



*Research opportunities in Industry from an
ICT domain perspective*

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Publication**

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engineering creativity

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Automotive

Embedded Electronics & ECU
Telematics

Wireless

CDMA / UMTS / 3G
WiMAX, Convergence

Consumer Electronics

Digital Still / Video Cameras
DVD players, Digital Video Recorders
Handhelds, Printers, Scanners

Media

Set-top Boxes, VOD & Media Servers
Digital Content Creation Software
Multimedia Codecs



Semiconductor

SoC & ASIC development
Silicon Deployment
solutions.

Storage

Embedded storage
Enterprise storage

Networking & Communications

VOIP
Routing & Switching
Network Management Systems

Scientific Instrumentation

Medical Imaging
Data acquisition & Visualization
Test & measurement equipment

Technology Development during Recession



Recession Period	President of US	Technology Development
1953-1954 (10 Months) Korean War	Dwight D. Eisenhower - Republican	<ul style="list-style-type: none"> • Transistor Radio USA from Texas Instruments • Solar Cell USA also called photo voltaic cells • Robot USA by George C Devol Jr
1957-1958 (8 Months)	Dwight D. Eisenhower - Republican	<ul style="list-style-type: none"> • Soviet Union launches Sputnik 2 with a dog • Microchip USA by Jack Kilby • Computer Modem USA • Remote Control USA Zennith Corporation
1960-1961 (10 Months)	Dwight D. Eisenhower - Republican	<ul style="list-style-type: none"> • Laser USA by Theodore Maiman • Heart Pacemaker USA by Wilson Greatbatch • Weather Satellite USA Tiros I • Vertical Take off Jet UK • Human Space Travel - Yuri Gagarin - Russia
1969-1970 (11 Months)	Richard Nixon - Republican	<ul style="list-style-type: none"> • Internet USA US military • Manned Moon Landing USA • Charge Coupled Device - to capture image • LCD England by George Gray • Battery Powered Smoke Detector USA

Technology Development during Recession



Recession Period	President of US	Technology Development
1973-1975 (16 Months) Raising oil prices by OPEC	Richard Nixon & Gerald Ford - Republican	<ul style="list-style-type: none"> •Genetic Engineering, Bar code, Optical Fiber •Space Station USA by Skylab •Personal Computer USA Microsoft •The Digital Camera Steven and Kodak Company •Laser Printer USA
1981-1982 (16 Months) tight monetary policy in the U.S.	Ronald Reagan - Republican	<ul style="list-style-type: none"> •Space Shuttle USA Columbia •Scanning Tunneling Microscope Switzerland •Human insulin produced by bacteria
1988-1992 stock crash in the U S	George H. W. Bush - Republican	<ul style="list-style-type: none"> •Laser Eye Surgery USA •First release of Microsoft Office Package •Microsoft Releases Windows 3.0 & MS Dos 5.0 •Internet is made available for commercial use •AT & T release video telephone for \$1,499
2001-2003 Sep 11 Attack	George W. Bush - Republican	<ul style="list-style-type: none"> •Wikipedia, a free encyclopedia, goes online •Apple Computer releases the 'iPod' •Microsoft Releases Windows XP

Source: <http://www.thepeoplehistory.com> & <http://www.socyberty.com/Economics/World-Recessions.112332>

- The Indian ICT Industry has excellent growth in the past 15 years. The advantages of talent and efficient youngsters, lower cost of operation and the innovative remote delivery model, India has established itself as a global leader in the ICT sector.
- However, the industry today is facing many challenges in terms of rising costs, availability of quality talent pool, security and IP protection and infrastructure Concerns.
- To sustain the growth and achieve global leadership, the Indian ICT industry needs to move from being a **service provider** to a **solution provider**.
- The Indian industries needs to provide innovative solutions of higher value to the International customers. This innovation need not necessarily be in Products but could be in Services, Processes and even Business models.
- The growth also must reach the second level cities also and shall not be limited with in major cities.
- The areas are open for new innovation in Indian ICT Industry are Semiconductor, Wimax and Networking etc.,

1. Communication Channel and Bandwidth
2. Computer Processing Power
3. Capacity for Digital Storage
4. Critical Software Facilities
5. Content Production for Digital Assets
6. Compliance to Evolving Standards

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In Communication Channel and Bandwidth

Wired Network (Data)	LAN, WAN, MAN setups
Wireless Network (Data)	Wi-Fi, Wimax, GPRS (3G), EDGE (4G)
Wired and Wireless Network (Voice)	Cell Phones, VOIP over Wi-Fi Networks
Other Channels	TV- Analog to Digital and Satellite Networks

In Computer Processing Power

- Desktop computers have a CPU that runs at 3 GHz or more
- Grid and Cloud Computing
- Latest PC Applications

In Critical Software Facilities

PC / Server OS	Windows XP/Vista, Linux, Mac, Solaris
PDA and Mobile OS	Palm, Win CE, Symbian
Hardware Specifics	Router, Hub, Modem etc.,

Today's ICT - Area wise



In Capacity for Digital Storage

Type of Storage	Unit Capacity (KB/MB/GB)	No. of pages that can be stored
5.25" floppy diskette	1.2 MB	300
3.5" floppy diskette	2.88 MB	750
USB Memory Stick	512 MB	128,000
CD-ROM disc	640 MB	160,000
DVD disc	4 GB	1,000,000
PC Hard Drive	40 GB	10,000,000
Server Hard Drive	400 GB	100,000,000
Backup tapes	40 GB	10,000,000
Optical Jukeboxes	1 TB	250,000,000
NAS setup	40 TB	10,000,000,000
SAN setup	160 TB	40,000,000,000

Source: <http://unpan1.un.org/intradoc/groups/public/documents/un/unpan014026.pdf>

In Content Production for Digital Assets

- Businesses and educational institutions have constantly generated content and placed it online within their premises, with some offered to the outside world.
- Individual online content has also increased with time as a result of subscriptions to credit cards, magazines and census fulfillments.
- English has by far been the most dominant content language on the Internet (80 to 85%).

