An Evaluation of Different Models for the Issuance of Licenses for Service Provision and Frequencies

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CONTENTS

LIST OF ACRONYMS

BOP	Bottom of the Pyramid
ICT	Information and Communication Technology
GPS	Geographic Positioning System
TCO	Total Cost of Ownership
DSL	Digital Subscriber Line
GSM	Global System for Mobile communication
CDMA	Code Division Multiple Access

1. INTRODUCTION

There seems to be almost no dispute that mobile phones are the only platform that can help in bridging the quintessential digital divide. Wireless technology revolutionized voice telephony and helped in altering a typically monopoly market with its associated problems into a highly liberalized and competitive market with its attendant benefits. A similar revolution is expected in data services with wireless mobile technologies having largely overcome two previous barriers to their adoption on a wider scale. Wireless networks today are cheaper, more powerful and faster to deploy today than their fixed line (copper wire) counterparts. The data speeds, which were until recently available only on copper wire networks using technologies like DSL, are high enough for routine internet access. New wireless technologies are considerably faster.

This offers a unique opportunity to bridge the so-called digital divide by providing electronic connectivity and services to poor communities, euphemistically termed the "Bottom of the Pyramid" (BOP) who have historically enjoyed little or no such access. BOP users could expect to use wireless technologies to over come the many disadvantages they face in their work, livelihoods and social lives. For instance, the use of mobile phones and other Information and Communications Technologies (ICTs) could reduce travel. A wealth of other services, including those based on internet and geographic positioning systems (GPS) are now provided using the mobile phone, which can be a potentially dramatic intervention in lives of BOP consumers with its impact extending beyond its ability to enable them to talk.

The mobile phone is no longer a product that only the affluent can afford and use. With Total Cost of Ownership (TCO) falling one can safely say that the mobile phone has the potential of becoming a mass product, if it is not already. Bangladesh, India, Pakistan and Sri Lanka, are among the countries that have the lowest monthly total cost of ownership of mobile communications for a low-income consumer. Their TCOs are less than half the average TCO of the 80 emerging markets studied by Nokia[1], ranging from Chad to Turkey. This increased affordability has consequently resulted in more than 3 billion mobile phones in use today. The numbers continue to increase at an impressive pace especially in emerging markets. India alone adds over 10 million new connections each month.

There is considerable evidence that poor have adopted mobile phones because of the many tangible benefits that accompanies their use (Vodafone Public Policy Series, Uppal, & Kathuria, 2009). The phones offer increased productivity at work and flexibility in time management – which is invaluable to a poor entrepreneur who needs to multitask frequently; Those who work from home or stay alone, can access people in emergencies and this increases perceived security; Social ties are stronger since working away from home at uncertain hours does not mean being out of touch with loved ones. These

[1] Nokia (2008), Affordability key in bridging the digital divide, *Expanding Horizons,* 1/2008

features are even more important at the BOP where balance between personal life and livelihoods is often more difficult to achieve since informal workers have less control over location and work timings.

In this background it is important that in their licensing and frequency allocation mechanisms governments do not constraint the diffusion of this technology which holds the promise of trickling down the benefits of growth. Radio frequencies carry wireless signals. Be it a mobile phone call, providing emergency services, surfing TV programmes, controlling space vehicles, operating car locks from a distance, no wireless application or service can work without use of some part of radio frequency spectrum. Access to appropriate radio frequencies – or simply spectrum, for short- is therefore critical for diverse players ranging from the academics, hobbyists, emergency relief agencies, defence forces, and telephone companies who deploy wireless devices in their respective activities.

The main objective of this paper is to discuss the various trade offs and incentive structures created by the various mechanisms of allocations of licences and frequencies in the telecom sector. International examples will be cited for the purpose of discussing the various mechanisms. What are the relative merits and demerits of these mechanisms from the economic and social perspective? What is the impact of these mechanisms on the structure of the market? What are the "best practices" of allocation that reconcile various objectives of promotion of competition and equity concerns through transparent mechanisms rather than distortionary prices?

To this end the paper is organized as follows. The next section first briefly outlines the importance of radio frequency management in general and for BOP in particular. Section 3 discusses the instruments and approaches adopted by the regulators to manage frequencies. Section 4 evaluates the different models of allocation of frequencies. Section 5 discusses these models with some international examples. There is a huge controversy regarding the ability of the market mechanisms such as auctions for allocating frequencies ad they are perceived to have deleterious impact on the interests of the BOP customers. In Section 6 we discuss that while exploiting the benefits of auctions what safeguards should be put in place in order to protect the interest of the BOP customers. As this section shows it may still be possible to re-concile the benefits of auctions with the universal service agenda. Finally, we conclude in Section 7 with some recommendations.

2. RADIO FREQUENCY MANAGEMENT AND THE BOP

Radio frequencies are a finite- though inexhaustible- resource, much like land. Different technologies used for radio, TV, mobile phones etc, are associated with a particular range of frequencies. The specific part of the spectrum and the range of frequencies available for a specific use are important; it determines the size and quality of wireless signals to be carried, the number of users or devices to be accommodated and whether other signals could interfere with them. Sometimes, it is possible to deploy a service on several frequencies, but not at the same cost. Many of these issues are

interconnected. The price and quality of the service provided using a radio frequency depends on the extent to which a service provider can control its supply of spectrum. Therefore, decisions of governments or regulators[2] who typically manage this resource in their countries - can influence- if not determine completely- which technology eventually reaches end users.

Allocation and price of a key input in wireless communications viz. radio frequencies are therefore important public policy issues. Governments and communities accord varying priority to wireless applications that depend on access to spectrum. Emergency and defence are high priority and rarely seen as commercially contentious issues. However, there is much more debate and controversy about spectrum for public mobile phone services and broadcasting which are increasingly run by commercial players who need increasing quantities of spectrum to meet the fast growing demand for their services. In many cases, players are making speculative moves to hold on to unused spectrum, or, to acquire fresh spectrum with an eye on future commercial value or in order to restrict entry into their markets, since resale of spectrum - which could blunt these incentives - is disallowed in most countries. The link between rules for spectrum and the needs of BOP is sometimes missed. For instance, if the price of spectrum is artificially high, the commercial users of spectrum, in order to recover costs incurred, may prioritise higher revenue customers and delay coverage in sparsely where BOP communities live. An example of perverse incentive originating in spectrum allocation and pricing is visible in India where operators qualify for more spectrum, when they reach a specified subscriber-base. The price paid for additional spectrum is relatively low and computed by the government without reference to the market value of spectrum. Since subscriber additions are faster in urban areas, operators have arguably less incentive to expand networks in rural areas where it may take them time to develop markets. An operator who prioritizes rural areas over urban areas risks future access to spectrum in a market where roughly a dozen operators compete for it.

