.

In addition, spectrum rights or licenses will need to be defined and enforced in such a way to limit interference between operators in nearby bands. Traditionally, regulation also limits technology. For reasons explained in more detail below, TRAI may be better advised to limit regulation to power and out-of-band emissions, and not regulate technology directly or types of services provided.

TRAI will want to limit concentration of spectrum holdings in different frequency bands so as to ensure competition in the provision of wireless voice and data services. In the near term, separate caps for 2G and overall 2G and 3G spectrum holdings may be worth considering. Within a few years, as services are deployed using 3G spectrum that are competitive with those using 2G spectrum, the separate caps on the 2G spectrum should be lifted.

Niche, or rural, services present particular challenges. Such regions tend to be underserved absent regulatory intervention. Making spectrum available suitable for serving niche areas is undoubtedly advisable. Reserving spectrum only for rural service may be less advisable. And limiting services that can be offered on such spectrum is likely to retard deployment of services in areas of concern.

2. On the Role of the TRAI

The Government of India has charged the TRAI with providing recommendations about how spectrum can be most efficiently utilized, spectrum allocation procedures and spectrum pricing. A key part of these recommendations is the ongoing role of government in regulating spectrum use. The Telecommunications Regulatory Authority of India web site lists “competition and efficiency” first among its policy goals. My discussion of the ongoing role of government and of the policy options is largely in terms of these goals. In addition, in shaping its recommendations, TRAI will undoubtedly want to consider the impact of alternative policies on total telecommunications penetration and access in all parts of India.

To measure efficiency, economists compare economic surplus¹ of alternatives. Economic surplus is measured as the sum of consumer and producer surplus. Economic surplus differs from technical measures of surplus, such as Erlangs per square kilometer per MHz, in that economic surplus includes both monetary measures of consumer value (consumer surplus) as well as producer revenues net of costs (producer surplus). Technical efficiency measures typically only rank options using engineering performance measures, and are independent of any value created or cost of development and deployment. In addition,

The two goals of economic efficiency and teledensity can, at times, conflict. Absent direct government support of universal service programs, economic theory suggests that a competitive market will efficiently maximize economic surplus. Government programs may want to boost teledensity beyond what may be possible absent subsidy.

Market forces cannot be relied on to achieve optimal penetration targets when those purchasing or investing in telecommunications access service cannot capture a significant fraction of the value created due, for example, to network externalities. The fact that increased telecommunications penetration can benefit society as a whole suggests a type of market imperfection and for government intervention.

Similarly, government intervention is appropriate to ensure competitive markets. Absent regulatory oversight, competing operators will have significant incentives to merge so as to be able to increase prices and profit margins, toward monopoly levels.

If spectrum is allocated through a competitive process, and markets are competitive, then regulatory oversight is not needed to ensure efficient utilization of spectrum; competitive forces will ensure spectrum will be used for its most valuable purposes. At best, any regulatory review of spectrum efficiency is subject to measurement error. More

¹ Economic surplus is measured as the sum of consumer and producer surplus.

specifically, government evaluation of economic efficiency of alternatives for allocating spectrum requires detailed information about costs and demand. Data for both are difficult to obtain, and indeed cost of network infrastructure may depend on negotiation between the operator and equipment vendor, such evaluation. Therefore, any regulatory re-allocation based on measured efficiency is also subject to error; this means that spectrum allocation based solely on regulatory procedures is likely to result in misallocations that will not be corrected, except after lengthy review processes. In contrast, market forces tend to work quickly to reallocate based on economic incentives.

3. Spectrum Availability and Spectrum Needs

India is one of a few countries that have permitted 2G operators to use different standards, and has allowed competition rather than government mandate determine what technologies should be deployed. India has also allocated spectrum in the bands used in the European Union for GSM/DCS1800 technologies. Spectrum used in the Americas for GSM, CDMA and CDMA 1X, and soon WCDMA, has been allocated in India for CDMA. The overlap between the American and European 2G and 3G bands in combination with the success of 2G in India has resulted in conflicting requests for spectrum. This is in addition the spectrum scarcity that is the inevitable result of successful deployment of any 2G service. Figure 1 and Table 1 illustrate the spectrum allocations in both regions.