In Compliance to Evolving Standards

- ICT standards have evolved with relevant developments in both software and hardware solutions.
- National, regional and global bodies have constantly been formed to form and apply ICT standards.
- Beyond ICT, sector-specific information standards have evolved (identifier, communication, content and structure, etc) to facilitate harmonized interchanges between different Industries.
- Standards have allowed for broader acceptance of most ICT products (buyers are assured of compliances) and have brought ICT professionals together for a rewarding cause.

- **Wimax – Worldwide Interoperability for Microwave Access**
- Wimax with other wireless Technologies
 - WiMAX is a broadband wireless access (BWA) technique, offering fast broadband connections over long distances. It is an IEEE 802.16/ETSI HiperMAN based certificate for equipment fulfilling the interoperability requirements set by the WiMAX Forum
 - The technology underlying the standard is often referred to as "Wireless MAN wireless local loop" or "WiMAX".
 - A key aspect of WiMAX is the interoperability between products from different vendors.
 - WiMAX uses different modulation schemes between the consumer and the base station along different distances.
- The goal of **802.16** is to 'create wireless versions of Ethernet that can operate over distances from a few meters to tens of kilometers –from personal area networks to wide area networks.'

Wimax Standards from Past to Present



Standard	802.16	802.16a	802.16d (Fixed)	802.16e (Mobile)
Completed	Dec 2001	Jan 2003	July 2004	Dec 2005
Alignment mode	LOS only	LOS and NLOS	LOS and NLOS	NLOS
Spectrum	10-66 Ghz	2-11 Ghz	<11Ghz	<6Ghz
Bit rate	32-134 Mbps (28 Mhz channel bandwidth)	75Mbps (20 Mhz channel bandwidth)	75 Mbps	Upto 15 Mbps (5 Mhz channel bandwidth)
Modulation	QPSK, 16QAM, 64QAM	OFDM 256 sub-carriers, QPSK, 16QAM, 64QAM	OFDM 256, 16QAM, 64QAM	Scalable OFDMA
Mobility	Fixed	Fixed, portable	Fixed	Mobile but Low speed
Channel bandwidth	20,25 and 28Mhz	1.5-20 Mhz	Selectable between 1.5 and 25Mhz	Same as 802.16a with UL sub channels to conserve power
Applications	<ul style="list-style-type: none"> - E1/T1 services for enterprises - Backhaul for hotspots 	<ul style="list-style-type: none"> - E1/T1 services for enterprises - Backhaul for hotspots - Wireless DSL 	<ul style="list-style-type: none"> - Indoor broadband access for residential users (High speed Internet, VoIP) 	<ul style="list-style-type: none"> - Portable Broadband access for consumers - Mobile Internet - Always best connected

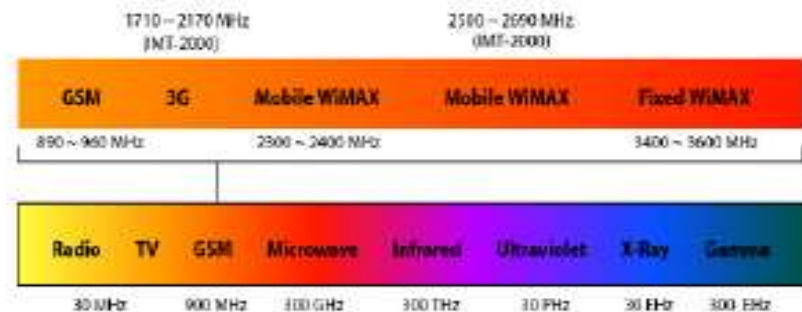
Fixed Wimax and Mobile Wimax



- We can get to know about the Fixed Wimax and Mobile Wimax using the Frequency Spectrum of Wimax
- Research opportunities are there with Mobile Wimax in ICT perspective.

Frequency Spectrum

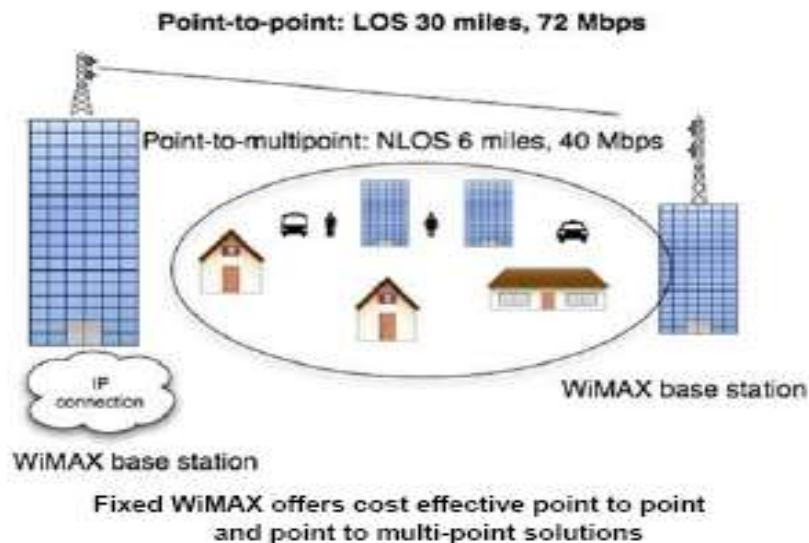
- Fixed WiMAX
 - 2 – 11 GHz
 - 10 – 66 GHz
 - OFDM modulation
- Mobile WiMAX
 - 2 – 6 GHz
 - OFDMA modulation



