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IMPORTANT TRENDS IN COMMUNICATIONS AND MEDIA TECHNOLOGIES, APPLICATIONS AND SERVICES—POSSIBLE IMPLICATIONS

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Abstract

The Important Trends provide a concise overview of technology, applications and services over the next 5 to 10 years. It identifies the potential impact these trends may have on Indian Telecommunication & IT functions and responsibilities. Most important Trends and its Implications are grouped as under.

Key words: Communications, Media Technologies, IT functions

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Introduction

Overview- Most Important trends

1. An ***accelerating pace of change*** driven by overlapping developments in technology, and connections between people, databases and objects.

2. ***Diversity in the development of physical infrastructure*** including broadband, digital broadcasting, smart radio systems, sensor networks, mesh networks, efficiency techniques in multimedia transmission, location sensing and context-aware technologies, intelligent transport systems and satellite services.

3. Continuing ***spread of distributed connectivity*** through the integration of

information processing beyond the desktop into everyday objects and activities.

4. ***Enhanced content and network management capabilities*** driven by developments in deep packet inspection and content filtering technologies, coupled with the need to improve e-security, identity management, intellectual property protection and energy efficiency.

5. The ***emerging social web*** acting both as a platform and database, enabling innovation and creativity by users and service providers.

6. ***Continuing scientific and technological innovation***, which in combination are driving advances in computing power, display technologies, artificial intelligence and nanotechnology.

1. Accelerating pace of change

Innovations in technology, services and use are being driven by digitisation, higher-speed broadband networks and diversity in physical infrastructure, distributed connectivity and the emerging social web.

a. The Present Scenario

The last decade has seen the unprecedented pace of change. The trend are already evident in real-time data networks and high-resolution display screens. Consumers are creating, re-using, remixing and distributing content one-to-many and one-to-one. Content when viewed can be shifted to suit personal preferences. News is captured in digital form and distributed by individuals—more or less in real time. The Social Web has enabled people to connect and communicate in new ways, driving new forms of social interaction and entrepreneurship. At the same time, identifying and meeting the needs of people who may lack the capacity or desire to access and use new forms of communications and media is an emerging social inclusion issue.

b. The longer term view

Overlapping developments in technology and increasing interconnections between people, databases and objects—which together enable innovation and creativity—are expected to accelerate change over the next 10 years and beyond.

I**mplications—** The key regulatory elements are being conceptually stretched and pulled, drawing into question the sustainability of current regulations. A sustainable regulatory framework needs to provide for flexible approaches that are responsive to change and can accommodate new dynamics. Regular and systematic scanning and analysis of developments and regulatory implications is necessary to maintain the relevance of regulatory practice.

2. Developments in physical infrastructure and broadband networks

There are multiple distribution channels for professional content—mobile, IP-based services, terrestrial and satellite broadcasting. Network access arrangements are likely to be a mix of open or shared access and closed systems.

Advances in smart radio design and distributed connectivity is increasing the prevalence of wireless relative to wired access.

a. Broadband

Broadband is a class of data transmission technologies, including optic-fibre (FTTx), xDSL (such as ADSL, ADSL2+ and VDSL), HCF cable and wireless (such as WiMax, HSDPA, LTE and iBurst), offering a data rate significantly higher than narrowband services. Higher bandwidth is necessary to meet demand for increasingly data and

multimedia traffic that is increasingly two-way; that is, upstream and downstream.0ptical-fibre provides local access rates nearing 100 Mbit/s. In terms of wide-area networks scalable beyond 10 Gbit/s using optical-fibre technology is under development.

I**mplications** -To ensure availability and quality of service, allocate spectrum for broadband wireless and facilitate IP-based technologies.

b.Digital broadcasting and Mobile video

TV and radio broadcasting are in transition to digitisation. There is competitive internet delivery of broadcast-like services. Mobile video content is developing as a complementary platform to viewing digital content on the television set and PC.

Implications -

TRIA is likely to have an ongoing role in allocating the spectrum that is likely to become available following the ultimate closure of analog transmission. Considerable work is required to understand the likely planning and allocation issues .

Industry standardisation and bandwidth capacity issues from the deployment of high-definition (HD) services are relevant now and in the near future. HD broadcasting will provide distribution of very high bandwidth traffic television to supplement broadband platform capacity.

c**. Smart Radio System—Cognitive and Software defined**

While some smart radio capabilities are available now, a variety of new technologies are expected to . Cognitive radio (CR) and software-defined radio (SDR) technologies are frequency agile and share spectrum without interference.

