QUALCOMM Incorporated

5775 Morehouse Drive
www.qualcomm.com
San Diego, CA 92121-1714
(858) 587-1121

July 14th, 2004

Mr. Pradip Baijal
Chairman
Telecommunications Regulatory Authority of India
New Delhi
India

QUALCOMM Incorporated appreciates this opportunity to provide comments to the Telecommunications Regulatory Authority of India (TRAI) May 2004 Consultation Paper on Spectrum entitled, "*Efficient Utilization, Spectrum Allocation, and Spectrum Pricing,*" as the agency analyzes the broad range of issues involved in the allocation, assignment and award of spectrum for mobile services. We commend the TRAI for recognizing spectrum as a scarce national resource whose management is of utmost importance to India's advancement and economic growth.

QUALCOMM is the primary developer of Code Division Multiple Access (CDMA), the world's fastest growing wireless communications technology, which is used by wireless providers in India and more than 200 million subscribers worldwide. CDMA solutions are available for a number of communications applications, including mobile cellular, fixed wireless and satellite communications. QUALCOMM supports all members of the IMT-2000 family of standards that use CDMA, including both the CDMA Multi-Carrier (CDMA2000) and CDMA Direct Spread (WCDMA), which share a common underlying CDMA technology base. QUALCOMM has also developed a number of other technology solutions for wireless service providers including BREW®, QChat®, and QPoint™.

In order to satisfy the growth in consumer demand, help the Government fulfill its targeted goal of 100 million mobile subscribers by 2005, and ensure the economic and social well being of Indian citizens and businesses, the implementation of a fair and adequate spectrum allocation policy has become increasingly important. In this submission, QUALCOMM provides comments on a number of questions raised in the TRAI Consultation. We have not answered those questions which we feel are not applicable to either QUALCOMM's business interest or area of technical expertise.

Frequency Band Nomenclature:

When referring to different frequency band pairings discussed in the TRAI Consultation Paper, QUALCOMM uses the following terminology, principally the common names.

Frequency Band	Specific Band Pairing	Common Names
450 MHz	452.5-457.5 / 462.5-467.5 MHz	450 MHz
800 MHz	824-849 / 869-894 MHz	800 MHz or Cellular band
1700 MHz	1750-1780 / 1840-1870 MHz	Korean PCS band
1800 MHz	1710-1785 / 1805-1880 MHz	DCS band or DCS 1800
1900 MHz	1850-1910 / 1930-1990 MHz	PCS band or PCS 1900
2100 MHz	1920-1980 / 2110-2170 MHz	UMTS band

Chapter 2: Current Spectrum Availability and Requirement:

(i) Should the 450 MHz or any other band be utilised particularly to meet the spectrum requirement of service providers using CDMA technology?

Comments on the 450 MHz band:

QUALCOMM notes that there is commercially available CDMA2000 equipment from several vendors in the 450 MHz band but there are currently no dual-band 450 MHz and 800 MHz handsets available. This makes 450 MHz an expensive solution for existing CDMA operators and limits roaming opportunities. Also the amount of spectrum available at 450 MHz as specified in the CDMA2000 standard is slightly less than 2 x 5 MHz which would not enable all operators to receive sufficient spectrum in this band. However, there are advantages to utilizing the 450 MHz band for wireless systems. Radio waves propagate further at lower frequencies increasing the potential coverage area of base stations which would translate into fewer cell sites than at higher frequency bands. Thus QUALCOMM recommends that the 450 MHz band be considered as a complementary band for operators particularly in rural and hard to serve areas. This band should not be considered as a stand-alone solution that can meet the increasing spectrum needs of the CDMA operators.

Comments on the PCS 1900 MHz band:

As AUSPI/ABTO and CDMA operators have indicated, they would prefer to utilize 2 x 25 MHz of spectrum in the 800 MHz band. However, the regulatory agencies have determined that there is no additional spectrum available in this band. Thus, QUALCOMM urges the TRAI to recommend that paired spectrum from the PCS 1900 MHz band be made available to meet the urgent spectrum requirement of CDMA service providers in India. The economies of scale for infrastructure equipment in the PCS band and the availability of dual band 800/1900 MHz handsets make the PCS band preferable to any other frequency band option. The PCS frequency band pairing is used in more than 20 different countries around the world, as is evident from the multiple CDMA networks deployed globally (see Appendix 1 for a full listing) and it is included as a band identified by the ITU for IMT-2000. Using this band pairing to meet the spectrum needs for CDMA operators in India would enable the deployment of cost-effective networks thus keeping the cost of service affordable for consumers.

- As shown in Appendix 2, it is clear that in most countries where CDMA technology is used, the frequency allocation is either in 1) 800 MHz or 1900 MHz bands or 2) the 800 MHz and 1900 MHz bands with the exception of two operators in the Republic of Korea and certain countries utilizing CDMA at 450 MHz.
- As of June 2004, there were 31,951,040 CDMA subscribers utilizing the PCS 1900 MHz band, and over 132 million CDMA subscribers in the 800 MHz and PCS 1900 MHz bands combined.[1]
- More than 40 countries utilize CDMA in the 800 MHz and/or PCS 1900 MHz frequency (see Appendix 2), meaning dual band 800/1900 MHz phones can take advantage of international roaming.
- As of June 2004, 58 operators in 13 countries have CDMA networks operating in the PCS 1900 MHz band. Thirty of these networks utilize CDMA2000 3G technology (see Appendix 1).
- The ten most populated countries in the world have CDMA systems operating in either or both the 800 and 1900 MHz bands. Further, multi-band, multi-mode GSM/CDMA phones have been introduced into the markets that operate on 900/1800/1900 MHz for GSM and 800/1900 MHz for CDMA.
- Currently, there are 553 CDMA handset models operating in the 800 and/or 1900 MHz frequency bands supplied by a variety of vendors. All major equipment vendors supply infrastructure for the 800 MHz and/or PCS 1900 MHz band.

Comments on the DCS 1800 MHz band:

The DCS 1800 MHz band is not an appropriate frequency band for use by CDMA providers in India. If the Government of India were to require CDMA operators to utilize the DCS 1800 MHz band, it would be the only country to do so. We note that this band in Europe, China and elsewhere is currently reserved for GSM–based systems and is not used at all in North America. Because no CDMA equipment is currently available for operating in the DCS 1800 MHz band, CDMA operators would have to wait a few years before equipment would become available at a higher cost than commercially available equipment in the PCS 1900 MHz band. Additionally, it is not clear that dual band handsets would be developed because India would be the only country in the world utilizing both 800 MHz and DCS 1800 MHz for CDMA. Also, global roaming for CDMA in the DCS 1800 MHz band would be impossible as again India would be the only country in the world utilizing this allocation for CDMA.