Source: www.rict.co.ir/modules/Submit_News/upload/wimax.pdf

Fixed Wimax and Mobile Wimax

- Fixed WiMAX: 802.16-2004 - Currently holds the market advantage as certified products are already available
- Mobile WiMAX: 802.16-2005 - Scheduled to become the dominant version of WiMAX as it supports both fixed and mobile services and operates on a wider range of frequencies



Source: WiMAX.com

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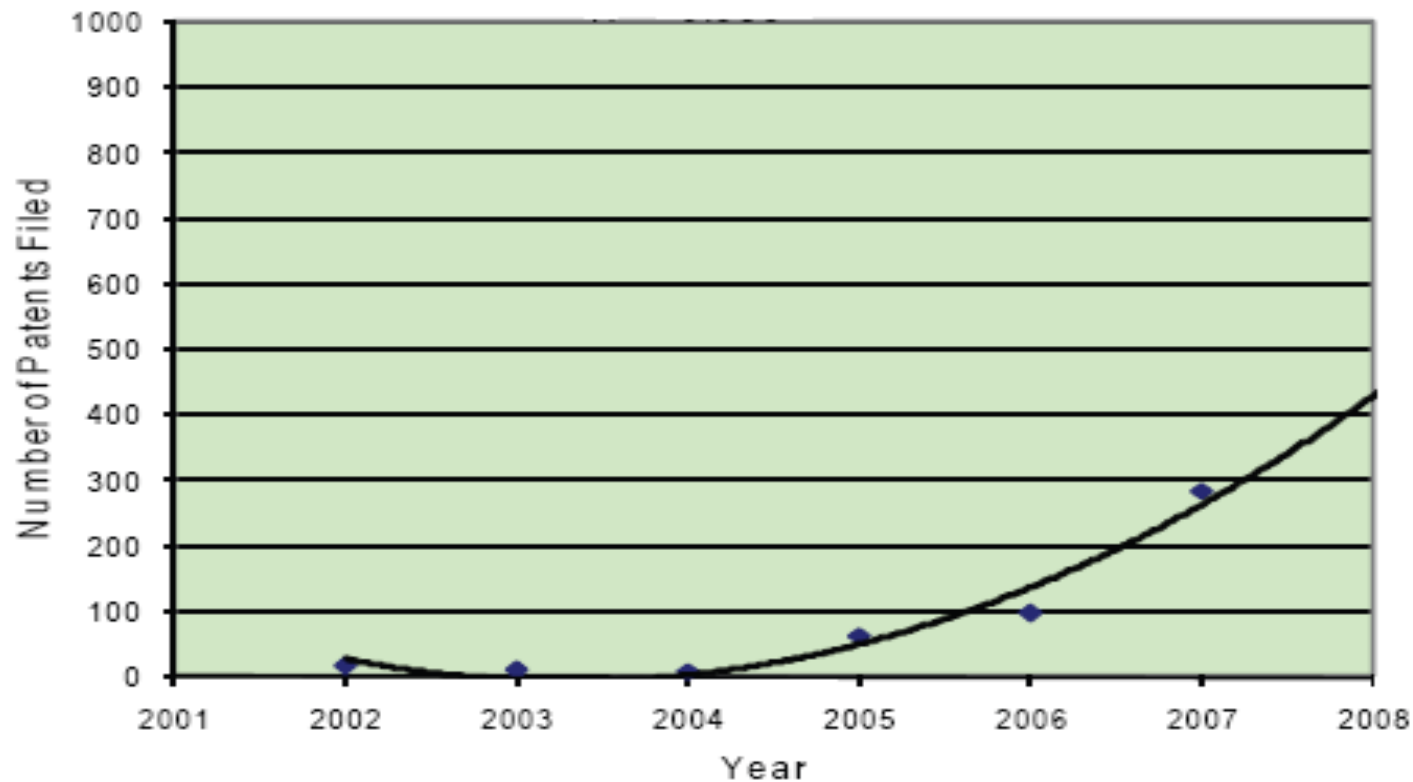
Source: www.rict.co.ir/modules/Submit_News/upload/wimax.pdf

- The Mobile Wimax standards was established for mobile broadband wireless access system. The IEEE working group ratified the standard in December 2005 . Fixed Wimax (802.16d-2004) has been superseded by 802.16e-2005, also known as Mobile Wimax
- The first Patent of Mobile Wimax filed by **Samsung** Electronics at 2008.
- Later so many companies like Nokia Networks, Signpost Networks Llc, Ortel Networks Limited, Mbiz Networks Global Co Ltd, Fujitsu Ltd, LG, Ericsson etc., are filed patents for their invention on this mobile Wimax.
- The GSM-based subscriber base now stands at 315.7 million, an increase of 2.9 percent over the 306.8 million in the previous month. Like that CDMA mobile user base is 19 million.
- Around **30 patents** are there in this Mobile Wimax Technology
- There is a work opportunity to create/enhance 802.16/WiMAX network level simulation
- Technical contributions characterizing 802.16 performance and network capacity are much needed