Ideally, CR can individually and dynamically adapt its spectrum usage, taking into account local RF conditions such as interference and demand (the number of users and the applications they are using). CR is seen by many as a key enabling technology for making use of the so-called spectrum 'white-space'—spectrum that is under-utilised by existing services. Of particular interest are the UHF television bands. A given channel in these bands may be unavailable for a high-power service due to the potential for interference to an adjacent area, but may support low-power services such as wireless local area networks. CR is likely to be attractive to licensees who currently manage self-coordination issues manually.

SDR-operating parameters are defined by its software rather than its hardware, enabling it to tune into different frequencies and receive any modulation across a large frequency spectrum. By its design, the SDR can receive and transmit different forms of radio protocols simply by running different software. SDR enables fast upgrades and extremely flexible operation. For example, a telecommunications company using a software-defined mobile phone base station may be able to use a software upgrade rather than an expensive hardware upgrade to implement significant changes to its network, subject to the limitations of radio-frequency input/output elements. A software-defined handset could then be upgraded 'over-the-air' to operate on the new network without the customer having to replace the handset. The many economic and technical advantages of SDR mean that its use will continue to grow.

Implications The flexibility offered by SDR poses various regulatory challenges; in particular, facilitating the introduction of new services while managing the existing rights of incumbents.

c. Sensor Networks and related Technologies

Sensor networks refer to embedded sensing and intelligence in materials and the environment. An early example of this is the development and deployment of passive Radio Frequency Identification (RFID) tags. Miniature wireless data chips are being embedded in objects, such as security passes or a medical patient's wristband, that provide broad access to digital content in the physical world, ushering in new consumer and business applications.

Advances in nanotechnology and miniaturisation will mean that smaller objects will have the ability to interact and connect to networks more generally, such as local area networks in homes and offices. Elements within sensor networks can report on their location, identity, history, operational status and operational needs. With the deployment of sensor networks and ambient intelligence, networks and interconnected devices is expected to emerge over the next few years.

Ultra wideband (UWB) technology has also been used to create precision location RFID tags to allow the tracking of high-value items such as monitoring equipment, and doctors and patients in hospitals. UWB can transmit data at very high speeds over a wide spectrum of frequency over relatively short distances.

Other examples of networked devices include domestic energy meter reading, smart measurement and control, status/fire/fault monitoring, smart fault rectification for electricity distribution and railway networks, and many more. Interconnection of these devices is by combinations of wireless networks and wired infrastructure.

Implications

The challenge for regulatory authorities in managing the spectrum regulatory regime is to enable such applications to be deployed and, if necessary, to address any regulatory barriers to their mass deployment. Where these sensors are close to, or even inside the body, community concern over the public health and safety of the electromagnetic transmissions may become an issue.

d. Mesh Networks

Mesh networking enables wireless network-enabled devices to establish low-cost, high-bandwidth, self-configuring and self-healing peer-to-peer networks over local geographic areas i

I**mplications**

The application of existing telecommunications regulation may be tested where it is not clear who is providing the network or service , including whether there are multiple people providing multiple services.

e. Efficiency Techniques

There are ongoing technological developments that increase the amount of data that can be transmitted over a given physical infrastructure. These developments occur in terms of:

- multiplexing—the number of channels that can be supported on the infrastructure, be it wireless, copper cable or fibre;

- encoding—the conversion of a signal from one format to another;

- compression—techniques used to reduce the actual amount of data carried while preserving as much of the original content as possible; and

● error-correcting—techniques used to detect, correct or reduce the impact of errors in digital transmission.

Relentless research and development in compression technologies is expected to better handle bandwidth demanded by HD video and multimedia services.

Research into FAST copper (Frequency Amplitude Space Time) proposes to leverage the installed copper plant, which is by far the most ubiquitous access network. The aim is to make 100 Mbit/s broadband access available over fibre-copper DSL architecture.

The technique combines optimisation and signal-processing techniques with novel system architecture and protocols, as well as an integrated plane of real-time control, computation, data collection and auto-configuration.

The combination of advancements in encoding and compression techniques continues to deliver large increases in the effective capacity of existing infrastructure, and also contributes to new or innovative methods of communication. These developments have important economic implications for the carriage aspects of the industry and will make bandwidth-hungry services available sooner, hastening convergence.