Comments on the Korean PCS 1700 MHz Band:

The same applies for the Korean PCS band which has sometimes been confused with the DCS 1800 MHz band but is in fact different with a transmit-receive separation unique to

[1] All statistics in this section are from EMC Database, June 2004.

the Republic of Korea. In addition, operators in Korea either operate in the 800 MHz frequency band or Korea's 1700 MHz PCS band, not both as is under consideration in India. Assigning both 800 MHz and 1700 MHz to operators in India would be globally unique, making international roaming and economies of scale for the equipment unlikely. This would lead to a more costly proposition for Indian service providers placing them at an international competitive disadvantage. As an example, after seven years of this allocation in Republic of Korea, no dual-band 800 MHz and Korean PCS handsets have been developed.

General Comments on Spectrum Allocation:

Even as we support the 800 MHz and 1900 MHz bands for CDMA service providers in India, QUALCOMM believes that these specific allocations should not be marked for any particular technology. Any allocation for the mobile service should be technology and service neutral to encourage the use of state-of-the-art innovative and spectrally efficient technologies. This would also apply to the likely opening of the DCS 1800 MHz band for IMT-2000 technologies and services. However, in the allocation process, it is critical for the Government to recognize in which frequency bands commercial equipment is currently available so that operators can acquire affordable infrastructure and terminals in a required time frame to offer affordable and high quality services.

QUALCOMM's Spectrum Recommendation:

QUALCOMM's primary recommendation for spectrum allocation in India that could provide a near term solution for the dearth of spectrum available for CDMA operators and a medium term solution for any mobile operator and IMT-2000 technology is to allocate the following bands on a technology neutral basis to be shared as needed amongst the mobile operators in India:

1) 1710-1755 / 1805-1850 MHz
2) 1850-1910 / 1930-1990 MHz
3) 452.5-457.5 / 462.5-467.5 MHz

While this recommendation enables the deployment of various competing mobile technologies and services including IMT-2000, there is a need to account for a unique condition in India. QUALCOMM recognizes that the corDECT technology occupies the band 1880-1900 MHz, and cannot be easily moved in the near term. Thus corDECT could continue to be allowed to operate in this band until such time that the technology can be relocated to another band, eg.1910-1930 MHz, which has been recognized internationally for TDD technologies. This would still leave 2 x 40 MHz of spectrum in the PCS 1900 MHz band available for immediate use by mobile operators.

In conclusion to the question asked above, due to the lack of spectrum availability and limited roaming opportunities, the 450 MHz band should be allocated for mobile providers not as a substitute for but rather as a complement to the PCS 1900 MHz band.

In order to address the current spectrum disparity, the former Basic Service Operators should receive assignments as soon as possible from the PCS 1900 MHz band.

(iii) Whether IMT 2000 band should be expanded to cover whole or part of 1710 – 1785 MHz band paired with 1805 – 1880 MHz?

The ITU has already identified this band, also known as the DCS 1800 MHz band, for the introduction of IMT-2000 technologies and services. QUALCOMM supports the view that IMT-2000 technologies and services should be allowed in this band worldwide (including India).

(iv) Should IMT 2000 spectrum be considered as extension of 2G mobile services and be treated in the same manner as 2G or should it be considered separately and provided to operators only for providing IMT 2000 services?

Spectrum for IMT-2000 technologies and services should not be considered separately and provided to operators only for providing IMT-2000 services. Mobile operators should have the flexibility to transition their systems to offer IMT-2000 in their existing bands, yet also receive additional spectrum to expand their networks to offer advanced voice and data services. It is essential to recognize that there is not one particular frequency band that can be referred to as the only band suitable for IMT-2000 technologies and services. The ITU has identified several bands for IMT-2000 and outlined a variety of specific band pairings for IMT-2000 under ITU-R Recommendation M.1036-2.[2] In fact, all bands currently used by mobile providers in India (along with the PCS 1900 MHz band allocation proposed above) have been identified by the ITU in Radio Regulation Footnotes 5.388, 5.317A, and 5.384A for possible use by IMT-2000 systems. Thus it is inappropriate to identify one specific band for "IMT-2000" technologies and/or services.

QUALCOMM suggests that these frequency bands are not defined for specific services or technologies, such as 2G or 3G, but rather defined in a generic manner. In the United States for example, the Federal Communications Commission utilizes the term advanced wireless services when referring to the services which can be offered in the frequency bands authorized for use by commercial mobile systems. Advanced wireless services can be offered utilizing a variety of mobile technology systems, including TDMA, GSM, CDMA, CDMA2000, GSM/GPRS/EDGE, and WCDMA/HSDPA, or whatever may evolve in the marketplace provided that license conditions are complied with.

With technology and service neutral regulations as outlined under the Unified License Regime, operators can already decide to migrate to IMT-2000 systems in their existing bands and offer a variety of services not specific to 2G or 3G technologies. Currently, there are service providers in India utilizing CDMA2000 1X and EDGE technologies (both recognized IMT-2000 technologies by the ITU per Recommendation M.1457) in existing frequency bands to provide advanced services to their customers. Operators and regulators in Europe and China are considering the potential to deploy WCDMA

[2] Specific band pairings from ITU-R Recommendation M. 1036-2 can be found on page 8 of TRAI's Spectrum Consultation paper.

technology in the 900 and 1800 MHz frequency bands while in Region 2, WCDMA systems will be deployed in the 800 and 1900 MHz bands.[3] DoCoMo in Japan has indicated it will deploy WCDMA in the Japanese 800 MHz band (which is different from the cellular 800 MHz band with a higher band for mobile transmit).[4] These particular examples of existing and future IMT-2000 technology deployments in the 800 MHz, 900 MHz, 1800 MHz and 1900 MHz bands show that it is crucial not to stringently separate 2G and IMT-2000.

(v) Reorganisation of spot frequencies allotted to various service providers so as to ensure the availability of contiguous frequency band is desirable feature for efficient utilisation of spectrum. Please suggest the ways and means to achieve it.

QUALCOMM has provided inputs to TRAI in the past on potential solutions for the reorganization of spot frequencies in the 800 MHz frequency band. We recognize that this is a challenging problem to solve but we urge the Government to move towards contiguous spectrum allocations for operators for all the reasons outlined in the Consultation Paper. With such a reorganization, four mobile operators can obtain useful access to fourteen CDMA channels, in the present 20 MHz wide band (825-845 / 860-880 MHz).