Wimax patent Filing Analysis

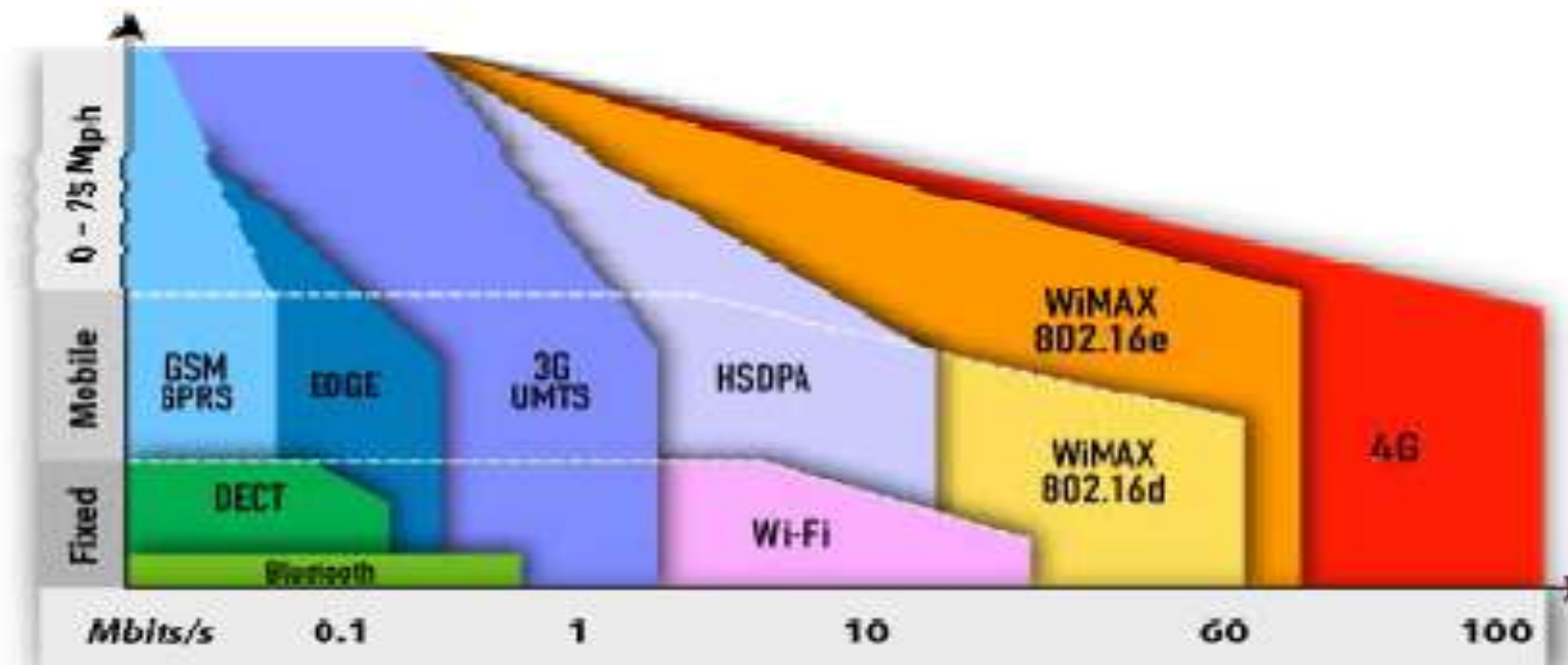


WiMAX-related Patent Filing Activity Analysis



Source: http://www.researchandmarkets.com/reports/591021/wimax_ip_and_patent_report

