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?

The present inadequacy of the spectrum in 800 MHz frequency band for CDMA operators has been clearly brought out in the consultation paper which states " there is no path available for provisioning more than the currently allocated/ committed amount of 2x5 MHz to four service providers". We would like to point out that even 5 MHz is not available for allocation and only 14 carriers are available which is totally inadequate to meet even the current needs of CDMA operators, let alone the future requirements. We need initially at least 10+10 MHz progressively increasing to 20+20 MHz with an average of 15+15 MHz.

The consultation paper mentions in Para 5.4 regarding allocation of spectrum to service providers " For allocating spectrum to the existing service providers, it is imperative to keep in mind the availability of equipment in the bands proposed to be allocated so as to take advantage of the economies of scale"

Keeping this in view and considering the availability of handsets and equipments, we would recommend the utilization of North American PCS band viz 1850-1910 MHz paired with 1930-1990 MHz in India. The PCS frequency band pairing is used in many countries as shown in Appendix 1. The reasons why other frequency bands cannot be used for CDMA operations are enumerated below:

It is to be noted that

?? It can be seen from Appendix 2, CDMA technology uses in all countries except Korea the frequency bands either in 1) 800 MHz or PCS 1900 MHz bands or 2) the 800 MHz and PCS 1900 MHz bands and certain countries utilizing CDMA at 450 MHz.

?? There are 130 million CDMA subscribers in these bands and 25% of these subscribers are using PCS 1900 MHz band.

?? Availability of a variety of handsets models in dual bands of 800/1900 MHz makes international roaming easy.

?? The DCS band 1710-1785 MHz paired with 1805-1880 MHz and the Korean PCS band 1750-1780 MHz paired with 1840-1870 MHz are not possible to use in India as there is no CDMA equipment commercially available.

?? Universal availability of equipment and handsets as well as facility of international roaming is possible only in 800 MHz/ PCS 1900 MHz bands. This has a considerable impact on prices.

In view of the above, we propose allocation of US PCS band as follows:

- **1850-1880 MHz paired with 1930-1960 MHz for CDMA**
- **1900-1910 MHz paired with 1980-1990 MHz for CDMA and in Band 5,**
- **1755-1805 MHz paired with 2110-2160 MHz with equal spectrum for CDMA and GSM service providers**

Using the 450 MHz band could also be considered for use as a complement for the 1900 MHz PCS band but not as a stand-alone solution. The 450 MHz band has many advantages as it is possible for one base station to cover a radius of two to three times greater distance than at higher bands. Thus it is possible to use these systems particularly in rural and sparsely populated areas with reduced capital costs. This will help telephone penetration in rural areas faster.

CDMA2000 equipment from a variety of vendors in the 450 MHz band (452.5-457.475 MHz paired with 462.5-467.475 MHz) is available. However, no dual-band 450 MHz and 800 MHz handsets are available and hence, roaming is not possible. 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.

We, therefore, recommend that the 450 MHz band be considered for CDMA as a complement for the 1900 MHz PCS band in rural and sparsely populated areas. This band should not be considered as a substitute for the 1900 MHz PCS band.

(ii) The consultation paper has discussed ITU method for assessment of spectrum requirement. Based upon the methodology submit your requirement of spectrum for next 5 years. While calculating the required spectrum, please give various assumptions and its basis.

We have calculated our requirement of spectrum taking voice and data into account and our requirement over a period of next 5 years is 20+20 MHz. We reiterate our demand that we should be allocated 15+15 MHz in the initial stage itself so as to plan the network efficiently in a cost effective manner. As and when required we can present our calculations in personal discussions with TRAI.

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

We recommend that IMT 2000 band should be expanded to cover whole of the 1710-1785 MHz paired with 1805-1880 MHz.

(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?

IMT 2000 is a service specific technology and ITU has identified several bands for this service as outlined in ITU-R Recommendation 1036-2. In fact, all bands currently used by mobile providers in India have been identified by the ITU in Radio Regulation Footnotes 5.388 5.317A, and 5.384A for possible use by IMT-2000

systems. Moreover CDMA 2000 1x and EDGE are recognized as IMT 2000 service capable. It is for the operators to decide when to introduce these services based on commercial considerations in the spectrum allotted. It is therefore not justified to identify a specific band for "IMT-2000" technologies and/or services.