(vi) Whether the band 1880 – 1900 MHz be made technology neutral for all BSOs / CMSPs / UASLs and be made available with the pair 1970 – 1990 MHz or should it be kept technology neutral but reserved for TDD operations only.

Per the PCS 1900 MHz frequency allocation, the band 1880-1900 MHz is paired with 1960-1980 MHz and not with 1970-1990 MHz as noted above. Also the band 1900-1910 MHz is paired with 1980-1990 MHz. QUALCOMM recommends that the band, 1880-1900 MHz be paired with 1960-1980 MHz, declared technology neutral and made available to service providers in India along with the bands noted above in Question (i) and whichever other bands deemed necessary by the Government of India. Continuing to keep the band 1880-1900 MHz reserved for TDD does not encourage the most efficient use of spectrum for Indian consumers; especially in this case where the spectrum is underutilized in many urban areas.

As noted in the Consultation, the band segment 1880-1900 MHz has been dedicated in India for micro-cellular systems using TDD technology, and operators have largely deployed the indigenous CorDECT TDD technology. So, whether or not the band could be used for mobile services including IMT-2000 depends on two factors:

(a) where, geographically, the TDD CorDECT technology is deployed, eg in rural or urban environments, and

[3] Lucent Press Release, "Cingular Wireless selects Lucent Technologies for 3G UMTS trial network in t Atlanta," May 26, 2004.
[4] "Telecom Council Reports on Technology to Improve Transfer Rates of W-CDMA," NEAsia Online, May 27, 2004 (TOKYO) http://neasia.nikkeibp.com/wcs/leaf/CID/onair/asabt/news/309853

(b) if the CorDECT systems could be relocated to an ITU band designated for TDD systems, eg 1910-1930 MHz.

If in (a) the TDD service is used primarily in rural areas where the capacity need is low, then the 1880-1900 MHz band could possibly be shared by TDD and FDD technologies for considerable time.

Then for (b), if the TDD corDECT system could be relocated to within the 1910-1930 MHz band in urban regions, this would enable the full use of the PCS 1900 MHz FDD bands for mobile technologies and services.

QUALCOMM encourages the Government of India to consider whether the prospects for developing a viable market for wireless applications in the 1880-1900 MHz band currently allocated for "WLL TDD based on indigenous technology," would be better served by introducing a technology and service neutral approach with a corresponding ITU FDD band pairing. This would enable access to more spectrum for operators and encourage the provision of a wider variety of services to citizens of India.

Chapter 3 Technical Efficiency of Spectrum Utilization:

(vii) Please offer your comments on the methodology outlined in this Chapter for determining the efficient utilisation of spectrum. Also provide your comments, if any, on the assumptions made.

As requested, QUALCOMM offers some general comments on the methodology and assumptions outlined in this Chapter for determining the efficient utilization of spectrum. While we believe that the methodology based on ITU-R M.1390 can be useful when estimating the total amount of spectrum required for new technologies, it is not suitable for calculating specific operators' spectrum needs. It is our view that there is no basis for the regulator to attempt to estimate the efficiency of established technologies such as CDMA and GSM in order to allocate spectrum. Due to the varying nature of assumptions and the ever changing character of mobile network technologies and their enhancements, an agreement on a common methodology to utilize for both technologies would be difficult, if not impossible, to attain. The Government should instead work to establish a level playing field that will enable operators to compete on an equal basis with the freedom to leverage the strengths of their chosen technologies and services to their full potential. If operators are running out of capacity despite having well-deployed, well-performing networks, then there should be the opportunity to acquire additional spectrum.

If the Government needs a method of determining whether or not a network is running well, it could use a benchmark comparison on the performances of other networks around the world. There are many examples of well performing networks with more than 1.5 billion mobile subscribers globally. In the case of CDMA, for example, TRAI uses the benchmark of 25 Erlangs/Carrier/Sector to denote a well functioning network (Section 3.2.3.8). However even well-performing networks have varying benchmark data; for example as noted in Section 3.2.2.6, GSM networks in Europe can vary from 8.35 Erlangs/MHz/km^2 to in excess of 100 Erlangs/MHz/km^2. Thus we suggest TRAI focus on implementing policies which make spectrum available to operators on a fair and equal basis while at the same time creating incentives to ensure the spectrum is utilized. This will enable the market to decide which technology is deployed to provide high quality mobile voice and data services.

Comments on the Definitions:

- In Figure 3.1, the "spectral efficiency concept" would appear to be upside down. This figure shows that network quality improves as the network load is increased, which is not the case in reality. In any network, one should expect the network quality to degrade as the network load is increased.
- In Section 3.2.2, the terminology relates to GSM networks only. CDMA networks use both similar and different terms which should be included. For example, Broadcast Control Channel in a GSM network corresponds to a pilot channel in a CDMA network. In CDMA systems, a "cell" usually refers to the entire base station or site. The term "sector" always refers to the area covered by a set of transmitting and receiving antennas. Thus a 3-sectored cell in a CDMA network corresponds to 3 cell sites in a GSM network. Each sector in a CDMA network is assigned a different Pilot sequence (out of a possible 512).

Comments on the Methodology:

To prevent misunderstanding of the process, it would be helpful in there were a brief but complete description of the end-to-end methodology at the beginning of Chapter 3. As it stands, Chapter 3 discusses spectrum efficiency factors but does not clearly state their purpose.

The examples presented for GSM and CDMA are not comparable since the GSM discussion uses a theoretical method while the CDMA discussion is based on practical data. As long as they are used as examples for calculations, and not used as final values, QUALCOMM does not have major objections to the process. However, since these results may effect how spectrum is allocated, the values must be compared to practical performance no matter how the spectrum efficiency factor is derived. Chapter 3 concentrates on a particular measure of spectral efficiency, Spectrum Utilization Efficiency (SUE), expressed in units of Erlangs/MHz/km^2. As noted by TRAI, while SUE may be useful in demonstrating how much traffic can be supported in a given region using a given bandwidth, it completely ignores the cost of doing so. The cost factor, which is a direct function of packing density, is critically important when considering how to allocate spectrum. We also note that the SUE which is extensively described in the Chapter does not appear in Annexure B.

