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टी ई सी संचारिका

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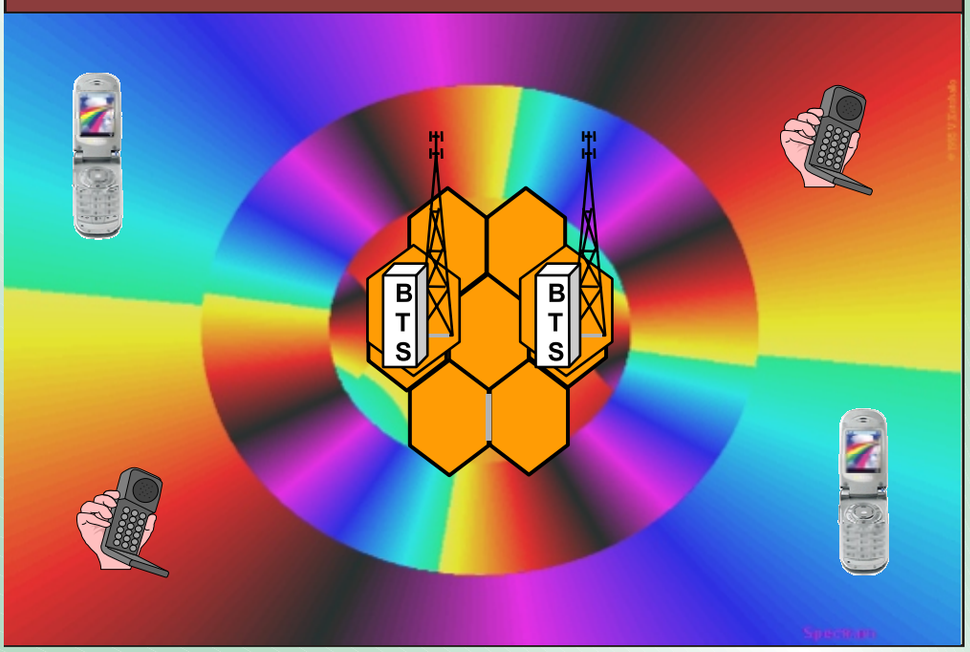
SPECTRUM



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SPECTRUM

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Global Mobile subscriber growth has been phenomenal from zero levels in 1992 to cross the landline billion by 2002 and the climb to 1.5 billion by June, 2004. By 2005 end, mobile subscribers are likely to exceed landlines by almost 38%. It is thus abundantly clear that mobile has become the dominant means of communication.

In India too, with a total of over 110 million phones, mobile subscribers have surpassed the landline subscribers with the total number of mobile phones in the country as 62.57 million and that of fixed phones as 47.44 million. Tele-density - *the percentage of people who own phones* - stood at 10.12 at the end of August, 2005 as per the TRAI Report. The target set by DOT is 250 million telephones by year 2007, out of which 200 million telephones would be through mobile networks.

It is thus abundantly clear that it is the mobile segment that has accelerated the growth of tele-density in the past few years and it will continue to be the main engine of development in future. It is therefore, but natural that the requirement of spectrum which is a critical resource for the development of telecommunication networks in the country, would be increased significantly.

The National Frequency Allocation Plan 2002 (NFAP 2002) has been under review and comments from all the stake holders are being sought on the new draft NFAP 2005 which would be finalised once all comments received are studied and examined.

DoT is in the process of formulating a new spectrum policy.

Calculation of Spectrum Requirements:

Estimation of spectrum requirements is not a straight-forward calculation as it involves several parameters to be considered.

ITU-R recommendation M-1390 gives a methodology for this purpose. It includes geographic considerations (dense Urban, urban, Suburban, Rural In-building, Pedestrian, Vehicular etc., Cell-Area etc.); Market and traffic considerations (population density, users/cell, traffic/user, Type of service, effective call duration, BHCA, QoS etc.); Technical and system consideration (Service channels/cell, Service channel Bit Rate, Net-system-capabilities in Mbit/s/MHz/cell).