Hence in our view, IMT 2000 spectrum should be considered as extension of 2G mobile services and be treated in the same manner as 2G.

(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.

We advocate the setting up of a Task force involving industry representatives to prepare and implement a time bound action plan for a) vacating of spectrum by non telecom service providers and b) harmonization of carrier assignment especially for CDMA which are currently in non standardised channeling plans.

(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.

There appears to be an inadvertent error in the pairing. As per the PCS frequency allocation, the band 1880-1900 MHz should be paired with 1960-1980 MHz not with 1970-1990 MHz. The band 1880-1900 MHz paired with 1960-1980 MHz should be made technology neutral and available for all BSOs/CMSPs/ UASLs. Continuing to keep the band 1880-1900 MHz reserved for TDD does not encourage the most efficient use of spectrum particularly in many urban areas.

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.

In addition to the methodology outlined for determining the efficient utilization of spectrum using technical criteria such as erlangs/ MHz/sq.km, we have to take other parameters such as the coverage area and the amount of spectrum allocated to the operator. Small changes in the coverage area, location, the time of day, subscriber numbers, traffic numbers, can significantly impact the technical efficiency. In our view, technical efficiency criteria alone should not be used as they do not include economic considerations.

It is to be noted that CDMA coverage and capacity performance is affected by intra-cell and inter-cell interference. The interference in CDMA systems is highly dynamic, due to traffic patterns, changing user profiles and the local radio environment. A combination of multi user interference, and external narrow and wide band interference are major considerations in determining the forward and reverse link performance of CDMA systems. Moreover, in CDMA systems, Quality of service and capacity performance are interference driven, making coverage and capacity mutually non-exclusive.

We are of the view that computation of spectrum efficiency is highly complex and should not be used as a regulatory tool for allocating the spectrum.
We recommend that allocation and assignment of 15+15 MHz spectrum be made, in the first instance so as to plan and implement the network in a cost effective manner.

Comments on the methodology

In 3.2.2 the terminology relates to GSM network only. Such as Broadcast Control Channel in GSM network corresponds to pilot channel for CDMA.

Comments on assumptions

The methodology outlined for determining the efficient utilization especially for CDMA:

1.In paragraph 3.2.2.3, the calculation on 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.

2.With respect to the Efficiency Factor computed for CDMA, the assumed capacity of 25 Erlangs/Carrier/Sector will decrease as the packing density increases. It is estimated that the Erlang capacity per sector could decrease as much as a factor of 2 when the packing density reaches 5 cells/sq km. The reason is that inter-cell interference encounters only a 20 dB/decade (as in free space) rather than the typical 40 dB/decade propagation loss.

3.In 3.2.2.1.2, 6 MHz is assumed for 4 carriers, which is not correct. 5.5 MHz is required for 4 carriers with guard bands.

All of the above mentioned points highlight the fact that technology neutrality is an important consideration in allocating spectrum. To be considered technology-neutral, the regulatory agency must maintain policies and incentives that are agnostic in terms of the technology and services provided.

(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?

In our view, it is far easier to rollout data services in wireless medium than in wired domain. Data services on cellular mobile systems will see an exponential growth in the coming years. Our perception is based on the Korean example which is replicated in South East Asia. Video messaging , 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 are some of the wireless content and applications currently available.. 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. As a CDMA operator, we are planning introduction of some of these data services in the second half of this year.
We also believe that expansion of data services will result in creation of a substantial number of jobs. There are over 1,000 content providers in Korea with about 10-300 employees each. We are of firm view that this will be replicated in India many more times and will create tremendous job potential. The availability of the content in regional languages will boost the usage of data services in rural areas.
We will require 5 MHz (4 carriers) exclusively for data services, as per our calculations, and should be made available immediately.