When analyzing network performance, other measures of spectral efficiency should be considered as well. As noted above, QUALCOMM believes that there is no one metric that should, or even can, be used to allocate spectrum. This is especially true when there are two fundamentally different technologies competing for spectrum. In the development of global standards, one common metric used to define spectral efficiency for voice is based on the amount of voice traffic that can be carried in a given bandwidth in a given cell (sector). This metric utilizes units of Erlangs/MHz and is a pure technology comparison. This allows competing approaches to be evaluated and is a good metric to use when evolving a given technology towards greater efficiency. When standards bodies develop their official documents, they are not usually permitted to consider cost, but can consider complexity. The goal is to maximize performance using "available" technology. There are other metrics used to quantify the efficiency of data networks such as maximum user data rate, typical user data rate and sector throughput, expressed on a carrier or per MHz basis.

Experience has shown that it is impossible to anticipate all the advances in technology that continue to increase these various measures of efficiency. The one metric that could perhaps be appropriate in allocating spectrum, if it could be made reliable, would be something akin to a Spectrum Utilization Cost. The units in this case would be Erlangs/MHz/km^2/Rupee. Such a metric would allow the Government to trade off the cost of spectrum versus the cost of deployment which is one of the goals stated in the TRAI Consultation. QUALCOMM ultimately believes that given the inability of various metrics to determine the spectral efficiencies of competing technologies, the TRAI should establish a level playing field and rely upon market forces to ensure operators use spectrum as efficiently as possible.

Comments on the Assumptions:

- In Paragraph 3.2.2.3, the calculation of the minimum spectrum requirement for hierarchical networks in GSM uses a different set of assumptions than those used to estimate spectral efficiency, notably in the frequency reuse factors of the macro and micro cell layers. It would better if all assumptions were consistent.
- A much higher fraction of microcells should be considered for GSM.
- With respect to the spectrum efficiency factor computed for CDMA, QUALCOMM notes that the assumed capacity of 25 Erlangs/Carrier/Sector will decrease as the packing density increases. There is no real empirical data on this effect, but it is estimated that that the Erlang capacity per sector could decrease as much as a factor of 2 when the packing density reaches 5 cells/km^2. The reason is that as intercell distance is reduced, intercell interference stops decreasing as a 4th power of distance, and starts decreasing only as a second power of distance (i.e. as in free space loss). The entire concept of cellular operation assumes that power from neighboring cells is less than that expected from free space loss.
- In 3.2.2.1.2, 6 MHz is assumed for 4 carriers which is not correct; with guardbands, 5.5 MHz is required for 4 carriers. This is a minor point, but it does illustrate how these assumptions can affect the SUE. In this case alone, the difference is about 10%.

Comments on the Process:

In summary, QUALCOMM would like to reiterate that we do not recommend using the technique based on ITU-R M.1390 as described in TRAI's Consultation to allocate spectrum for mobile operators in India. The concept cannot keep pace with the enhancements continually being made to mobile networks, and the fundamental differences between CDMA and GSM technologies prevent a side-by-side comparison. It is unlikely that interested parties could ever reach agreement on the Spectrum Utilization Efficiency concept. Rather than expend additional time on this exercise, we recommend the Government take immediate steps to allocate additional spectrum for mobile operators to be in line with international practice so that they may grow their networks to meet the required demand. This will allow market forces to decide which technologies are deployed.

(viii) Please provide your perception of the likely use of data services on cellular mobile systems and its likely impact on the required spectrum including the timeframe when such requirements would develop?

QUALCOMM believes that data services over cellular mobile systems in India will be used extensively due to the importance the Government is placing on broadband access and because the number of mobile phones in India is set to exceed the number of landlines in 2004.[5] Third generation mobile systems can provide data rates equivalent to those achieved in DSL and cable networks. Therefore it is certain that operators will need additional spectrum beyond that required for voice capacity in order to offer high-quality and competitive broadband data access.

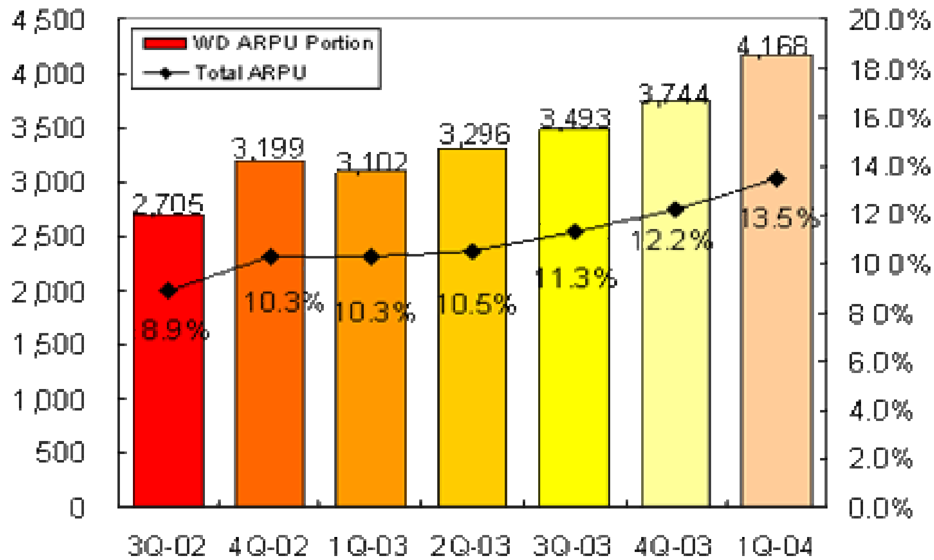
As an example, nowhere has data usage on cellular networks been as prevalent as it has in the Republic of Korea, an advanced marketplace for telecommunications with 75% mobile wireless penetration utilizing state-of-the-art CDMA technology. In the years from 2001-2003, one Korean operator noted that its revenue from wireless Internet services over CDMA2000 has grown by 505 percent while its revenue based on SMS has remained flat.[6] The average revenue per user from wireless data as a percentage of total revenue has also steadily grown and accounts for up to 17% of total revenue in the case of one operator.[7] Chart 1 below depicts the growth of wireless data revenue in the Korean market.

Popular wireless data content and applications available on CDMA2000 networks in Korea include video messaging and monitoring of people and assets, video (news/TV) on demand, recording and sending of video clips, multi-media messaging, broadband Internet access for companies, residents and public entities, interactive gaming, live music downloads (songs and videos), and interactive map and location based services. Wireless data services can also be used in a number of other applications such as the provision of emergency services, ATM connectivity, and Internet access in a variety of places like railways, schools and hospitals where people could be diagnosed remotely. Indeed CDMA2000 operators in India have begun to offer an array of innovative multimedia services such as live TV streams. Mobile operators in Korea have a minimum of 2 x 30 MHz of spectrum and up to 2 x 45 MHz of spectrum.