Figure 1: 2G and 3G Allocations in Europe and the Americas

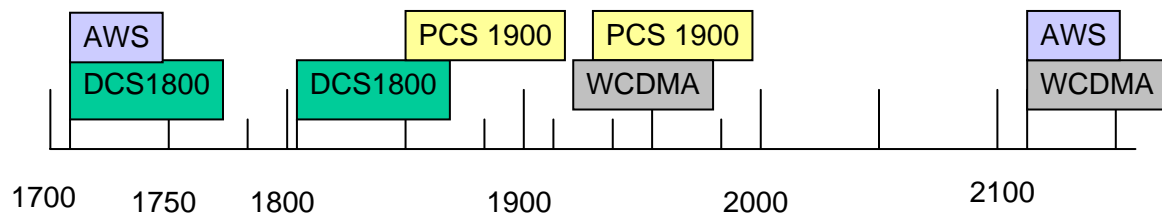


Table 1: Bands for Broadband Voice and Data Services

450 MHz	450.4 - 457.6 MHz paired with 460.4 - 467.6 MHz or 478.8 - 486 MHz paired with 488.8 - 496 MHz or 380 – 400 MHz paired with 410 – 430 MHz
700 MHz	698 – 746 MHz paired with 746 – 794 MHz
850 MHz – AMPS	824 – 849 MHz paired with 869 – 894 MHz
900 MHz – GSM	880 – 915 MHz paired with 925 – 960 MHz
1700 MHz	1750 – 1780 MHz paired with 1840 – 1870 MHz
1800 MHz – DCS 1800	1710 – 1785 MHz paired with 1805 – 1880 MHz
1900 MHz – PCS	1850 – 1910 MHz paired with 1993 – 1990 MHz + 1910 – 1920 x 1990 – 2000 MHz
2100 MHz – EU 3G	1920 – 1980 MHz paired with 2110 – 2170 MHz
DECT	1880 – 1900 MHz, 1900 – 1920 MHz and/or 1910 – 1930 MHz

The most valuable frequency is that for which equipment is more readily available and at lowest cost. This would be the European 900 MHz and 1800 MHz bands and the American 850 MHz and 1900 MHz bands, given that those regions are where there is the largest installed base.

Most countries in ITU Region 2 have permitted operators to choose technology. As a result, both GSM and CDMA equipment is readily available in the 850 MHz and 1900 MHz bands. An allocation of frequency in those bands would provide both GSM and CDMA nearly equal opportunity.

Options for operators are limited by the limitations of equipment availability. CDMA equipment is essentially only available at 850 MHz and 1900 MHz. There are no dual band 850 MHz/ EU 3G CDMA handsets that would work in India. Europe has not allowed CDMA to be deployed in the GSM/DCS1800 MHz bands, nor has CDMA 1X been permitted in the European 3G bands. Therefore, equipment is not available for CDMA in those bands and an allocation of those frequencies is not technology neutral. Note, in Japan both CDMA 1X and WCDMA will be available in the European 3G bands, eventually. The Japanese reverse the channels at 850 MHz and so the use of European 3G and the 850 MHz bands in Japan may not be of much relevance for the availability of dual band CDMA terminals for 850 MHz and the European 3G bands in India. In addition, the US is using different bands than the EU 3G bands for *Advanced Wireless Services*. This suggests that there is no market for dual band 850 MHz/ EU 3G terminals. Similarly, there is not yet any terminal equipment for CDMA that works at 850 MHz and in the 450 MHz bands.

Therefore, spectrum allocations using the American band plan is more technology neutral than is adherence to the European band plan. However, India has already allocated most of the GSM bands, part of the DCS1800 bands for GSM, and most of the 850 MHz band for CDMA. In addition, the Defence Ministry is currently using much of the remaining DCS1800 and PCS1900 bands. This leaves relatively few options.

The option that would be most beneficial from the perspective of maximizing economic surplus would be to allow all operators to compete for whatever spectrum they would want. This means that individual blocks, and not pairs are allocated, and operators would bid, or submit applications, for the pairs or singletons they may want. In a competitive spectrum market, the relative values to be derived from GSM and CDMA technology for a particular band would determine its use. This could result in some single blocks not being used very intensively, but this appears to be likely no matter what. An administrative process, an auction, or another competitive process can be used to choose among competing offers for spectrum.