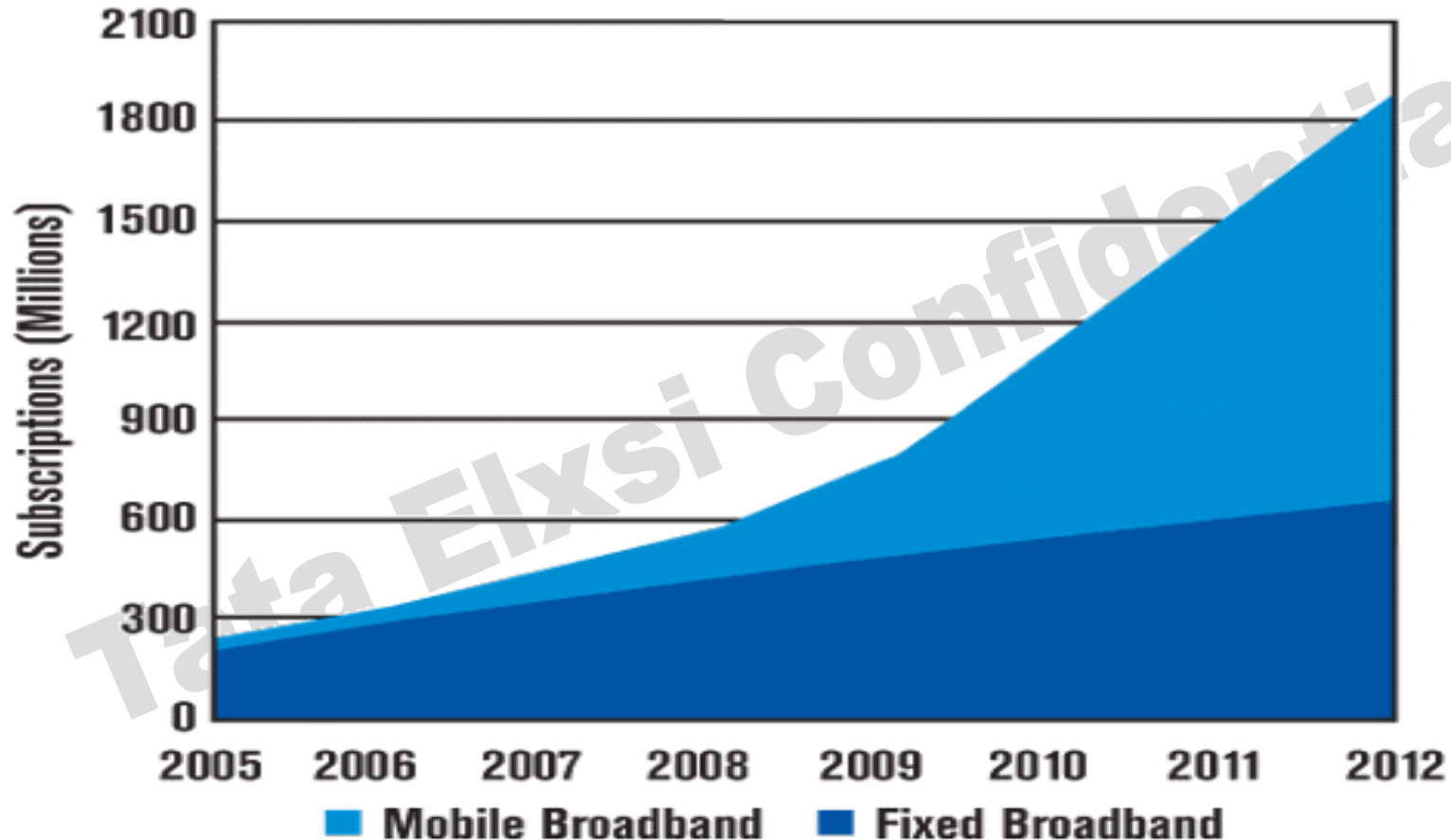
Wireless Technologies used in ICT



Source: WiMax Spectrum Owners Alliance, www.Wisoa.n

- **LTE (Long Term Evolution)** is the fourth generation of radio technologies designed to increase the capacity and speed of mobile telephone networks. Where the current generation of mobile telecommunication networks are collectively known as 3G, LTE has been given the moniker of 4G
- **LTE** provides , In addition to enabling fixed to mobile migrations of Internet applications such as Voice over IP (VoIP), video streaming, music downloading, mobile TV and many others
- Higher Performance
 - Higher data speeds - With download speeds up to 100 Mbps and upload speeds up to 50 Mbps
 - Higher capacity - thousands of subscribers per square mile/square kilometer
 - Lower latency – It offers a latency in the range of 10-20 msec round trip
 - Lower total cost for ownership
- **4G** networks are IP-based and flatter with fewer nodes to manage. The benefits are significant and can make 4G mobile broadband a truly disruptive technology providing service providers a cost-effective way to deploy next generation technology and services and redefining the end-user experience.

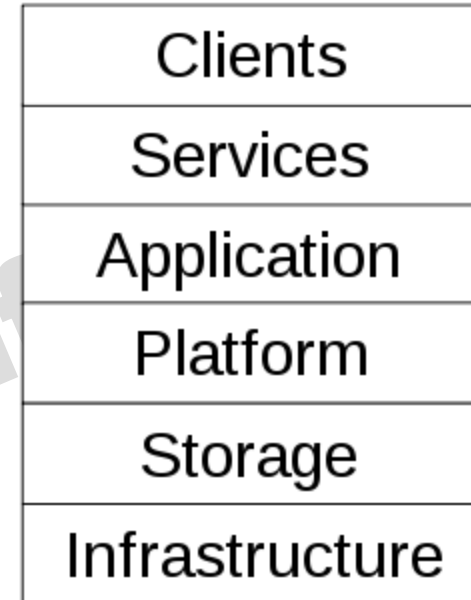
Expected Broadband Growth in 2012



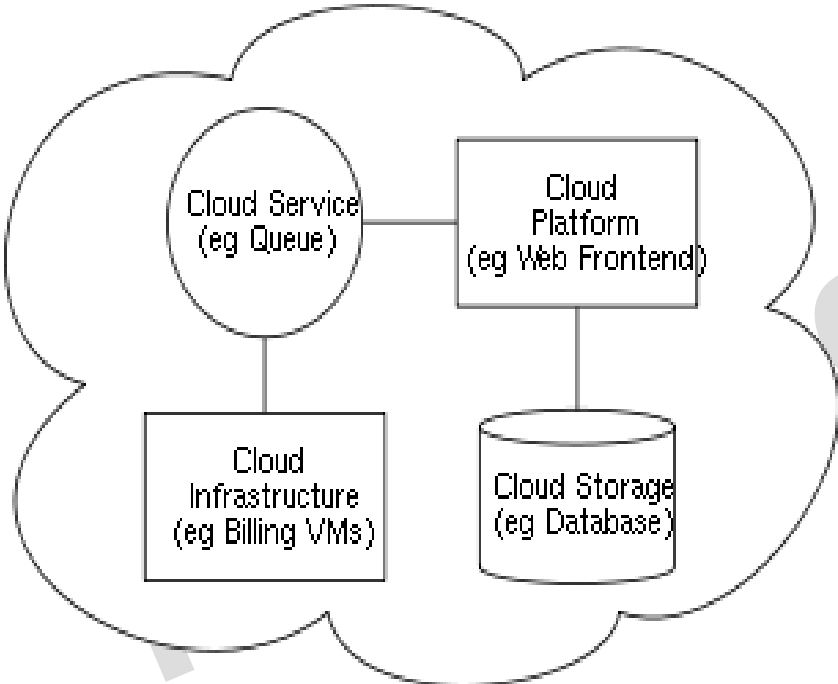
Source: <http://www.wirelessweek.com/Article-What-is-Beyond-3G.aspx>

- LTE, like GSM and UMTS, will require the use of a SIM. WiMAX requires no SIM or other such hardware token.
- Both WiMAX and LTE are based on IP packet-based data carriage, in contrast to 3G and earlier cellphone systems which were designed to accommodate circuit-switched communication.
- Both WiMAX and LTE use OFDMA for the **downlink** and so have broadly similar performance, for any given RF bandwidth and set of conditions. WiMAX (including Mobile WiMAX) also use OFDM for **uplink**, while LTE uses a new technique—SC-FDMA
- The crucial difference is that, unlike WiMAX, which requires a new network to be built, LTE runs on an evolution of the existing UMTS infrastructure already used by over 80 per cent of mobile subscribers globally.
- LTE is used to support mobile broadband users and WiMAX to support fixed or lower-mobility broadband users. Alternatively, they could well use LTE for macro cellular coverage and WiMAX for micro cell coverage.

