Communication networks have become a key economic and social infrastructure in most of the countries in the world. The telecommunication network infrastructure is crucial for exchange of goods and services, and acts as a main catalyst in changing economic interrelationships through rapid technological change and the proliferation of a range of new services. With the development of the Internet, the role of communication networks has evolved and their importance increased. The advent of higher access speeds, in many cases symmetric speeds, available to business and to residential subscribers, has also increased the role of communication infrastructures by expanding the available range of services. High speed networks are increasingly helping resolve ongoing societal concerns in areas such as the environment, health care and e-education, are increasingly playing a role in social networking. However, for the potential of new network technologies to be realized, the market will require that these networks have universal, or close to universal coverage. The full potential of networks is only likely to be achieved where markets are effectively competitive and solutions have been implemented which ensure adequate coverage to most geographic areas.

A key innovation which is expected to bring further significant changes in the communications market is the transformation from circuit-based public switched telecommunication networks to packet-based networks using the Internet Protocol, so-called next generation networks (NGN). NGN is expected to completely reshape the present structure of communication systems and access to the Internet. The present structure of vertically independent, although interconnected networks may be transformed into a horizontal structure of networks based on Internet Protocol. Investment requirements for NGN are high and as for any investment, there are risks. Policies need to ensure that risks and uncertain returns are compensated while ensuring competition since, without competition, the benefits of high speed broadband and NGN will not be realized.

The developments in new communication structures and the impetus they are expected to give to the present process of convergence in networks, services and terminals are expected to lead also to new policy challenges. Convergence, by changing service boundaries, service characteristics and stimulating the offer of new services, may require that new markets are regulated differently than existing ones. It remains to be seen to what extent the deployment of NGN and convergence will facilitate the process of creating durable competitive conditions in communication markets or will raise further obstacles to the creation of
competition. It is fairly evident, however, that changes taking place as a result of investment in next generation access and core networks and the convergence of technologies, services and markets will require reviews and rethinking of existing policy and regulatory frameworks.

Applications

The digitalization of content, added to the shift towards IP-based networks, the diffusion of high-speed broadband access, and the availability of multi-media devices, allowed an increasing convergence of broadcasting and telecommunication sectors. The production and diffusion of audio-visual content does not seem to be limited to traditional broadcasters anymore. Telecommunication operators are providing content along with Internet access, newly emerging providers are offering access to content over IP, and traditional broadcasters are crossing over to other platforms, transmitting their programs also over IP networks.

Furthermore, the development of next generation mobile services-using 3G and 4G networks, or mobile broadcasting systems – enables the delivery of high quality audiovisual (AV) content to portable devices and mobile phones. Convergence is nowadays a reality, with different types of content and communication services delivered through the same pipes and consumed over a variety of platforms and user devices.

Convergence over multiple access platforms has not only affected the distribution market, but also created new forms of usage, providing consumers with greater choice and control over content. Multimedia, interactive audiovisual services are increasingly transforming users from passive watchers of TV programs to active players able to decide what they want to see, when and on which device. Video on Demand (VoD), Personal Video Recorder (PVR) services, Peer to Peer (P2P), or user-created video, therefore, herald an important change in the traditional broadcast model to exchange audiovisual content among large audiences. Media consumption, tastes and preferences may become more fragmented, the importance of social networks as a means to participate in content creation will probably continue to grow, and there will be an increasing demand for new types of content, able to fully capture the new capacity of the Internet for interactivity, non-linear consumption and participation.

Audio-visual content providers may include - in addition to traditional broadcasters - network operators, which are usually providing digital television and content over IP networks (such as Video on Demand) as part of their “triple play” bundles, or new service providers, such as Joost, using P2P technologies to stream content over the Internet, or YouTube, based *inter alia* on user created content. Broadcasters are also entering the IP market, launching new content platforms, such as Hulu-a NBC/NewsCorp venture.
Technological developments associated with next generation networks should help combine the characteristics of the traditional telecommunication model, and of the new Internet model, dissolving the current divisions and moving towards a harmonized and coherent approach across different platforms, gradually bringing in full convergence of fixed and mobile networks, voice, data services, and broadcasting sectors. In short, in the future the choice of the technology used for the infrastructure or for access will no longer have an impact on the kinds and variety of services that are delivered. This is contrast to what is prevailing currently, where the two worlds have different visions and commercial models.