The European 3G spectrum should also be allocated. As there is still much more equipment available for the American PCS 1900 bands, as well as the European DCS1800 bands, allocating these latter frequency bands should take priority over European 3G allocations. Moreover, the availability of WCDMA in PCS1900 suggest that there is no harm from allocating those bands for 3G, and there may be some benefits if the GSM 2G operators can make better use of additional GSM spectrum than of WCDMA. In particular, the operators, and not TRAI, can decide what technology is best to deploy and when. The CDMA 2G operators should be provided an opportunity to compete for spectrum that may be of greater or lesser value for WCDMA (or for CDMA 1X/3X at 1920 – 1980 x 2110 – 2170 MHz). Market forces and competition can better decide this rather than government fiat. Moreover, government spectrum allocation should not make the decision implicitly through a choice of a band plan.

In the near term, the limited incremental spectrum in the DCS1800 MHz bands available for GSM operators should be released as soon as possible. In addition, at the same time some *useful* spectrum should be allocated for CDMA operators, such as 1900 – 1920 MHz and 1980 – 2000 MHz (the American C-4, C-5 and G blocks).which could be available for CDMA operators. Note that the G block was only recently allocated and I have not been able to confirm availability of CDMA equipment for that block.

Allocating spectrum that only has value for GSM operators, and perhaps limited value at that, i.e., the European 3G bands would effectively put the CDMA operators at a long run disadvantage. The fact that GSM equipment is widely available at 1900 MHz, and WCDMA should be available in those bands soon means the main reason for GSM operators to prefer the European 3G bands to the 1900 MHz is the competitive advantage they would gain by limiting spectrum available for the CDMA operators.

This is not to suggest that allocation of any spectrum that any operator can put to a valuable use should be unduly delayed. I am only suggesting that TRAI and the Indian Government not fall into any traps of allocating spectrum only for specific technologies and which may not have significant impact for several years.

4. Spectrum Clearing

Spectrum availability for 2G and 3G is limited by government use by Defence. This spectrum may be extremely valuable for such purposes, and no other good substitutes may be available. The submission of the Defence Ministry suggests that this is not likely to be the case. However, Defence would incur re-location costs to free up some spectrum, and the more spectrum being used for 2G service between 1710 and 1990 MHz the greater the difficulty for Defence. This suggests first that the spectrum used by Defence has a value to the government. This value should be a floor on spectrum charges. If Defence relocation costs exceed the value of the spectrum to operators then it would be inefficient for Defence to relocate its communications.

In addition, spectrum license fees whether set administratively or through a bidding process, can be used to defray the costs of Defence relocation. In effect, this would occur as the Defence relocation costs come out of treasury funds, and the licence fees would accrue to the treasury. However, a more direct mechanism for funding relocation costs could help expedite spectrum clearing. A sliding scale could be set too, providing more spectrum clearing if operators are willing to pay a higher licence fee. The higher fee can be an administratively determined fee or a reservation price for an auction that can affect the amount of spectrum released in the auction. More spectrum would be available in the auction the higher the bidding went.

5. Spectrum Allocation Procedures

A. When to Allocate Additional Spectrum

I first discuss the economic principles that can be applied to determine when additional spectrum should be allocated for provision of mobile services. Economic would suggest that *all* potentially valuable radio spectrum be released essentially with no delay.

A few factors suggest that the government should not release all currently unused spectrum for public use. First, as I have discussed above, governmental agencies, such as Defence, may have spectrum needs. Licensing spectrum for private sector use may displace public sector agencies and impose costs. In addition, spectrum can be valuable when made available for common or unlicensed, use. One example of such spectrum is that now used for WIFI to provide short distance wireless broadband connections. However, many other spectrum commons provide some benefits, such as for Citizens Band Radio, Ham Radio, and unlicensed bands used for cordless phones, baby monitors and garage door openers.

A third reason why the government might want to hold back spectrum is that there can be non-commercial experimental benefits from some spectrum being maintained for such purposes.

Fourth, if the only buyers, or the most likely winners of spectrum rights for a particular band, are speculators seeking to “flip” spectrum, then there is no real social welfare loss from the government retaining rights until technology develops that would utilize the spectrum more effectively.

Fifth, spectrum rights can be an important source of non-tax revenues for the government. If taxes would be needed to supplement for lost spectrum revenues, then social welfare would be improved if the government were to try to time spectrum sales to increase revenue proceeds.