So, the spectrum allocation regime can have a direct impact on when wireless services reach BOP communities as well as their quality and price which will reflect the quantity of spectrum that operators can access and the price they pay for it.

The massive increase in access to mobile phones across the developing world can diminish the huge challenge of connecting the many persons and regions that mobile phones are yet to reach. This is largely true of rural areas where the proportion of BOP populations is significantly higher. For instance, according to Market Skyline of India[3] out of the 70 million urban households and 159.3 million rural households 10 million and 82 million are classified as BOP (defined as those earning less

[2] Governments are typically not synonymous with regulators. Indeed, in some cases regulators are expected to demonstrate a certain independence from government. However, unless a distinction is explicitly made, for convenience, the regulator is being used as shorthand for the public agency, including the government itself that performs the regulatory task of managing spectrum irrespective of its specific institutional design and status.

[3] Market Skyline of India: District Profile, Indicus Analytics, New Delhi.

than 75,000 pa). That would make 51% of rural households as belonging to BOP while only 14% of urban households would fall under the same category. Since roughly 70% of Indians live in rural areas, in India, BOP users are the norm and not the exception. However, the cost of access to mobile services could still be a barrier to many at the BOP, despite the large fall in prices in recent years as has been revealed by the recent LIRNEasia Teleuse@BOP3 survey.

Expanding access to BOP consumers may be an even bigger challenge than it might appear when one considers the cost of existing services. The BOP consumer often faces other unique disadvantages. (S)he is typically, less literate, have poorer access to other infrastructure such as power and roads, may speak a language that not be supported in software designed with predominantly urban user in mind. Therefore serving BOP users may not necessarily be identical or a simple extension of the needs of those who live in cities.

BOP populations typically enjoy lower levels of formal literacy. This means that text based applications which require minimal spectrum are less appropriate. The more appropriate graphics and multimedia are however more demanding of bandwidth. BOP populations with especially low levels of textual literacy present unique challenges. For example, as Raj Reddy in a recent article in the economic times pointed out that a simple email containing a couple of equations would communicate to an engineer would require a great deal of pictures, graphs and explanatory text for easy comprehension by those with only rudimentary education and by extension those who are illiterate.

Technologists have made strides in delivering powerful devices at progressively lower costs. But, if they and the operators who deploy wireless technologies cannot access the radio frequencies needed to accomplish the task of delivering services at the BOP, their success could be eroded to a significant extent. This will be particularly relevant for BOP populations of South Asia and Africa who enjoy little if any access to fixed line networks almost ubiquitous in western economies even before large-scale adoption of the mobile phone. Given the lower cost and speed of deployment of wireless networks, the poor have a much higher stake in wireless communications, which is their only realistic option for connectivity.

The BOP communities have a strategic interest in wireless communications and its vital resource viz. radio frequencies or spectrum (as they are called in telecommunications literature). If operators cannot access sufficient spectrum or must pay an exorbitant price to do so, they must spend more on wireless infrastructure (e.g. towers) to support the same number of subscribers or provide comparable quality of service. Inadequate supplies of spectrum will also hurt provision of and access to data services of interest to BOP users since rich media would in most cases - require more spectrum. The policies of allocation therefore impact how and the extent to which the BOP access these technologies. Inadequate spectrum can affect the cost of deployment as well as the applications that can be deployed.

Governments that ignore the potential impact of spectrum rules on BOP, risk exacerbating – sometimes even causing- market failure.

3. ROLE OF REGULATORS IN FREQUENCY ALLOCATION

The task of reconciling the often-conflicting demands for frequencies from market players, current and future technology innovators and users falls on regulators responsible for making markets work effectively. Regulators have an important residual role in allocating and pricing radio frequencies. This is in contrast to their increasing willingness to leave other aspects of the telecommunications sector e.g. service provision, tariffs, quality of service, innovation, research and development etc to competitive markets. They must recognize and reconcile conflicting demands of public policy goals and markets. The focus and creativity of regulators will be critical if wireless technologies are to reach BOP users and enable them potentially to transform their lives as has been noted above

The evaluation of the various approaches to allocation and pricing of radio frequencies, is therefore of critical relevance to BOP users. It could well determine when and if all BOP consumers will be able to access communications services. Equally, this will determine the price, quality and potential use of such services.

Regulatory instruments and their links to spectrum access

The telecommunications sector - and in particular its wireless component - are inextricably linked to regulatory actions. Spectrum is a scarce public resource and governments are key players in how much is released, to whom, for what use and on what terms.

Regulatory instruments have therefore an important bearing on type and amount of spectrum allocation and the challenges posed in such an exercise. In practice, these instruments include:

1. *Market Structure*

Regulators determine how many players can access radio frequencies, by laying down how many licences or authorizations are to be issued for a particular wireless service. The spectrum demand can be correspondingly high or low depending on whether market entry is restricted or closed. Regulators typically reconcile the task of ensuring competition in the wireless markets with the need to ensure that the limited supply of spectrum is used to optimal potential.

2. *Controlling demand and supply of spectrum*

Regulators frequently control the amount of spectrum that operators can access for delivery of wireless services. As a part of this task, they often work with those existing allottees to vacate spectrum that is no longer needed or whose communication needs can be met without use of radio frequencies required by commercial players. For instance, copper cable or optical fibre could be a workable alternative. In India, for instance, the government and other stakeholders have frequently

spoken of getting defence to vacate spectrum. Similarly mobile industry has often demanded spectrum currently reserved for terrestrial broadcast and occupied by public television. The relevant broadcast frequency is lower (700 MHz) and because of its unique propagation characteristics offers a cheap and effective means to cover large BOP areas where networks have yet to reach.

Regulators could take several measures including support for research and development towards more efficient use and possible sharing of spectrum. This could be achieved through subsidy mechanisms such as universal service funds that exist in many countries.

3. Competition Rules

Regulators not only determine the level of competition through control on number of players that can enter the market, but also the robustness with which they must compete with each other. The demand for spectrum and the value placed on it and its efficient usage will depend on how competitive the resulting markets are. A weak competition regime or fewer curbs on abuse of the market will inevitably hurt the growth of the market.