Spectrum Utilisation Efficiency (SUE) is expressed as Traffic in Erlangs/Spectrum in MHz/Area in Square Kms, for a given Grade of service. The traffic capacity that a given amount of radio spectrum can support in a cellular network is a function of the number of times the same radio channels can be re-used within a cluster of cells and the amount of traffic carried per channel. This is determined by the carrier to interference ratio the radio receiver needs for a minimum quality of baseband signal. The re-use factor determines the number of cells in a re-use cluster and the smaller the cluster size, the greater is the re-use of frequencies in a given area. Finally, the smaller the cell size, the greater is the density of traffic that can be supported.

Wireless Technologies

GSM

GSM requires paired spectrum with a specified carrier bandwidth of 200 kHz. It is commonly operated in 900 MHz and 1800 MHz bands. However, 850 MHz and 1900 MHz bands are also used. The GSM radio interface uses a hybrid of Frequency Division Multiple Access (FDMA) and Time Division Multiple Access (TDMA) for multiple access and Frequency Division Duplex (FDD) for duplex operation. A TDMA frame on each carrier is divided into

8 time slots of 577 µs each, and is repeated every 4.615 ms. GSM supports a gross bit-rate (inclusive of coding bits) of 22.8 kbps per time slot or physical channel. GSM supports 13 kbps voice or 14.4 kbps data in a single time slot. Basic GSM supports voice bearers using full-rate (FR) at 13.6 kbps, or half rate (HR) codec or enhanced full rate (EFR) codec. These are fixed rate codecs with constant error protection level.

The capacity of GSM network can be further increased by using the adaptive multi-rate (AMR) codec. This adapts the error protection level to the radio channel and traffic conditions. However, this capability needs to be supported by mobile stations also.

Another factor that enhances the capacity is the reduction in frequency re-use (ability to use the same frequencies repeatedly across a cellular system) factor, or cluster size. This addresses the interference generated by the neighbouring cells using frequency planning.

The use of techniques such as single antenna interference cancellation (SAIC) and antenna arrays promise to improve performance over and above those achieved above.

Minimum spectrum being allocated to GSM operators (in India) initially is 4.4 MHz and the maximum at present is 10 MHz subject to fulfillment of subscriber-base eligibility criteria prescribed for additional allotment from 4.4 MHz to 6.2 MHz, 6.2 MHz to 8 MHz and 8 MHz to 10 MHz.

General Packet Radio Service (GPRS) is the packet switched data implementation in the current 200 KHz GSM carrier system supporting higher data rates upto 115 kbps by concatenating upto eight 14.4 kbps time slots. (At present data speeds even upto 170 kbps is possible by increasing data speeds of each time slot)

The next advancement of GPRS is **Enhanced Data rates for GSM Evolution (EDGE)**, supporting data speeds up to 384 kbps (48 kbps per time slot). The higher data rate is achieved in the current 200 Khz GSM carrier using a new modulation scheme known as eight-phase shift keying (8PSK) as against Gaussian minimum-shift keying (GMSK) used in GSM.

No additional spectrum is required for migrating from GSM to GPRS and GPRS to EDGE. Thus within the existing allotted spectrum, it is possible to offer GPRS and EDGE based Enhanced services.

WCDMA and its enhancements

Wideband Code Division Multiple Access (WCDMA) is the access scheme used in Universal Mobile Telecommunication System (UMTS), which is the 3G option for the GSM.

The WCDMA architecture is such that the core network of GSM is shared, and the GSM BSS is replaced with WCDMA radio access network (RAN).

WCDMA uses code division multiple access (CDMA) instead of the classical time division multiple access (TDMA) as the multiple access technique. Users are separated by unique codes allowing all users to transmit at the same time using the same frequency band. Since the same frequency band is used in all cells, the re-use factor is 1. However, it uses a wide band of 5 MHz per carrier with a chip rate of 3.84 MHz, and a frame size of 10 ms. This high bandwidth and spreading factor increases the processing gain and multi-path resolution, and thereby improves coverage and combats fading.