Given these considerations, a prudent approach, which can be based on economic principles, is for the government to set a reserve price and to allocate spectrum for which a potential licensee is at least willing to match the reserve price. As I have discussed above, the limited available 2G spectrum should be released fairly soon. TRAI can set an annual administrative fee per MHz and per POP to reduce the incentives for warehousing of spectrum and commensurate with relocation costs for public sector use. Spectrum manager concessions can be awarded, in lieu of setting aside spectrum for commons use. Such spectrum managers should pay spectrum fees comparable to those paid by other licensees for similar spectrum.

B. How to Allocate Spectrum

In India, as in many other countries, spectrum licenses have been awarded through an administrative review process. The process for awarding 2G spectrum has been based on a regulatory review of the spectrum needed for an operator to get started and specific subscriber targets for allocating additional slivers of spectrum. This process provides operators a strong incentive to sign up, and retain, subscribers. For decades, economists have argued that market mechanisms should be used to efficiently allocate spectrum.²

Over the past decade, auctions and other market mechanisms have been introduced for a limited set of spectrum rights. The first spectrum auctions were conducted during the early-1990's in New Zealand and the U.S. The idea behind the use of market mechanisms and auctions is that prices should be used to ration the spectrum supply among competing users and uses. If the value of a slice of spectrum is higher for one party in one application than it is for others currently using that spectrum in different ways, then the entity with the high value use can compete by bidding up the price. In this manner, competitive forces will achieve and maintain an efficient allocation of spectrum rights, even or especially in cases where the regulator cannot know all of the relevant information needed to make the efficient allocation decision.

Ideally, an initial allocation, whether by an auction, other market mechanism, or regulatory review, would result in an efficient outcome and maximization of total surplus. Allocations which result in inefficient assignments – such as giving GSM operators spectrum for which only CDMA equipment is available and vice versa or not making adequate provisions to limit need for guard bands by assigning operators contiguous spectrum – will reduce both economic efficiency and social welfare.

² See Ronald Coase, "The Federal Communications Commission," *Journal of Law and Economics*, Volume II (1960): 1-40, or Evan Kwerel and Alex Felker, "Using Auctions to Select FCC Licensees," Office of Plans and Policy Working Paper No. 16 (1986).

Providing spectrum for which only custom-made equipment is available tends to reduce the value of the spectrum and increases cost of services provided using that spectrum. For this reason, TRAI would likely want to identify bands that can be used most cost-effectively by GSM and CDMA operators. In the near term this would be the US PCS 1900 MHz bands, or for GSM only the DCS1800 MHz bands. Bands should not be partitioned so small as to require guard bands that take up a high percentage of usable spectrum. Allowing operators to determine their own needs, and to determine the spectrum they can get access to subject to a few restrictions, such as caps, greatly reduces the likelihood of such inefficiencies occurring. Moreover, as long as concession rights are transferable and transaction costs are not too high, spectrum manager concessions can approximate efficient allocation and assignment of spectrum rights, no matter how they are assigned in the first place. This argues too in favor of spectrum trading.³ Indeed, initial allocations can, for a variety of reasons, be inefficient. Spectrum trading should be encouraged if only to correct for inefficiencies caused by the initial allocations. The benefits of so doing can be very large especially when initial spectrum holdings are highly fragmented and requiring a relatively high percentage of spectrum being needed for guard bands.

Market approaches for allocating the relatively small slices of spectrum currently available may not be practical in the near term. 2G operators face constraints that can limit subscriber growth. Moreover, the current allocation method, of essentially rewarding operators for achieving high subscriber growth by allocating them additional spectrum will tend promote subscriber growth at a faster than might occur even in an efficient and competitive market for 2G services. However, for additional 2G and 3G spectrum that may be cleared in larger chunks, market mechanisms such as auctions would, if properly designed and managed, provide appropriate incentives for operators to each acquire the amount of spectrum that they can use efficiently. Auction rules, and licensing terms that permit some secondary spectrum transactions, will take time to develop. Continuing current approaches for the approximately 10 MHz of 2G spectrum now available would be practical option.

