Chapter II

CONCEPTUAL BACKGROUND OF INDIAN TELECOM SECTOR

2.1 Evolution and Growth of Telecom Sector

In order to map the growth of telecom it is desirable to capture the history of the sector and specifically that of the Indian telecom sector as this is the subject matter of the study, an effort to briefly note the movement from its evolution and track the growth of Indian telecom sector, with focus on the acceleration stages and their limitations is documented.

For an extended period from its inspection, the sector languished first in establishing the technology and then the privilege to secure a connection. There is an obvious movement in this tracking and it is common knowledge that the great shift occurs after the transition from the limited fixed line telephones where the services were catered to by the public sector because during the inception phase, there was a huge wait listing in securing this precious resource to the freeing of the sector and privatising it, and the evolution of the mobile phone wherein this service is hard sold to consumers very competitively.

Technological evolution has furthered the growth of telecom, providing the much needed ability to cut costs making it more accessible to the common folk, increasingly attractive features that provides the ability for ease in technology aided use and a flourishing entertainment medium. Discussion also extends to the regulatory framework in Indian telecom sector, and assesses the targeted growth vs. the achieved growth. There is time spent in detailing the technologies used to understand the technological advances that aided the sector to flourish, the finish would not be complete without the discussion on future of telecom in India.

2.2 History of Indian Telecom

The history of Indian telecom commenced in 1853 when a 33 Km line was built between Calcutta which was the then capital of India and the diamond harbour anchorage of the British East India Company. By the time of Indian independence the country had 403 telephone exchanges and 91424 telephone lines. Since then the growth in communication was never at the desired pace. By 1980 India had less than 2,500,000 telephones, most of them in a few urban centers. Almost 7%
of the country's urban population had 55% of the nation's telephones. By then India had only 12,000 public telephones for 700,000,000 people, and 97% of India's nearly 600,000 villages had no telephones at all.

In 1981, Prime Minister Indira Gandhi set up a high-level committee to review telecom development, the actual work in earnest began with the high level of interest shown by her son Rajiv Gandhi and the inclusion of an expatriate Indian in Mr Sam Pitroda into the thick of the development plans. Prime Minister Rajiv Gandhi, when he later became the prime minister, identified telecommunication as a "Core Sector" together with traditional industries such as electrical power generation, oil and automobiles.

This era saw India built indigenous switching systems and small digital exchanges best suited for the extent of connections required at the village level, ie 100-200 telephones. The Centre for Development of Telematics (C-DOT) designed Rural Automatic Exchanges (RAXs) to meet the needs of the rural telecommunication network which were survived in conditions that did not require air conditioning. The smallest exchanges manufactured in the US were suited for 4000-10000 telephones & required controlled conditioning. Even in those early days it had registered that to have satisfactory penetration of telecom into rural area lowering the price of communication was proportional to the growth. After his electoral defeat in 1989, the IT sector languished. The new administration used the India telegraph act of 1985 by which all civil and commercial telecommunication in India except for radio and television broadcasting fell within the preview of the ministry of communication, as a result the Government of India held total monopoly on all types of communication.

In 1993 the Government of India decided to open telecomm operations and invite private players, this process of liberalization was initially unsuccessful in attaining the objectives of increasing penetration levels for telecom since the new players initially concentrated on snatching high end customers from the present operator, therefore not compelled to reduce the cost which was essential for growth.

After the process of economic liberalisation the Foreign Direct Investment (FDI) for the telecomm section was approved $11.25 billion between 1991–2002, however, the actual investment amounted to $1.9 billion, i.e. nearly 17% of approved amount, an indicator that foreign investors were not properly utilised. In October 2001, the merger of IT and Telecomm ministries was
proposed to set right years of regulatory confusion that resulted in stunting the growth of telecomm industry and discourage overseas investments. Another factor to discourage FDI investment was lack in clarity in revenue sharing percentage and interconnects issues.

A prohibitive import duty on telecom equipment was also a major contributor that resulted in the average phone call in India costing 10 times that in other countries. The data available for this period therefore registers a minor percentage of international call traffic in India, originating in India. The National Democratic Alliance (NDA) led by Sh. Atal Bihari Vajpayee in 1997, signaled a renewed interest in the IT sector. Prime Minister Vajpayee organised a national IT task force to make recommendations for a comprehensive policy overall. The task force recommendations were instrumental in initiating wide ranging fundamental changes in IT policy.

In 1999 a new telecomm policy National Telecom Policy (NTP) was implemented and the internet services were opened up. In 2002 national long distance and international long distance services were also opened up. The present government based operators were converted into corporate and a national regulatory authority was also set up.

Studies showed (affordability data from International Telecomm Union) that in 2002 residential demand for basic telephone services in India was not sufficiently served, the year accounted for only 0.28 increases in penetration level and that low penetration statistics did not necessarily spell opportunity, the right price was necessary to spur growth.

The key contributor to the price was the capital expenditure (CAPEX), this comprised of equipment cost like fiber optics, electronics for lighting the fiber, switches and routers, service platforms, operator maintenance consoles, network management systems, customer care and billing systems and web hosting and mail services. The other factors contributing are the cost of finance i.e. the interest factor, the equipment replacement cost or depreciation, the operational maintenance cost, the license fees, spectrum charges and taxes.
The government of India also set up a separate section for administrating Universal Service Obligation Fund (USOF) in the year 2002 under the ministry of communication for implementing universal service support policy. The funds created by universal service levy were to be spent in rural and remote areas on both public access telephones and individual household telephones.