4. Fees for spectrum rights and usage

The demand for spectrum and the regulatory challenge in meeting the goals of spectrum management will also depend on the price, if any charged for the use of radio frequencies. High entry fees will attract fewer entrants than a 'back loaded' fee regime, where players pay less in the beginning and more later.[4] Similarly, a poorly designed auction for spectrum can increase barrier to entry by potentially raising entry fees.

5. Allocation based on levels of usage

Regulators can influence the supply of spectrum to potential users by linking the amount of spectrum that an operator receives with the number of subscribers or services that must be supported. For instance, India follows an allocation system where operators receive spectrum based on the number of subscribers on their network. This system of allocation may create perverse incentives as over reporting subscribers or pushing multiple subscriptions to claim more spectrum.

6. Spectrum Trading

The possibility of acquiring or disposing of spectrum can enable unused spectrum to reach potential users. By offering an alternative source of spectrum, other than the traditional one viz. government, spectrum trading provides an incentive against spectrum hoarding which could otherwise be a significant risk when speculators acquire precious spectrum.

7. Incentives for innovation

[4] This has been most evident in India. In 2007, when the low price of spectrum attracted several hundred applications from new players including several novices.

Regulators can manage spectrum supply and demand by defining and implementing incentives – such as concessions, subsidies etc. – to ensure productive use of radio frequencies e.g. supporting more users in a given bandwidth

8. *Standards Setting*

Selecting one or more standards can significantly affect spectrum use. For instance, India had settled on GSM in the early years of mobile network deployment. The addition of CDMA to the list of accepted technologies made it possible to access frequencies not in use until then. 3G technologies, when deployed, will free up 2G GSM and CDMA spectrum.

9. *Measures for ensuring spectrum availability for high priority services*

Regulators can take specific steps to ensure that spectrum needs of defence or emergency services are met. In some cases, where the same spectrum is in demand by say, commercial players, this could influence supply of spectrum to the latter.

10. *Spectrum allocation based on technology used, region served etc.*

Regulators often allow operators considerable freedom in the use of the spectrum allocated to them. In rare cases, regulators have devised technology specific rules for allocation of spectrum. For instance, rules for allocation and pricing of spectrum for GSM and CDMA services could be different.

The above list is not exhaustive or indicative of best practices. In principle, regulators could devise many new instruments or rules to manage spectrum. Several instruments above (e.g. 7, 9 above) have even been controversial and have been listed here to explore the approaches taken by regulators.

Current approaches to spectrum allocation

As mentioned earlier, the task of managing spectrum resources has almost invariably gone to government agencies. In general, spectrum Regulators would aim to meet the following goals:

1. Create a transparent and equitable regime to allocate spectrum,
2. Allocate radio frequencies based on market demand,
3. Ensure spectrum is available for high priority non-commercial purposes e.g. safety and emergency services,
4. Create efficiencies in use of Spectrum,
5. Promote innovation in wireless technologies to maximize value of radio frequencies,
6. Eliminate technical interference caused by and between spectrum users, and
7. Promote public interest by ensuring productive use of radio frequencies.

While there is a consensus on most of these broad "high level" goals, the means to realize them have varied depending on variety of technical, political and market realities that exist in different countries.

Broadly speaking, there are three main approaches to allocation of spectrum to prospective users viz.

1. **Administrative or "Command and Control" approach** where the regulator decides which frequencies any user can access at any place, at what price and under what technical conditions;
2. **Property rights or market based approach** where prospective users are allowed to buy and sometimes even sell the use a particular frequency on payment of its estimated market value; and
3. **Commons Approach,** where prospective users are allowed, without any accompanying rights or licence for exclusive use, to access designated frequencies along with others who might wish to.

The above three approaches correspond, respectively to saying (Buetti and Ubeso ,2007) government officials "decide", the market "decides", technology "decides" highlighting the dominant focus in the three approaches. There are important implications of each approach. We consider them in the next section.

4. EVALUATION OF DIFFERENT MODELS OF ISSUANCE OF LICENSE FOR FREQENCIES

While countries prefer one or the other of the three approaches a country may not use the same approach for all types of wireless services. This reflects the varied demand for spectrum for diverse wireless services. The number of players wanting to deploy networks depends on market size as well as barriers to market entry. Therefore, while the demand for spectrum for astronomy, emergency services is limited, that for mobile telephony would be much higher. This allows regulators to choose a mix of these approaches depending on the expressed demand for spectrum and the opportunity costs that accompany its use.

However, it is worthwhile to discuss the merits and the limitations of each of the approaches

The Administrative Approach

The Administrative approach is the oldest and has been popular since the earliest deployments of wireless technology. Public officials determine the agency or commercial entity authorized to use radio frequencies – including their location in the spectrum and the amount- and at what price, if any. They also determine the number of players that can operate services based on the radio frequencies in question, and how they could acquire more frequencies if they need them later. In general, the

administrative approach comprises using one or both of the following two ways to select which company or agency can access the spectrum:

"Beauty contests" – where regulators select spectrum licensees based on a set of criteria which could include technical, financial and others

"First-come, first-served" – where regulators award licences for radio frequencies in the order in which they receive requests from prospective licensees

The Administrative approach gives regulators considerable freedom to decide the amount of spectrum each player can access and fix its price. This can be particularly useful when one must protect vulnerable users or control the price of specific services. The approach has worked relatively well in most countries until now. It is arguably, suited to addressing spectrum needs for non-commercial uses –e.g. for defence or emergency services or space research etc- where discretion available to regulators could help them dispose of requests for spectrum speedily and effectively.

Administrative approach inter alia leads to a "Political Determination of Spectrum Sharing Rules", (Hazlett, 2007) deters innovators, and seeks to deal with power limits and technology constraints by fiat. Public functionaries rarely understand or appreciate the opportunity costs of radio frequencies.

Public officials are particular unsuited to implement beauty contests since they are frequently prone to setting arbitrary or self-serving criteria for selecting who receives the spectrum. The first-come-first-served approach, on the other hand, places a much higher premium on timely request than can sometimes be justified for a high value public resource but may be misused by the beneficiaries for speculative purposes.