---

[5] Ministry of Communications & Information Technology Press Release, 7/02/04 and TRAI Quarterly Statistics, June 2004.
[6] KT Freetel, Based on Operators' Monthly Fact Sheet.
[7] SK Telecom. As of May, 2004: Based on Operators' Monthly Fact Sheet.

Chart 1: Wireless Data Average Revenue per User (WD ARPU): KT Freetel Korea



Source: KTF's Monthly Fact Sheet (June 2004); Units: Korean Won

A number of wireless carriers with CDMA networks around the world are now deploying a CDMA2000 wireless broadband technology referred to as CDMA2000 1xEV-DO[8]. Revision 0 of this technology delivers data at peak rates of 2.4 megabits per second and at average rates of 300-600 kilobits per second. Verizon Wireless in the United States has deployed EV-DO technology[9] on their licensed spectrum throughout Washington, DC and San Diego, California and will be deploying it nationwide over the next two years. SprintPCS in the United States has also announced it will deploy EV-DO technology nationwide in the 1900 MHz PCS band. CDMA2000 1xEV-DO technology has also been deployed in Korea, Japan, Guatemala, Brazil, and Bermuda and additional deployments are under way in Ecuador, Brazil, Indonesia, Israel, Taiwan, and in the United States. Trials are ongoing in India. Today, over 7.7 million people use EV-DO technology for wireless broadband Internet service and the number of subscribers is growing at an ever-increasing pace each day.[10]

The 3GPP2 standards body has developed enhancements to this technology as specified in CDMA2000 1xEV-DO Revision A. Revision A features increased data rates with peak upload speeds of 1.8 megabits per second and peak download speeds of 3.1 megabits per second. Hardware for this technology will be available in mid-2005 and is backwards compatible with existing CDMA2000 1X technology already deployed by many operators in India (i.e. Reliance Infocomm, TataTeleservices, MTNL, Shyam Telelink)

[8] CDMA2000 1xEV-DO, or CDMA2000 1xEvolution-Data Optimized is often referred to as EV-DO. 3GPP2 has standardized both Revision 0 and Revision A of this technology as IS-856. In addition all versions of CDMA2000 are recognized by the ITU as IMT-2000 technologies in ITU-R M.1457.
[9] All deployments of CDMA2000 1xEV-DO to date are Revision 0.
[10] As of June 2004, www.3gtoday.com. This number only represents the number of reported EV-DO subscribers.

and by others around the world. Revision A is also backwards compatible with Revision 0 of EV-DO technology.

Most operators with legacy GSM networks have chosen Wideband CDMA (WCDMA) as their path to 3G CDMA. These operators (and even some without any legacy networks) are beginning to offer high-speed, high quality wireless broadband service over licensed spectrum using the WCDMA path. WCDMA technology enables users to send and receive data at peak rates of 384 kilobits per second. More than 6 million people have subscribed to WCDMA networks.[11] High-speed downlink packet access "HSPDA" is the most notable enhancement to WCDMA, which was standardized by 3GPP in Release 5 of WCDMA. HSDPA will enable users to transmit and receive data at high peak rates upwards of 2.4 megabits per second.

Chapter 5 Spectrum Allocation:

(xviii) How much minimum spectrum (refer approach (I) and (II)) in section 5.4) should each existing operator be provided? Give the basis for your comments.

QUALCOMM encourages TRAI to follow Approach II as described in section 5.4 of the Consultation. In order to ensure level playing field and to ensure the Government of India's teledensity goals, all mobile service providers in India should initially have access to a minimum amount of 2 x 10 MHz of spectrum.

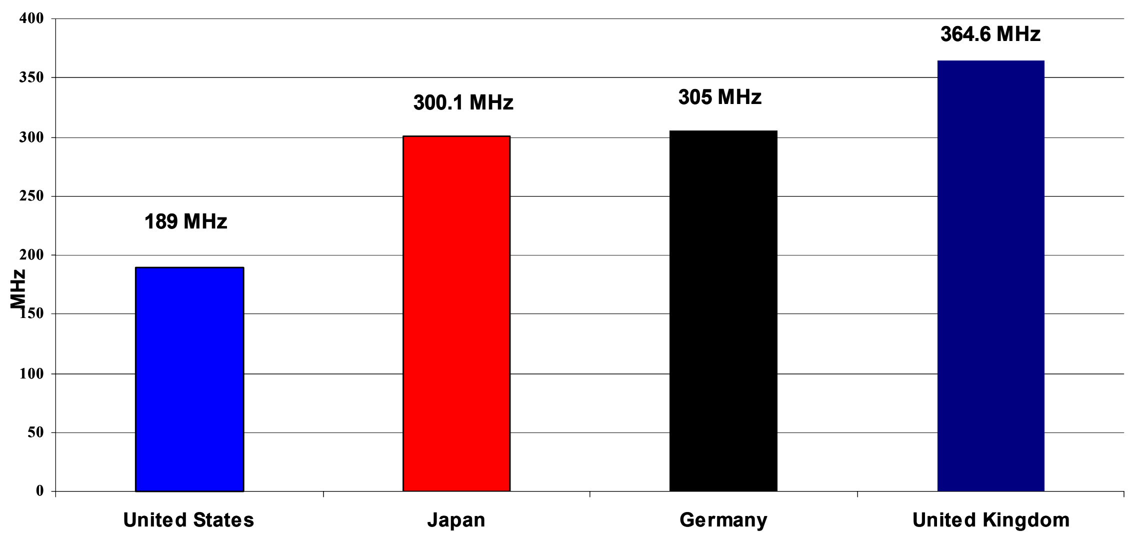
Approach II not only ensures a transparent and level playing field but would eliminate the case-by-case approach based on the different sets of criteria currently used in India which is subjective and inconsistent with technology neutrality. Access to an initial 2 x 10 MHz of spectrum is also critical for operators to have a reliable network plan which impacts the quality and efficiency of the network. Efficient networks keep the overall network cost per subscriber down and enable service providers to offer more affordable services to a greater portion of the public. Insufficient spectrum hampers operators' development of long term business plans and network investments, which in turn directly impacts shareholder confidence and interest in the wireless industry. Further, the large investment in backhaul and business support systems is underutilized if operators are not awarded a minimum of 2 x 10 MHz to expand their networks to meet the potential growth in their subscriber base.