Chapter 4 Spectrum pricing

(ix) Is there a necessity to change from the existing revenue share method for determining the annual spectrum charge?

Yes, There is a necessity to change from the existing revenue share method for determining the annual spectrum charge as the present pricing mechanism penalizes he most efficient operator (in terms of revenue).

(x) If yes, what methodology should be used to determine spectrum pricing for existing and new operators? (Please refer to table in Section 4.8)

For existing operators, we recommend the current structure of one time fee up to 15+15 MHz of spectrum. **We do not recommend any pricing of spectrum other than cost recovery as the operators have paid a high entry fee and paid additional fees for migration to UASL.** But beyond 15+15 MHz of spectrum, we recommend AIP method of pricing meaning marginal cost of spectrum should be equal or higher than the cost of additional equipment required if spectrum is not available. We agree with your suggestion 4.4.1.1.2.1 that the calculation of marginal value of the spectrum should be based on traffic in the dense areas where traffic is the highest.

The table 4.8 with our recommendations is placed below:

	New Entrants	Spectrum for Existing operators Up to 15+15 MHz	Additional spectrum for all operators Beyond 15+15 MHz
One time Entry fees	Same charge as the existing licensees	Nil	Nil
Annual Charges	Cost Recovery	Cost Recovery	AIP

(xi) In the event AIP is adopted as a means to price spectrum, would it be fair to choose GSM as a reference for determining the spectrum price?

The value of the spectrum should be based on the " second best" technology, since this provides users of that technology with an incentive to use it in the most efficient manner whilst avoiding penalizing users of the more efficient technology.

(xii) Please provide your comments on the assumptions used in AIP.

We agree with the assumptions used in the AIP. In addition, we recommend cell density per Sq. Kms which has an impact on cost and spectrum usage.

(xiii) In case Auction methodology is used for pricing the spectrum, please give suggestions to ensure that spectrum pricing does not become very high and spectrum is available to those who need it.

We do not recommend Auction as a methodology for pricing spectrum.

(xiv) Should the new pricing methodology, if adopted, be applicable for the entire spectrum or should be continue with revenue share mechanism till 10 +10 MHz, and apply the new method only for spectrum beyond this?

The new pricing methodology, if adopted, should not be applicable for the entire spectrum. It should be applicable beyond 15+15MHz.
As mentioned in answer (x) the new pricing methodology should be used only for spectrum beyond 15+15 MHz. Operators (now mobile CDMA operators), who have paid the additional fee to migrate to unified license, should be awarded additional spectrum to bring them on an equal footing with the GSM mobile operators. We have recommended the adoption of cost recovery up to 15+15 MHz of spectrum.

(xv) What incentives be introduced through pricing to encourage rural coverage and /or using alternative frequency bands like 450 MHz?

We recommend waiving of spectrum charges to encourage rural coverage and / or using alternate frequency bands like 450 MHz.

(xvi) Does M X C X W formulae for fixed wireless spectrum pricing need a revision? If so, suggest the values for M, C, W

We recommend that fixed wireless spectrum pricing be revised as there is still need for deploying microwave systems The pricing should be the same as is adopted for GSM cellular operators.
The present rate of 0.25% of AGR for bandwidth of 112 MHz for the Circle and 224 MHz for the Metro may be retained. Additional spectrum of 28 MHz for the Circle and 56 MHz for the Metro may be charged at 0.05% of AGR.
In view of this, the formulae M X C X W is no longer valid.

This should be effective from the date of migration of BSOs to UASL. We also recommend that allocation of spot frequencies should be considered for the whole circle as is being done for GSM operators.

(xvii) Should there be different pricing levels for shared spectrum versus spectrum that is allocated with protection? How should this be determined?

There should be different pricing levels for shared spectrum. It should be in proportion to the number of operators using the spectrum. For example, if three operators are sharing the same frequency, then pricing should be 33% of the dedicated spectrum.

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.