Implication

Bandwidth-efficient techniques simultaneously increase the payload capacity of any infrastructure and reduce the spectrum bandwidth requirements of radio communications technologies. Offsetting this is potentially greater susceptibility to interference, which needs to be considered in designing spectrum frameworks.

f. Location- sensing and context –aware technologies

Wireless devices may know with increasing accuracy where a user is. Location-based services are expected to evolve through devices or objects with RFID and GPS connectivity.

The Geographic Information System (GIS) is becoming more widely deployed for tasks such as requesting directions, locating services or directing emergency service response.

Examples of location services are mobile phones delivering location-based marketing and real-time traffic information, monitoring local, interstate and international delivery vehicles and directory-style information.

They also encompass GPS functionality in mobile phones, digital cameras and real-time maps to hand-held devices and cars.

Content marked with location data has forged the development of what has become known as the Geospatial Web—the merging of geographical, location-based information with web-based information; for example, Google Earth. People-tracking and location awareness by machines (including position sensing & visual orientation) has emerged.

Implications—location-sensing

Key issues are safeguarding privacy, security, location service accuracy and reliability for users . Some countries have updated mobile location technology as another means to access emergency services.

g. Intelligent transport systems technologies

Intelligent Transportation Systems (ITS) use a broad range of wireless technologies that, when integrated into the transportation system infrastructure and

vehicles themselves, help to monitor and manage traffic flow, relieve congestion, provide alternative routes to travelers, improve safety and save lives. The ITS technologies are enabled using Dedicated Short Range Communications (DSRC).

DSRC for ITS applications is the use of non-voice radio techniques to transfer data over short distances between in-vehicle mobile radio units and roadside units. They perform operations that improve traffic flow and safety, as well as other intelligent transport service applications in a variety of public and commercial environments.

Implications

Internationally, the US and Europe have allocated the 5.850–5.925 GHz frequency band for ITS. Mobile equipment is likely to be manufactured into vehicles imported . The road transport industry have to find the way for the introduction of ITS by way of an extensive roadside radio communications infrastructure.

h. Satellite services

Satellites are an increasingly capable substitute for terrestrial access infrastructures. Far from being banished to niche markets covering remote and sparse populations over huge distances, they are a common access method for many mainstream services such as pay and free-to-air TV services. In telephony, remote area extensions to cellular services using satellite services are moving from niche to mainstream, **while broadband services to aircraft can only be provided by satellite and are becoming a basic facility for commercial international travel(This service is presently not provided by airlines in India and being hotly debated)**

Looking beyond communications, weather and other scientific disciplines will expand their use of sensing satellites, as public and commercial interests demand that weather forecasts, for example, be extended further into the future with a higher reliability. This will drive the need to gather more data more frequently and from more locations.

Implications

Need for ensuring that satellites have access to appropriate spectrum that, given their nature, is likely to be harmonized internationally. Satellite services are particularly sensitive to interference and, even with developments in cognitive radio and other interference-management technologies, they will probably continue to require greater levels of interference protection than other services.

3. Distributed connectivity

Inclusive of computer networking and IP-multimedia services, this trend is perhaps most notable for the integration of information-processing beyond the desktop into everyday objects and activities, or what is sometimes described as ubiquitous computing.

a. Computer Networking Technologies

The cost of data storage is decreasing and demand is increasing. With solid state or flash memory (no moving parts as opposed to hard drivers) higher capacity storage can be incorporated into smaller form factors (eg. smaller sized iPods with multi-gigabyte storage capacity). Computers at the edge of the network, including PCs, game consoles and mobile devices, have ever-increasing processing and storage capacities. Increasing capacities and use of local storage and data re-use has possible implications for communications and media business models.

Implications

Related issues are the deployment of home or personal-area networks and issues of network boundaries, interconnectivity and interoperability. The need for computer

literacy & skills, importance of consumer education and awareness.

b. IP –Based services

The use of internet protocol (IP)-based transmission technologies is driving the design and use of telecommunications network and platform convergence. Developed by the mobile communications industry, IP Multimedia Subsystem (IMS) is an open systems architecture that supports a wide range of IP-based multimedia services over packet and circuit-switched networks. IMS may form the basis of the convergence of fixed and mobile communications. *Voice over IP* (VoIP) and *IPTV* are examples of IP-based services and applications. VoIP is one of the better-known manifestations of peer networking.