As noted in Annex A of the TRAI Consultation, international practice has been to make at least 2 x 10 MHz or more spectrum available to service providers. Appendix 1 lists CDMA operators utilizing the 800 and 1900 MHz frequency bands around the world. These operators have all been licensed a minimum of 2 x 10 MHz of spectrum. As the allocation currently stands in India, the amount of spectrum reserved for CDMA operators (up to 2 x 5 MHz each) is inadequate to support even the minimum voice-only capacity projections for the next two years. As noted above, we believe the market for wireless data in India is significant and must also be accounted for.

[11] As of June 2004, www.3gtoday.com.

Ideally, operators should be assigned larger blocks of spectrum, at least 2 x 15 MHz or 2 x 20 MHz, if the total availability of spectrum permits. Larger blocks of spectrum provide an operator with increased flexibility for the provision of services and permit the operator to better meet the needs of its subscribers. As indicated on page 15 of the TRAI Consultation, the Government of India has *allocated* a total of 106.8-136.8 MHz (including uplink and downlink) of spectrum for commercial wireless services. This is a step behind countries such as the United States, the United Kingdom, Germany and Japan who have already *licensed* between 189 MHz -364.6 MHz of spectrum for commercial mobile services. It is important that the Government of India make additional spectrum available for commercial service providers as soon as possible in order to be aligned with international practice and facilitate the growth in wireless subscribers expected by 2005.

Chart 2: Total Licensed Spectrum for Commercial Mobile Services



Source: CTIA Presentation, Brussels Belgium, April 2004.
**Note that the US has issued service rules on 90 MHz of additional spectrum for advanced wireless services not reflected here. The 1710-1755 MHz / 2110-2155 MHz band will be licensed by the FCC in the next few years.

Approach number 1 recommends freezing the allocation of existing levels except those where license conditions warrant further allocation. This approach has serious flaws including the fact that it is not technology neutral as envisioned by the Unified License because the current spectrum allocation for CDMA operators in India varies from 2 x 2.5 MHz to 2 x 5 MHz compared with 2 x 4.4 MHz to 2 x 10 MHz for GSM operators. The amount of spectrum assigned should be independent of the technology chosen by the operator and the same regulatory environment should apply equally to all mobile service providers ensuring that their success or failure depends solely on marketplace factors. Thus, it is imperative that CDMA operators have access to the same amount of spectrum as GSM operators on an equal basis provided that similar regulatory conditions are adopted.

(xx) Should spectrum be allocated in a service and technology neutral manner?

We strongly agree that spectrum should be allocated in a service and technology neutral manner as envisioned by the Unified License. Enabling operators to choose which technology(ies) to use and which services to provide over their spectrum brings countries a number of substantial social and economic benefits. Service and technology neutrality is of the utmost importance to allow for the development of innovative applications, more efficient technologies, consumer choice, lower prices, and competition. An important part of technology neutrality as it pertains to spectrum allocation is licensing frequency bands that encourage multiple technology standards to compete.

(xxi) What should be the amount of cap on the spectrum assigned to each operator?

Given that operators currently have such insufficient spectrum with such a high level of competition, the spectrum cap should be set fairly high; for example, at 2 x 20 MHz, in order to prevent anticompetitive behavior. Besides promoting competition in the provision of mobile services, the purpose of a spectrum cap is to allow the efficient administration of mobile service spectrum acquisitions and provide regulatory certainty to the marketplace. QUALCOMM notes that several countries including the United States have determined sufficient competition exists in the mobile marketplace, making a spectrum cap no longer necessary or in the public interest. These countries instead rely on rules which facilitate the recovery of spectrum should it remain unused after definite time periods, as specified in the license conditions.

(xxii) What procedure for spectrum allocation be adopted for areas where there is no scarcity and in areas where there is scarcity?

QUALCOMM is of the opinion that each procedural method for spectrum allocation has its benefits and drawbacks. We believe the TRAI should utilize a method designed with the intent to promote competition, encourage the efficient use of spectrum, and to increase access to voice and data services keeping in mind the cost of providing the service. Most importantly, the procedure must provide a fair opportunity for service providers to acquire the appropriate spectrum to meet the needs of their customers and serve the public. QUALCOMM does not comment further on the methods of spectrum allocation.

(xxv) Comments of stakeholders are invited on the minimum blocks such as 2 X 2.5 MHz / 2 X 5 MHz of additional spectrum to be allocated to existing service providers in situations where IMT 2000 band is opened as well as in situation where it is not opened. Additionally, comments are also invited on the minimum allocation to new entrants.

Keeping in mind the objectives of the Unified License regime to be technology and service neutral, we suggest that every effort be made to allocate additional spectrum for existing operators in minimum blocks of 2 x 5 MHz. Larger blocks of contiguous spectrum provide operators with additional capacity, the ability to plan for long-term growth and greater flexibility to offer a variety of voice and data services. International practice tends to support the allocation of paired spectrum blocks of 2 x 5 MHz, 2 x 10 MHz and 2 x 15 MHz.

Chapter 6 Re-farming, Spectrum Trading, M&A and Surrender:

(xxxii) Should we open up the spectrum market for spectrum trading? If yes, what should be the time frame for doing so?

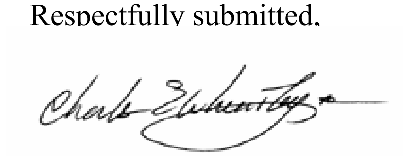
QUALCOMM has been an active proponent of spectrum trading in many countries around the world. We believe that spectrum trading and secondary markets, especially in conjunction with a liberal technology neutral spectrum policy encourage a more efficient use of spectrum and bring substantial benefits to citizens ensuring that spectrum is used in the best manner possible to deploy innovative services of great social and economic benefit. For example, spectrum trading has the potential to increase broadband access by facilitating the entry of new wireless broadband solutions that can provide a variety of commercial and non-commercial applications to consumers including e-learning, e-health, and e-government. Spectrum trading provides enhanced flexibility to all those involved in spectrum use, including operators and equipment manufacturers, and would help increase investment in the IT sector and potentially attract new sources of investment in Research and Development. Ultimately though, all benefits resulting from the introduction of spectrum trading should directly or indirectly benefit consumers.

QUALCOMM recommends that TRAI seriously consider the implementation of spectrum trading and the benefits it can bring the country especially in situations where spectrum is in high demand. With respect to the appropriate time frame for implementing spectrum trading, QUALCOMM recommends that the TRAI maintain its immediate focus of making more spectrum available for mobile operators in order to satisfy the growing demand for wireless services in India and eliminate the disparity of assigned spectrum among operators which is now dependent upon the wireless technology they use. We propose that TRAI initiate a separate proceeding on spectrum trading in which we would welcome the opportunity to provide additional comments.