In many countries, given the importance of wireless communications for defence and security needs, the respective agencies were in charge of or played a central role in spectrum management. This too has been frequently problematic. It is rarely possible for other stakeholders to verify or query the diagnosis of problems or estimates of radio frequencies required by defence agencies, in view of the perceived sensitivity of the latter's mandate. This can mean sometimes, that the needs of commercial and other players e.g. mobile operators, take a back seat and artificial scarcities are created. Often this translates to delay in launch of the latter's services and sometimes if it means spectrum is held up, it hurts quality of services too. India has witnessed several unresolved debates about whether defence forces are in a position to release spectrum required for 2G and the yet to be launched 3G services.

Bureaucrats, who often preside over spectrum management in the administrative approach, can also be especially slow and inflexible. In an area like wireless communications, known for its speed of innovation and aggressive competition, it can often lead to critical delays in introduction of a technology that could potentially seal its fate in the market place.

This approach is fraught with well-known risks. Artificially cheap or free spectrum can distort markets and eventually hurt consumers. Subsidies to operators too come with similar risks.

Therefore, regulators implementing the administrative approach work harder to mitigate such risks. This is a challenge for non-specialist staff that typically performs such functions. However, with adequate care, e.g. by keeping subsidies transparent, specific policy goals can often be realized.

There have been efforts, notably in United Kingdom to move to an incentive based administrative pricing model, which is variation of the administrative approach. Here, the price of spectrum is set closer to its estimated market value.

Property Rights or Market Approach

Coase first advocated the Property Rights approach in his seminal paper in 1959. He argued that spectrum and property had many of same characteristics. In addition, similar market principles should determine their allocation and price. The approach is especially suited when demand for spectrum is greater than supply. This is increasingly true for some frequencies required for mobile communications and broadcasting. In such cases, an administrative approach, in which public officials seek to choose 'winners' from amongst the many contenders can be difficult to implement.

Property rights approach is based on the premise that market players are best placed to help discover the price of spectrum. Further, having paid the market price of spectrum, these players have an obvious incentive to recover its value by putting it to best use. The approach has found increasing support in recent times as wireless markets have become more competitive

The Property Rights approach though simple in theory is not trivial to implement. There are no clear answers to how these rights are assigned to private – especially commercial - players and for how long. What is a fair price for those rights? Should the rights be tradable?

Most holders of private property rights for spectrum are expected to obtain them after paying market rates for spectrum. However, there is no consensus on how regulators can determine market rates of spectrum. India has seen frequent debates about how spectrum could be valued.

The property rights approach has often been implemented by conducting auctions of radio frequencies especially for mobile and broadcast services where the demand-supply gap has made auctions a relatively transparent way to determine the spectrum price to be charged from those interested in deploying these wireless services.

Licence Exempt or Commons Approach

The licence exempt or Commons approach leaves users to share the frequencies and take appropriate steps to deal with possible interference or other issues. In each case, the regulators often- though not always- decide the frequency bands for allocation and the specific use that can be made of such frequencies.

Regulators concentrate instead on defining power limits and the consequent geographic range of wireless signals. The absence of intrusive regulation is a significant incentive for technologists and companies to provide innovative services. The experience of Wi-Fi services – which is licence exempt in over 80 territories (Horovitz, 2007) - is sign of the manifestly high popularity of the licence exempt bands. Cave therefore argues that the UK governments, his client, further liberalize the use of licence-exempt or "Commons" bands.

However, the Commons approach is no guarantee of optimal usage of a scarce resource. In addition, with more players in the market, because of low entry cost, the transmissions can be degraded through over use. This will probably be unacceptable in traditional mobile communications where reliability of service is often paramount.

This may of course force further innovation in the market place. In addition, the use of spread spectrum technologies has helped to reduce the possible interference. Nevertheless, the fact that there is no penalty for wasting spectrum in this approach is a serious theoretical and practical concern.

In addition, in spite of the many innovative uses of wireless technologies due to the free access to spectrum that the Commons approach enables, there is concern that the approach has not resulted in a significant or noticeable increase in investment in the corresponding technologies or services e.g. Wi-FI access to IP services. Most users continue to depend on other means of accessing voice or internet. In that sense, the success of Commons approach in delivering on the promise of wireless technologies has been limited.

It would also be difficult to avoid the "tragedy of the commons."[5] In the absence of sufficient regulation, it is as Hardin showed, easy to see how small abuse of the spectrum by private users would go on to hurt most if not all users of shared spectrum.

The Commons approach may however be more effective than skeptics claim. Recent advances in wireless technologies such as spread spectrum communications have made it much easier to deal with interference. Also, new software based cognitive radios enable unlicensed users to access licensed spectrum – such as, for example, allocated by the Administrative or Property Rights approaches – when it is not in use and without causing interference. This could enhance the value of the Commons approach.

However, the Commons approach is not applicable seamlessly in certain markets such as mobile communications, which are larger, more complex and pose serious legacy issues in most markets. Its success is also considerably hindered by the fact that many incumbents have large investments in

[5] the reference to commons here is not specifically to spectrum but to shared resources

alternate technologies, use different business models and in most cases have exclusive legal rights to spectrum, which they may not wish to dilute voluntarily.

Therefore, incumbency issues, especially in larger more active markets where the cost of changeover – money and time- could be daunting for most stakeholders, limit the higher innovation possible in the Commons approach. For the near future, the Common approach might be easiest to implement for services based on newer technologies or those that exploit hitherto unused parts of the spectrum where incumbency would be less of a challenge.

Evaluating Approaches to Spectrum Allocation from the BOP users' Perspective

The appropriateness or usefulness of the three broad approaches above depends on their ability to meet the goals set out in earlier sections and not simply on their formal elegance or theoretical strengths. However, these approaches come not just with their unique strengths; they also bring with them their own cost of implementation. The chosen approach must therefore combine high benefits with low or zero cost.

The essential unity of the subject of spectrum, which refers to the continuum of radio frequencies for wireless communications, can be misleading. In practice, regulators rarely face major challenges in allocating most radio frequencies since the demand does not outstrip supply. It is only radio frequencies for mobile voice and data services and broadcasting that present most of the challenges in allocation and pricing. To that extent, the interest in the three approaches to spectrum allocation beyond these services is largely academic. Our subsequent discussion of spectrum allocation in this paper is around mobile communications.