Where spectrum cannot be fully cleared in the near term, the TRAI may wish to consider secondary allocating secondary licenses for spectrum bands, where the incumbents may have grandfathered primary rights, at least for a time, to continue using spectrum. The secondary license holder could use the spectrum subject to not interfering with the primary holder. This approach works well when the primary licensee is making limited use, or has limited coverage. CorDECT frequency is one example where spectrum use is limited to rural areas. In other areas, e.g., in cities, the same spectrum can be used without risk of interfering with service in the rural areas. The rural licensees can, if they wish, obtain coverage in urban areas. This secondary licensing approach has been used elsewhere. In the US, incumbent microwave operators in the PCS1900 MHz bands were provided primary status for a few years after the PCS licenses were awarded. A similar approach has been adopted in the 700 MHz bands in which UHF television stations have, for a period of

³ See Statement of 37 Concerned Economists, FCC (2001).

time yet to be determined, but based on high-definition television diffusion, the right to continue to broadcast.⁴

Incumbents were also provided primary rights for MMDS frequency in the US and Mexico, and SMR (trunk radio) frequency in the US. In many cases, as in Europe with 1G, operators in the old spectrum have been shut down.⁵

C. Spectrum Pricing

Several approaches have been adopted in other countries for setting spectrum prices. One common approach is to base the prices on an allocated share of the administrative costs associated with the spectrum licensing process. This has been generally the approach adopted for example by Industry Canada. Prior to 1994, the US Federal Communications Commission could only impose spectrum charges to defray costs, and not raise revenues.

Another approach to setting spectrum pricing that has been used is for the Government to commission a study to determine the spectrum value. Sometimes, these studies are used to set reservation prices. This was the case with the Band B and 2G auctions in Brazil. This approach is an effort to ascertain market values. At times, the prices have been set so high so as to choke off demand. This has been the case in Brazilian 2G auctions and in the prices the French Ministry of Communications and ART set for 3G licenses. The notion of setting prices based on estimated market values does encourage operators to conserve on use of spectrum and to use it efficiently. This approach is also consistent with administered incentive pricing (AIP) mentioned in the Consultation Report and in the Indepen report. However, as the experience in France and Brazil illustrate, the estimates can be too high, and the spectrum remains unused.

Reservation prices or AIP can also be based on other measures of opportunity cost. One such measure is the cost existing government users re-location and clearing a spectrum band. The drawback of this approach is that it can overstate the value of spectrum when the incumbent users are very inefficient.

Whatever approach is used to set spectrum prices, prices should account for differences in the value of different bands. Even adjacent bands can have significantly different prices. Such was the case for example in the German 3G auction where the frequency division duplex, paired, bands sold for over ten times the amount per MHz as did the time division duplex, unpaired, bands. This has also been the case in US spectrum auctions where Wireless Communications Spectrum (WCS) around 2.2 GHz has sold for less than \$15M for a nationwide allocation of 2x10 MHz plus two unpaired 5 MHz blocks, while 10 MHz of nearby PCS spectrum covering New York City alone, or less than 10% of the US, sold for more than \$5 billion. Industry Canada, which sets spectrum fees with the intent of

⁴ See www.fcc.gov/wtb/auctions

⁵ See "[The FCC Spectrum Auctions: An Early Assessment](#)," *Journal of Economics and Management Strategy*, 6:3, 431-495, 1997, and Kwerell and Felker *op.cit.*

recovering administrative costs, allocates costs in part based on estimated spectrum values of the different blocks.

In the long run, competition and market forces should be relied on to set spectrum prices. In the near term, spectrum prices should not be set so high as to choke off demand unless opportunity costs are high, as might be the case with Defence needs, or perhaps for a very limited amount of unlicensed frequency for a spectrum commons. Also, for rural service, where there is a specific desire to increase penetration, subsidizing availability of spectrum can encourage entry into marginal profitable or unprofitable areas.

Spectrum pricing should be based on the band (bands for which more and cheaper equipment which is available and which can be used more directly for valuable services), the population of the area covered by the license (also known as POPs) and the bandwidth (MHz) of the license. Other factors can affect license values, such as population density, but for purposes of ensuring availability of spectrum on affordable terms, it is probably not necessary or advisable to try to adjust spectrum prices to extract all producer surplus. Clearly the amount of spectrum allocated and the population of the market should positively correlated with spectrum license values and so license fees within a band should be based on POPs x MHz. In addition, imposing an annual fee, rather than a one time up front license fee encourages operators whose business plans are not succeeding with incentives to turn back in their spectrum or otherwise make it available.