Services provided over next generation networks will differ from services currently provided over the public Internet which is based on a “best effort” approach, where the quality of transmission may vary depending on traffic loading and congestion in the network, while with NGN packet delivery is enhanced with Multi Protocol Label Switching (MPLS). This allows operators to ensure a certain degree of Quality of Service – similar to the more constant quality of circuit switched networks – through traffic prioritization, resource reservation, and other network-based control techniques, as well as to optimize network billing as in circuit-switched transport.

Emerging Trends

Recently, web-based multimedia services have gained popularity and have proven themselves to be viable means of communications. This has inspired the
telecommunication service providers and network operators to reinvent themselves to try and provide value added IP-centric services. There was need for a system which would allow new services to be introduced rapidly with reduced capital expense (CAPEX) and operational expense (OPEX) through increased efficiency in network utilization.

Various organizations and standardization agencies have been working together to establish such a system. Internet Protocol Multimedia Subsystem (IMS) is a result of these efforts. IMS is an application level system. It is being developed by 3GPP (3rd Generation Partnership Project) and 3GPP2 in collaboration with IETF (internet Engineering Task Force), ITU-T (International Telecommunication Union-Telecommunication Standardization Sector), and ETSI (European Telecommunications Standard Institute) etc. Initially, the main aim of IMS was to bring together the internet and the cellular world, but it has extended to include traditional wireline telecommunication systems as well. It utilizes existing Internet protocols such as SIP (Session Initiation protocol), AAA (Authentication, Authorization and Accounting protocol), and COPS (Common Open Policy Service) etc, and modifies them to meet the stringent requirements of reliable, real-time communication systems. The advantages of IMS include easy service quality management, mobility management, service control and integration.

At present a lot of attention is being paid to providing bundled up services in the home environment. Service providers have been successful in providing traditional telephony, high speed Internet and cable services in a single package. But there is very little integration among these services. IMS can provide a way to integrate them as well as extend the possibility of various other services to be added to allow increased automation in the home environment.

**Challenges**

The design of NGN and convergence of networks and services will pose a number of significant challenges. There are several crucial issues that need to be investigated before a true convergence can happen in the network and service perspective. Some of the important issues are enumerated below:

- **Architectural Framework:** The migration towards NGN changes the architecture and topology of networks which potentially involves several structural changes, such as a reorganization of core network nodes and changes in the number of network hierarchy levels. The shift to IP networks also raises questions whether interconnection frameworks need to be revised.

- **QoS issues:** NGN will be all-IP based and will have to provide guaranteed QoS to mobile terminals. QoS provisioning in a heterogeneous wireless and mobile networks will bring in new problems to mobility management,
such as location management for efficient access and timely service delivery, QoS negotiation during inter-system handoff, etc.

- Design of user terminals: The design of single user terminal that is able to autonomously operate in different heterogeneous access networks will be another important research challenge. This terminal will have to exploit various surrounding information (e.g., communication with localization systems, cross-layer with network entities etc.) in order to provide richer user services (e.g., location/situation/context-aware multimedia services). This will also put strong emphasis on the concept of cognitive radio and cognitive algorithms for terminal re-configurability.

- Location and handoff management in wireless overlay networks: Future wireless networks will be inherently hierarchical where access networks have different coverage areas. Mobility management in wireless overlay networks will pose a difficult challenge to solve.

- Cross-layer optimization: Design of efficient cross-layer-based approaches will be instrumental in developing new mobility management schemes. It has already been observed through research that cooperation between the network and link layers is able to improve the performance of mobility management in IP-based heterogeneous communication environment. Information from the link layer such as signal strength and velocity of mobile terminals may help the decision making of mobility management techniques at the network layer. In cross-layer optimization, how to cooperate, how tight the cooperation is, and how much information is to be exchanged between the two layers are possible research issues.