The result of the efforts to consolidate soon resulted in India having the lowest call charges in the world. A 60% to 80% fall in rate over the previous period. Competition in cellular telephony was allowed in a duopoly mode. The application of policy to having four operators for the metros and the thirteen circles was the key initiative the policy for landline sustained at one external operator with that from the state, this in spite that private parties were laying their own infrastructure. This continued to contribute to the state driving away competition, distancing the chance of it completely disappearing. In November of 2003 a unified licensing plan was proposed making CDMA operators having wireless loop licenses and offering services in limited geographic areas more competitive allowing for full mobility. By now India’s demographics were helping propel economic growth, the population was young and becoming more educated, almost 60% of the population was under the age of 35 years. This accounted for the 20 million wireless subscribers of which 15 million were GSM and 5 million CDMA. The GSM services were primarily marketed to those who travel and needed extended coverage area. Illiteracy in rural areas was still as high as 40%, the tribal belts lacked further behind and had only 20% people who were literate. Nearly 35 million children in the age group 6 to 11 years were out of school and one out of four dropped out during primary classes. Universal access to information had therefore to be planned and the implementation was however possible only through public tele-info center’s as a majority of the villagers in India could not afford separate connections home.

There were also initiatives in offering telecomm services in non-traditional ways for rural areas like hundreds of postal delivery people carrying wireless phones while delivering mail. Projects like “Gramdoot” and “Gyandoot” have been implemented for e-governance, Gyandoot which means knowledge messenger is a non-profitable organisation which is financially independent wherein the state government plays role of facilitator only to ensure timely delivery of e-governance services.

Agriculture is the primary occupation of nearly 70% of Indian population, but it contributes only 23% of the GDP thus the need for improving productivity and efficiency. The sector is largely
vulnerable to weather uncertainties, market inefficiencies and investment related hurdles. Accordingly, telecommunication technologies can play a crucial role to improve agriculture sectors through various means.

In India agriculture output per unit area is one of the lowest in the world, the need is to create awareness among farmers about managing healthy crop production, diversification of agriculture into less explored areas like horticulture, floriculture and oil seeds, market support and financial support. Information developed by agriculture professionals and agricultural research institutes will improve farm profitability and reduce environmental spill over from agriculture.

The reach of communication and technology will help minimise the impact of these deficiencies. Development of application programs and content in local languages is required although enormous effort will be required to achieve this. Many government initiatives through projects like “Warna Wired Village” meant to provide information on crop cultivation practices of major crops, pest and disease control and marketing information are already in place. E-Choupal, a model by Indian Tobacco Company (ITC) to establish more efficient agriculture supply chain aimed at delivering sustainable value to its customers and tackle challenges posed by fragmented farms, weak infrastructure and multiple intermediaries, is already in place since its launch in 2000 reaching more than 18000 villages through 3000 kiosks across 5 states. These initiatives will encourage organised financial sectors into lending to farmers and make integrated risk management approach to insurance cover available, stimulating faster growth of economy and employment to rural village youth.

By September 2004 the combined mobile base in India had reached 43 million, of this 33.56 million were GSM users a substantial growth over the previous year. The penetration rate of GSM was however still at a very low 3.1%. The rapid growth however prompted the government to consider the relaxing of FDI in January 2005; proposals were made to increase the FDI limits from 49% to 74%. It was also understood that the full benefits of raising the limits would only be fulfilled with new reforms that would allow fair, independent and neutral regulation.

In the mid 1990’s Motorola and Flextronics wanted to start mobile hardware plants in India but later relocated to China. Erriscons established manufacturing in India in 1994 and also launched a manufacturing unit for GSM radio based station in March, Canada’s Nortel also established a manufacturing base. 2005 also saw the beginning of new proposals trickling in for manufacturing
units from companies like Nokia, Motorola and Hyundai mobile. In February of 2005 Eleoteq—a Finland based original equipment manufacturer (OEM), commissioned a plant in Bangalore at an estimated cost of $100 Million to manufacture 40 to 60 Lakh handsets. LG also commenced its mobile device manufacturing unit in Pune in February 2005. By then Motorola was also working with local experts in India to see the feasibility of producing low cost handsets and enter the market.

In September 2005 Texas Instruments (TI) demonstrated a new “Single phone chip” aimed at slashing handset costs. The first telephones to be built entirely in India from concept to design to production were built by this technology. The first phones based on TI and BPL cooperation were available in September 2005 and a little later the same year with TI and Primus cooperation.