D. Spectrum Auctions and Spectrum Markets

The European 3G auctions have been subject to extensive analysis and debate about their merits. On one hand, many, and most economists, argue that market mechanisms/auctions allocate spectrum more efficiently than the alternative administrative processes, often called beauty contests. On the other hand, the European 3G auctions have been criticized for creating such a financial burden on the “winners” as to create significant obstacles for securing the necessary financing for build-out. Indeed, this has appeared to be the case in Germany where two of the six winners have indicated that they would essentially forfeit their licenses, after spending approximately \$8 billion each. It is hard to argue though that the auction was responsible for the mistaken business planning that led these two operators to win the licenses at such a high cost.

There are a few important details about the European 3G auctions that are often overlooked. First, not all the auctions were expensive. Prices per MHz POP ranged from \$0.14 in Switzerland to \$4.84 in the UK. Second, as the auctions were sequential, economic theory and experience would suggest that the first auctions would be the most expensive, and the latter auctions the least. This is what occurred in practice. Bidders in the UK and German 3G auctions were bidding to be European operator. Anyone with such a goal would not want to be shut out of those first two auctions. And any bidder having been shut out of the UK and German 3G auctions would have less of an incentive to bid in subsequent auctions. There were thirteen bidders competing for five licenses in the UK. In Germany, seven bidders were competing for between four and six licenses. In all the

subsequent auctions there were either the same number of bidders as licenses or one more bidder than licenses. None of the other 3G auctions could be considered very competitive.

Secondly, these offers were voluntarily placed and based on extensive analysis of the license values. Firms such as Vodafone, T-Mobile, BT (now MM02), KPN, Telefónica, etc., are generally among the most conservatively managed in the private sector, and largely national PTTs.

Another area largely overlooked in most, but not all, of the discussion of the 3G auctions,⁶ is that auction design and procedures can have a very large effect on the outcome. The European 3G auctions followed similar rules (except Denmark), all variations of the Simultaneous Multiple Round (SMR) format first used by the US Federal Communications Commission for selling Personal Communications Services licenses in the 1994. The auctions had the desired effect, similar, substitute licenses sold for essentially identical prices within each auction. More valuable 15 MHz licenses in the UK and the Netherlands sold for more than the less valuable 10 MHz licenses.⁷

Other aspects of the auction processes varied quite a bit across countries. Most significant was the fact that the auctions in each country were conducted at separate times. Parallel or even a simultaneous European auction might have produced more uniform prices across countries and more efficient outcomes. This is not to suggest that this was a practical alternative.

Of perhaps greatest significance is the amount promotion that was conducted in advance of each auction. The UK hired an investment banker, N.M. Rothschild, long before the auction to develop offering materials, conduct road shows and otherwise promote the auction. Other countries were somewhat less aggressive in promoting their auctions (although Italy hired Crediop/Dexia to promote their auction).

Further, restrictions on license use has resulted in a long lag between the auctions and the time the winning bidders can deploy services, and starting generating the cash needed to pay off the license fees. To put operators in a position of having to purchase licenses four to six years before they can reasonably expect to earn money from those licenses increases risks for all, and the likelihood of winner's curse.

A carefully designed and well managed auction process should result in the most efficient allocation of spectrum possible. A key part of the process is defining spectrum licenses in a way to provide those winning licenses the flexibility and opportunity to profitably deploy services. Wireless voice and data service has reached a level of maturity that qualified

⁶ See Paul Klemperer, "How (Not) to Run Auctions: The European 3G Telecom Auctions," in *European Economic Review*, 2002 46(4-5) 829-45.

⁷ I would favor use of the Simultaneous Multiple Round auction over the Anglo-Dutch suggested by Klemperer. The Anglo-Dutch has an advantage when bidder collusion or coordination is a significant concern. However, the final round of the Anglo-Dutch auction need not have pure (non-random) equilibria, which makes bidding decisions difficult and can lead to misallocations.

bidders should not be inclined to grossly overestimate, or underestimate, the value of spectrum licenses, and their bids should reflect their valuations.