Looking at spectrum allocation from the perspective of BOP users, the right approach must combine the following:

1. Inclusion: Expand access to wireless services to BOP consumers,
2. Affordability: Make services affordable to BOP consumers,
3. Innovation: Create incentives for design, implementation and marketing of services of interest to BOP users,
4. Service Diversity: Promote BOP consumers' interest in diverse services besides simple voice calls, e.g. broadband data, and
5. Sustainability: Create an environment where BOP consumers can be served sustainably without risk of discontinuity or sudden change in price or quality of services

1. *Inclusion*

In developing countries where BOP communities often live, spectrum – especially for public voice and data services- is a bigger challenge than is conventionally recognized. Unlike most developed

countries, there is no fixed line network to fall back. They would inevitably rely more on wireless services than their developed world counterparts would. Managing wireless spectrum effectively is therefore a bigger priority for developing countries. The potential welfare surplus for BOP users too is therefore greater.

BOP communities can access wireless services if wireless networks reach where they live and work. Inadequate amounts of spectrum or a high price for its use will probably tend to exclude BOP users who would be a priori more expensive to serve and less profitable in the light of their low incomes.

2. Affordability

As experience in India has shown, BOP customers do well when markets are competitive. Therefore spectrum rules that do not reflect norms for fair and robust competition are most likely to raise end user prices and lower service quality in the long run. High usage charge[6] for spectrum which increases operational expenses will in all likelihood be passed on to users and hurt BOP subscribers more.

Similarly, if spectrum quantities available for wireless services are low, operators need more infrastructure such as base stations and other equipment. This will hurt affordability in the long run.

Government agencies including defence often receive large chunks of spectrum. Companies frequently start services with the handicap of inadequate spectrum. This reduces competition as well as increases user prices.

3. Innovation

Telecom providers, especially mobile, have only recently discovered the revenues that BOP users can generate. BOP communities in India, Bangladesh, Kenya, Tanzania, Pakistan and Sri Lanka have adopted mobile phones in a big way. Markets in these countries have delivered substantial returns to their investors. This is not simply because that lower prices have made services affordable and expanded markets. It is also because mobile operators now offer innovative tariff packages that are more in harmony with small and unreliable cash flows of BOP consumers with modest incomes. Micro pre paid recharges of less than a dollar are well known examples of such innovative tariffs targeted at budget subscribers. BOP consumers require access to many expensive technologies like touch sensitive screens, multimedia support to meet challenge such as illiteracy, multiple languages etc. The price of these technologies will depend in great measure on innovation by the players. Spectrum rules could create several incentives for such innovation.

[6] Here, we distinguish between a one time entry or access charges from usage charges. An operator may, typically pay a one time entry cost and a recurring cost for usage of spectrum after its allocation. Often the one-time cost is high and the usage charge is nominal. Economists regard the former as a sunk cost for market entry which has little bearing on end-user prices. The latter, especially if it is high, would, in traditional businesses, be an operating cost to be recovered from users.

. For instance, if spectrum is allocated on a purely administrative basis without regard to how efficiently it is used, then there is little incentive to economize in its use or to invest in efficient wireless technologies. There is also little incentive to provide innovative content of use to BOP users, if spectrum is easier to obtain by providing services of interest to urban or wealthier users. On the other hand, when operators have to pay a market price for spectrum, there is an incentive to derive better value by innovating in its usage. The commons approach, it has been argued, encourages users to innovate since absence of exclusive access encourages users to device appropriate ways to offer an acceptable quality of service.

4. *Service Diversity*

BOP users need other services besides voice. It is increasingly clear that if mobile phones are used to provide internet access and services linked to governance and entertainment they will meet an important need of BOP users. These latter services are a small subset of the many data services of interest to BOP communities. However, if while allocating spectrum, regulators overly focus on spectrum for voice calls, BOP users will lose out. The delivery of such diverse services is also linked to there being adequate supplies of 3G spectrum. In the absence of appropriate spectrum provision for 3G and similar broadband technologies, the goal of service diversity may be pushed back further.

5. *Sustainability*

However, a spectrum regime that aims at short-term results is usually unsustainable in long run and bound to fail. For instance, free spectrum may lower entry costs but may also raise costs of legitimate players competing with a surfeit of less serious players lured by easy access to spectrum. Such subsidy may exhaust supplies more rapidly and hurt future users too.

A preferential spectrum for a specific technology may encourage economies of scale but will also deny the benefits of competition to end users condemning them to higher prices and poor quality of services in some cases.

A spectrum regime that goes counter to sound economic rationale or market realities is likely to be unsustainable in the future. BOP consumers are likely to be more vulnerable to such failure.

Institutional compatibility

A spectrum regime that seeks to promote the interest of BOP users is likely to work better if its methodology and processes are compatible with institutional structure of the country concerned. For example, an overly technical approach would be difficult to implement in a country with few trained personnel.

Institutional strengths or weaknesses frequently come into play (Spiller and Levy, 1996). For instance, a Scandinavian country with higher quality of governance and accountability may be able to use an administrative approach far more productively than a developing country with a poorer quality of

governance where bureaucrats, politicians and even judiciary cannot often be relied on to be independent.

A country with weaker markets or a more sensitive security environment may be more prone to crony capitalism and more likely to misallocate a precious resource like spectrum.

A country unable to enforce excellent regulation is likely to risk distortion of its market as well as potentially hurt user interests. Thus, while the commons approach may be sound in theory, if power outputs of spectrum users cannot be controlled effectively and legitimate users and innovators end up at risk, its value would be much diminished.

Wellenius and Netto, 2008 point out that developing countries are often reluctant to share detailed information amongst potential users. This makes it difficult for the latter to make informed decisions relating to investment or technology. Thus, administrative approaches that work well elsewhere can be riskier and sub-optimal in developing countries.

There is a tendency in many countries to depend on spectrum for raising large revenues for the exchequer. "Governments often forget that the value of spectrum is overwhelmingly in the consumer surplus not in licence prices (which reflect producer surplus) (Hazlett op cit, 2007). For instance rules that favor monopoly market structure typically hike licence valuations, but reduce consumer welfare. This is sometimes a bigger problem in developing countries where spectrum fees are used as a means to address budget deficits.

In summary, the three approaches to spectrum allocation throw up new possibilities and challenges when seen from the perspective of BOP users. In particular, administrative approaches, which can protect BOP users by fiat, are likely to be most difficult to implement in the absence of quality governance and technical expertise that developing countries often lack. The commons approach may result in cheaper spectrum and encourage innovative new services. However, it is relatively weak in dealing with legacy issues that the massive commercial investments in mobile networks already in use by many if not all BOP users. This will make its implementation for current services a daunting task in most countries especially developing countries with limited resources.