With the development of maximum likelihood sequence estimation (MLSE) based signal processing engines, digital electronic distribution equalization (EDE) became practical and economical, delivering significant capital and expenditure benefits to network providers. The adoption of EDE into optical networks enabled them to become more open, more tolerant of different transmission conditions and more flexible. While the DCM technology available used a spool of negative dispersion fiber, EDE used electrical processing in silicon. Silicon though having a lower cost requires significant design investment upfront, but once the investment is made, high volume manufacturing dramatically reduces recurring costs. The DCM technology requires more amplifiers due to losses adding more noise consequently reducing optical signal to noise ratio (ONSR) of the signal and reducing distance achievable before regeneration. Digital EDE is estimated to achieve a 30% reduction in capital expenditure (CAPEX) across point to point networks.
The published figures for telephones in 2004 were 46 Million main lines and 104 Million phone sets. The wire-line telephone per 100 populations was 4.3 while mobile subscribers per 100 populations were 4.4. The teledensity achievement for India by May 2005 was only 9.5% compared to the advanced countries this figure is still very small. While the USA had teledensity of 117%, Japan had 120%, Germany 98%, Canada 58% and China 55%. Although new cellular telephone connections in India accounted for 94% of the overall. The teledensity only increased by 1.96% over the previous year. Of this BSNL and MTNL had 51.39% and private operators 48.61%.

The number of phones per hundred people in a rural India, in 2008 was, 9 as compared to 70 in the urban region. The chief reason for the sparse teledensity is the low connectivity present in these regions. This is by any standards the very minimal average earnings per user compared with other countries.

Despite of the challenges, in the form of global recession, the Indian telecom sector showed remarkable growth in 2009, the quarterly revenue from the telecom sector crossed Rs. 40000 Crore, for the quarter ending at 31st March 2009. The figure of 500 million mobile subscribers was achieved by December 2009.

This trend continued in the next year as teledensity in India crossed 51.05% in March of 2009, however the growth was very skewed, majorly in the urban area. By end of march only 79,924 panchayats out of total 242,279 panchayats had broadband connections. The DoT site then mentioned that the target by DoT was to have broadband connections to all panchayats by 2012.

In 2010 UN report it was mentioned that “People have greater access to cell phones than toilets in India.” This statement enumerates the telecom growth story in India.

On 19th May 2010, history was created when 3G auction took place. The Cellular Operators Association of India (COAI) summarised this event in following words, “The conclusion of 3G auction adds to the success of India’s telecom sector and its growth story and takes it a step forward. We are happy that it has concluded in the estimated time,” as told by COAI director general Rajan S.

In spite of the success, the telecom sector was also facing many challenges. One of the major challenges was the tariff wars in the sector. Intense tariff war caused the steep fall and overall
slowdown in the performance in all segments, including cellular services that over the past several years have been leading the growth in earnings for the telecom services sector,” said a report by industry journal Voice & Data. The telecom services industry, bowed to internal competitive forces in 2009-10, slowing its pace of growth to 2.5%, to post revenues of Rs.159,510 crore against the previous year’s earnings of Rs.155,683 crore, the report added.

Tariff cuts and introduction of one paisa per second call rates introduced by the new players forced the leading operators to bring down charges. Though the number of subscribers grew about 50 percent, the mobile services segment revenues rose only 3.6 percent to 96,860 crore. “This is the worst telecom services revenue growth in the last five years. More tariff wars are not sustainable. There is likely to be consolidation ahead which should arrest more tariff wars and revenue attrition,” as said by Prasanto K. Roy, then chief editor, Cyber Media India.

In November 2010, the sector was hit by catastrophe when it was discovered that the then telecom minister Mr Raja took bribes while distributing the 2G licenses, and there were many irregularity in the licensing process. The 2G scam hit the sector so gravely, that its effects are still felt, even after almost two years. Financially it hit the telecom sector as the loss to the government due to the scam was estimated to be 176,645 crore (US$35.24 billion) as valued by Comptroller and Auditor General of India based on 3G and BWA spectrum auction prices which were held in 2010. What followed the scam was the chain of events - the Supreme Court of India delivered judgment on a public interest litigation (PIL) which was directly related to the 2G spectrum scam. The Supreme Court declared allotment of spectrum as "unconstitutional and arbitrary" and quashed all the 122 licenses issued in 2008. This lead to tarring of Indian image in the foreign countries. Despite of all the adversities, the Indian telecom sector kept growing at steady pace. By May 2012, Indian telecom sector was ranked 2nd (After China) having 919,170,000 telephone subscribers with teledensity (phones per 100 people) of 76.00%.

It can be noted from the above data, that the growth of teledensity in other countries is not as much as compared to India.
The digital divide was also appearing to be narrowing as the rural tele-density reached to 39.22%, as compared to 9% in 2008. This is still a beginning of the process of reducing the digital divide as there is still a long way to go. The urban tele-density also has grown to 169.55% indicating there is still wide gap between rural and urban tele-density.

2.3 Evolution of Indian Telecom Sector

From 91424 phones in 1947 to 919,170,000 phones in 2012, i.e. 10000 times in 75 years, India's telecommunication system is evolved with high pace. The actual growth stimuli for the sector was when Indian telecom industry underwent a high pace of market liberalization since 1998.

India is served by an extensive system of automatic telephone exchanges connected by modern networks of fiber-optic cable, coaxial cable, microwave radio relay and is being served by one of the largest domestic satellite systems (INSAT ) of the world. India possesses diversified communications systems that link all parts of the country by telephone, Internet, radio, television and telegraph.