We do not recommend Approach number 1 as it freezes the allocation of existing levels provided except to those where license conditions warrant further allocation but limit the maximum only upto the levels committed in the license. **This approach has serious flaws including the fact that it is not technology and service neutral as envisioned by unified license.** As detailed in the consultation paper, the current spectrum allocation for CDMA operators in India varies from 2 x 2.5 MHz to 2 x 5 MHz only as compared with 2 x 4.4 to 2 x 10 MHz for GSM operators. In our view, the level playing field is not maintained in respect of spectrum assigned. CDMA operators are at a disadvantage as compared to GSM operators.

We recommend Approach 2 for retaining the existing methodology for allocation and pricing upto 2 X 15 MHz allocation or 3 years whichever is earlier. As noted in Annex A of the TRAI consultation paper, international practice has been to make a minimum of 2 x 15MHz or more spectrum available to CDMA operators utilizing the 800 and 1900 MHz frequency bands. This allocation enables the operators to plan an efficient and reliable network keeping the overall network cost per subscriber down. It is possible in the initial stages to cover an entire city with fewer base stations, thus keeping the network costs low. As the subscriber base increases, additional network elements can be added. This kind of strategy results in optimum network costs, thus enabling the service provider to offer affordable cost of services benefiting the ultimate consumer.

We therefore recommend all CDMA service providers in India should have access to a minimum amount of 2 x 15 MHz of spectrum initially on par with GSM operators, to ensure level playing field

(xix) At what stage the amount of spectrum allocation to new entrants be considered in the 800 MHz / 900 MHz / 1800 MHz frequency bands?

Allocation to new entrants should be considered in the 800 MHz / 900 MHz / 1800 MHz frequency bands, only after the all the existing operators, meeting the qualifying

criteria, have been awarded 15+15MHz .As brought out in Table 5.1, there is practically no spectrum available in 800 MHz/ 900 MHz frequency band

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

Section 4.3.3 of The consultation paper states " in a Unified License regime, the endeavor is to proceed from technology neutrality to service neutrality". We strongly agree with this view. Spectrum should be allocated in a service and technology neutral manner as envisioned by the unified license. 5

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

As answered in question (xviii), the spectrum of 15+15 MHz should be allotted in the initial stage itself. The purpose of a spectrum cap is to discourage anti-competitive behavior while at the same time maintaining incentives for innovation and efficiency. This has been brought out very well in section 5.10 of the Consultative paper. The amount of cap per operator should be 20+20 MHz of spectrum and this is to be reviewed as and when required.

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

In areas, where there is no scarcity, spectrum should be allocated on demand.
In areas, where there is scarcity, spectrum allocation should be for a minimum of 15MHz per operator so that they can plan the network efficiently.

(xxiii) Which competitive spectrum allocation procedure (Auction / Beauty Contest) be adopted in cases where there are scarcity?

We do not recommend Auction/Beauty Contest to be adopted for allocation of spectrum.
After a minimum allocation of 15MHz on cost recovery basis, we advocate the adoption of AIP as enumerated in Chapter 4 of Consultation paper to price the spectrum.

(xxiv) Should we consider giving some spectrum in 900 MHz band to fourth CMSPs?

No. There is a difference of 5 MHz between international allocation and Indian allocation for CDMA operations in 800 MHz band. The band 844-849 MHz paired with 890-894 MHz is not allocated as GSM operators have been allocated from 890 MHz onwards. Thus the band 844-849 MHz is wasted. If there is surplus in 900 MHz, then it is better that this band is harmonized according to international practice and 844-849 MHz paired with 890-894 MHz is allocated to CDMA operators.

(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 Unified License regime to be technology neutral and service neutral, we recommend that additional spectrum for existing operators be allocated 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. This is also in consonance with international practice.

(xxvi) In the event that IMT 2000 spectrum is treated as continuum to 2G, should existing operators using spectrum below the specified benchmark be treated as those eligible for IMT 2000 spectrum?