For these reasons, "moving management of the radio spectrum closer to markets is long overdue (Wellenius and Neto, op cit). The need to design appropriate processes to determine market value of spectrum is therefore important not because of the possible rents that government can extract but because of their transparency. This makes them less susceptible to later legal challenges and time-consuming court processes, often the bane of many developing countries. Market based procedures, like auctions of spectrum, also reduce the incentives for corrupt public officials to use their discretion to serve sectional or private interests.

To summarize, market based procedures are preferable for spectrum allocation not because they are inherently superior, but because they can mitigate the many risks faced by developing countries,

where BOP consumers are more numerous. They are easier and faster to undertake and leave many important judgments about the value of spectrum to those are more likely to value it more precisely. With some care in design, it is possible to mitigate the residual risks of the market approach, e.g. excessive valuation of spectrum by commercial players that threatens to push smaller players out of the market.

Implementing Market Based Spectrum Allocation

There are obvious benefits to a spectrum regime, which reflects market principles in much the same way as the popular services like mobile telephony that use spectrum are already being run across the world. Auctions of spectrum have emerged as a transparent way of allocating spectrum based on market principles. Most countries that relied on the administrative approach are slowly moving to one based on property rights. They are undertaking auctions of spectrum to ensure that the process for its allocation is fair and that there is adequate compensation for government exchequers for transferring [7]the rights to use it to private parties.

However, even if one concedes that market based principles are most appropriate for allocation of frequencies it is worth considering whether auctions protect interests of BOP users – namely inclusion, affordability, innovation, sustainability and service diversity. Do they bring any additional risks that cannot be mitigated easily?

India's mobile markets are proof that auctions can protect BOP users. Mobile networks are expanding at a faster pace than fixed line networks ever did. There has been continuing innovation, both in the range of services on offer and the creative tariff options offered to users especially at the bottom-of-the-pyramid. India's mobile operators offer recharge coupons of barely US$0.20. Indian mobile operators are some of the most profitable even as they offer some of the world's cheapest call rates, which indicate that sustainability is not an issue (PriceWaterhouseCoopers, 2008). Market based allocation of spectrum cannot however, be a goal by itself. The manifest increase in penetration and falling prices demonstrates that competition and contestable markets remain an important weapon for expanding access to BOP users. Indeed, there is little evidence that administrative approaches have had comparable success in addressing the needs of BOP consumers.

However, many still oppose auctions. They cite the risk that companies greedy to grab spectrum to any cost will eventually raise prices to recover their costs or will quit markets putting services to users at risk.

In practice, however, auctions are less risky. The demand-supply gap is a problem in only some situations. At any given time and especially in rural areas where BOP users are proportionately higher in number, useful spectrum is largely unused. In general, no auctions will be necessary if rural areas

are treated separately. If auctions become necessary, the bids generally, will reflect the low demand for spectrum.

The situation is different in larger markets, where demand for services is typically higher and the spectrum price often much higher. Here, operators are usually constrained by market dynamics. Even if there is temptation to recover spectrum costs quickly, the need to be competitive is arguably greater. The threat of losing market share and becoming unprofitable ensures that high spectrum charges paid through auctions-, which are one-time sunk costs for market entry-, do not pass to end users (Kwerel, 2000).[8] This is very evident in markets like India, where auctions of mobile licences have not led to high prices in the market. A similar situation exists in other markets like Australia, New Zealand, and UK etc where competitive processes for spectrum have been the norm and believed by regulators to be good policy for the near future. Recent policy documents attest to that belief (Ofcom 2006, 2007 and other sources cited under country references).

Many believe that the auction of 3G licences in the UK and Germany and the cripplingly high winning bids made by incumbents is evidence of the kind of distortions auctions can cause. The companies in question later faced severe setbacks in raising funds. Many believe that if the auctions had not nearly bankrupted the telecom companies who were successful at the spectrum auction, the 3G services would have been deployed earlier (Ure, 2008).

However, despite the experience in UK especially after the controversy and the fear that British companies incurred huge debts after their massive bids in the 3G auctions, Martin Cave, the author of an independent review done for the British government states: “The review strongly supports the use of auctions to assign spectrum licences to competing users. This should become the default means of assigning licences to exclusive frequency bands. The specific design of individual auctions should be decided on a case-by-case basis, taking account of competition, marketing and technical analysis…. The review rejects claims by opponents of auctions that the competitive bidding process will inevitably lead to a number of negative effects, including the raising of prices to consumers and the delay of deployment of services. Indeed the author goes on to say that “Rather, the review considers that its proposed combination of auctions, together with secondary trading of licences and fewer restrictions on usage, should bring benefits to companies, which will have more information and choice about spectrum supply than they do at present.”. Recent decisions of the country’s regulator OfCom testify that, far from abandoning future auctions, UK plans to move towards a more market-based allocation of spectrum (Cave, 2002).

Paul Klemperer, who designed the UK 3G auctions on behalf of the government, has written extensively on designing auctions. He warns against a “one-size-fits-all” approach, which ignores the

[8] This is in contrast to a recurring usage charge, which increases operational expenses that most businesses would seek to recover from users.

ground reality and the context in which the auctions is held. Klemperer offers design solutions for many of the potential ills of the auction approach Klemperer, 2002.

The risk of collusive behavior in auctions i.e. rigging is real but manageable. Klemperer provides the different design solutions that can prevent abuse and mitigate risk. For instance if companies are allowed to raise their bids only in fixed increments, bidders cannot use specific bid amounts to signal intent. He examines the relative merits of single stage bidding vs multistage bidding, of declaring the identity of bidders or not doing so, and many other options that exist to design an auction in line with goals. Such goals could include maximizing revenues for the 'owners' e.g. governments auctioning spectrum rights. On the other hand, they could as naturally prioritize service rollout or end user prices for services using the resource.

Klemperer recommends the Anglo Dutch approach, which begins with an ascending auction to eliminate all but two bidders and finishes with a sealed envelope bid from the bidders to decide the winner.

The importance of auction design and its often-direct impact on the number of bidders as well as the size of their bids, begs the question whether there is a unique market price for a product being auctioned. There is not. The strength of the auction approach lies not in its ability to discover that price but in its transparent process. This is an especially important benefit when governments seek to offer limited public resources for commercial use.

Melody (2001) has drawn attention to how governments created an artificial scarcity of 3G spectrum, which led to the massive bids in European 3G auctions. As technical experts have frequently pointed out, markets are rarely perfect and quality information on which to base decisions on the market value of spectrum, rarely available to all players. Often the most vulnerable countries, are also the most likely to be manipulated by better-informed commercial interests who could sabotage their goals. This only fortifies the argument in favor of well designed auctions which can mitigate the inherent risks.