The estimated growth rate for the industry is a phenomenal 344500 crore (about $69 billion)by end of 2012, approximately 26% growth, this could translate into employment opportunity for 10 million people in the period.

It was predicted that this industry would generate employment both direct and in direct, it was estimated that the overall impact would cumulate to about 10 million additional employment. The total revenue of the Indian telecom sector grew by 7% to 283,207 crore (US$56.5 billion) for 2010–11 financial year, while revenues from telecom equipment segment stood at 117,039 crore (US$23.35 billion). (Wikipedia)
2.3.1 Technology Evolution in Telecom

Evolution is necessary for growth, same holds true for advances in telecom technologies. The telecom technology can be divided in two namely, Hardware technology Software technology
Hardware technology is in the physical form such as the various instruments used in telephone like, phone, switches, towers exchanges etc.
Software technology is in the form of the programs that run the physical form.
Incidentally, there has been parallel growth in the hardware as well as software technology. Since the software is required to operate the hardware, the evolution of only one cannot occur.
The hardware technology can be in terms of transmission media, or the other devices. There are numerous mobile communication technologies which enhance the growth of cellular industry. This section will discuss the different technologies and their advantages/disadvantages.

Transmission Technology

Communications between phones and computers require a medium to transmit data. A transmission medium is the path between a transmitter and a receiver that carries information encoded in a signal. There are two categories of transmission media (guided or unguided) and several types within each category. Guided media (wired) requires a physical path like a cable to transmit electromagnetic waves. Unguided media (wireless) transmits the electromagnetic waves through air, water or a vacuum.

Wired Transmission Technology

Wired communications is a broad term that is used to describe any type of communication process that relies on the direct use of cables and wiring to transmit audio and visual data. A classic example of wired communications is the traditional home telephone that is connected to the local telephone switch via wires that are ran from the home to the switch. While wireless communication solutions have become more common in recent years, the use of wired services remains common and is not likely to disappear in the near future.

In general, wired communications are considered to be the most stable of all types of communications services.
Following are different wired transmission technologies

**Twisted Pair**

Twisted pairs are the most inexpensive guided-transmission medium. They consist of two insulated copper wires twisted into a spiral pattern and bundled into a cable. Twisting the copper wires lowers the interference between pairs. Twisted pairs are typically used for digital and analog signals used in telephones (land lines) and computer networks. They can be used only for short distance communication, although they can now transfer a large amount of data over that short distance.

The application of such cables is generally for corporate offices and homes, depending on the specific requirement these are used in the three types of twisted pairs available. Foiled, Shielded and Unshielded.

**Coaxial cables**

For the ability to confine the electromagnetic waves to the inside of the cable ie between the external shield and the center conductor, Coaxial cables are used.

The transmission of energy in the line occurs totally through the dielectric inside the cable between the conductors.

To an extent Coaxial lines can be twisted without much change in their ability, the strapping of these to conductive supports does not contribute to inducing in them currents that are not wanted.

This type of cables are more often used for television and such applications that need bandwidth of multiple megahertz. the advent of high speed home network for the homes will see the extended use of the Coaxial lines.

In the 20th century they carried long distance network & telephone connections. Coaxial cable transmits over long distances and supports more locations and shared connections than twisted pairs.

**Optical Fiber**
Optical fiber is a guided transmission medium made of thin material that requires a light source, transmission system and a detector. The detector gives an electric pulse when light hits it and it guides optical rays to transmit the data. The fibers are extremely thin, and each strand is protected by plastic or glass that has optical properties different from the core fibers. Optical fiber has a higher bandwidth than coaxial or twisted pairs. It is smaller and lighter as well and isn't vulnerable to interference.

Optical fiber gives off no radiation and is more secure than other guided mediums. Optical fibers are becoming more common in telephone networks and may be able to carry image and video in addition to data.

Wireless Transmission Technology

Wireless telecommunications is the ability to receive and transmit information between different sources without the requirement for them to be physically connected to each other. Distances can be short or long. Examples of wireless technology are many and remote controlled toys for children to the more sophisticated robots that are remotely operated.

Microwave communication, is used short distance communication transfer, for long range ability to communicate it is required to communicate through radio frequency, especially when the receiver is not visible and directional antennas are required to effect the transfer. Microwave communication is therefore mainly for the consumer remote control devices.

For telecommunication, only Radio frequency and microwave communication can be used.

Radio Communication Radio is the transmission of signals through free space by electromagnetic waves with frequencies significantly below visible light, in the radio frequency range, from about 3 kHz to 300 GHz. These waves are called radio waves. Electromagnetic radiation travels by means of oscillating electromagnetic fields that pass through the air and the vacuum of space.

Information, such as sound, is carried by systematically changing (modulating) some property of the radiated waves, such as their amplitude, frequency, phase, or pulse width. When radio waves strike an electrical conductor, the oscillating fields induce an alternating current in the conductor. The information in the waves can be extracted and transformed back into its original form. Microwave Transmission Microwave transmission refers to the technology of transmitting
information or energy by the use of radio waves whose wavelengths are conveniently measured in small numbers of centimeter; these are called microwaves

Microwaves are widely used for point-to-point communications because their small wavelength allows conveniently-sized antennas to direct them in narrow beams, which can be pointed directly at the receiving antenna. This allows nearby microwave equipment to use the same frequencies without interfering with each other, as lower frequency radio waves do. Another advantage is that the high frequency of microwaves gives the microwave band a very large information-carrying capacity; the microwave band has a bandwidth 30 times that of all the rest of the radio spectrum below it.