High Speed Downlink Packet Access (HSDPA) is an evolution of WCDMA in the Downlink (DL) for packet data communications theoretically supporting peak data rates of 14.4 Mbps in the DL.

The WCDMA enhanced uplink High Speed Uplink Packet Access (HSUPA), an evolution of WCDMA for uplink is also emerging and this may theoretically support a peak data-rate of 5 Mbps in the uplink.

Spectrum allocations - internationally and in India			
	International allocations	**Indian allocation (As per NFAP 2002)**	**Available spectrum & Extent of allocation** *(As per Indian Allocation)*
800 MHz	824 – 849 paired with 869 – 894 MHz (Frequency arrangement A1)	824 – 844 paired with 869 – 889 MHz ***(used by UASL & WLL service providers, deployment of CDMA systems only in this band)***	20 + 20 MHz (Almost complete 20+20 MHz allocated)
900 MHz	**890 – 915 paired with 935 – 960 MHz** ***(880 – 890 MHz paired with 925 – 935 MHz E-GSM band)*** (Frequency arrangement A2)	**890 – 915 paired with 935 –960 MHz** ***(Used by 1st, 2nd and 3rd Cellular Mobile Service Providers (CMSP), deployment of only GSM systems in this band)***	25+25 MHz **(Almost complete 25+25 MHz allocated)**
1800 MHz	1710 – 1785 paired with 1805 – 1880 MHz (Frequency arrangement B2)	1710 – 1785 paired with 1805 – 1880 MHz ***(Used by 4th CMSP and for additional allocations to 1st, 2nd and 3rd CMSPs. deployment of only GSM systems in this band till date)***	75+75 MHz (very small part, of the order of 10 MHz allocated to GSM operators on coordinated basis with Defence.)
1900 MHz	1850 – 1910 paired with 1930 – 1990 MHz *(North American PCS band)* – (Frequency arrangement *B3)* 1880 – 1920 MHz ***(DECT, PHS & other TDD systems)*** 1885-1920 and 2010 – 2025 MHz ***(IMT 2000 TDD systems i.e. mainly for TD-SCDMA)***	1880–1900 MHz is Earmarked for Micro cellular technologies based on TDD ***(Mainly corDECT is deployed by UASL operators)*** 2010 – 2025 MHz (For IMT 2000 TDD)	20 MHz (Almost complete 20 MHz allocated for corDECT mainly)
2100 MHz	1920 – 1980 paired with 2110 – 2170 MHz *(IMT 2000 FDD System)* (Frequency Arrangement B1)	1920 – 1980 paired with 2110 – 2170 MHz *(For IMT 2000 FDD)*	Being currently used by defence and other users for variety of other applications.

FDD : Frequency Division Duplex TDD : Time Division Duplex TD-SCDMA : Time Division Synchronous CDMA

IMT-2000 (3G) Spectrum

Spectrum allocations for IMT-2000 identified during WARC-92 were:

- 1885-2025 MHz and
- 2110-2200 MHz (3G core band)

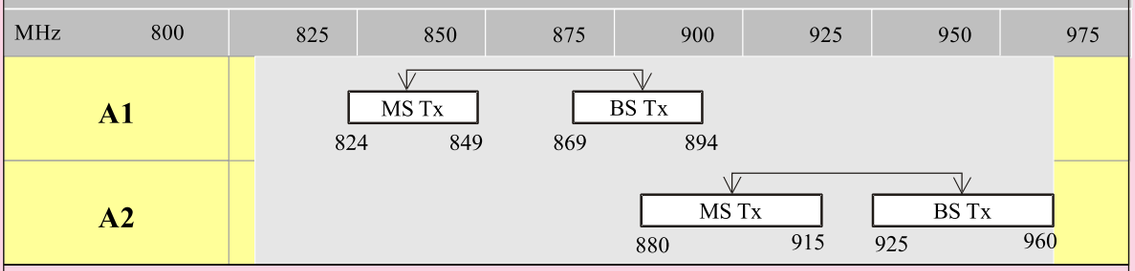
Out of above, the portion allocated to the 3G mobile satellite service (MSS) is 1980-2010 MHz and 2170 -2200 MHz.
Subsequently, during WRC 2000, the following additional bands was identified for possible use by IMT-2000 systems.