- Other issues: Efficient use of spectrum, Fault-tolerance, availability of network services, enhanced security, intelligent packet and call routing, intelligent gateway discovery and selection protocol design and development of a unified protocol stack and vertical protocol integration mechanisms are some of the other important research issues in next-generation heterogeneous networks.

**Opportunities for Standardizations**

The heart of NGN and convergence is the issue of interoperability and interworking between heterogeneous networks, devices and applications. For interoperability, it is mandatory that different standardization bodies the world work in close collaboration on the important issues of convergence. Some of these issues are:

- Design of packet-based transfer mechanisms
• Separation of control functions among bearer capabilities, call/session, and application/service.
• Decoupling of service provision from network, and provision of open interfaces.
• Support for wide range of services, application and mechanisms based on service building blocks (including real time/streaming/non-real time services and multimedia).
• Broadband capabilities with end-to-end QoS and transparency.
• Interworking with legacy networks via open interfaces
• A variety of identification schemes which can be resolved to IP addresses (in IPv6 format) for the purposes of routing in IP networks
• Unrestricted access by users to different service providers
• Converged services between fixed/mobile
• Independence of service-related functions from underlying transport technologies

Convergence - Indian Perspective

India is one of the fastest growing wireless markets in the world. It is now the second-largest telecom market, just after China. Despite the global economic slowdown, the Indian telecom industry continues to grow substantially, delivering strong returns on investment, fuelled by the growth in the wireless industry. The wireless subscriber base grew at a CAGR of 61% over FY04- FY09, while fixed-line subscribers dropped to 38 million in FY09 from 40.9 million in FY04. The subscriber base reached 392 million as of March 2009 with more than 10 million subscribers being added every month. However, India accounts for 7% of the total subscribers in the Asia Pacific. Thus, low mobile penetration provides huge growth potential. Moreover, the teledensity levels between the urban and rural areas vary widely, which suggests untapped potential in the rural segment. It appears quite clearly that the rural areas would be the next growth driver for the Indian telecom industry.

With exponential increase in the mobile subscriber base, growth in investment in telecom sector, consolidation of the industry, increase in affordability of the consumers, India is has a very high potential to make the benefits of convergence and NGN reach the both the rural and urban population.

Challenges

The adoption and deployment of NGN and convergence in India will, however, face a number of significant challenges:
• Regulatory uncertainties: With TRAI and TEC increasing the subscriber base criteria, it has now become difficult for the existing operators to get additional spectrum. However, for efficient and quality services, spectrum availability is a must. The scarcity of spectrum in India is an industry-wide issue and needs to be addressed. Moreover, the issue of mobile number portability is still not resolved.

• Competition: The fierce competition in the telecom sector will lead to most of the new entrants losing out on high ARPU subscribers. Spectrum cost also will be prohibitively expensive for the new small players to design any feasible business model.

• Lack of affordability for most of the consumers: The cost of value added services and the prices of new handsets with advanced features of multimedia applications will be beyond affordability for the majority of the population.

• Lack of infrastructure: In many villages in India, lack of availability of electricity, backhaul and last mile for Internet connectivity are serious concern.

• Social issues: For many rural families, phone is not a personal object. Mobile phones, like a land line, are used by the entire family. Unless this attitude changes, the rural teledensity will remain low.

Conclusions

We have presented the concept of a converged, all IP communications environment, which fulfils almost all the expectations and requirements of an NGN system. The major drivers and their impact on convergence in NGN are also discussed. Various issues of NGN are pointed out and the current and future trends of standardization activities for NGN are presented in detail. IMS is depicted as a major enabler for achieving convergence. Some possible important areas of standardization in convergence are discussed and some challenging issues in this regard are presented. An organization like GISFI can possibly work in collaboration with other global standardization bodies to address these challenges. Finally, the emerging trends of the Indian telecommunication industry are discussed and some of the challenges that the industry is facing today for its growth and evolution are presented.