**Wi-Fi**

Wi-Fi Alliance defines Wi-Fi as any "wireless local area network (WLAN) products that are based on the Institute of Electrical and Electronics Engineers' (IEEE) 802.11 standards" However, since most modern WLANs are based on these standards, the term "Wi-Fi" is used in general English as a synonym for "WLAN".

The use of creating a hot spot to make available the Wi-Fi network as a network access point can be restrictive in indoor areas due to walls that block radio waves and could be generally about 20 mtrs. The hotspot in open areas is more effective for range specially using multiple overlapping access points.

**WiMAX:**

WiMAX (Worldwide Interoperability for Microwave Access) is a wireless communications standard designed to provide 30 to 40 megabit-per-second data rates, with the 2011 update providing up to 1 Gbit/s for fixed stations. It is a part of a “fourth generation,” or 4G, of wireless-communication technology. WiMax far surpasses the 30-metre wireless range of a conventional Wi-Fi local area network (LAN), offering a metropolitan area network with a signal radius of about 50 km. The name "WiMAX" was created by the WiMAX Forum, which was formed in June 2001.
to promote conformity and interoperability of the standard. WiMax offers data-transfer rates that can be superior to conventional cable-modem and DSL connections, however, the bandwidth must be shared among multiple users and thus yields lesser speeds in practice.

HSPA The first HSPA specifications supported increased peak data rates of up to 14 Mbit/s in the downlink and 5.76 Mbit/s in the uplink. It also reduced latency and provided up to five times more system capacity in the downlink and up to twice as much system capacity in the uplink compared to original WCDMA protocols.

These improvements are achieved in several ways:

Shared-channel transmission, which results in efficient use of available code and power resources in WCDMA A shorter Transmission Time Interval (TTI), which reduces round-trip time and improves the tracking of fast channel variations Link adaptation, which maximizes channel usage and enables the base station to operate at close to maximum cell power Fast scheduling, which prioritizes users with the most favorable channel conditions Fast retransmission and soft-combining, which further increase capacity 16QAM and 64QAM (Quadrature Amplitude Modulation), which yields higher bit-rates MIMO, which exploits antenna diversity to provide further improvements in bit-rates and system capacity.

GPRS

For the application of GSM mobile communication, the GPRS was originally standardized by Europe. GPRS is a General packet radio service, which is packet oriented for mobile on 3G and 2G global system for mobile.

The GPRS system is an integrated part of GSM network switching sub system, the GPRS core network allows WCDMA3G and 2G mobile networks to transmit IP packets to the internet which is an external network.

In response to the CDPD and i-mode packed switched cellular technology, ETSI now maintains GPRS in 3GPP, ie 3rd generation partnership project.

EDGE
EDGE technology or Enhanced Data rates for Global Evolution facilitates improved data transmission rates as a backward compatible projection of GSM. Installing EDGE compatible transceivers and upgrading the base station subsystem to support EDGE, networks can be upgraded to EDGE and no software or hardware changes are required to be made in the GSM core network.

The advanced methods used in data transmission and coding in EDGE is a resultant higher bit rate per radio channel, the capacity and performance obtained is almost three times that which can be achieved with ordinary GPRS/GSM connection. The EDGE technology can used for an Internet or any packet switched application.

With the enhanced Evolved EDGE the performance of the technology is found to be doubled and latency reduced to 80ms using dual carriers, this is achieved by lowering Transmission Time Interval by half from 20ms to 10ms, this complements HSPA or High Speed Packet Internet delivering a standard 400kbit/s and at peak bit rates upto 1Mbit/s. the enhanced technology also delivers higher order modulation and higher symbol rate from an original 8-PSK to 16 QAM and 32 QAM, the turbo codes also improve error correction.

1G

The first generation technology in mobile technology was first used in the early 1980, this is a analog technology for radio signals, subsequently replaced by the onset of 2G technology where networks are digital 2G which is basically second generation wireless telephone technology, its introduction ushered in three distinct advantages over the 1G, the ability to send SMS text messages, hugely popular until the introduction of what’s app, digital encryption of phone conversation & a much greater ability for mobile phone penetration due to its efficiency on the spectrum.

2G

2G is a short form for 2nd Generation wireless transmission technology. The technology in the 2G form was suitable for voice services, but is slow for data transmission. The type of multiplexing used differentiates the use in two types of base use CDMA and TDMA (GSM). GSM is more
popular with almost 80% use. There are few other TDMA based usages like PDC, iDEN and D-AMPS.

A few other technologies were introduced in the interim before the arrival of 3G technology, they were 2.5G or 2.75 g, these however used a packet-switched domain in addition to circuit-switched domain in addition to packet-switched domain, the bundling of the timeslots in used circuit-switched restricted speeding up the services.

With the entry of 3g mobile telecommunication, telecommunications fulfilled the International Mobile Telecommunication 2000 specification, set by International Telecommunication Union, which laid down technical standards for reliability and data transfer rates. The IMT 2000 standards specify a requirement of peak data rate at 200Kbit/s.