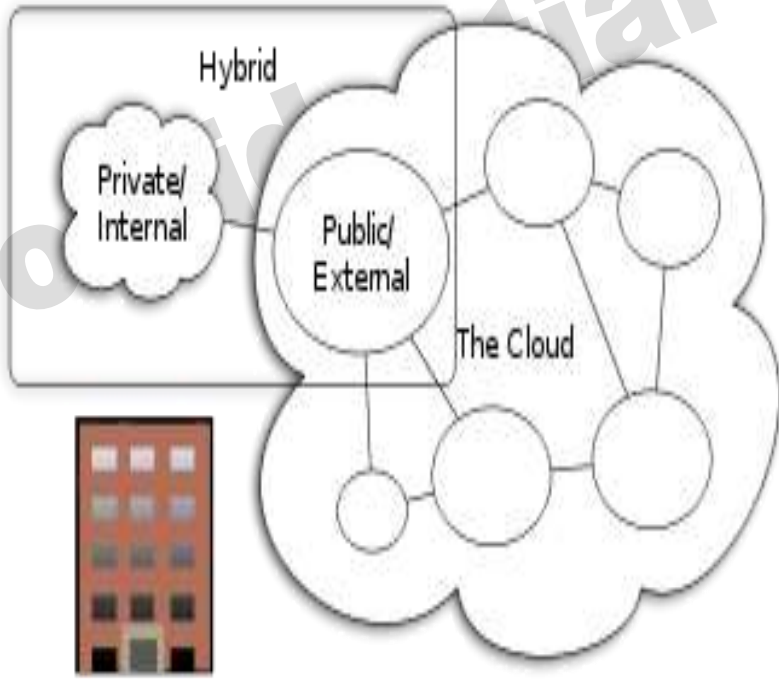
- Cloud computing is a style of computing in which dynamically scalable and often virtualized resources are provided as a service over the Internet.
- The concept generally incorporates combinations of the following:
 - * infrastructure as a service (IaaS)
 - * platform as a service (PaaS)
 - * software as a service (SaaS)
- Cloud networking is the interconnection of components to "meet the networking requirements inherent in cloud computing". Cloud networking allows users to "tap a vast network of computers that can be accessed from long distance by a cell phone, laptop or mobile device for information or data".



Six Layers of Cloud Computing



Sample Architecture



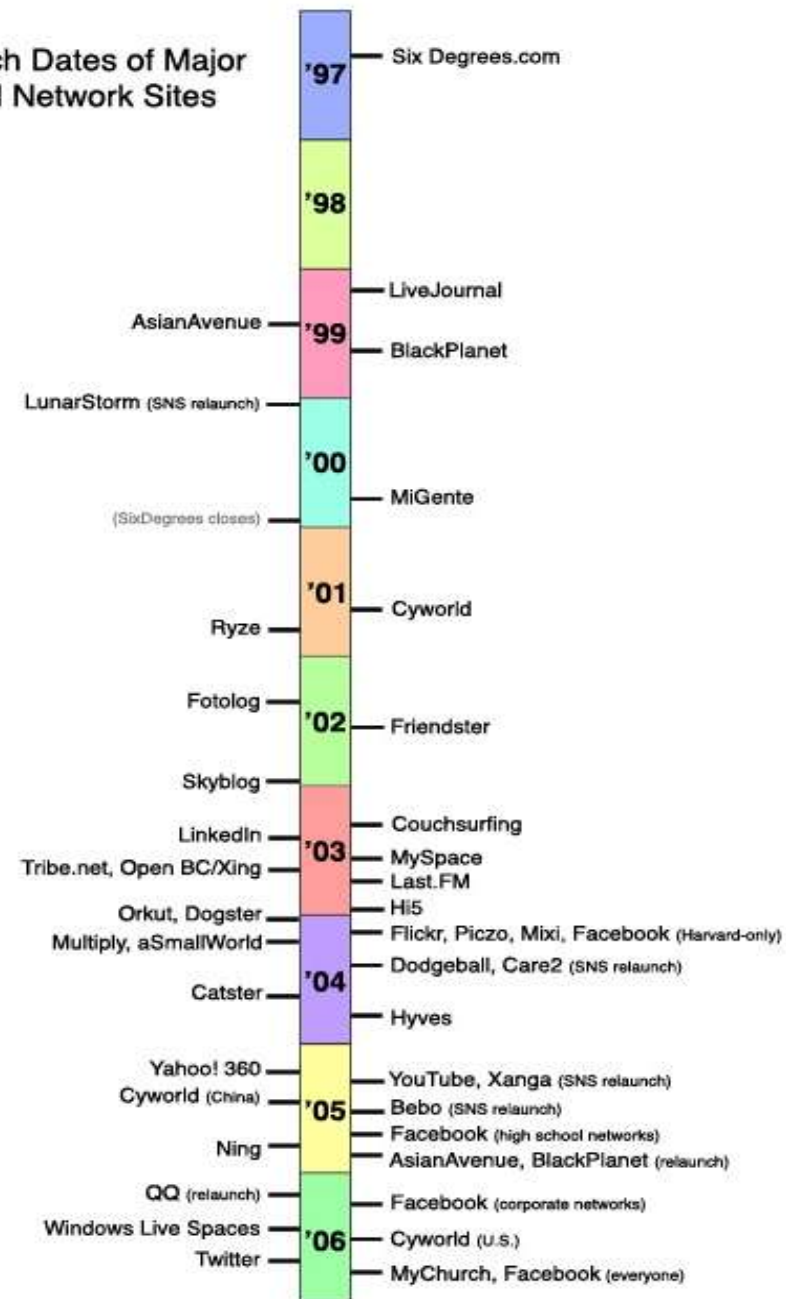
Types

Usage of Social Networks in ICT

- **Social Network:**


- Social network sites as web-based services that allow individuals to (1) construct a public or semi-public profile within a bounded system, (2) articulate a list of other users with whom they share a connection, and (3) view and traverse their list of connections and those made by others within the system.
- The first recognizable social network site launched in 1997.
- Previously these online social communities were used by people to share their funs, views etc., But nowadays because of the large usage, the online social networking services are **very big marketing area** to reach the people through web.