Yes, As noted earlier in the submission, in answer to Question (iv), we have recommended that Spectrum for IMT-2000 technologies and services should not be considered separately and allotted accordingly. Again in answer to Question (xviii), we have recommended the adoption of Approach 2 enabling all the operators to have access to 15+15 MHz of spectrum which should be treated as benchmark.
We have maintained that IMT 2000 services can be offered even now. Hence the question of separate eligibility for IMT 2000 spectrum does not arise. Operators who are having spectrum less than the prescribed benchmark should be eligible for allotment of additional spectrum.

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

Re-farming of Spectrum

(xxvii) What approach should be adopted to expedite the re-farming of 1800 MHz and IMT-2000 spectrum from existing users?

Presently this band is occupied by non-telecom users. Government funding is necessary for the re-farming of the existing users. The funding can be done from the revenues earned from entry fee, spectrum fee etc

(xxviii) What approach should be adopted for re-farming of the spectrum after expiry of license?
In our view, this is a hypothetical question. Telecom is a service industry and there will be active customers even after expiry of license. These customers will have to be shifted to any of the other operators with the concurrence of the Licensor. In other words, the license will get merged with another operator in that service area. The re-farming will follow the guidelines of M&A.

Surrender of spectrum

(xxix) Should there be any refund for spectrum in principle?

In principle, there should be a refund for voluntary surrender of spectrum by an operator. This will act as a strong incentive for voluntary surrender. However, we

believe that there is no excess spectrum with the service providers to surrender at this point of time.

(xxx) Should there be refund for spectrum surrender consequent to Unified Access license policy? If yes, What should be the basis?

No, as per the reasons stated in para 6.1.1 of the consultation paper..

(xxxi) How should the amount of refund be estimated?

Not applicable.

Spectrum trading

(xxxii) Should we open up the spectrum market for spectrum trading? If yes, what should be the time frame for doing so?
(xxxiii) What are the pre-requisites to adopting spectrum trading?

We agree with the view expressed in the consultation paper " Opening of secondary trading requires lot of technical and legal preparedness and in any case is not linked with this exercise. Perhaps it may not be advisable to consider secondary trading at this stage."

Mergers and Acquisitions:

(xxxiv) Whether we should specify a cap higher than 2X 15 MHz for Metros and Category "A" service area and 2X 12.4 MHz for Category "B" and "C" service area in case of M & As or should it be retained?

We recommend a uniform cap of 20+20 MHz in all service areas.

(xxxv) In case, IMT 2000 is considered as a continuum of 2G Serices, is there a need to have a cap higher than that without IMT 2000 services? Should there be individual caps on 2G and 3G spectrum or a combined cap?

We reiterate our stand as answered in Question (iv) and (xviii) that 15 +15 MHz should be initially allotted to rollout 2G and IMT 2000 services as CDMA 2000 1X is considered as an IMT 2000 service. But beyond 15+15 MHz of spectrum, we recommend a combined cap of 20+20 MHz for providing 2G and IMT 2000 services.

(xxxvi) In case of M & As where the merged entity gets spectrum exceeding the spectrum cap, what should be the time frame in which the service provider be required to surrender the additional spectrum?

We recommend a period of 6 months for surrender of the additional spectrum

Appendix 1

Country	Operator	Freq	Technology
Angola Telecom	Angola	1900	IS-95A
Argentina	CTI	1900	IS-95A
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	IS-95A
Dominican Republic	Centennial D.R.	1900	CDMA2000
Dominican Republic	TRICOM	1900	IS-95A
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	IS-95A
Mexico		1900	CDMA2000
Mexico	Telefonica Moviles	1900	IS-95A
Mexico	Unefon	1900	IS-95A
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 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	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

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

Appendix 3: CDMA Operators Utilizing 450 MHz

Country	Operator	Freq	Technology
Belarus	Belcel (trial)	450	CDMA2000
Georgia	Iberiatel	450	CDMA2000
Indonesia	Mobisel	450	CDMA2000
Romania	Zapp Mobile (Telemobil)	450	CDMA2000
Russia	Skylink-Delta Telecom	450	CDMA2000
Russia	SOTEL-Video Skylink	450	CDMA2000
Russia	Moscow Cellular	450	CDMA2000
Uzbekistan	Uzbektelecom	450	CDMA2000