The evolving improvement has resulted in a change of cellular standards approximately every 10 years after the onset of 1G, each new generation of technology saw new frequency bands in use, non backwards compatible technology and higher data rates.

The advancement and evolution of LTE or Long Term Evolution standard to be backward compatible, or specifically LTE Advanced is a 4G technology, WiMAX though almost meets the IMT 2000 standards, the WiMAX is not very suitable for mobile phones and is rarely used, they are therefore not considered under even if it meets the requirements of IMT 2000.

4G

The fourth generation of mobile phone communication standards provides for mobile ultra-broadband internet access to mobile devices like laptops, smartphones, wireless modems and many such other devices. Applications include Video conferencing, gaming services, IP telephony, high definition mobile TV, 3D television and amended mobile web access.

2.4 Regulatory Framework in India

The Indian regulatory framework in telecom sector is summarised by the following diagram.

The Ministry of telecommunication and Information Technology has following five bodies namely, Telecom Commission DoT (Department of Telecommunication) TRAI (Telephone Regulatory Authority of India) WPC (Wireless Planning and Co-ordination Wing) TEC (Telecommunication Engineering Centre) Each of these is described in brief.
Figure 2.1 Indian Telecom Authorities

**Telecom Commission**

This is a government body which is inter-ministerial and is high level. The Commission is headed by a Chairman, the commission has four full time ex-officio members from the Government of India Department of Telecommunication who are at Secretary level, also participant are four part-time members who are secretaries to the Government of India from departments which are relevant to telecom. They function with the following mandate.

- Preparing the budget for the Department of Telecommunication and supervising the operations of the department.
- Formulating policies, issue of licenses and coordination in matters relating to telephones, telegraphs, facsimile services, wireless and data. Standardisation and promotion of research and development in telecommunication.
- Promoting investment of private investors in Telecommunication.
- International cooperation in matters connected with telecommunications.

**Department Of Telecommunications**

Based on the Telegraph Act of 1885 and the Indian Wireless Telegraphy Act of 1933, the central Government is exclusively privileged in establishing, maintaining and operating telegraph and
wireless telegraphy equipment, it also has the authority to grant licenses for these activities. The Department of telecommunication (DOT) to support these functions.

The formation of this separate department was actioned in 1985, from the earlier period in 1980, the telephone services and postal services both came under the department of Post and Telegraphs. The Department of communication formed thus under the purview of Ministry of Communication and Information Technology. With the basic mandate to accelerate the growth of telecommunication services.

Few of the important functions of DoT are Promotion of private investments in the Indian Telecommunication sector Standardization and promotion of research and development in the telecommunication sector.

Issuing licenses and regulating international cooperation with institutions like International Communications Union and International satellite organization.

TRAI: The government in 1997 setup the Telecom Regulatory Authority of India, with the intention to reduce the interference of government in telecom policy making and in deciding tariffs, under the Telecom regulatory Authority of India act 1997.

The main objective of TRAI as a independent regulator for telecommunication in the country is to provide a transparent and fair policy environment which supports a level playing field and promotes fair competition among the participating telecom players. TRAI’s powers are recommendatory, regulatory, mandatory and judicial.

The role of recommendations by TRAI include reviewing and proposing the need and timing for new service providers to be introduced, recommendations for the issue of new licenses including their terms and conditions and recommendation for revocation of license for non-compliance of terms and conditions of the license.

Seeking the recommendations of TRAI is mandatory for DOT even if it is the sole authority of licensing all communication services in India. It is interesting to note that DOT has the discretion to accept or reject the whole or part of the recommendation by TRAI.

Some of the TRAI recommendations almost wholly accepted by DOT are Recommendation on Infrastructure sharing and recommendations on Merger and Acquisitions 2011.
TRAI Recommendations accepted in part by DOT are Recommendations on allocation and pricing of spectrum for 3G and Broadband wireless Access Services 2006 TRAI recommendations not accepted by DOT are Recommendations on Next Generation Networks 2006, Recommendation on issues related to internet telephony and Recommendation on growth of value added services and regulatory issues 2009.

The above listing enumerates the ineffective and limited use of a specialist regulatory body created, which is in contrast to the workings and authority of such regulatory bodies in more advanced countries in the world. The indications of review to facilitate larger powers have been mooted by the government but not yet implemented. Both the regulator and DOT have sought legal opinion on matters which are in conflict. The final outcome is awaited.

In order to fulfill its mandate to provide transparent and fair playing field to facilitate competition, TRAI has on various occasions issued large number of regulations, directives and orders, to provide direction on a number of issues like tariff, interconnection and service quality, allowing the telecom market to move from a government dominated monopoly to a competitive multi operator, multi service market.