It is not sufficient to have auctions to determine the market price of spectrum at a given time and amongst a group of players willing to bid. In the absence of an option to buy and sell market in the secondary market, there are few advantages of transparent auctions since the 'now or never' situation reflected in such an auction would raise incentives to overbid. The knowledge that a company can buy spectrum in the market if it's going price i.e. bidding in auction – were to be too high can itself keep bids in check. In addition, the option to sell spectrum in case a company cannot justify its cost in an auction, can help reduce – though not eliminate entirely- the impact of the 'winner's curse'. As Cave puts it, "Entry barriers would come down and, with a more liquid market in spectrum, the impact of any one particular auction on an operator's business plans should be less critical."

India offers excellent lessons in the importance of good auction design. Its experiences in the two sets of auctions for mobile licences - which were de facto spectrum auction since spectrum is bundled

with a mobile licence in India - was radically different. The former, which allowed companies to pay the fees bid in the auction over several years, the bids were excessive and defaults many. In the second auction, when companies were required to pay the bid amounts up front, the bids were more restrained. There have been, to date, no defaults on auction commitments by winners. In a litigation prone environment, the second auction stands out as one where specific elements in design of the auction brought it in line with Indian market and political realities and ensured that policy goals were addressed more effectively.

There are the several other design options to ensure that users at the BOP or the operators wanting to serve them, do not lose out. Without adequate attention to auction design, for instance, there may not be enough bidders. This in turn would deprive BOP consumers of the manifest benefits of competition. Similarly, if the auction design leads to spectrum resources being divided in small chunks amongst diverse bidders, BOP consumers could miss quality as well as broadband services.

Simple safeguards to prevent waste of spectrum may be adequate for allocating radio frequencies for services where supply of spectrum far exceeds demand. In such cases, it may be possible to justify free access to spectrum in order to keep end user prices low. However, in today's market environment for wireless services like mobile voice and data, market based processes for allocation of spectrum such as auctions represent, on balance, the most promising ways to protect interests of BOP consumers.

5. LESSONS FROM INTERNATIONAL EXPERIENCE

While, administrative approach has been the most popular, most regulators are finding it more inadequate and unsuited to dealing with the rise in demand for mobile spectrum following the rapid growth in use of cell phones. The administrative approach is especially weak and arbitrary when it comes to determining who should be allowed to use spectrum, at what price and for how long. Moreover, one cannot deny that spectrum being a public resource should be priced such as the price reflects the scarcity of the resource. Administrative approaches do not allow for this and also can have pernicious rent seeking effects. These rents whose true beneficiaries should be the government and hence the tax payers are cornered by a handful of large corporations. Some may argue that this allows for cheap services (which we later say that money spent on auctions has no impact on the price of service), but in a general equilibrium sense it is not clear what is the opportunity cost for the economy at large.

US, Australia, New Zealand and United Kingdom have moved farthest on the property rights road. Italy, which considered an administrative approach to its 3G licences in May 2000, changed track to move to an auction a month later. Guatemala is an important example of a developing country that has devised a property rights approach to spectrum. However, it is significant that countries like Pakistan, India, Sri Lanka as well as China (ITU 2007) are now increasingly relying -or expect to rely -

on market-based processes to allocate and price spectrum for mobile services. Sometimes this takes the form of auctioning service licences that come with a quantum of spectrum. Since the value of a mobile licence is directly linked to the spectrum available to offer services, it is fair to say that auction of licences bundled with spectrum are de facto, auctions for spectrum. However, linking of additional spectrum disbursement to subscribers can create perverse incentives of hoarding and consequent market foreclosure etc. However, as mentioned earlier this problem can be mitigated if there is a secondary market for spectrum trading.

As mentioned before, the experience with auctions e.g. 3G licences in the UK and Germany has not always been satisfactory. Auction of early mobile licences in India in 1995 could similarly also be construed as a failure. Several companies who won licences through their high bids were eventually unable to pay and had to be bailed out by the government. However, over 100 subsequent auctions for 3G spectrum have been largely successful. Vodafone of UK, Hutchison Whampoa of Hong Kong, Singtel of Singapore have competed in several auctions worldwide and won roughly 10 licences each since the auction in UK.

Many countries allow sales by holders of spectrum. These include US, UK, Australia, and New Zealand. Others allow only some type of spectrum. EU encourages its members to allow spectrum trading, but does not mandate them to do so. Some countries allow the radio frequencies to be used flexibly. For instance, mobile spectrum may be usable for broadcasting and such flexibility can enable optimal value – commercial or otherwise-to be realized. Auctions for the 700MHz band in the US in October 2007 allowed such flexibility to winners (FCC 2008).

Hazlett, 2008 citing his results of an empirical study on a unique data set encompassing 1,365 licenses assigned by competitive bidding in 38 auctions held in 24 countries argues that “Licenses awarded by regimes with more expansive spectrum property rights generated winning bids that were 61 percent lower, adjusting for other factors. This evidence reverses the equity argument against liberalization over the policy margin studied and is consistent with Coase's view that property rights lower retail prices, thereby increasing efficiency.”

6. DESIGNING SPECTRUM AUCTIONS TO PROTECT INTERESTS OF BOP CONSUMERS

As mentioned above, an auction is a two-edged sword which can cut both ways. With appropriate precautions, they can help BOP consumers enjoy the fruits of market competition without the many risks that accompany unfettered or unregulated markets. This will require regulators to take steps to prevent artificial scarcity, unhealthy speculation, the so-called “winners curse” as well as proactive measures to promote interests of BOP consumers. Several of the instruments available to regulators were described in a previous section. These can be used creatively to work towards creating a spectrum regime that addresses the needs of BOP users (Uppal, 2009).

Examples of such measures include:

1. ***Auction a larger amount of spectrum to reduce perception of scarcity***

   If sufficient amounts of spectrum are auctioned to ensure that most prospective bidders have a fair chance of getting access to radio frequencies, there will be less reason for auction participants to make sky-high bids.

2. ***Reserve some spectrum bands for auctions to a different category of entrant***

   A pre-specified amount of spectrum can be reserved for a entrant with a mandate to serve BOP consumers. However, the enforceability of such a mandate will require robust contracts and other supporting institutional infrastructure. Similarly, reserving spectrum for a new entrant could ensure that consumers have access to new service providers with possibly new business models.