Launch Dates of Major Social Network Sites



Need Research on Global Identity Management for Social Networks



Common Server	Individual Server	Required identifiers			
		Academics	Businessmen	Administrative	Others
	Orkut MySpace Facebook Digg etc.,	Username	Username	Username	Username
		Date of birth	Date of birth	Date of birth	Date of birth
		University	Business name	Admin Identity	Individual Identity
		Reg. No	Country code	Reg Code	National Identity
		Mail address	Company address	Country Code	Passport number

- Global common server for the secure identity Management in the social networking sites.
- The individual server of each social networking site have the collection of required identifiers depends on the user society nature. The common server has to maintain these identifiers for the individual.

“India's ICT market is estimated to grow at a five-year compound annual growth rate (CAGR) of 20.3% to reach \$24.3 billion, or nearly 2% of the country's gross domestic product (GDP), by 2011”

- Gartner India CIO Summit 2008

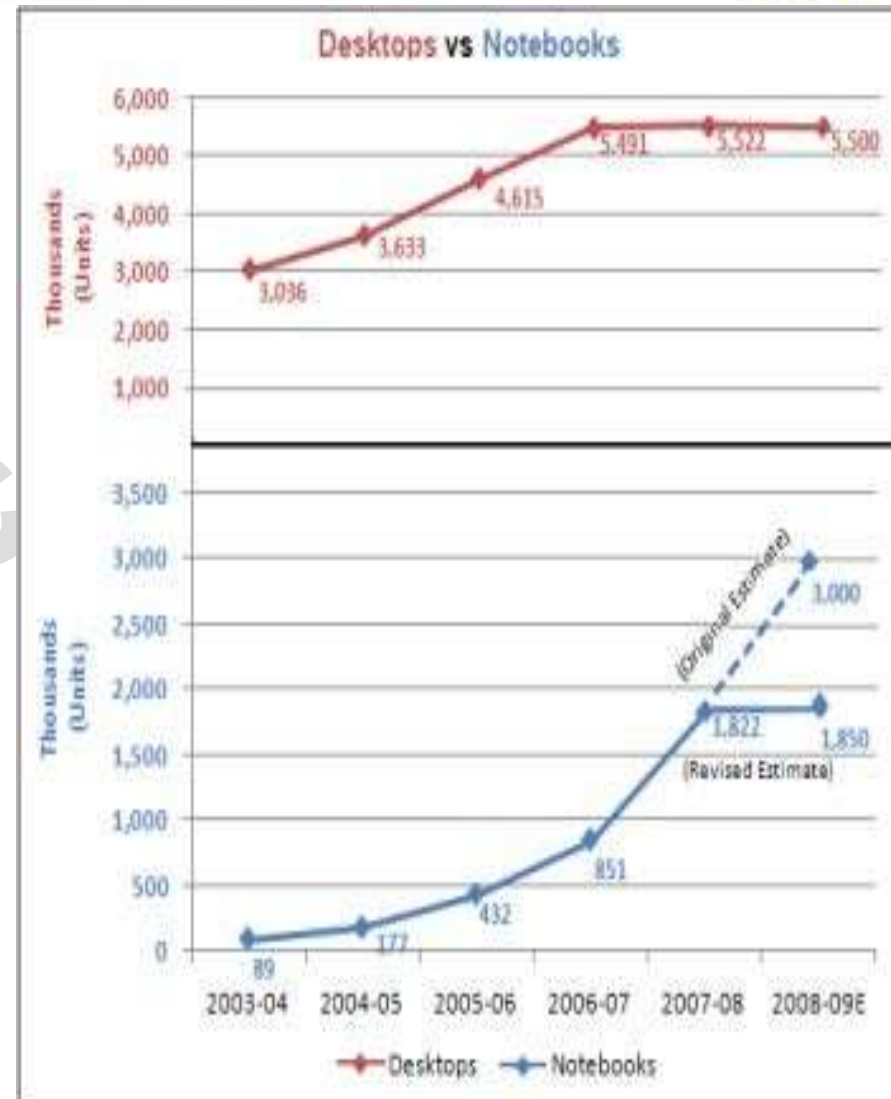
India: Hardware, Software and Services Share of Domestic IT Market, 2006-2011

	2006	2011	CAGR (%) 2006-2011
Hardware (%)	54.9	50.9	18.5
Software (%)	5.9	5.0	17.8
Services (%)	39.3	44.1	23.2
Total ICT Market (\$M)	9,632	24,313	20.4

PC Growth



- The number of personal computers worldwide is expected to 1.3 billion machines by 2010 and it will reach 2 billion by 2014.
- Nowadays in India every home have a PC and every professional / professional student has a Notebook.
- Laptop sales have accounted for a decline in the sales of desktop computers and are expected to take over 40 per cent of the overall PC sales in India by 2010.
- Over 1 million small businesses in India have plans to purchase PCs for the first time
- 'Gartner today' revealed 68.1 million desktops, notebooks and x86 servers were sold worldwide, representing a decline of 5%, far better than the 9.8% fall the market watcher had initially anticipated.