**Telecom Commission**

The Telecom Commission is an inter-ministerial high level government body. The Commission consists of a Chairman, four full time members, who are ex-officio, Secretary to the Government of India in the Department of Telecommunications and four part time members who are the Secretaries to the Government of India of the concerned Departments. The essential functions of the Telecom Commission are as under:

- Policy formulation, licensing and coordination matters relating to telegraphs, telephones, wireless, data, facsimile services and other similar forms of communications;
- International cooperation in matters connected with telecommunications;
- Promotion of standardization, research and development in telecommunications;
- Promotion of private investment in telecommunications;
- Preparing the DoT budget and supervising its operations Department of Telecommunications (“DoT”)
In the 1980s, telephone services and postal services came under the Department of Posts and Telegraphs. In 1985, the government separated the Department of Post and created the Department of Telecommunications (“DoT”). The DoT comes under the purview of Ministry of Communications and Information Technology. The Department of Telecom formulates developmental policies for the accelerated growth of the telecommunication services.

As per the Indian Telegraph Act, 1885 and the Indian Wireless Telegraphy Act, 1933 the Central Government has the exclusive privilege of establishing, maintaining and working telegraph and wireless telegraphy equipment and is the authority to grant licenses for such activities. The Central Government acts through the DoT. Some of the important functions of the DoT are as follows:

- Licensing and regulation International cooperation in matters connected with telecommunications (such as International Telecommunication Union (ITU), International Telecommunication Satellite Organization (INTELSAT), etc;
- Promotion of private investment in the Indian telecommunications sector;
- Promotion of standardization, research and development in telecommunications.

**Telecom Regulatory Authority of India (“TRAI”)**

In 1997, the government set up TRAI (Telecom Regulatory Authority of India) under Telecom Regulatory Authority of India Act, 1997 (“TRAI Act”), which reduced the interference of Government in deciding tariffs and policy making. The political powers changed in 1999 and the new government under the leadership of Atal Bihari Vajpayee was more pro-reforms and introduced better liberalisation policies. The government corporatised the operations wing of DoT on 1 October 2000 and named it as Department of Telecommunication Services (DTS) which was later named as Bharat Sanchar Nigam Limited (BSNL). (Wikipedia) Liberalization made it necessary for the Government to ensure that there is an independent communications regulator. TRAI acts as an independent regulator of the telecommunications industry in the country. One of the main objectives of TRAI is to provide a fair and transparent policy environment which promotes a level playing field and facilitates fair competition amongst various telecom players. TRAI’s powers are recommendatory, mandatory, regulatory and judicial.

The important recommendatory powers of TRAI are as follows:
• Recommendations regarding the need and timing for introduction of new service providers
• Recommendations pertaining to the grant of telecom licenses including their terms and conditions
• Recommend revocation of license for non-compliance of terms and conditions of license.
• TRAI is the sole authority empowered to take binding decisions on fixation of tariffs for provision of telecommunication services.

Emphasis needs to be placed on the interplay between the recommendatory powers of TRAI and the policy making powers of DoT. While the DoT is the sole authority for licensing of all telecommunications services in India, it is mandatory for the DoT to have before it TRAI’s recommendations with regard to matters over which TRAI has recommendatory power. Having done so, the DoT has the discretion to either accept or reject the recommendations of TRAI.4 TRAI has over the years come out with a number of recommendations; DoT has accepted some such recommendations either wholly or partially or has rejected such recommendations. Below is the status of some of the recommendations made by TRAI to the DoT

<table>
<thead>
<tr>
<th>TRAI Recommendations</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recommendations on Next Generation Networks (2006)</td>
<td>Not Accepted by the DoT</td>
</tr>
<tr>
<td>Recommendations on Allocation and Pricing of Spectrum for 3G and Broadband Wireless Access Services (2006)</td>
<td>Some of the recommendations were Accepted by the DoT</td>
</tr>
<tr>
<td>Recommendations on issues related to internet telephony</td>
<td>Not Accepted by the DoT</td>
</tr>
</tbody>
</table>
In this respect, there have been concerns that the very reason for the establishment of TRAI has been nullified in that a regulatory body whose specialist recommendations are not bound to be followed may be considered to be a paper tiger after all especially when comparisons are drawn with the more advanced regulatory agencies of the world such as the Federal Communications Commission (FCC) of the US which has been entrusted with very wide powers in telecom regulation including the granting of licenses.

There have been some recent reports wherein the government is considering giving wider powers to TRAI 5, however there has been no formal policy change as yet. Last year, the DoT had sought a legal opinion from the law ministry which stated that the DoT can change the terms and conditions of existing licenses and that TRAI's recommendations were not binding on the government. Subsequently, TRAI also obtained an independent legal opinion on the same subject from a former Supreme Court judge, who was also the former chairman of law commission, as well as from a noted Supreme Court lawyer, stating that the DoT cannot make any modifications to telecom licenses without consulting TRAI . The DoT has now referred both sets of opinions back to the law ministry to take a final call on this issue. The final outcome will define the scope of regulators in the country.

TRAI's mission is to create and nurture conditions for growth of telecommunications in the country in a manner and at a pace which will enable India to play a leading role in emerging global information society. One of the main objectives of TRAI is to provide a fair and transparent policy environment which promotes a level playing field and facilitates fair competition.
In pursuance of above objective TRAI has issued from time to time a large number of regulations, orders and directives to deal with issues coming before it and provided the required direction to the evolution of Indian telecom market from a Government owned monopoly to a multi operator multi service open competitive market.

The directions, orders and regulations issued cover a wide range of subjects including tariff, interconnection and quality of service as well as governance of the Authority.