- 806 - 960 MHz
- 1710 - 1885 MHz
- 2500 - 2690 MHz

WARC : World Administrative Radio Conference WRC : World Radiocommunication Conference

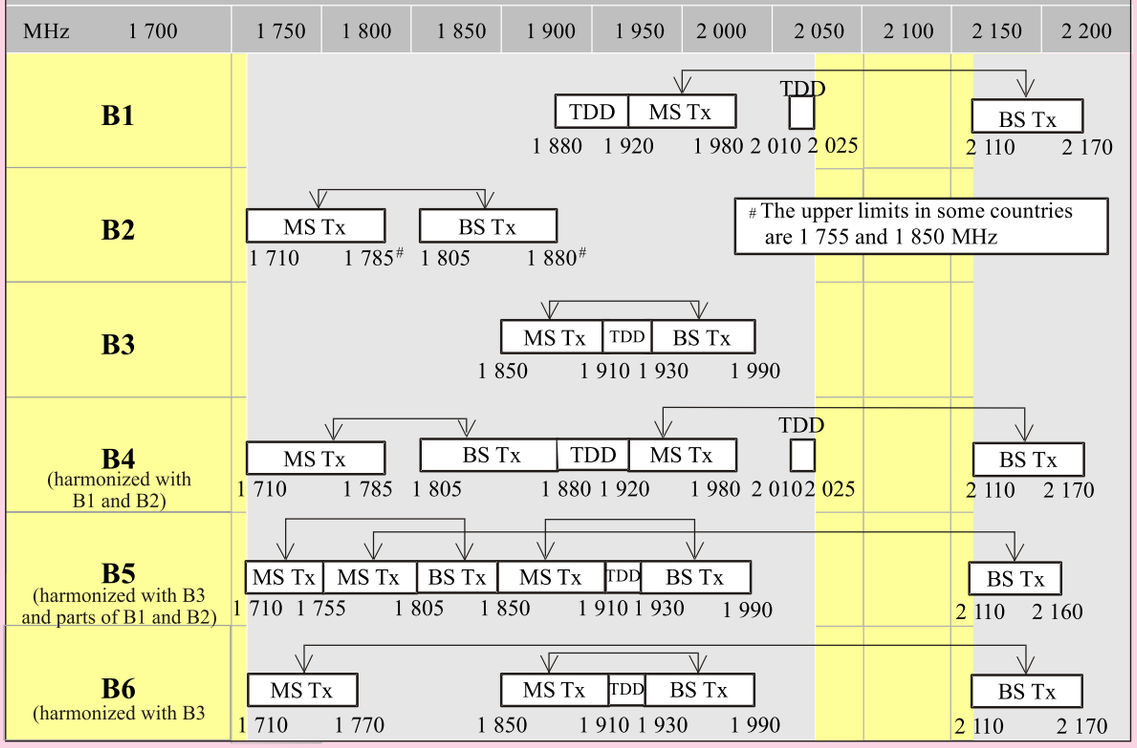
Recommended frequency arrangements in bands identified for IMT- 2000 (as per ITU-R M.1036)

Ba nd 8 06-960 MHz



MS Tx: mobile station transmitter
BS Tx: base station transmitter

Band 1 710-2 025 M H z, 2 110-2 200 MH z



Administrations can implement all or parts of these frequency arrangements. In the band 1710 - 2025 and 2110 -2200 MHz three basic frequency arrangements (B1, B2 and B3) are already in use by public mobile cellular systems including IMT-2000. Based on these three arrangements, different combinations of arrangements are recommended as described in B4,B5 and B6.