Source: www.ciol.com

Key Points for Innovations in ICT, India



- Creation and Production of IP
- Collaborative efforts between countries on Innovation and Research
- To increase investment in R&D Technologies
- To popularize the Dynamic usage
- Development of Infrastructure for new innovations in small companies
- Incentives for new research and innovation
- Building capabilities and capacity for growth
- Need to improve skilled manpower
- Trainings on college level
- Combined effect of research industries and educational institutes

Thank You



For More Information, Please Contact

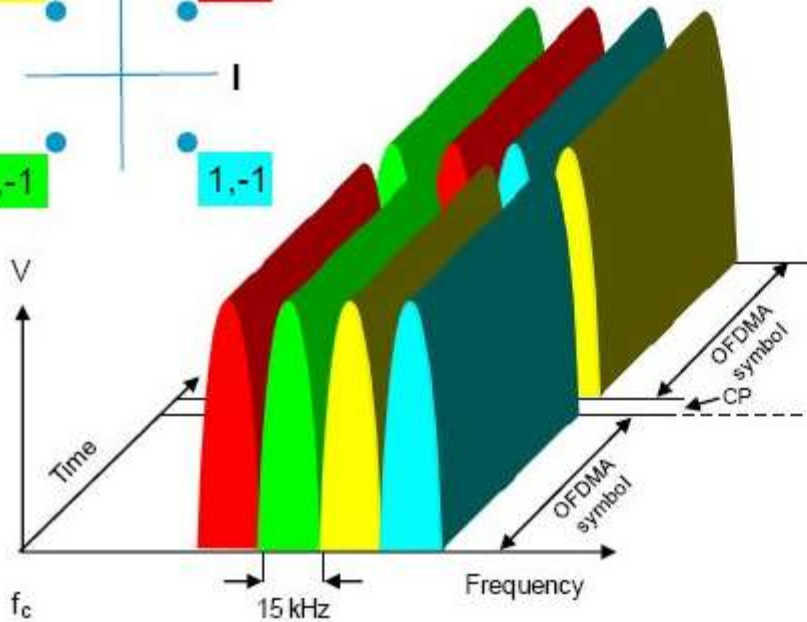
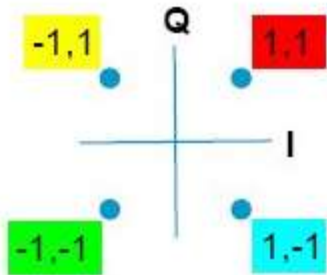
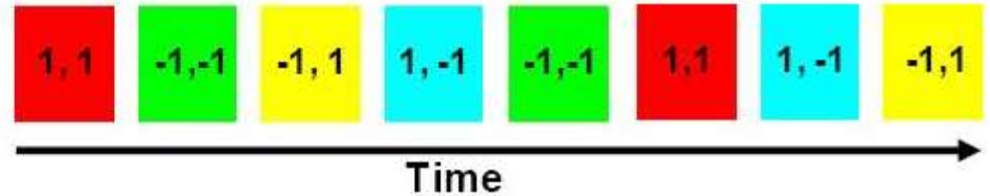
: jagannathans@tataelxsi.co.in

Wi-MAX Vs. LTE

Maker of standard and year	802.16e (mobile) in 2005 from IEEE	Second half of 2008 from 3GPP
Mass market availability	Late 2010	2011-2012
Technical capabilities	Multiple Input-Multiple Output (MIMO) Downlink: Orthogonal Frequency Division Modulation Uplink: OFDM	MIMO Downlink: OFDM Uplink: SC - FDMA (Single Carrier- Frequency Division Multiple Access)
Speeds	4Mbit/sec. average download; 10Mbit/sec. peak download 70Mbit/sec. theoretical max	100 Mbit/sec. theoretical max
Radio Spectrum expected	2.5 GHz	700 MHz

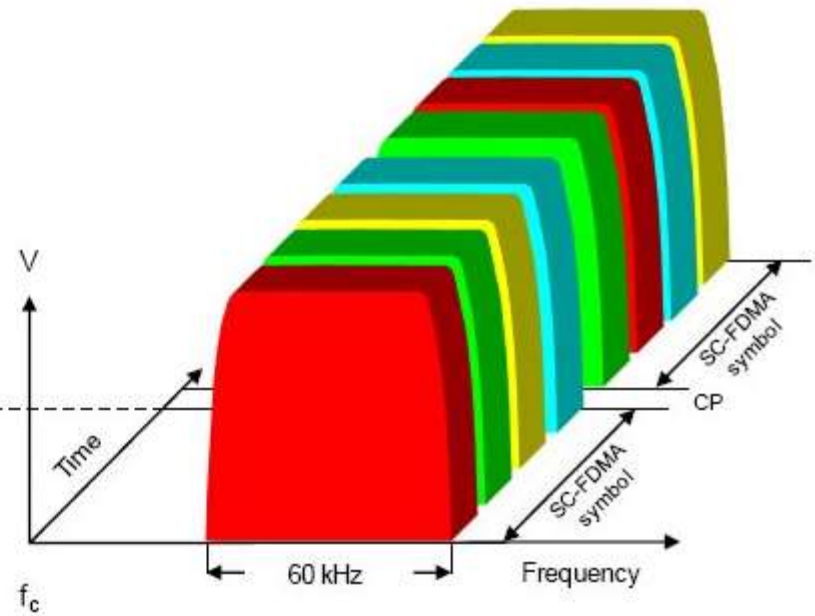
OFDMA Vs. SC-FDMA

The following graphs show how a sequence of eight QPSK symbols is represented in frequency and time



OFDMA

Data symbols occupy 15 kHz for one OFDMA symbol period



SC-FDMA

Data symbols occupy $M \cdot 15$ kHz for $1/M$ SC-FDMA symbol periods