Conclusion:

In conclusion, QUALCOMM would like to thank the Telecommunications Regulatory Authority of India for letting us provide our views on a variety of issues pertaining to the allocation and efficient use of spectrum. Kindly contact me at chuckw@qualcomm.com or at 858-658-4419 (direct) with any questions, or if QUALCOMM can be of further assistance.

Respectfully submitted,



Dr. Charles E. Wheatley
Executive Vice President, Technology
QUALCOMM Incorporated

Appendix 1: CDMA Operators Utilizing PCS 1900 MHz

Country	Operator	Freq	Technology
Angola Telecom	Angola	1900	IS95-A
Argentina	CTI	1900	IS95-A
Argentina	Movicom BellSouth Argentina	1900	CDMA2000
Brazil	Vesper	1900	CDMA2000
Canada	Bell Mobility	1900	CDMA2000
Canada	Manitoba Telecom Services (MTS)	1900	CDMA2000
Chile	BellSouth Chile	1900	CDMA2000
Chile	Smartcom PCS	1900	CDMA2000
Colombia	EPM Bogota	1900	CDMA2000
Democratic Republic of Congo	African Telecommunications Inc. (AfriTel, Intercel Holdings)	1900	IS95-A
Dominican Republic	Centennial D.R.	1900	CDMA2000
Dominican Republic	TRICOM	1900	IS95-A
Dominican Republic	Verizon Dominicana	1900	CDMA2000
Guatemala	BellSouth Guatemala (Comunicaciones Personal)	1900	CDMA2000
Guatemala	PCS Digital (Sercom)	1900	CDMA2000
Guatemala	Telefonica Centroamerica Guatemala (Telefonica MoviStar)	1900	CDMA2000
Haiti	Haitel	1900	IS95-A
Mexico		1900	CDMA2000
Mexico	Telefonica Moviles	1900	IS95-A
Mexico	Unefon	1900	IS95-A
Nigeria	Starcomms Limited	1900	CDMA2000
Nigeria	Boudex	1900	CDMA2000
Nigeria	Multi-Links Telecommunications Ltd	1900	CDMA2000
Nigeria	RelTel	1900	CDMA2000
Pakistan	TeleCard Limited	1900	CDMA2000
Puerto Rico	Centennial P.R.	1900	CDMA2000
Puerto Rico	Sprint Puerto Rico	1900	CDMA2000
Puerto Rico	Verizon Wireless	1900	CDMA2000
Puerto Rico	Telefonica Movistar Puerto Rico	1900	IS95-A
United States	3 Rivers Wireless	1900	IS95-A
United States	Alaska DigiTel	1900	IS95-A
United States	Alltel	1900	CDMA2000
United States	Blackfoot Comm.	1900	IS95-A
United States	Cellcom	1900	IS95-A
United States	Cellular South	1900	CDMA2000
United States	Centennial Wireless	1900	IS95-A
United States	ClearTalk	1900	IS95-A
United States	CMS St. Cloud	1900	IS95-A
United States	Comscape (Kiwi PCS)	1900	CDMA2000
United States	Leap Wireless	1900	CDMA2000
United States	Nebraska Wireless Telephone	1900	IS95-A

	Company		
United States	NorthCoast PCS	1900	IS95-A
United States	NTELOS	1900	CDMA2000
United States	Penasco Valley Telecom	1900	IS95-A
United States	Pine Belt Telephone & Wireless	1900	IS95-A
United States	PYXIS Communications	1900	IS95-A
United States	Qwest	1900	IS95-A
United States	Rural Cellular Corporation	1900	CDMA2000
United States	Snake River PCS	1900	IS95-A
United States	Souris River Telephone	1900	IS95-A
United States	South Central Utah	1900	IS95-A
United States	Sprint PCS	1900	CDMA2000
United States	UBTA	1900	IS95-A
United States	US Cellular	1900	CDMA2000
United States	Verizon Wireless	1900	CDMA2000
United States	Wireless North	1900	IS95-A
United States Virgin Islands	Centennial	1900	IS95-A
United States Virgin Islands	Sprint US Virgin Islands	1900	CDMA2000
Uruguay	BellSouth Uruguay (Movicom)	1900	IS95-A

Source: EMC Database, 2004.

Appendix 2: CDMA Operators Utilizing 800 and PCS 1900 MHz

Country	Operator	Freq	Technology
Angola Telecom	Angola	1900	IS95-A
Argentina	CTI	800, 1900	IS95-A
Argentina	Movicom BellSouth Argentina	1900	CDMA2000
Australia	AAPT	800	CDMA2000
Australia	Hutchison Telecom	800	IS95-A
Australia	Telstra	800	CDMA2000
Azerbaijan	Caspian American Telecom LLC	800	CDMA2000
Bangladesh	Pacific Bangledesh Telecom Ltd. (CityCell Digital)	800	IS95-A
Bermuda	Bermuda Digital Communications	800	CDMA2000
Brazil	Tmais	1900	CDMA2000
Brazil	Vesper	1900	CDMA2000
Brazil	VIVO	800	CDMA2000
Canada	Aliant Telecom Mobility	800	CDMA2000
Canada	Bell Mobility	800, 1900	CDMA2000
Canada	Manitoba Telecom Services (MTS)	1900	CDMA2000
Canada	SaskTel Mobility	800	CDMA2000
Canada	Telus/Clearnet	800	CDMA2000
Chile	BellSouth Chile	1900	CDMA2000
Chile	Smartcom PCS	1900	CDMA2000
China	China Unicom	800	CDMA2000
Columbia	BellSouth Columbia	1900	CDMA2000
Colombia	EPM Bogota	1900	CDMA2000
Democratic Republic of Congo	African Telecommunications Inc. (AfriTel, Intercel Holdings)	800, 1900	IS95-A
Democratic Republic of Congo	Telecel International	800	IS95-A
Dniester Moldavian Republic (formerly Moldova)	JSC Interdnestrcom	800	CDMA2000
Dominican Republic	Centennial D.R.	1900	CDMA2000
Dominican Republic	TRICOM		IS95-A
Dominican Republic	Verizon Dominicana	1900	CDMA2000
Ecuador	BellSouth Ecuador	800	CDMA2000
Ecuador	Telecsa	1900	CDMA2000
El Salvador	Telefonica Moviles El Salvador (Telefonica MoviStar)	800	IS95-A
Fiji	Telecom Fiji (EasyTel)	800	IS95-A
Guam	Guamcell	800	IS95-A