IS - 95 Standard- CDMA one

IS-95 is the first commercial CDMA mobile radio standard to use direct sequence spread spectrum, mainly for voice. This is a 2G system, operating in the 800 MHz cellular and 1900 MHz PCS bands. The carrier bandwidth of IS-95 is 1.25 MHz with a chip rate of 1.2288 Mbps, and the DL and UL is separated in frequency. The multiple access technique used is Code Division Multiple Access (CDMA) in which the transmitter multiplies the signal by an orthogonal spreading code. The received signal is multiplied with the same spreading code for demodulation. The frequency re-use factor is 1.

CDMA 2000 is a 3G CDMA technology which also includes a multi-carrier CDMA option in which a single 5 MHz band can accommodate three adjacent carriers (3x) of 1.25 MHz each. This multi-carrier concept is yet to see deployment.

CDMA 2000 1x RTT is One Carrier, Code Division Multiple Access (CDMA) 2000 radio transmission technology, where the 1x represents "1" times the frequency bandwidth of earlier IS-95 systems. It has a single carrier in this 1.25 MHz, and the chip rate is same as that of IS-95 systems. CDMA 2000 is backward compatible to the earlier IS-95 system, and allows for a smooth transition in a phased manner.

Minimum spectrum being allocated to CDMA operators (in India) initially is 2.5 MHz (2 carriers) and the maximum is 5 MHz (4 carriers) subject to fulfilment of subscriber-base eligibility criteria prescribed for additional allotment from 2 carriers to 3 carriers and 3 carriers to 4 carriers.

CDMA 1x -EVDO (CDMA -HDR or IS 856) - Single RF carrier 'Evolution to Data Only'

This is a broadband wireless packet data system. The channel bandwidth (1.25 MHz) and the chip rate (1.2288 Mcps) are same as that of the CDMA 2000. The forward and reverse links are separated in frequency. CDMA is the multiple access technique in the UL and TDM in the DL. The DL peak data-rate is 2.4 Mbps (may be evolved to 3.1 Mbps) and the UL peak data-rate is 153.6 kbps (may be evolved to 1.8 Mbps).

CDMA 1x - EVDV - Single RF carrier 'evolution of CDMA 2000 to data and voice'

The bandwidth, chip-rate, modulation and multiple access techniques are same as that of 1x-EVDO. However, unlike 1x - EvDO, this integrates voice and data on the same carrier.

DECT

DECT (Digital Enhanced Cordless Telecommunications) is a wireless Access standard of ETSI. The band of operation is 1.88 - 1.935 MHz, with a carrier spacing of 1.728 MHz. In India, carriers are currently assigned to operators in the band 1.88 - 1.90 MHz. The system employs the TDD mode of operation, and the access on each carrier is by TDMA. The frame is of 10 ms duration, with 5 ms each for uplink (UL) and downlink (DL). There are 12 basic ("full") slots in the UL and DL respectively, each capable of providing a user 32 kbps of payload and 9.6 kbps of signaling capacity. Two slots can be combined to obtain a payload of 70 Kbps.DECT stands apart from other TDMA standards due to its unique channel selection method, called Dynamic Channel Selection (DCS). In DCS, every subscriber terminal constantly monitors the base station beacons (or active slots) to determine the strongest one to lock to.

In India, corDECT wireless systems based on DECT standard have already been deployed. Next-generation of the corDECT Wireless Access Systems are capable of supporting data speed upto 256 Kbps.

Advance Wireless Technologies and Spectrum Management

The 18th - 19th century political economist Thomas Malthus (1766-1834) had made dire predictions about food supply, based on the ever-increasing population. However, the food supply turned out to be not as "scarce" as Malthus had originally believed because technology and innovation have drastically increased yields beyond what was thought possible at the end of the 18th century and technology has enabled a much more efficient use of a scarce resource, ***"land".***

Similar "Scarcity" arguments have been, and are still being made about the radio spectrum. While the number of spectrum users and uses continually increases, the amount of spectrum is still considered a limited resource. However, many have argued that this system makes the same miscalculations about the "productivity" of spectrum as Malthus made on the productivity of farm production in the late 1700s. They argue that spectrum is not as "scarce" as it appears because new technologies make much more effective use of spectrum, mitigating the scarcity problem. Essentially, technological advances, if implemented, could outpace the growth of demand for spectrum in the same way as aggregate food production has outgrown population growth.