Spectrum auctions have been also criticized as raising costs of services to be provided. Both economic theory and experience suggest that this is not the case. Indeed, many operators have paid for spectrum that was initially awarded through a beauty contest in an acquisition. Spectrum license fees are sunk costs and therefore should not have any significant effect on the tariffs.

In addition, initial spectrum allocations can be inefficient, or can become so over time as market conditions change. There are a number of ways in which such inefficiencies can be corrected. The simplest and most effective means is to allow secondary transactions and disaggregation. Operators should be allowed to re-sell rights to part of or their entire spectrum holdings, provided the buyers adhere to the same license conditions.

6. Spectrum Caps and Merger Policy

India has one of the most competitive wireless industries in the world. Virtually no other country or region has more than six operators, and most have no more than four or five. India has seven.

Economies of density in the wireless industry suggest that seven operators in each market may not be viable in long run. Consolidation will reduce competition, reduce costs and raise margins. To some extent efficiency gains can offset the impact of reduced competition when mergers occur. In most countries, market structure for 2G and 3G has been mandated by national regulatory authorities when spectrum licenses are awarded initially. Most countries have between three and five 2G operators and four and six 3G operators. A few countries have allowed market forces to determine concentration, subject to a variety of competition policy based limitations.

The United States FCC had, until recently, imposed a 45 MHz (2x22.5 MHz) spectrum cap. This cap was recently lifted with a case-by-case review based on American anti-trust policy. When Cingular acquired ATT Wireless, the US Department of Justice and FCC allowed the merger subject to some conditions. Cingular was required to sell some licenses where the combined entity would have more than 70 MHz (2 x 35 MHz). In addition, Cingular's participation in the upcoming PCS auction was also limited so that Cingular could not acquire spectrum beyond these limits subsequent to the merger. In the US, there are three other firms with essentially nationwide coverage, Verizonwireless, Sprint/Nextel and T-Mobile. In addition, there are a number of other regional operators, such as Alltel, MetroPCS, Leapwireless. Cingular's spectrum holdings are the largest. They are also one of the few operators maintaining AMPS, TDMA and GSM networks, and hoping to deploy WCDMA. Verizonwireless appears to be able to offer more service (they have already deployed 1X DO) with less spectrum, as they use cdmaOne, CDMA 1X and CDMA 1X DO. With CDMA, Verizonwireless, and Sprint, do not need separate bands for each

generation technology. Cingular is paying some premium for spectrum. Canada and Australia have also allowed some consolidation among 2G operators.

The rationale for spectrum caps as compared to a competition review process for evaluating mergers and acquisitions are that caps provide clear guidelines and reduce administrative costs and uncertainty. Uniform caps can be inappropriate and may need to change over time. Given the current situation in India, a cap of 20 or 25 MHz of all 2G spectrum, would permit consolidation to as few as three operators in each region. This is a higher degree of concentration than would be permitted in most other countries. India has less 2G spectrum currently available than is available elsewhere.

Initially, the 1920 – 1980 x 2110 – 2170 MHz band should *not* be included in spectrum cap calculation. In a few years, equipment availability for providing economical voice services, in addition to broadband data, in the European 3G bands should become competitive with availability for 2G spectrum. As that point is reached, a single cap should be imposed for combined 2G and 3G spectrum holdings. The cap should allow consolidation to approximately four or five operators. An initial allocation of 3G spectrum should permit any operator to acquire up to 2 x 15 MHz of spectrum.

7. Niche or Rural Service Areas

In its consultation, the TRAI mentioned the possibility of using 450 MHz frequency for rural services. The 450 MHz frequency is well suited for rural areas as there is now equipment in those bands, both CDMA and Tetra, and because propagation at 450 MHz is high so that the effective radius for service from a tower can exceed 40 km.

At some point, perhaps fairly soon, 450 MHz service may become an effective substitute for 2G and 3G services in the traditional bands. This fact suggests that policy toward 450 MHz should have provisions to accommodate technological change and promote diffusion of services in all bands. Therefore, 450 MHz service should probably not be limited to fixed point rural services. At the very least, mobility should be permitted.