The evolution of multimedia telephony is likely to include value-added services that blend voice with other applications.

An additional consequence may be that data carriage requirements will become more symmetrical. Currently upstream and downstream data requirements for residential internet access are generally asymmetrical, with the upstream path requiring much less data capacity than the downstream path. Increasingly, user interaction applications, such as Facebook, will require similar uplink and downlink capacities. This will impact on radiofrequency spectrum demand in wireless networks, as uplink and downlink RF bandwidths will need to be more balanced, and require a revision of xDSL deployment standards.

Implications

IP systems and IMS are of immediate interest to how existing voice services regulation applies to a variety of VoIP services.

The regulatory framework was designed in a circuit-switched network environment and the transition to IP-based networks has to consider how existing regulations translate to an IP environment. Issues for industry and regulators include device interoperability, network interconnection, operational systems inter-working and access to IP-based networks.

4. Emerging content and network management technologies

Key issues in this theme are the increasing use of content monitoring technologies, and the need to improve e-security and identity management. More recently, there has been a growing awareness of the potential improvements to energy efficiency and use from distributed micro-generation in 'smart-grids

a. Content Monitoring

Content monitoring technologies include deep packet inspection (DPI) and content filtering software.

DPI examines the inside structure of data packets to determine their contents. If the technology was to be deployed in internet service providers' (ISPs) networks it would be able to block, shape, monitor and prioritize that traffic—in any direction. . .

Implications

DPI has the potential to be significantly abused—service providers could discriminate between differentiated payloads, possibly for anti-competitive practices. Some regard DPI as a serious threat to the concept of internet neutrality.

Privacy may also be an issue through the secret monitoring of personal content without prior consent.

On the other hand, DPI is useful to law enforcement agencies in their interception and surveillance tasks. It could potentially

be used in e-security operations—detecting viruses, spam, and violated rules and policies, and collecting use statistics.

Content filtering can be used to block access to restricted or illegal content.

b. E-Security

As the internet and associated applications such as email and web browsers are used for an ever-increasing number of business and social transactions, organized crime is focusing increasingly on internet-related crime.

Given the burgeoning online economy and increasingly sophisticated criminal incursions into this economy, maintaining and enhancing the security of internet transactions and communications will become a growing priority. There will be a growing focus on website security.

Social networking sites are likely to be prime targets of criminal attacks, as are other websites with significant potential for the harvesting of personal identity information, including government websites.

Improved authentication and validation systems for internet communication and transactions need to be developed, both for high-level transactions such as internet banking and for more routine communications such as email. .

Implications

It is likely that coordinated government and industry action at the international level will be required to establish effective email authentication standards.

User education, effective legislation and enforcement, international cooperation, and the ongoing development and implementation of technical solutions and standards will be required to address e-security problems.

c. Identity Management

A digital identity is a set of attributes for an entity such as a person, service, device or an application. In order to assert a particular identity in each case, it is necessary to enable the mutual exchange of information that is relevant to the provision of a particular service or application, but which may also be personal or sensitive. The structure, security, storage, interoperability and availability of digital identities are requirements that form part of an Identity Management (IdM) framework. IdM has been developed by the International Telecommunications Union for standardization of for digital identity.

Implications

Whatever form identity may take, there is a need to manage globally the parameters that together form the identity of users or objects. As IdM exists in all walks of life, and required in a diverse range of technologies—including biochemical, biomedical, microelectronics, industrial control and physical resource management, as well as communications—the need for unified policies, legislation and codes is obvious.

The use of IdM in the delivery of communications and media services may be relevant for standardization of network and application layer addressing in Next Generation Networks.

d. Access and Management of Digital Content

Digital rights management (DRM) is the control and protection of intellectual property in content that is stored in digital form, including documents, images, video and audio. DRM

attempts to limit what a user can do with that content even when in possession of it. The arrangements for managing digital rights might be a combination of encryption and validation processes, conditional access; for example, smart cards, or any other means used to secure and control access to digital content.

Internationally, governments and holders of intellectual property are examining what action ISPs and end-users might take over illegal file-sharing. Some advocate legislative measures to force ISPs to take action. Others suggest self-regulatory measures. Whatever controls are put in place, compliance is likely to be problematic.