Some of the core technologies that can help make better use of spectrum are :

Spread Spectrum : These technologies send information over a much wider bandwidth than the actual bandwidth of the information by using a code to either modify the carrier wave or to define a hopping pattern for frequencies. The two different systems are direct sequence (DS) and frequency hopping (FH). One of the most successful implementations of DS Spread Spectrum Systems has been the IEEE 802.11b Standard, commonly known as Wi-Fi. Orthogonal Frequency Division Multiplexing (OFDM) is yet another popular modulation technique used for capacity enhancements.

Ultra Wide Band (UWB) : This can transmit data at very high speeds by sending the transmission over a wide range of frequencies but at very low power bands as compared to traditional radio. Also, unlike, traditional radio technologies, that use various carrier waves to send data information, UWB instead uses very fast pulses to represent the zeroes and ones of digital communication.

Smart Antennas : While Ultra Wide Band and other Spread Spectrum technologies change the way data is ***sent*** to increase spectrum efficiency, smart antennas focus on improving the ability of the radio to ***listen,*** via its antenna and the radio's signal processing power. These technologies can be classified into two main groups : switched beam and adaptive antennas.

Mesh Networks (Collaborative Gain Networks) : Mesh Network is a local area network (or LAN) where each device on the network simultaneously connects to and communicates with all devices in range.

Software Defined Radios (SDR) : Essentially, SDRs are radios that can be upgraded by changing software and this allows more effective use of expensive hardware and infrastructure.

Agile Radios : These act as frequency scavengers that aim to make use of periods of inactivity on a wide range of spectrum and will broadcast on an unused frequency until it `senses' another radio trying to use the same frequency.

Source : ITU-T Document RSM/08 Feb. 2004

Approvals issued by TEC during the period April 2005 to August 2005

Interface Approvals.....	71
Service Test Certificate.....	25
Total	**96**

Approvals issued by TEC upto 31.08.2005

Interface Approvals.....	4179
Service Test Certificate.....	1712
Grand Total	**5891**

IMPORTANT ACTIVITIES OF TEC DURING APRIL TO AUGUST 2005

Preparation of GRs/IRs

Following GRs/IRs and Technical documents were issued

- Softswitch For Local Applications
- Line Media Gateway
- Universal Subscriber Module (USIM)
- UMS for CDMA 2000 Network
- Universal Mobile Telecommunication Systems (UMTS) - Terrestrial Radio Access Network (UTRAN)
- Universal Mobile Telecommunication System (UMTS) - Core Network NMS standard
- CDN (Content Delivery Network)
- SMSC for CDMA 2000 Network
- Micro Duct Optical Fibre Cable
- STM-64 Synchronisation Multiplexer
- Flexible Optical Fibre Cable (For Indoor Application)

Revised GRs/IRs

- STM-1, STM- 4 and STM-16 Synchronization Multiplexer
- SPV Power Supply for Telecom equipments Portable
- 6 GHz Ultra High Performance Antennas
- 11 GHz Ultra High Performance Antenna
- Installation Accessories and Fixtures of Self Supporting Metal Free Optical Cable

Tests and Field trials

- Validation of 15 GHz M/W Radio
- Billing and Customer care, GPRS and MMS for BSNL IMPCS Project

INDIAN TELECOM- Another mile stone

Teledensity crosses 10

Total Subscriber base has become 110 million (mobile phones - 62.57 million & fixed lines - 47.44 million) and tele-density has reached 10.12 at the end of August 2005.

Source : TRAI

दूरसंचार इंजीनियरी केन्द्र, नई दिल्ली कार्यालय में हर वर्ष की भाँति इस वर्ष भी दिनांक 01-09-2005 से 15-09-2005 तक "हिन्दी पखवाड़ा" मानाया गया।

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अक्तूबर 2005
भाग 9
अंक 3

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