Any license restriction that reduces investment incentives in rural areas can only decrease penetration. One alternative to specific spectrum concessions for rural areas is to impose build out and coverage requirements on all spectrum licensees, or all that are awarded specific frequency bands, such as 450 MHz, possibly also GSM and CDMA. Coverage requirements are often imposed on 2G and 3G licensees. However, this effectively amounts to a cross subsidy of coverage. As not all licensees may be equally proficient at serving rural areas it may not be efficient to impose uniform coverage requirements. An alternative is uniform contribution toward coverage, perhaps in the form of a contribution toward a fund dedicated for rural service procurement. Access deficit or universal funds are common throughout the world.

If India wants to promote coverage in rural areas, then a procurement auction along the lines suggested by Milgrom (1997), and discussed by Salant (1996, 2000) and Sorana

(2000).⁸ Direct procurement of service will cost less in the long run, and the costs are more easily identified. The hidden tax of cross subsidies can impose costs in the form of reduced investment and lower penetration. Peru has been conducting procurement auctions for providing service in rural areas. Peru imposes a 1% tax on all telecommunications services to fund this. Arguably, funding to promote rural service should derive from general revenue funds, as the social benefits of improved rural service do not accrue solely to those using telecommunications services.⁹

The remarkable growth in the Indian wireless sector over the past few years, following release of spectrum, licensing of new operators, and liberalization suggests that a program to further promote niche services may have little incremental benefit. More spectrum availability, and continued liberalization are likely to be the main drivers of continued growth of teledensity in India.

8. Conclusion

- India should try to make as much 2G spectrum as possible and as soon as possible available to both GSM and CDMA operators.
- All operators should have equivalent opportunity to acquire at least up to 2 x 15 MHz of spectrum in the 850 MHz, GSM, DCS1800 and PCS1900 MHz bands.
- Existing allocation procedures should be used at least to the point where all 2G operators have an opportunity to acquire up to 2x10 MHz of spectrum. An annual per MHzPOP fee should replace the royalty for spectrum licenses. The magnitude of the annual licence fee should not be significantly greater than existing fees.
- The ITU Region 2 band plan provides greater technology neutrality than the EU band plan.
- Efforts should be made to clear more spectrum for any technology below 2 GHz. If total spectrum clearance is not possible, allocating *secondary* licenses, which contain clear provisions for and protection of incumbent users, such as Defence, should be allocated as soon as possible. Auction revenues or licence fees can be used to encourage re-location needed to clear spectrum. Relocation costs can be used to set reservation prices for spectrum.

⁸ See Paul. 1997. "Procuring Universal Service: Putting Auction Theory to Work." Lecture at the Royal Sweden Academy of Sciences in Honor of William Vickrey. *Le Prix Nobel: The Nobel Prizes, 1996*, Nobel Foundation: 382-392. Salant, David J. "Carrier of Last Resort Sales," Charles River Associates, Inc., mimeo (1996), Salant, David J. 2000. "Auctions and Regulation: Reengineering of Regulatory Mechanisms," *Journal of Regulatory Economics* 17(no. 3, May): 195-204, and Sorana, Valter. 2000. "Auctions for Universal Service Subsidies," *Journal of Regulatory Economics* 17 (no. 3, May).

⁹ If access in rural areas gives rise to an *external benefit* to those in non-rural areas that may communicate with the rural, then those who benefit should contribute. This is a rationale for a tax on telecommunications services for funding universal or rural service. But, if the benefit accrues more broadly, then a tax on telecommunications services is too narrowly focused.

- For additional spectrum allocations, such as for all 3G services,
 - The allocations should be for *unpaired blocks*, and operators be provided opportunity to apply or bid for pairs.
 - Auctions should be used for the initial allocations.
 - Spectrum trading and disaggregation should be permitted consistent with initial licensing terms and conditions.

- For niche markets,
 - 450 MHz spectrum should be made available under similar terms as is other 2G type spectrum.
 - i. No restrictions on 450 MHz should be imposed other than build out and coverage, and those imposed on 2G operators.
 - ii. Annual license fees for 450 MHz should be zero, unless coverage includes denser, urban markets. If this occurs, then licence fees should be one quarter or one third per MHz as they are in the usual 2G bands.
 - Subsidies or spectrum set-asides for niche markets may be unnecessary due to tremendous progress in India.
 - If policy makers want to boost niche market penetration more quickly, procurement auctions should be conducted that are open to all spectrum licensees. Funding for the procurement auctions can be from licence fees, a telecom tax or general revenue funds.