Guatemala	BellSouth Guatemala (Comunicaciones Personal)	1900	CDMA2000
Guatemala	PCS Digital (Sercom)	1900	CDMA2000
Guatemala	Telefonica Centroamerica Guatemala (Telefonica MoviStar)	1900	CDMA2000
Haiti	Haitel	1900	IS95-A
Honduras	Celtel	800	IS95-A
Hong Kong	Hutchison Telecom	800	IS95-B
India	BSNL	800	CDMA2000
India	HFCL	800	IS95-A
India	MTNL	800	CDMA2000
India	Reliance	800	CDMA2000
India	Shyam Telelink Limited	800	CDMA2000
India	Tata Teleservices	800	CDMA2000
Indonesia	PT Mobile 8 Telecom	800	CDMA2000
Indonesia	PT Radio Telepon Indonesia (Bakrie Telecom)	800	CDMA2000
Indonesia	PT Telekomunikasi Indonesia (TELKOMFlexi)	800	CDMA2000
Israel	Pelephone	800	CDMA2000
Japan	KDDI	800	CDMA2000
Jamaica	Oceanic Digital Jamaica	800	CDMA2000
Kazakhstan	JSC ALTEL (DALACOM)	800	CDMA2000
Kyrgystan	AkTel LLC (FONEX)	800	CDMA2000
Malaysia	Telekom Malaysia	800	IS95-A
Mauritius	Telecel International (Mauritius)	800	IS95-A
Mexico	Iusacell	800	CDMA2000
Mexico	Telefonica Moviles	800, 1900	IS95-A
Mexico	Unefon	1900	IS95-A
Mongolia	Movicom	800	IS95-A
Mongolia	Skytel	800	IS95-A
Myanmar	Myanmar P&T	800	IS95-A
New Zealand	Telecom New Zealand	800	CDMA2000
Nigeria	Boudex	1900	CDMA2000
Nigeria	Cellcom	800	CDMA2000
Nigeria	Intercellular	800	CDMA2000
Nigeria	Multi-Links Telecomm Ltd.	1900	CDMA2000
Nigeria	Reliance Telecomm. (RelTel)	1900	CDMA2000
Nigeria	Starcomms Limited	1900	CDMA2000
Pakistan	TeleCard Limited	1900	CDMA2000
Panama	BellSouth Panama	800	CDMA2000
Peru	BellSouthPeru	800	CDMA2000
Peru	Telefonica Moviles Peru	800	CDMA2000
Puerto Rico	Centennial P.R.	1900	CDMA2000
Puerto Rico	Sprint Puerto Rico	1900	CDMA2000
Puerto Rico	Telefonica Movistar Puerto Rico	1900	IS95-A
Puerto Rico	Verizon Wireless	1900	CDMA2000
Russia	JSC Bashinformsvyaz	800	IS95-A

Russia	JSC Chelyabinsk Svyazinform	800	IS95-A
Russia	JSC Electrosvyaz Primorsk Kkraya	800	IS95-A
Russia	JSC Elikson	800	IS95-A
Russia	JSC FOR A	800	IS95-A
Russia	JSC Ivtelecom	800	IS95-A
Russia	JSC Codotel	800	IS95-A
Russia	JSC Kubtelecom	800	IS95-A
Russia	JSC Metrotel Kazan	800	IS95-A
Russia	JSC Orskintersvyaz	800	IS95-A
Russia	JSC Peoples Telephone Saratov	800	IS95-A
Russia	JSC Personal Communication (Pcomm)	800	IS95-A
Russia	JSC Petrosvayz	800	IS95-A
Russia	JSC Rostov-on-Don Electrosvyaz	800	IS95-A
Russia	JSC RusSDO	800	IS95-A
Russia	JSC Severo osetin Electrosvyaz	800	IS95-A
Russia	JSC Tumen Telecom	800	IS95-A
Russia	Metrosvyaz	800	IS95-A
Russia	Personal Communication (Pcomm)	800	IS95-A
Russia	Sibchallenge Ltd.	800	IS95-A
South Korea	SK Telecom	800	CDMA2000
Taiwan	APBW	800	CDMA2000
Thailand	Hutchison (CAT)	800	CDMA2000
United States	3 Rivers Wireless	1900	IS95-A
United States	Alaska DigiTel	1900	IS95-A
United States	Alltel	800, 1900	CDMA2000
United States	Blackfoot Comm.	1900	IS95-A
United States	Cellcom	1900	IS95-A
United States	Cellular South	800, 1900	CDMA2000
United States	Centennial Wireless	1900	IS95-A
United States	ClearTalk	1900	IS95-A
United States	CMS St. Cloud	800, 1900	IS95-A
United States	Comscape (Kiwi PCS)	1900	CDMA2000
United States	First Cellular of Southern Illinois	800	IS95-A
United States	Leap Wireless	1900	CDMA2000
United States	Metro PCS	1900	CDMA2000
United States	Midwest Wireless	800	CDMA2000
United States	Nebraska Wireless Telephone Company	1900	IS95-A
United States	NorthCoast PCS	1900	IS95-A
United States	NTELOS	1900	CDMA2000
United States	Penasco Valley Telecom	1900	IS95-A
United States	Pine Belt Telephone & Wireless	800, 1900	IS95-A
United States	PYXIS Communications	1900	IS95-A
United States	Qwest	1900	IS95-A
United States	Rural Cellular Corporation	800, 1900	CDMA2000
United States	Sagebrush Cellular	800	CDMA2000
United States	Snake River PCS	1900	IS95-A

United States	Souris River Telephone	1900	IS95-A
United States	South Central Utah	1900	IS95-A
United States	Sprint PCS	1900	CDMA2000
United States	UBTA	1900	IS95-A
United States	US Cellular	800, 1900	CDMA2000
United States	Verizon Wireless	800, 1900	CDMA2000
United States	Western Wireless	800	CDMA2000
United States	Wireless North	1900	IS95-A
United States Virgin Islands	Centennial	1900	IS95-A
United States Virgin Islands	Sprint US Virgin Islands	1900	CDMA2000
Uruguay	BellSouth Uruguay (Movicom)	1900	IS95-A
Venezuela	Movilnet (CanTV)	850	CDMA2000
Venezuela	Telcel	800	CDMA2000
Vietnam	Saigon Postel (S-Telecom)	800	CDMA2000
Yemen	Public Telecommunications	800	IS95-A
Zambia	Telecel International	800	IS95-A

Source: EMC Database, 2004.