By discharging various recommendatory and regulatory functions, TRAI has been a harbinger of change and has contributed significantly in the growth of telecom services in terms of increase in the number of service providers, consumer base and vast network of the telecom services across the length and breadth of the country. These measures have resulted in overall benefits to the consumer in terms of choice of services, affordable tariff of telecom services, and better quality of services etc, as is evident from the exponential growth in the total number of subscribers of telecom services.

Telecommunication Engineering Centre (TEC) Under Department of Telecommunications (DoT), Ministry of Communications and IT, Government of India has been appointed as the Designating Authority (DA) on behalf of DoT for Telecom Equipment. TEC as DA will be designating Conformity Assessment Bodies (CABs)/ Certification Bodies (CBs) located in India to perform testing and certification of telecom products. The role of TEC as DA is also to recognising Foreign CABs/ CBs located in the territory of MRA partner to perform testing and certification of telecom products to India’s requirements.

2.4.1 Policy Framework

The government is regularly revising the policies for the betterment of the telecom sector in India. In this section we will discuss various telecom policies.

2.5 Digital Divide

The "digital divide" is widely regarded as a unitary phenomenon. And as a first approximation, it is indeed useful to distinguish, in a general way, between the rich and powerful who are part of the
Information Age and the poor and powerless who are not. But viewed analytically, there is not one, there are three digital divides -- and emerging in many nations a fourth.

2.6 Universal Service Obligation Fund

The USOF was initiated to enable rural Indians to achieve their fullest potential and participate productively in the development of the nation by virtue of being effectively connected through a reliable and ubiquitous telecommunications network, access to which is within their reach and within their means.

Fund Status As per Ministry of Finance the reimbursement of license fees and spectrum charges to BSNL amounting to Rs. 6948.64 crore over the period 2002-03 to 2005-06 for fulfilling rural obligation is required to be taken into account for arriving at the available balance.

Taking into account this compensation to BSNL, the available balance would provisionally be Rs. 21839.45 cr at the beginning of Financial Year 2012-2013 Collection of Universal Access Levy vis-a-vis Allocation and Disbursement of Funds from USOF ( in Crores of Rupees)

Collection of Universal Access Levy vis-a-vis Allocation and Disbursement of Funds from USOF ( in Crores of Rupees)

<table>
<thead>
<tr>
<th>Financial Year</th>
<th>Funds Collected as UAL</th>
<th>Funds allocated</th>
<th>Funds disbursed</th>
<th>Reimbursement of LF &amp; Spectrum Charges to BSNL</th>
<th>Balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002-03</td>
<td>1653.61</td>
<td>300</td>
<td>300</td>
<td>2300</td>
<td>-946.39</td>
</tr>
</tbody>
</table>
2.7 Challenges in overcoming Digital Divide

A fundamental requirement for reducing the digital divide in countries is to give priority to the development of their communication infrastructure and provide universal and affordable access to information to individuals in all geographical areas of the country. There are a number of barriers to bridging the digital divide. Although underserved communities in India are gaining access to computers and the Internet their benefits are limited because of the following factors.

Infrastructural barriers Despite the incredible growth of the Internet since the early 1990’s, India still lacks a robust telecommunication infrastructure with sufficient reliable bandwidth for Internet connection. Due to higher costs the necessary upgrading of hardware and software is difficult; hence, despite the rapid spread of the Internet the gap is growing wider as the technological standard grows even higher. Faster networks, higher level machines, more complex software and more capable professionals are required, but in many nations including India the funding is not available to support these developments.
Libraries and information centers, with their commitment to freedom of access to information and promotion of life-long learning in India, are yet to have a robust infrastructure. Public libraries which can provide access to the Internet do not have computers and Internet access. Although cyber–cafes have been increasing, poor people cannot afford to have access due to high cost.

Literacy and skill barriers  Education and information literacy will play an important role in keeping society from fragmenting into information haves and have–nots. In the perspective of the digital divide, IT literacy is very important to allow access to digital information. In a country like India where roughly 50 percent of people do not have reading and writing skills for functioning in everyday life, IT literacy is out of the question. Generally, online content and information have been designed for an audience that reads at an average or advanced literacy level and those who have discretionary money to spend.

Education in information literacy will play an important role in keeping the society from fragmenting into a population of information haves and have–nots. The lack of skill in using computer and communication technology also prevents people from accessing digital information.

Economic barriers Poor access to computer and communication technology also causes a digital divide. In India the ability to purchase or rent the tool for access to digital information is less among the masses. The lower income group does not have discretionary money to spend on cyber–cafes or to get Internet connectivity on their own to access digital information.

Content barriers  The Internet allows ideas and information to be shared freely from citizen to citizen globally. In many ways the strength of the Internet is a function of the number of people and organisations creating quality content. Since no entity controls the Internet, anyone with Internet access has the potential to contribute information. Therefore, to solve the digital divide, steps should be taken by the government to ensure that all citizens are able to receive diverse content relevant to their lives as well as to produce their own content for their communities and for the Internet at large.

Language barriers  India is a country having a multicultural and multilingual population. Today a large percentage of information content on the Internet is in English, which is a barrier for the people whose primary language is not English.