Implications

Government has primary responsibility for protecting intellectual property and has a role in promoting consumer awareness of rights and responsibilities. Other issues relevant include industry standardization for DRM, technology interoperability and access to information. As these technologies run in the background, there are potential implications for privacy and security.

e. Energy Efficiency Applications

There is now a growing awareness of the effects of climate change and a focus on saving energy. The communications industry is a major user of energy by virtue of its facilities, installations, production activities, equipment and devices. As a consequence, the emerging reality is that industry has the responsibility to reduce energy consumption; for example, through policies, standards and codes governing devices and equipment. At the same time, its own technologies, innovations and developments have tremendous potential to assist other industries in their efforts to increase the efficiency of energy use. Important examples include digital IdM, web-based measurement, analysis and control systems heavily dependent on electronic acquisition, processing, transmission and the networking of energy-related information.

This is a fast-developing technology driven by the unprecedented business opportunities . Attention is being paid to techniques that measure energy usage parameters and allow energy data to be communicated and analyzed. Video and web-conference tools now reduce the need to travel for work and allow more employees to work from home.

Implications

Governments potentially have an increasing role in promoting energy efficiency through industry co-regulation. This is the government's commitment to international agreements.

5. Web-based services and the emerging 'social web'

For some years now, the web has enabled highly innovative developments at the edge. The web is now turning into both a platform and a database. Recent examples of this include the third-party development of applications programming interface (APIs), enabling interaction between programs on networked computers, mashups (content drawn from multiple websites) and widgets (portable code that any user can install and execute on their web pages).

a. Social Networking Sites (SNS)

These sites enable individuals to 'put their lives online' by posting personal profiles and other information on dedicated Sites, online media (music and video) and other information. Social networking sites are examples of web-based innovation andSNS are used by journalists and others as a means of obtaining instant news or hook-

ups with people on the ground at a particular event.

Traditional media are also attracted to the social networking market due to the growth in online advertising revenue. They are partnering with or acquiring social networking sites.

SNS may evolve over the next five years to become integrated hubs for individuals, organisations and their extended networks to connect, communicate, access and share tailored news, information and entertainment. They are becoming social destinations in their own right, which can lead to a 'blurring of the boundaries' between online and offline worlds. Young people in particular have been quick to use SNS to share information about themselves, meet their need for self-expression, make new connections and organise social activities.

Some organisations see real-time collaboration through social networking as an effective way to manage large-scale and geographically dispersed teams, and for organisational communication.

b. Mobile WEB

Although web access was earlier largely via a PC or games console, over the past few years the mobile web is already well advanced and is beginning to emerge in other developing economies.

c. Internet TV

Beginning with online video streaming and downloading through applications like YouTube, more advanced internet TV services are now available. In about 10 years, internet TV may have high-quality pictures and streaming, along with established web features such as sharing and personalisation.

d. Cloud Computing

Also known as 'computing on demand' or 'software as a service', cloud computing is the shared use of distributed computing resources as an alternative to in-house IT applications and services using local servers or personal devices. Cloud computing offers scale flexibility and cost-efficiency, and has the potential to be highly disruptive to desktop computing technology within the next five years.

e. Vitual Identities

While currently dominated by online games such as Second Life and virtual identities such as avatars on social networking sites or other online interactions, more forms of virtual world activity are anticipated. Developments may include enhanced reality (electrochemical stimulation of the brain), augmented reality (combination or blurring of real and digitally modified identities and physical environments) and telepresence (video conferencing with more sophisticated video capture through holographics). The blurring of the boundaries of real and virtual identities is currently being experienced most intensively by young people, but may become more widely experienced over the next 10 years.

f. Semantic WEB

The semantic web involves using metadata to enable computers to process the meaning of data (intelligent agents). Although this has now been in 'gestation' for some time, an increasing number of companies are working to fully implement the semantic web. Over the longer term, the aim is to develop a common framework that allows data to be shared and reused across application, enterprise and community boundaries so that a machine can perform particular tasks to the extent that humans do now.

Implications – WEB based services

Social networking is emerging as a platform where individuals and networks of people influence and shape behaviour, community views and corporate strategies. There are now issues of inconsistent regulation. To set much higher benchmark to permitted versus prohibited content.

The take-up and use of SNS is achieving broader recognition. Twitter is one of a number of such sites called to support in US the InSTEDD project (Innovative Support to Emergencies, Diseases and Disaster), which aims to provide advice and warnings, and to coordinate aid in times of emergency. SNS services are seemingly well-placed to undertake this role because they transmit new developments instantly and can make connections with people on the ground. Should this initiative succeed, SNS might potentially complement traditional means of communication for emergency services.