3. ***Allow spectrum trading to remove a now-or-never' perception amongst bidders***

   Governments are routinely over-cautious in allocating spectrum rights and frequently disallow users to resell or transfer these rights. Spectrum prices discovered in auctions can be expected to be higher if regulators in such cases. Bidders would be less inclined to pay high prices, if there was a secondary market for spectrum from where it could be acquired for a payment.

4. ***Mandate spectrum sharing***

   Regulators could incentivize efficiency and innovation besides reducing the perceived value of spectrum by mandating that auctioned spectrum be shared when possible. This would reduce the demand for spectrum and the price offered- through auction bids- for its use.

5. ***Reduce duration of spectrum licence***

   The up-front price of spectrum can be lowered if the tenure for which it can be used is reduced from the often-long leases, which regulators commonly provide to users, to a shorter period which is attractive enough for a commercial operator for running viable business.

6. ***Reserve the right to redefine use of a particular spectrum band on a later date***

   This will not only reduce the perceived value of spectrum for bidders, but will also help in more rational deployment of spectrum in future, as wireless technologies evolve.

7. ***Specify (low) end user prices in advance[9] of bidding***

   Regulators can lower operators' incentive to focus on lucrative customers by specifying a price affordable to BOP as a condition for access to spectrum. Auctions for mobile licences in Morocco in 2000 had a similar provision.

8. ***Require auction participants to bid for royalties***

   It has been argued that companies will bid less speculatively if they were not expected to pay a one-time price for spectrum. If companies bid for a share of revenue that they would be prepared to pay for use of spectrum, than to an extent the risk would be shared between the government auctioning the spectrum and the company using it.

9. ***Include rewards for efficient usage and/or penalties for spectrum wastage or hoarding post acquisition of spectrum by auction.***

   A usage fee structure that provides, respectively, substantive rewards or punishment for efficient or inefficient use of spectrum posts its acquisition can encourage companies to use it more economically and less wastefully.

10. ***Have tougher roll-out conditions***

    A tougher rollout regime can have two separate effects, which can benefit BOP consumers. First, it can make spectrum rights less of a bargain and thus lower possible bids. Second, it could specifically expedite the creation of infrastructure where BOP consumers live.

11. ***Specifying standards for quality of service***

    Requiring that winners of spectrum auctions provide a specific standard of service across users and regions can alter the perception of the price of spectrum.

12. ***Specify targets for narrow and broadband coverage separately***

    Similar to the previous item, any attempt to specify narrowband and broadband coverage will inevitably influence the perceived value of spectrum and consequently the price companies may be willing to bid for it.

13. ***Separate spectrum auctions for rural and urban areas***

    When spectrum to be auctioned is for use in large areas with a mix of well off and BOP communities, companies tend to use the potential market in the richer areas to base their bids. The high bids leave little incentive to rollout services in poorer rural areas where

[9] Morocco required mobile operators bidding for a licence, to commit to offering services at a pre-agreed price

BOP populations are often concentrated but where infrastructure costs are higher. However, if auctions for spectrum in rural areas were held separately from those for urban areas, they would raise lower bids from parties possibly more keen to serve those areas. The separate auction for spectrum in rural could bolster their business case.

14. Allow flexibility in buying and selling equity in companies that win spectrum auctions

As mentioned earlier, creating a secondary market for spectrum could go some way to deter speculative bids for spectrum use.

There are several other options, and not all are standalone. For example, stipulating a higher quality of service may lower cost of entry but might raise operational costs and consequently, user rates. Allowing companies to pay over a longer period for spectrum may increase risk to the exchequer by passing the results of operator inefficiencies to the government. It is also clear that a different kind of auction design could achieve a different result such as maximizing the revenues to governments auctioning spectrum rights. In general, the more exclusive and unfettered the right being auctioned, the higher the revenues the government could expect from the process.

7. CONCLUSION AND RECOMMENDATIONS

Wireless technologies present a unique weapon today in the fight for digital inclusion. Protecting and furthering the interests of BOP users of wireless services is an important policy objective. It is possible to meet this objective using market based allocation and pricing of frequencies. However, not all market-based solutions will work. Indeed some can harm BOP users by reducing the likelihood of services reaching them or, for them to be affordable to a particularly vulnerable, but large group of consumers.

While it is important to avoid a doctrinaire approach to the supremacy of markets, their role should not be underestimated. Further, market mechanisms work best when entry is open and abuse of market dominance prevented by careful and creative regulation. Regulators must recognize stakes of BOP users in robustly competitive wireless markets.

Market mechanism is ideally suited for allocation and pricing of frequencies for mobile telephony and data services, which have emerged as the largest single priority for BOP users. Given the massive demand for spectrum, it is important that allocation of spectrum be transparent and equitable. Auctions will be suitable in all cases where demand exceed supply.

For spectrum for emergency, safety and other public services for which service providers or governments would not be in a position to compete with commercial interests, the administrative approach should be adequate.

Advances in technology have made the licence exempt commons approach less prone to interference and more able to exploit unused spectrum in even those radio frequencies, which are allocated in a

property rights approach. Given the convenience and the possibility for innovation, especially among smaller players, progressively more spectrum should be made available to be used in the commons approach. Regulators will need to address legacy issues and define power output and other parameters to facilitate this.

Auctions offer a unique weapon to developing countries where the majority of BOP population lives. In an environment usually vitiated by frequent arbitrary and/or corrupt decisions, auctions offer a relatively simple way to protect BOP users as well as other stakeholders from their consequences.

However where auctions are most appropriate, as in the case of the all important mobile and data spectrum, only careful design can protect BOP users. The previous section lists several measures that can be implemented to reduce the risks to BOP users of an ill-conceived auction design.

Of particular importance is to ensure that spectrum regimes do not incur permanent or “in-perpetuity” rights to those authorized to use spectrum. Doing so will reduce future options in a sector where technology has frequently ‘changed the game’ for players as well as users. The goal should be to ensure maximum flexibility in the future while allowing sufficient comfort to current investors in wireless technologies. Such flexibility can also, ironically, be achieved if owners of spectrum are able to transfer it to others, much like owner can with real estate.

It is critical that spectrum is allowed to be used to maximum potential by governments, operators, vendors as well as users. This will require a speedy move towards spectrum sharing, spectrum trading to enable best use to be made of an especially precious resource. Regulators must insist on technology neutrality and service neutrality in their decisions to ensure spectrum resources are used optimally.

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