6. Continuing scientific and technological innovations

New innovations are taking shape at fast pace in computing processing power, display technologies, artificial intelligence and nanotechnology.

a. Computer Processor Power

Computer Processing power is increasing at a very fast pace and is expected to continue to grow over the next decade and beyond. The multi-core processors are building. Technological breakthrough has been demonstrated whereby light is used instead of wires to connect hundreds of thousands of processing cores on a tiny chip. Expected benefits include reductions in cost and energy use, while increasing bandwidth.

Multiple cores on a chip potentially allow a processor to be dedicated to sub-tasks such as vision processing and speech processing. Indexing and searching image and video data is another emerging advance. These developments suggest further dramatic changes in the nature of ICT devices and services—which may create novel and unexpected challenges.

Further in the future, and subject to considerable investment and research, is quantum computing.

Implications

Although they are unlikely to develop into standard consumer computer equipment, developments in this domain are of critical interest because of their particular application to breaking current factor-based encryption schemes. When and if quantum computing occurs, contemporary communications security will face a severe challenge.

b. Display Technologies

There are several emerging display technologies that do a better job than either of the current large-screen contenders—LCD or plasma display.

Canon has unveiled Surface-conduction Electron-emitter Display (SED) technology that is based on the same technology as traditional cathode ray tube (CRT) televisions, miniaturised and packed inside a flat-panel display. SED technology can create HDTV video quality with all the benefits of a CRT display without the CRT size. Sony and others have been working for several years on a technology called Field Emission Display, which has yet to reach commercial standards.

These are steps toward the goal of selling enormous, ultra-thin displays (or even wallpaper) televisions to all homes at affordable prices. Developments are also likely in the form of electronic newspapers, flexible screens, among others. Disposable screens on consumer products may also be

feasible. There may evolve functional portable electronic-document readers with display that can unroll to a scale larger than the device itself.

These developments will lead to a much greater range of display surfaces, with electronic content consequently permeating virtually every corner of people's lives.

Implications

Content regulation issues may become more acute due to material being displayed or located in places that do not match community standards or that raise questions of what children should be exposed to.

Educating consumers about some of the complexities in the digital TV supply-chain may arise. For example, a consumer may have a HD-capable tuner but a screen that does not have the necessary resolution to show the program.

c. Artificial Intelligence

Artificial Intelligence (AI) enables computers to recognise objects or patterns and perform tasks that usually require human intelligence. There is growing interest in consumer-oriented robots, such as robot dogs that are capable of understanding some human speech and intelligent humanoids that can walk down stairs, respond to verbal instructions and talk.

Most useful robots are unlikely to be humanoid as such, but they are likely to be extensive users of spectrum in a variety of ways. Although many are sceptical, the promise of AI on the web continues to attract interest, and the possibility of breakthroughs in this area over the next 10 years cannot be dismissed.

Implications

Artificial Intelligence may need to be supported by rules governing decision-making and overall responsibility. Networked robots are likely to be another growth area in the use of radiofrequency spectrum.

d. Nanotechnology

In broad terms, nanotechnology is the understanding and control of matter at the molecular and atomic level. The impacts of development activities are already being felt in the market, facilitating the emergence of communication devices like digital cameras, mobile phones and flat-panel televisions. Battery technology generally is improving at a slower rate than processing and chip technology, potentially limiting applications development. However, reducing conventional lithium ion batteries to nanoscale improves power density and recharge time dramatically. By developing computing in organic substrates rather than silicon, nano computing is likely to address the integration of information technology with biological systems.

As a pervasive and fundamental technological shift, it is hard to predict now what impacts nanotechnology might have on ICT, but they are important to monitor. Further developments in nanotechnology might result in a large increase in sensor networks, including networks that reside either on or in the human body.

Implications

Nanotechnology is still at nascent stage and it will have most far reaching effects in every domain of technology as and when its application is commercially available .and needs to be discussed separately.

Conclusion

The trends and implications mentioned above are based on present and likely emerging technologies in the near

future. They need to be reviewed and upgraded as newer technologies mature, its application become affordable and reaches to the masses. As and when the applications are more and more widespread so are its implications. Therefore there is a need to have a technically and legally competent /effective National & International regulatory organization to guide / regulate both technical / legal aspects of these trends and its implications.

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